Alan Mathison Turing: the man who cracked the Enigma code (Turing Digital Archive)

Manjunath.R

#16/1, 8th Main Road, Shivanagar, Rajajinagar, Bangalore560010, Karnataka, India
*Corresponding Author Email: manjunath5496@gmail.com

Abstract: Alan Mathison Turing -- English mathematician, logician and philosopher who made important advancements in the field of computer theory and who contributed important logical analyses of computer processes. In an unfortunate end to his prolific career, Turing was arrested in 1952 after British authorities found out he was having a relationship with another man. Under British law, homosexuality was a crime, and it resulted in Turing losing his security clearance to continue his work at Bletchley Park. Rather than face a life in prison, Turing accepted treatment of regular estrogen injections, which were believed to neutralize libido. On 8 June 1954, Turing died of potassium cyanide poisoning while conducting electrolysis experiments. The cyanide was found on a half eaten apple beside him. An inquest concluded that it was self-administered but his mother always maintained that it was an accident. In 2013, a bill was passed offering statutory pardon to Turing for offences under section 11 of the Criminal Law Amendment Act 1885. In 2016, the law (known as Turing's law) was widened to retroactively pardon all men who were convicted under the historical legislation of gross indecency.
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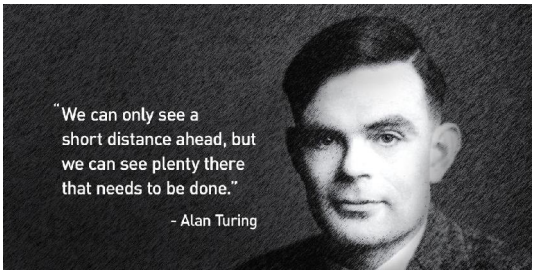
Key words: Alan Mathison Turing; brilliant mathematician; codebreaker; German Enigma machine; Bletchley Park.

Alan Turing -- Timeline
1912 (23 June): Birth, Paddington, London.
1926-31: Sherborne School.
1930: Death of friend Christopher Morcom.
1931-34: Undergraduate at King's College, Cambridge University.
1932-35: Quantum mechanics, probability, logic. Fellow of King's College, Cambridge.
1936: The Turing machine, computability, universal machine.
1936-38: Princeton University. Ph.D. Logic, algebra, number theory.
1938-39: Return to Cambridge. Introduced to German Enigma cipher machine.
1939-40: The Bombe, machine for Enigma decryption.
1939-42: Breaking of U-boat Enigma, saving battle of the Atlantic.
1943-45: Chief Anglo-American crypto consultant. Electronic work.
1945: National Physical Laboratory, London.
1946: Computer and software design leading the world.
1947-48: Programming, neural nets, and artificial intelligence.
1948: Manchester University, first serious mathematical use of a computer.
1950: The Turing Test for machine intelligence.
1951: Elected FRS. Non-linear theory of biological growth.
1952: Arrested as a homosexual, loss of security clearance.
1953-54: Unfinished work in biology and physics.
1954 (7 June): Death (suicide) by cyanide poisoning, Wilmslow, Cheshire.

Alan Turing (1912 - 1954)
BRITISH MATHEMATICIAN AND LOGICIAN



Born:
23 June 1912
Maida Vale, London, England

Died :
7 June 1954 (aged 41)
Wilmslow, Cheshire, England

Cause of death:
Cyanide poisoning

Resting place:
Ashes scattered near Woking Crematorium

Residence:
Wilmslow, Cheshire, England

Education:
King's College, Cambridge (BA, MA)
Princeton University (PhD)

Known for:
Cryptanalysis of the Enigma
Turing's proof
Turing machine
Turing test
Unorganised machine
LU decomposition

Awards:
Smith's Prize (1936)

Scientific career:

Fields
Logic
Mathematics
Cryptanalysis
Computer science
Mathematical and theoretical biology

Institutions:
University of Manchester
Government Code and Cypher School
National Physical Laboratory

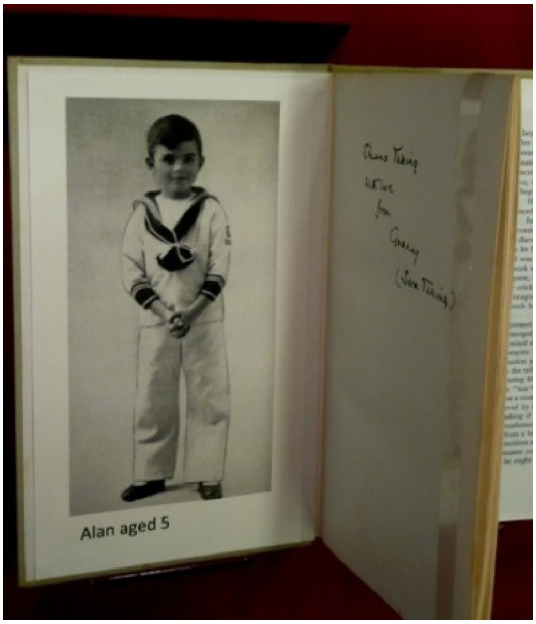
Thesis:
Systems of Logic Based on Ordinals (1938)

Doctoral advisor:
Alonzo Church

Doctoral students:
Robin Gandy

Influences:
Max Newman

Signature:
A. M. Turing



Turing, age 5.

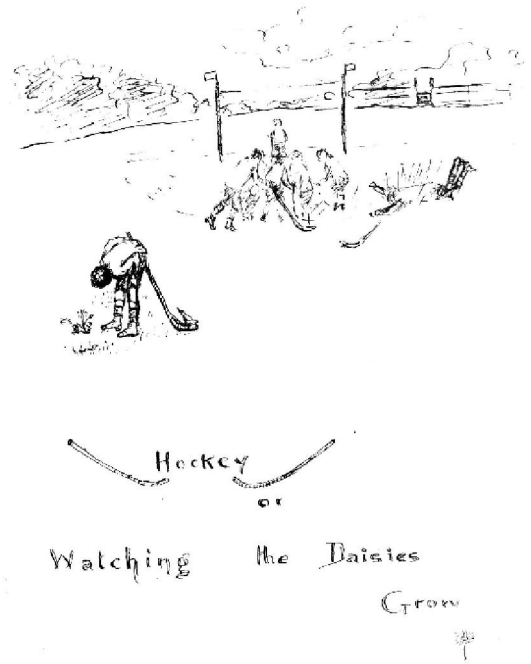
Turing starts his school education at the age of six at St. Michael's School.

Alan Turing as a boy.

Alan Turing with his mother and brother on a beach on the South Coast of England in 1913.

Alan and his elder brother John.

Alan Turing with his mother Ethel Sara Turing.



Drawing of Alan Turing by his mother, at his preparatory school, Hazelhurst, Sussex, 1923.

Preparatory school, Hazelhurst.

Turing and friends on a Cornish beach, April 1930.

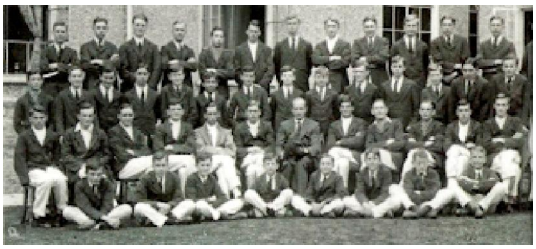
Alan Turing, second from right, with (L-R) Hogg, Geoffrey OHanlon (housemaster) and White.

Alan Turing with school friends, Robin and John Wainwright and Hugh Highet.

Turing in a photo from his days at the Sherborne School.

Alan Turing, aged 15, at Westcott House, Sherborne School.

Sherborne School.



Turing (front row far left), aged 13, at Westcott House Sherborne, 1926.

SHERBORNE SCHOOL

UPPER SCHOOL. REPORT FOR TERM.

Form VI th. Group III. Average Age

Name Turing Age SUMMER TERM, 1929.

		MASTER.
DIVINITY		
PRINCIPAL SUBJECTS	Chemistry. He is endeavouring to improve his style in written work, with good results. Mathematics. His work on Higher Certificate papers shows distinct promise, but he must realise that ability to put a neat & tidy solution on paper – intelligible & legible – is necessary for a first-rate mathematician. Physics He has done some good work but generally sets it down badly. He must remember that Cambridge will want sound knowledge rather than vague ideas	a.g.p.a. D.B.E. H.S.C.
SUBSIDIARY SUBJECTS	French Fair. His proses have been very weak. Most of the mistakes are elementary and the result of hasty work. English: Reading weak. Essays show ideas but are made grandiose than printed.	C.D.W. H.H.B. R.St. A.K.
MUSIC DRAWING EXTRA TUITION		
HOUSE REPORT	I am quite satisfied with him: I am very glad he is ready to come out of his shell. His Higher Cert: papers were pretty good.	C.O.H.

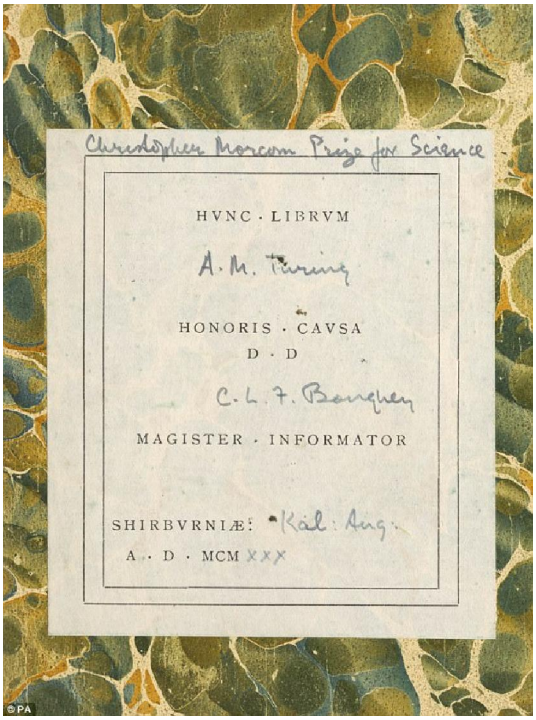
Good

C. O. Bourgeois

Headmaster.

© PA

Alan Turing's school report when he was 16-years-old.



This is the copy of the school prize which Turing chose in honour of his 'first love' Christopher Morcom.

Christopher Morcom with his parents in 1929.

Turing, age 18, next to Ben Davis, head of Mathematics at Sherborne School.

Young Alan Turing.

Alan Turing aged 19, bathing on the island of Sark

Alan Turing in his early 20s.

Turing running.

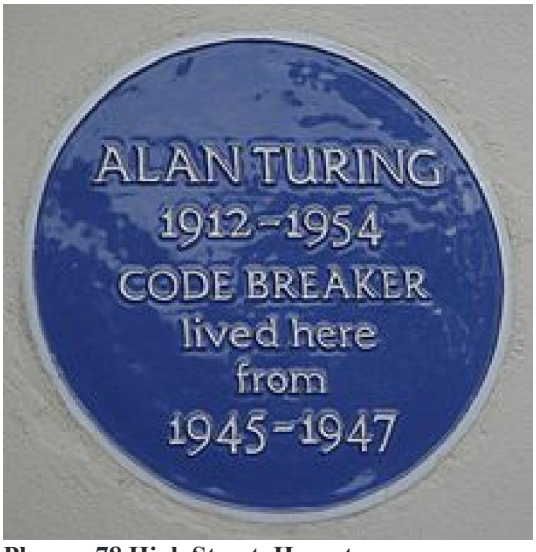
Turing reading.

Turing (right) and Mermagen in their last year at Sherborne.

Alan Turing in 1934.

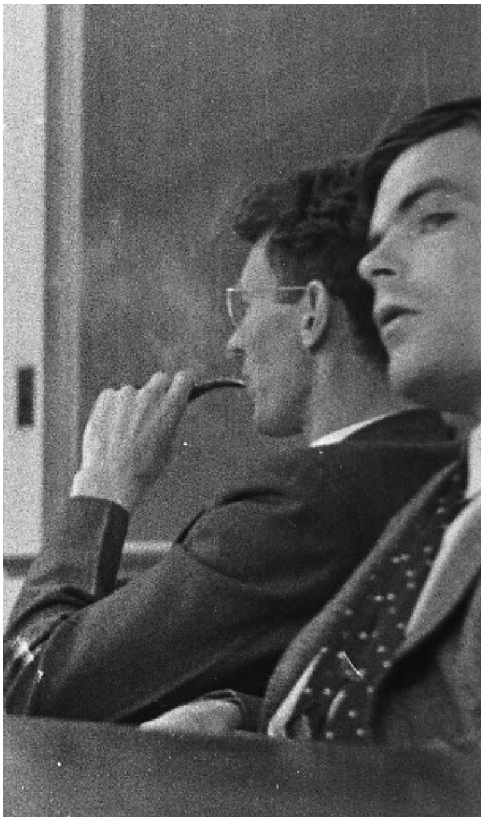
Hut 8, where Turing's Naval Enigma section was based.

The young Alan Turing in more innocent times.



Plaque, 78 High Street, Hampton

As a fellow at King's, Cambridge.



On the right is a rare snapshot of Alan Turing in a seminar at Princeton at this period.

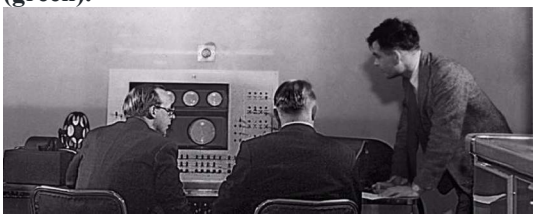
Princeton University.

Alan Turing in a boat just before the Second World War.

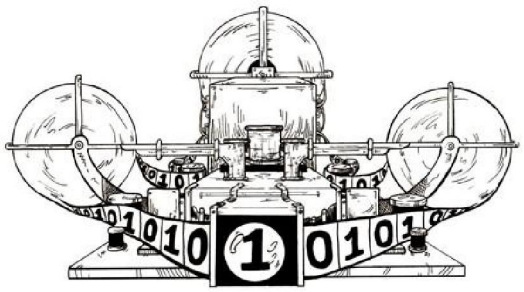
Alan Turing (far left) on a bus.

Alan Turing in a garden in Dene Road, Guildford in 1928.

Ratio Club at Cambridge 1952, Giles Brindley (yellow), Donald MacKay (red), Alan Turing (green).

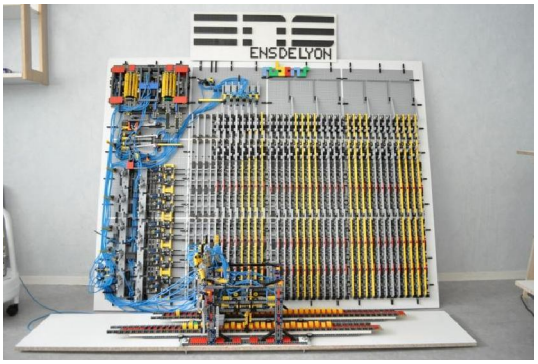


Alan Turing (right) stands next to the Ferranti Mark I.

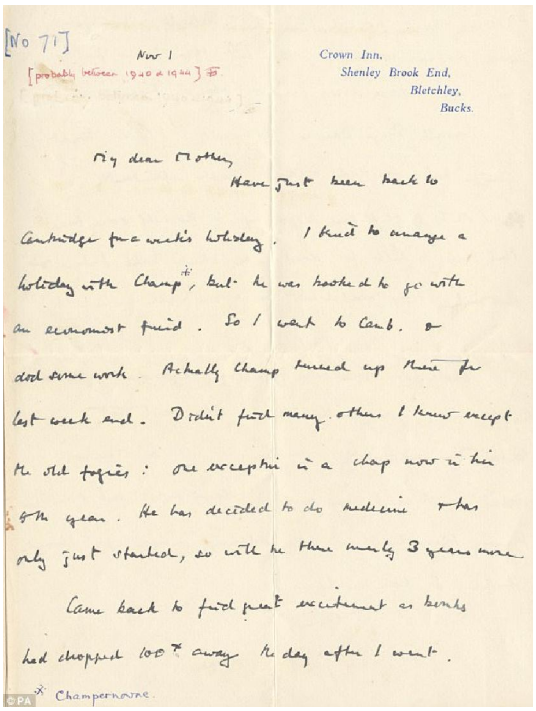


Conceptualization of the Turing Machine invented by Turing in 1936.

Mechanical Wooden Turing Machine.



This is a Turing machine built from Legos. It's a theoretical machine Turing designed for computing in the late 30s.



[No 7]

Nov 1

[probably between 1940 & 1944]

Crown Inn,
Shenley Brook End,
Bletchley,
Bucks.

My dear Mother,

Have just been back to Cambridge for a week's holiday. I tried to arrange a holiday with Champ*, but he was hooked to go with an economist friend. So I went to Camb. & did some work. Actually Champ turned up there for last week end. Didn't find many others I knew except the old topics: one exception is a chap now in his 4th year. He has decided to do medicine & has only just started, so with he there mainly 3 years more.

Came back to find great excitement as bonds had dropped 10% away the day after I went.

* Champernowne.

A letter which Alan Turing sent to his mother.

A12

This is the spoon which I found in Alan's laboratory. It is similar to the one which he gold plated himself. It seems quite probable he was intending to gold plate this one using a quantity of potassium from his own manufacture.

E. Sara Turing.

Despite his death being ruled suicide, Turing's mother said it was 'quite probably' his death from cyanide poisoning was a mistake.

Alan Turing memorial − Manchester

Turing lived the last years of his life at this home in Wilmslow, Cheshire near Manchester. He took his own life at this house on June 7, 1954.

Turing led the Naval Enigma codebreaking efforts from this office in Hut 8. The building at Bletchley Park has been fully restored.

Hut 8 at Bletchley Park is the building Turing worked in during the early years of World War II. Turing was instrumental in breaking the German naval Enigma code.

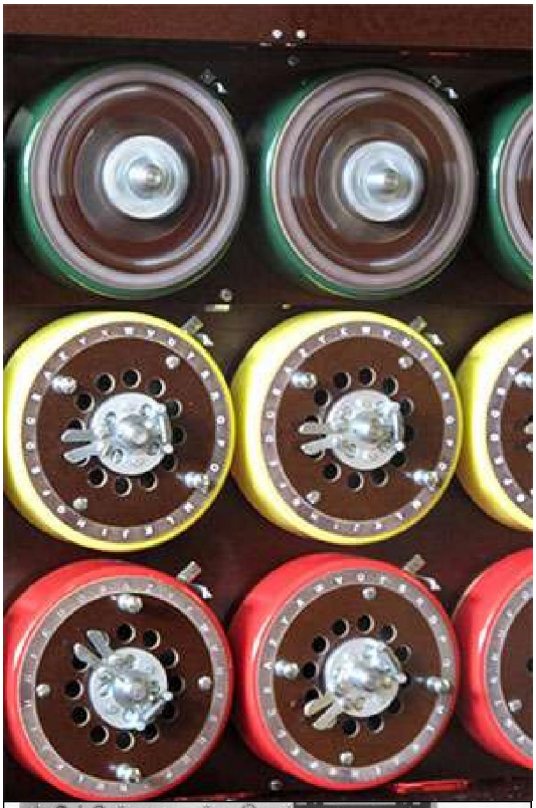
In 1931, Turing began his studies at King's College, Cambridge.

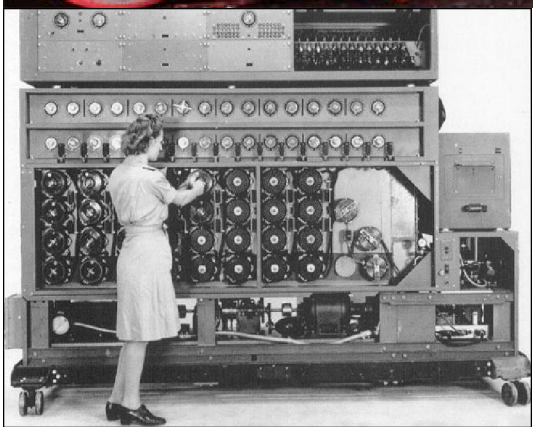
Two cottages in the stable yard at Bletchley Park. Turing worked here in 1939 and 1940, before moving to Hut 8.

Alan Turing's OBE currently held in Sherborne School archives.

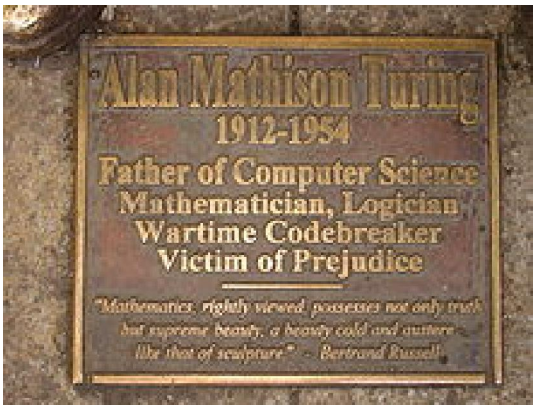
Photograph of Alan Turing statue at University of Surrey.

Turing's statue at Bletchley Park (made of layers of stacked slate, shown from the chest up).



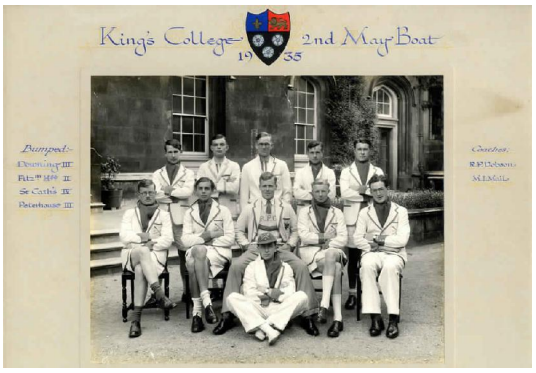


Bombe machine, a code-breaking machine, originally developed by Alan Turing and others, used during World War II.

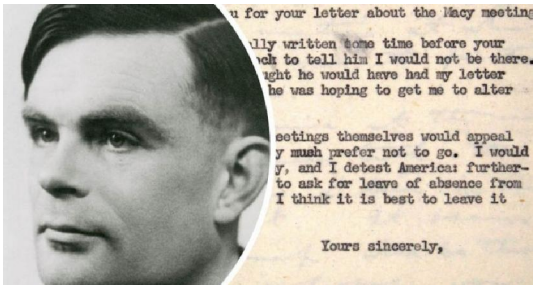


Turing memorial statue plaque in Sackville Park, Manchester.

Welsh codebreaker Mair Russell-Jones recognised Alan Turing's genius at an early age at Bletchley Park.

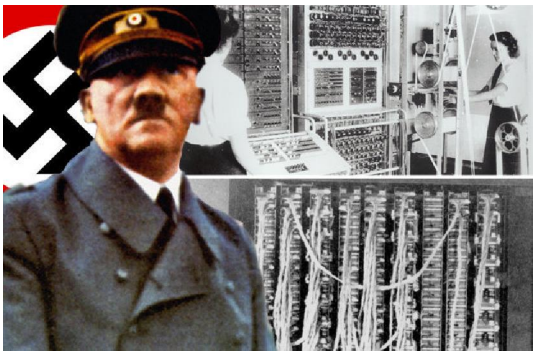


Crew of King's College's 2nd boat, May 1935. Alan Turing is second from the Right



During World War II, Bletchley Park housed the UK's code breaking efforts against the Axis powers. Turing worked here.

Turing was recruited to the National Physical Laboratory in 1945.



Alan Turing's codebreakers decoding of the Enigma Machine helped win World War II.


THE OLD POST

ILLUSTRATED WEEKLY NEWSPAPER

Est. 1908 Wednesday, June 23, 1942 Price 5¢

John Bucchen

WWII: Germany's Codes Cracked

Speech Encipher in the Works

In a mission codenamed "Delilah", a hundwld, voice communications device has been in development at the Secret Service's Radio Headquarters in Buckinghamshire, England. Looking to electronically encipher speech, Allied researchers have been working tirelessly to create a product for long-distance use overseas. As of yet, the transmissions have been unable to pass military testing, but leading researchers are confident this technology will be perfected before the conclusion of the war. If implemented, this device could

Turingery Spoils German Plans

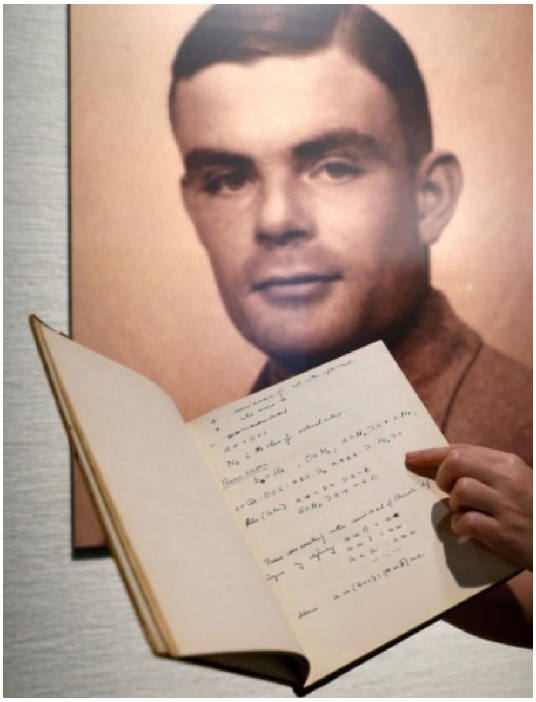
Although a physical machine has yet to be created, Alan Turing has uncovered a manual method in which the Lorenz cipher can be broken. Nicknamed "Turingery", this process is derived from a code-breaking strategy known as wheel breaking, which analyzes imprint imperfections from active cams on the wheels of the German encryption machine. The Allies are now capable of translating the Germans' encoded messages produced by the SZ40 and SZ42, two of their often used rotor stream cipher mfachines.

Turing-Welchman Bombe Delivers

Previously unable to decisively decode German messages through their Enigma system, English logician and computer scientist Alan Turing has collaborated efforts with mathematician Gordon Welchman in an attempt to alleviate this pressing issue. Serving as a more effective version of the Polish's creation, The Turing-Welchman bombe is currently an integral part of the Allied attack on Axis cryptology. Now two years since the first installation on March 18, 1940, there are now over 50 in operation throughout the US and Western Europe. Government officials estimate that as many as two hundred could be created to meet the needs of the war.

ALAN TURING: Bletchley Park will reopen as the National College of Cyber Security.

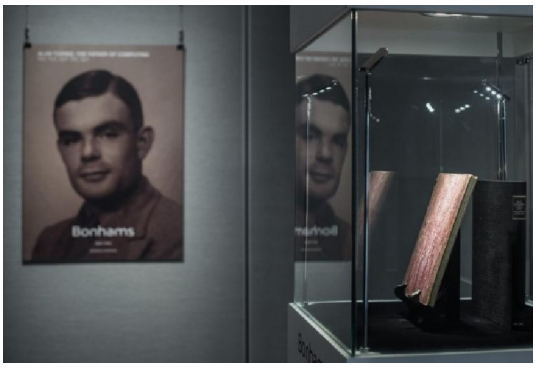
U-BOATS: Breaking the Enigma code allowed Brit ships to evade German U-boats.



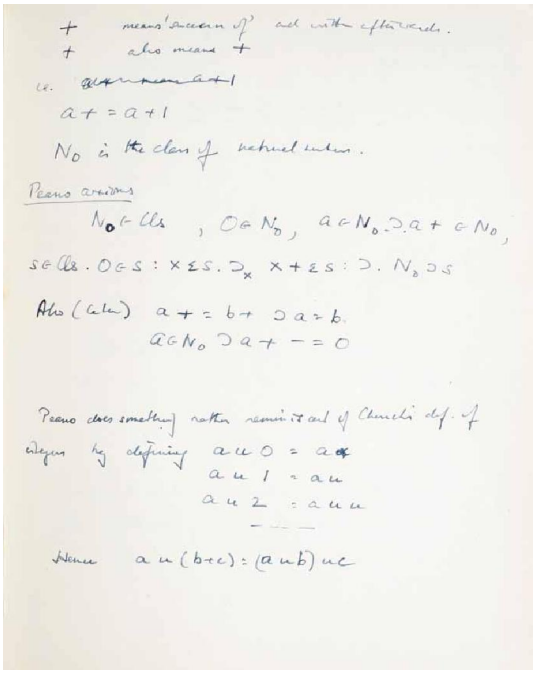
A page from the notebook of British mathematician and pioneer in computer science Alan Turing, displayed in front of his portrait during an auction preview in Hong Kong.

The DEUCE: Digital Electronic Universal Computing Engine, was the first commercially produced digital model and was developed from earlier plans by Alan Turing.

Cassandra Hatton, senior specialist in fine books and manuscripts and director of the history of science from Bonhams auction house, shows a notebook of British mathematician and pioneer in computer science Alan Turing, during an auction preview in Hong Kong.

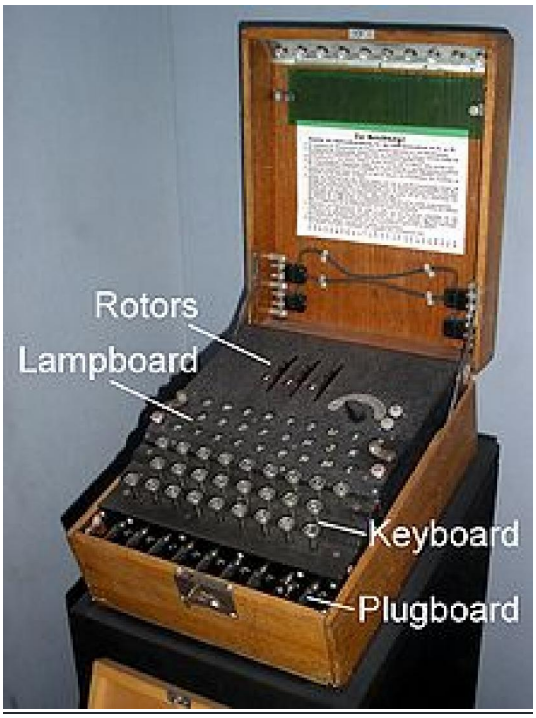


A rare manuscript belonging to British mathematician and code breaker Alan Turing displayed in Hong Kong on March 19, 2015.

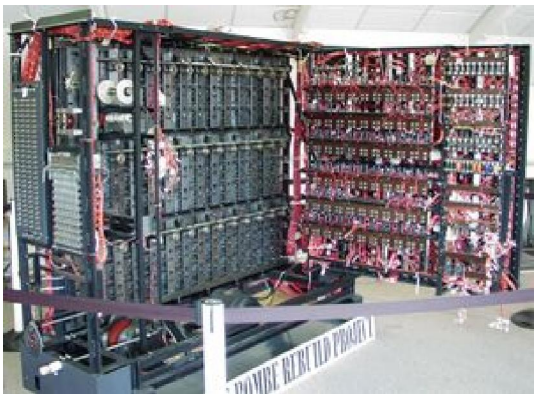


A page from the notebook of codebreaker Alan Turing seen at Bonham's auction house during an auction in New York, on April 13, 2015. The paper, in which he details his work on the foundations of mathematical notation and computer science..

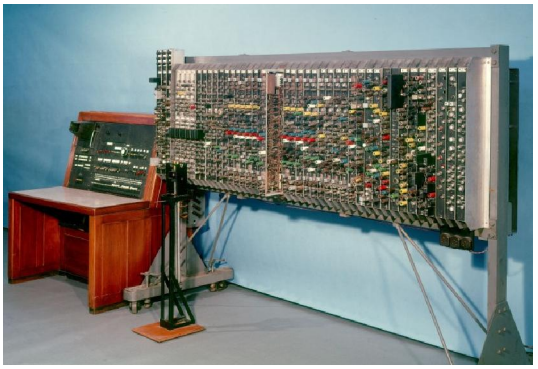
Bonham's senior specialist Cassandra Hatton discusses a working Enigma cipher machine that along with the 1942 56-page notebook belonging to codebreaker Alan Turing.



A working Enigma cipher machine.

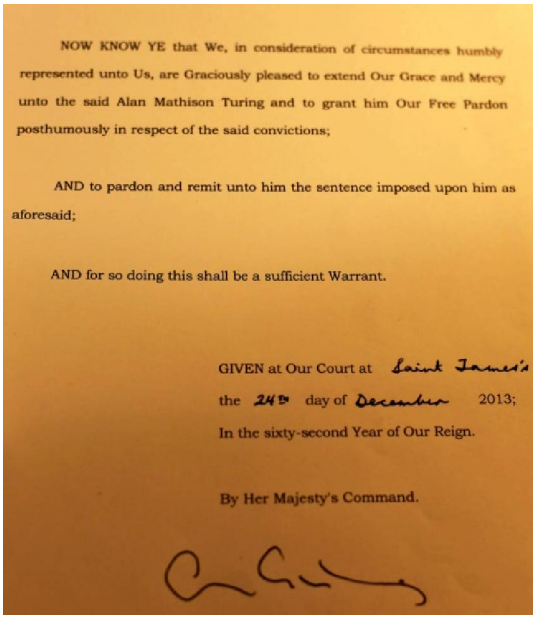


A rebuild of a machine made by Alan Turing.



Britain's earliest stored program computers designed by the mathematician Alan Turing (1912−1954) at NPL between 1945 and 1947.

The Queen visits Bletchley Park and studies an Enigma machine. She grants Turing a royal pardon on 23 December 2013.



NOW KNOW YE that We, in consideration of circumstances humbly represented unto Us, are Graciously pleased to extend Our Grace and Mercy unto the said Alan Mathison Turing and to grant him Our Free Pardon posthumously in respect of the said convictions;

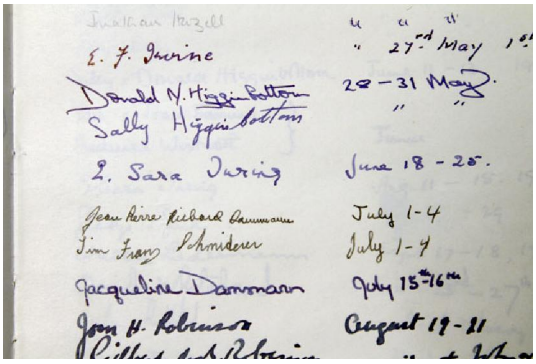
AND to pardon and remit unto him the sentence imposed upon him as aforesaid;

AND for so doing this shall be a sufficient Warrant.

GIVEN at Our Court at Saint James's
the 24th day of December 2013;
In the sixty-second Year of Our Reign.

By Her Majesty's Command.

Alan Turing's Royal Pardon (UK Government).



Signature of Alan Turing's mother Sara, from when she visited after his death.

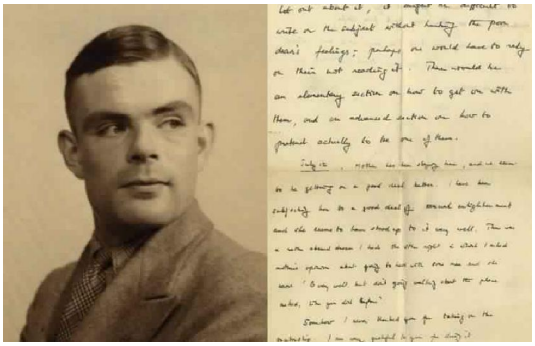
PARDONED

Queen acts on 1952 homosexuality conviction which destroyed life of wartime codebreaking hero Turing

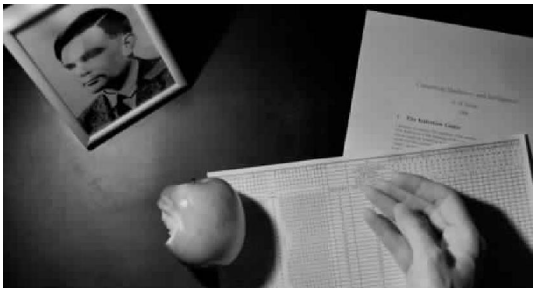
Royal Prerogative that's rarely used

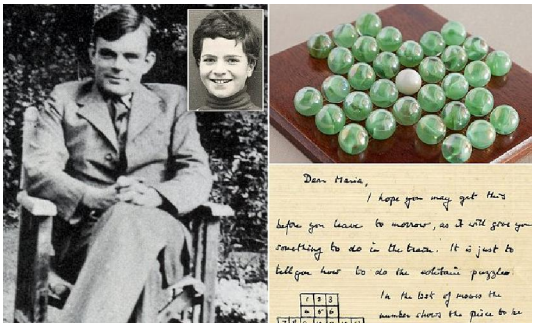
'A great blight on our history'

Alan Turing Stamp

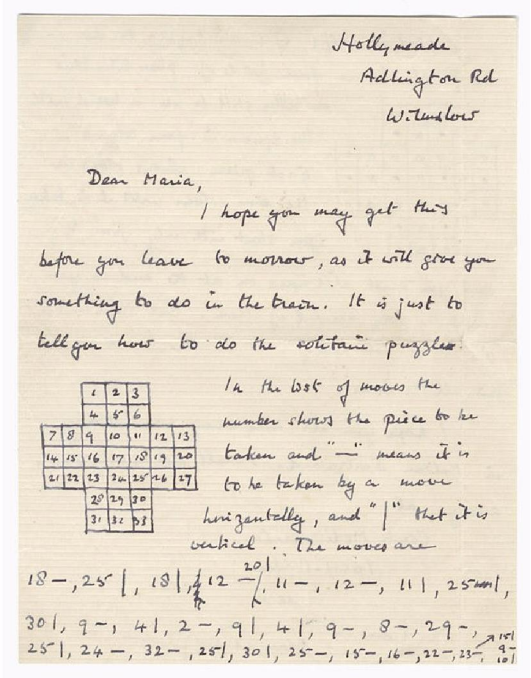


Alan Turing Letter Reveal Turmoil Over Sexuality, 'Gay Cure' Hormone Therapy





Letter Alan Turing wrote to Maria Greenbaum in July 1953 with his advice for playing Solitaire.



Hollymeade
Adlington Rd
Wilmslow

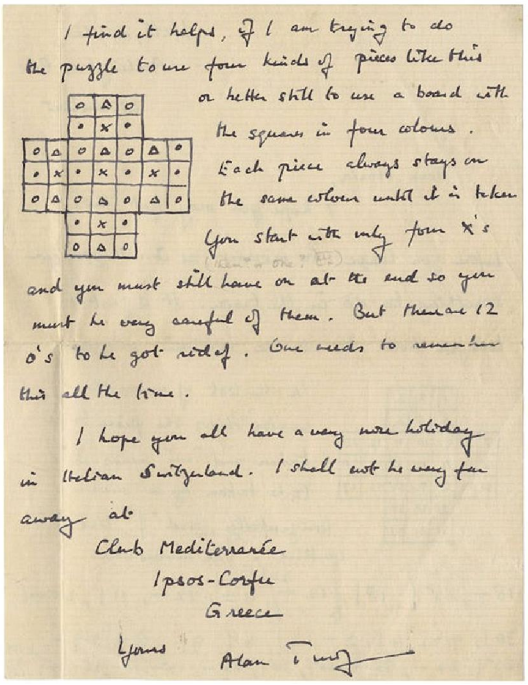
Dear Maria,

I hope you may get this before you leave to morrow, as it will give you something to do in the train. It is just to tell you how to do the solitaire puzzles.

In the list of moves the number shows the piece to be taken and "—" means it is to be taken by a move horizontally, and "|" that it is vertical. The moves are

18—, 25|, 18|, 12—, 11—, 12—, 11|, 25—|, 30|, 9—, 4|, 2—, 9|, 4|, 9—, 8—, 29—, 25|, 24—, 32—, 25|, 30|, 25—, 15—, 16—, 22—, 23—

The detailed letter provided an explanation of how to avoid having pieces scattered around the board, including a series of moves to help crack the puzzle.



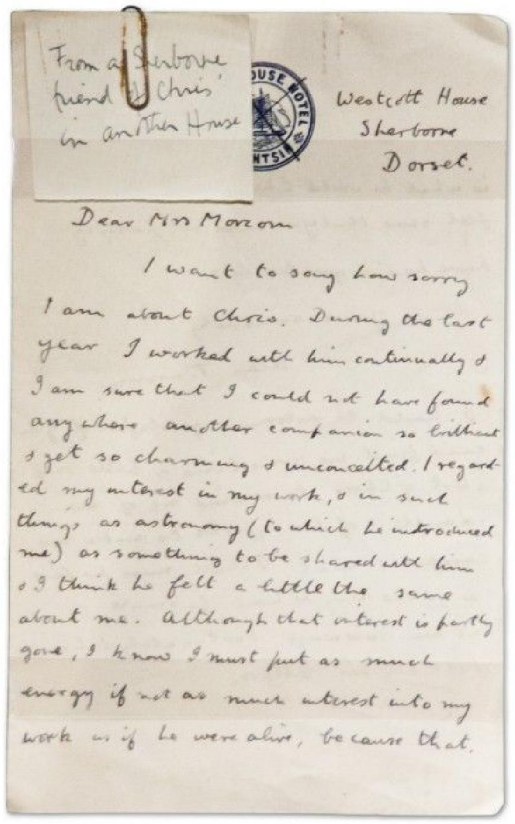
I find it helps, if I am trying to do the puzzle to use four kinds of pieces like this or better still to use a board with the squares in four colours. Each piece always stays on the same colour until it is taken. You start with only four X's and you must still have one at the end so you must be very careful of them. But there are 12 O's to be got rid of. One needs to remember this all the time.

I hope you all have a very nice holiday in Italian Switzerland. I shall not be very far away at

Club Mediterranée
Ipsos-Corfu
Greece

Yours
Alan Turing

He used diagrams to help explain to his niece how she might succeed with the puzzle.



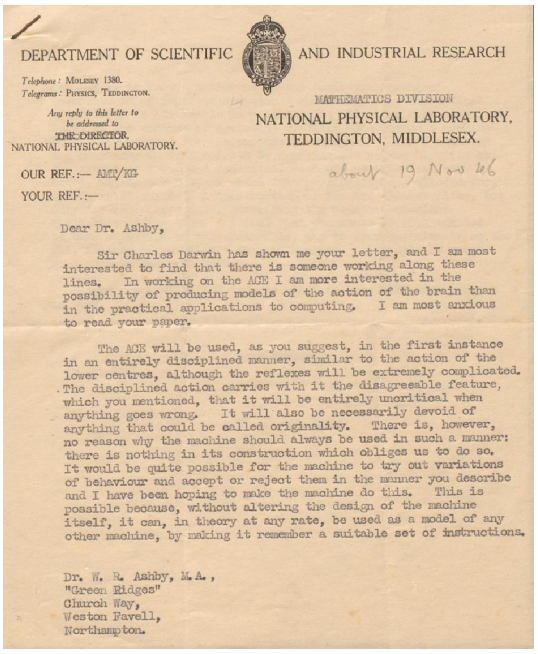
From a devoted friend & Chris in another House

Westcott House
Sherborne
Dorset.

Dear Mrs Morcom

I want to say how sorry I am about Chris. During the last year I worked with him continually & I am sure that I could not have found anywhere another companion so brilliant & yet so charming & unconcealed. I regarded my interest in my work, & in such things as astronomy (to which he introduced me) as something to be shared with him & I think he felt a little the same about me. Although that interest is partly gone, I know I must put as much energy if not as much interest into my work as if he were alive, because that

Alan Turing's letter to Christopher Morcom's mother. Christopher was Alan's first love, and he died very young.



DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Telephone: Molesey 1380.
Telegrams: Physics, Teddington.

Any reply to this letter to be addressed to THE DIRECTOR, NATIONAL PHYSICAL LABORATORY.

MATHEMATICS DIVISION
NATIONAL PHYSICAL LABORATORY,
TEDDINGTON, MIDDLESEX.

OUR REF.:— AMT/KG

about 19 Nov 46

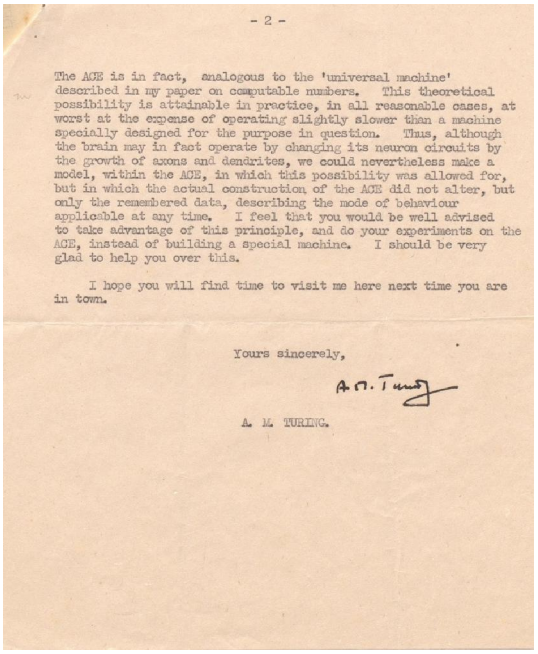
YOUR REF.:—

Dear Dr. Ashby,

Sir Charles Darwin has shown me your letter, and I am most interested to find that there is someone working along these lines. In working on the ACE I am more interested in the possibility of producing models of the action of the brain than in the practical applications to computing. I am most anxious to read your paper.

The ACE will be used, as you suggest, in the first instance in an entirely disciplined manner, similar to the action of the lower centres, although the reflexes will be extremely complicated. The disciplined action carries with it the disagreeable feature, which you mentioned, that it will be entirely uncritical when anything goes wrong. It will also be necessarily devoid of anything that could be called originality. There is, however, no reason why the machine should always be used in such a manner: there is nothing in its construction which obliges us to do so. It would be quite possible for the machine to try out variations of behaviour and accept or reject them in the manner you describe and I have been hoping to make the machine do this. This is possible because, without altering the design of the machine itself, it can, in theory at any rate, be used as a model of any other machine, by making it remember a suitable set of instructions.

Dr. W. R. Ashby, M.A.,
"Green Ridges"
Church Way,
Weston Favell,
Northampton.



- 2 -

The ACE is in fact, analogous to the 'universal machine' described in my paper on computable numbers. This theoretical possibility is attainable in practice, in all reasonable cases, at worst at the expense of operating slightly slower than a machine specially designed for the purpose in question. Thus, although the brain may in fact operate by changing its neuron circuits by the growth of axons and dendrites, we could nevertheless make a model, within the ACE, in which this possibility was allowed for, but in which the actual construction of the ACE did not alter, but only the remembered data, describing the mode of behaviour applicable at any time. I feel that you would be well advised to take advantage of this principle, and do your experiments on the ACE, instead of building a special machine. I should be very glad to help you over this.

I hope you will find time to visit me here next time you are in town.

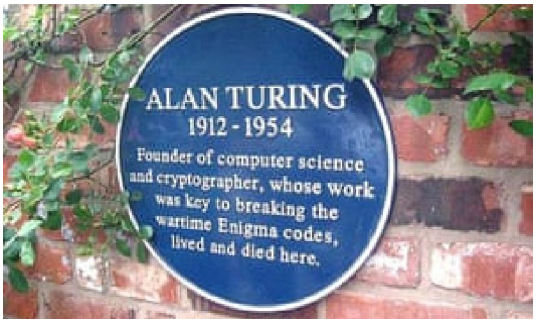
Yours sincerely,

A.M. Turing

A. M. TURING.

Letter from Alan Turing to W Ross Ashby.

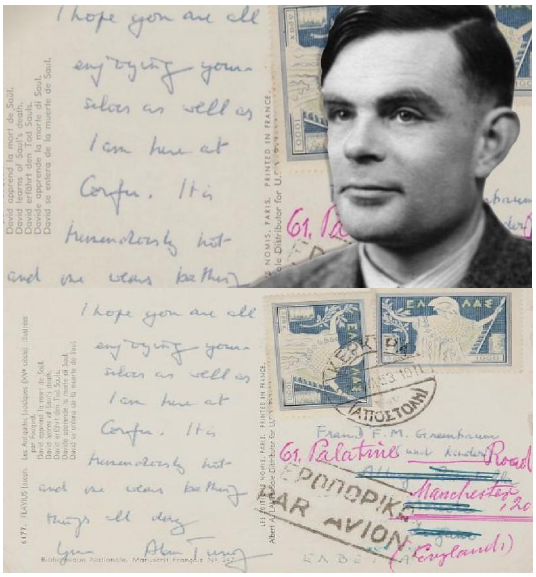
Alan Turing at the Science Museum.



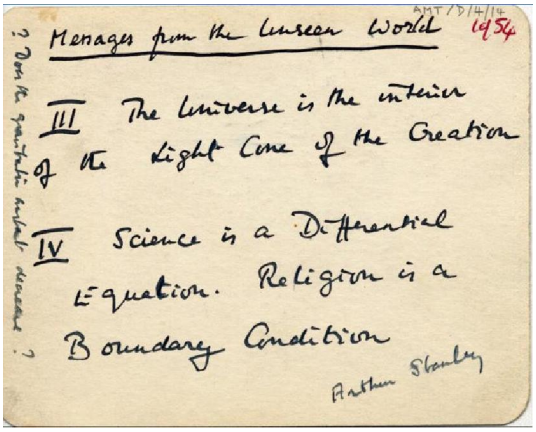
The blue plaque at Alan Turing's house on Adlington Road.

Bronze bust of Alan Turing presented to ACM by Tom and Grant Mackenzie.

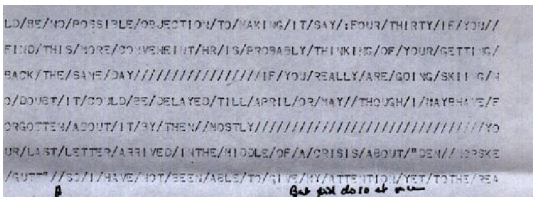
ACM A.M. Turing Award.



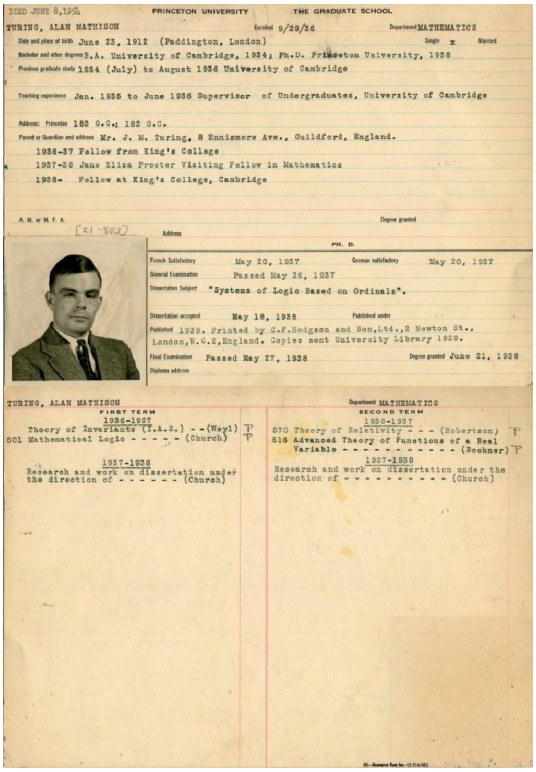
A postcard Alan Turing sent to his psychologist "Dr Franz Greenbaum" while on holiday in Corfu.



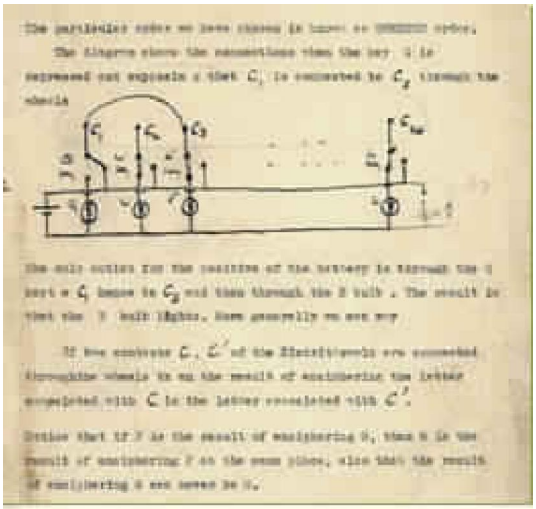
Note from Alan Turing to Robin Gandy, March 1954.

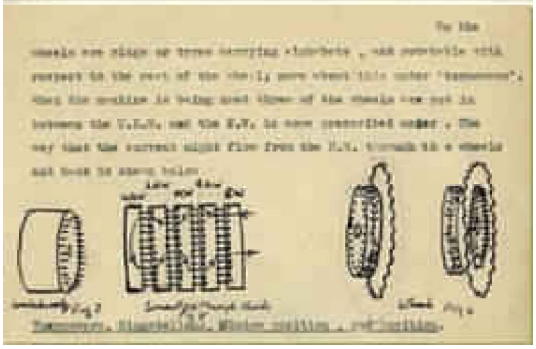


Message from Turing to Gandy, printed off the Manchester Mark I, ca. 1953.

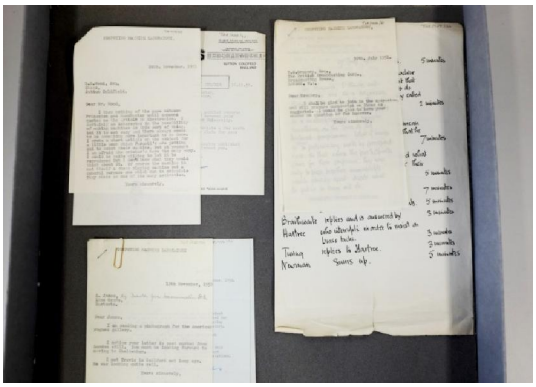


Alan Turing's Princeton University File.

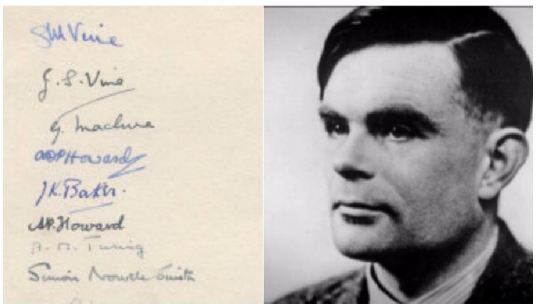




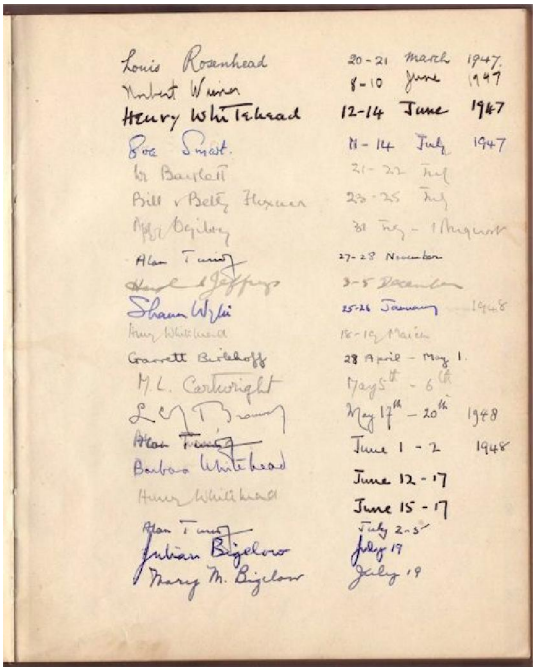
Extracts from Turing's notes on the Enigma Machine, c.1939–42.



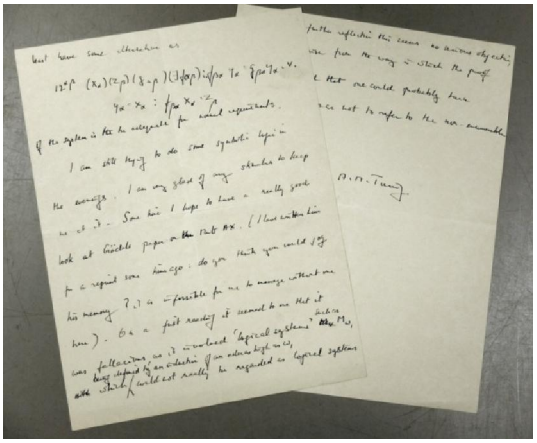
A unique collection of letters and correspondence from Alan Turing found in an old filing cabinet in a storeroom at the University of Manchester.



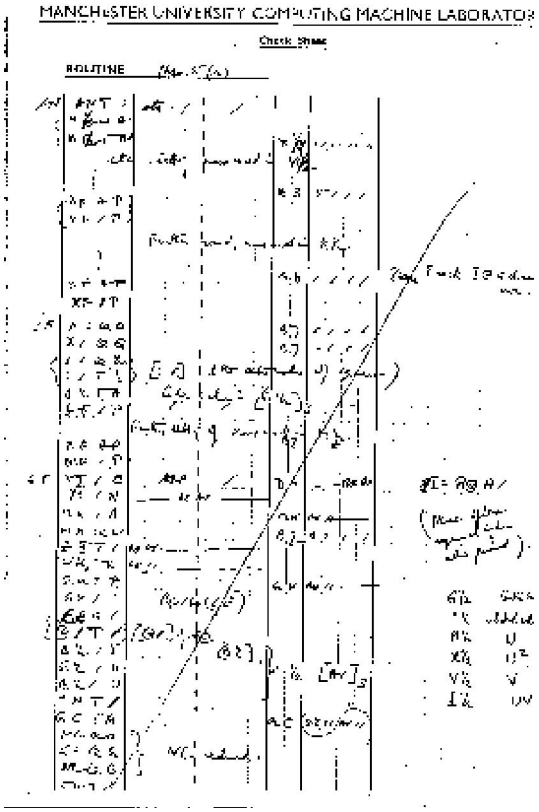
Alan Turing autograph.



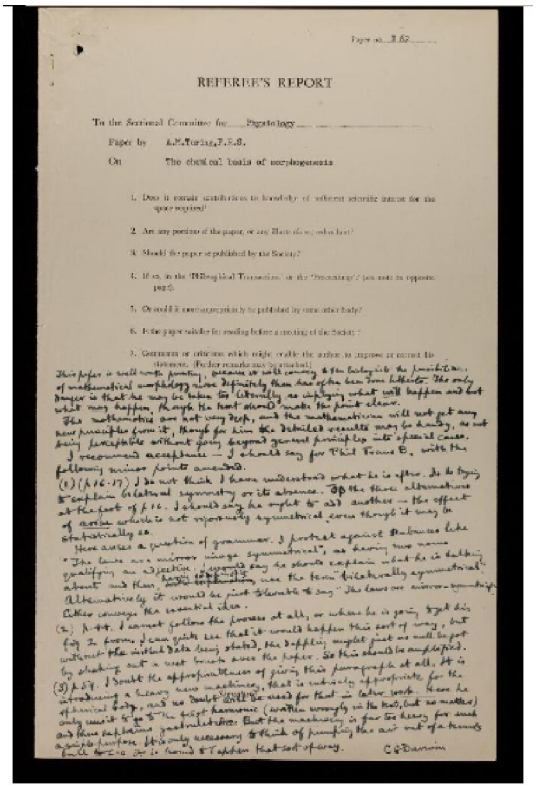
Visitor's Book signature: Alan Turing's signature 8th from the top.



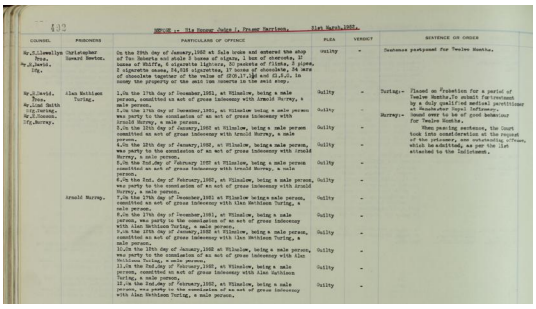
Alan Turing Letter to Alonzo Church.



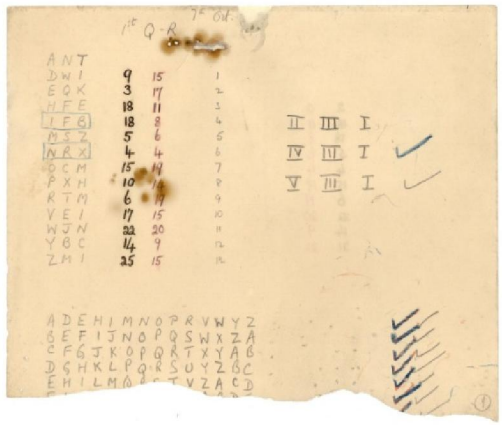
Alan Turing Scrapbook.

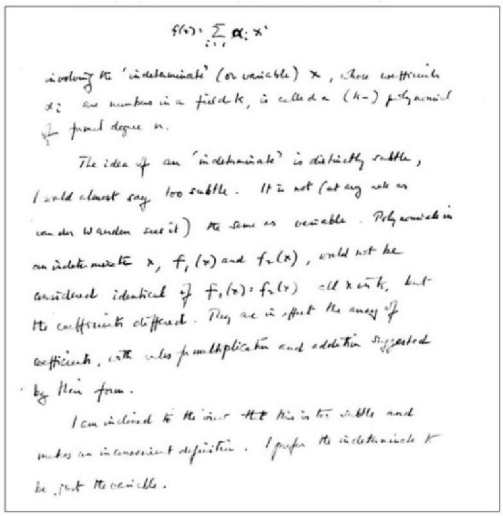


Referee report by C. G. Darwin on 'On the Chemical basis of Morphogenesis' by A. M. Turing.

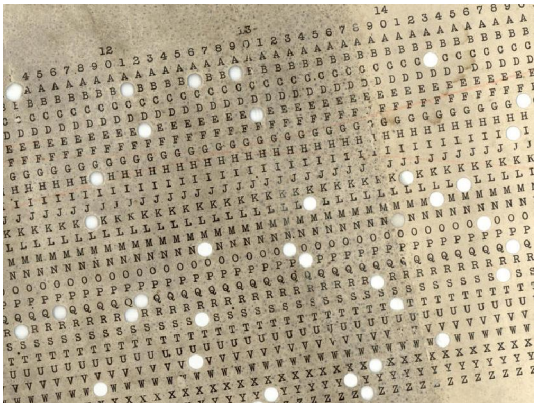


This is a photograph of the official record of the charges, pleas, and sentences passed on Alan Turing and Arnold Murray in respect of their crimes, 31 March 1952.

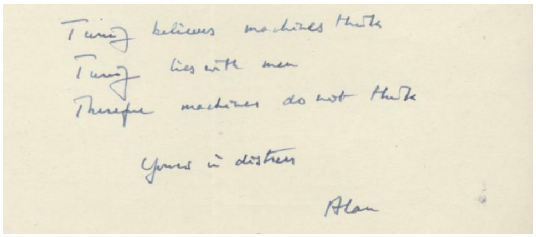




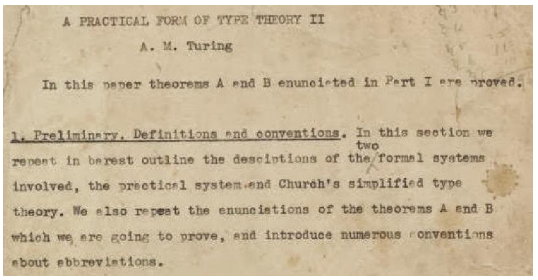
A sample of the handwriting of Alan Turing.



Alan Turing's Code-Breaking Papers Discovered In Roof Holes At Bletchley Park.



Alan Turing Letter to Dr. N. A. Routledge.



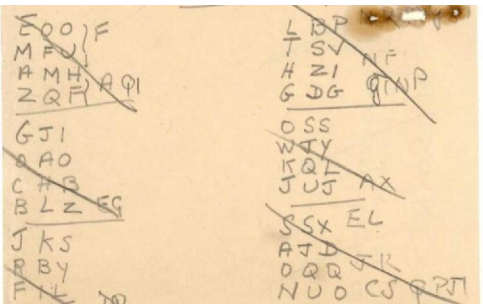
A PRACTICAL FORM OF TYPE THEORY II

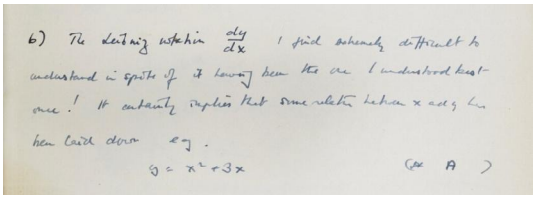
A. M. Turing

In this paper theorems A and B enunciated in Part I are proved.

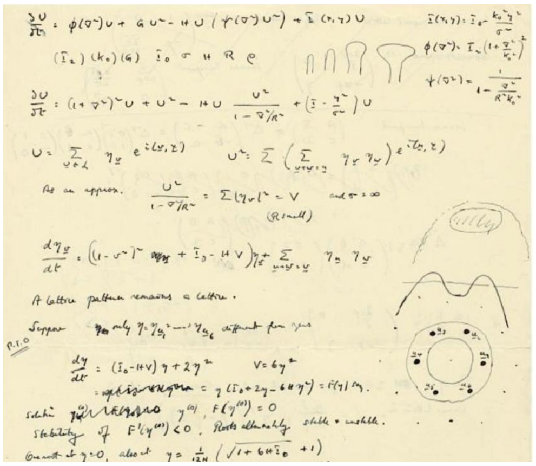
1. Preliminary. Definitions and conventions. In this section we repeat in barest outline the descintions of the formal systems involved, the practical system and Church's simplified type theory. We also repeat the enunciations of the theorems A and B which we are going to prove, and introduce numerous conventions about abbreviations.

A sample of Turing's typing.





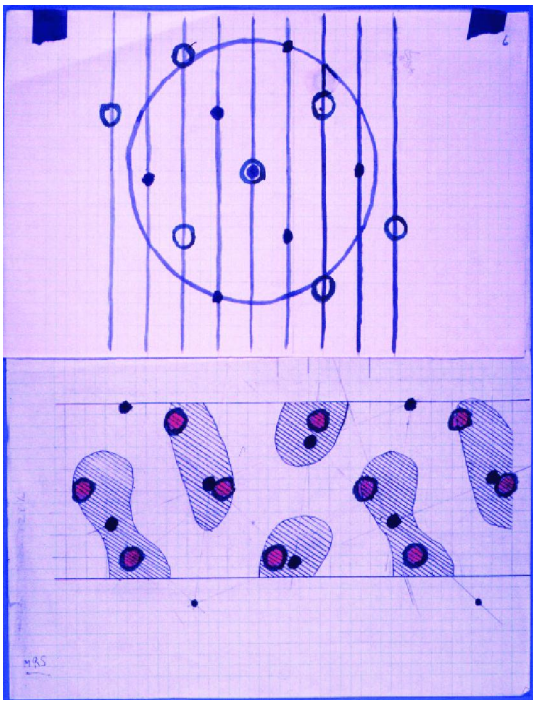
One of Alan Turing's journals, written while he was hacking away on the German Enigma Code.



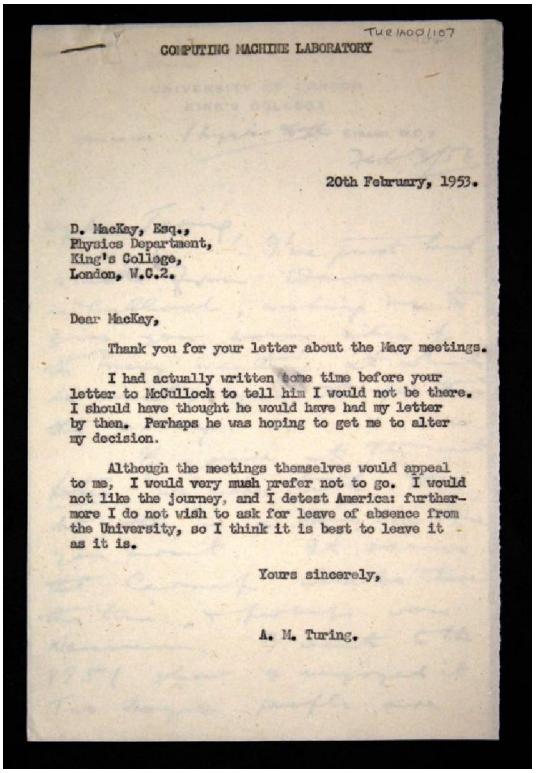
The unpublished work by the late Alan Turing (1912-1954). It includes many topics (how to play Go, eliptic functions...) and drawings and calculations related to his theory of morphogenesis.

The Alan Turing Building at the University of Manchester.

The London 2012 Olympic Torch flame was passed on in front of Turing's statue in Manchester on his 100th birthday.



Colored diagrams showing patterns of dappling and calculations, made by Turing in connection with work on morphogenesis.



COMPUTING MACHINE LABORATORY

20th February, 1953.

D. MacKay, Esq.,
Physics Department,
King's College,
London, W.C.2.

Dear MacKay,

Thank you for your letter about the Macy meetings.

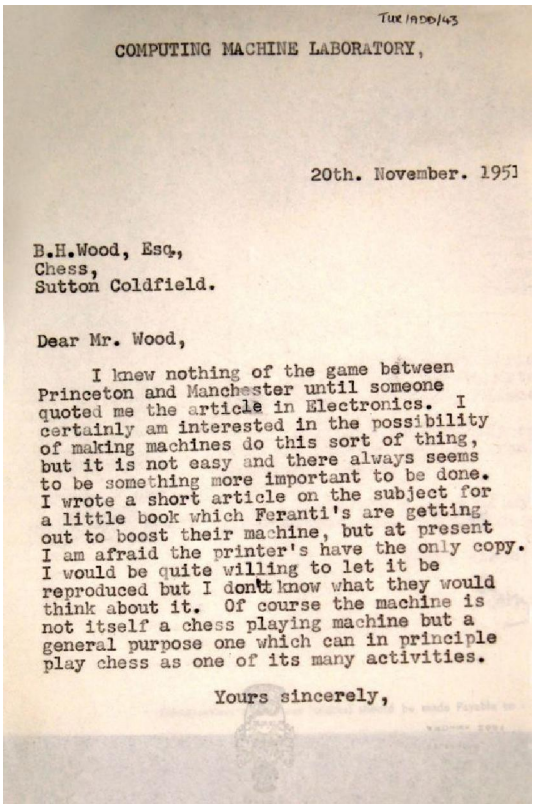
I had actually written some time before your letter to McCulloch to tell him I would not be there. I should have thought he would have had my letter by then. Perhaps he was hoping to get me to alter my decision.

Although the meetings themselves would appeal to me, I would very much prefer not to go. I would not like the journey, and I detest America: furthermore I do not wish to ask for leave of absence from the University, so I think it is best to leave it as it is.

Yours sincerely,

A. M. Turing.

Alan Turing Letter to London physicist Donald Mackay.



Tur/ap6/43

COMPUTING MACHINE LABORATORY,

20th. November. 1951

B.H.Wood, Esq.,
Chess,
Sutton Coldfield.

Dear Mr. Wood,

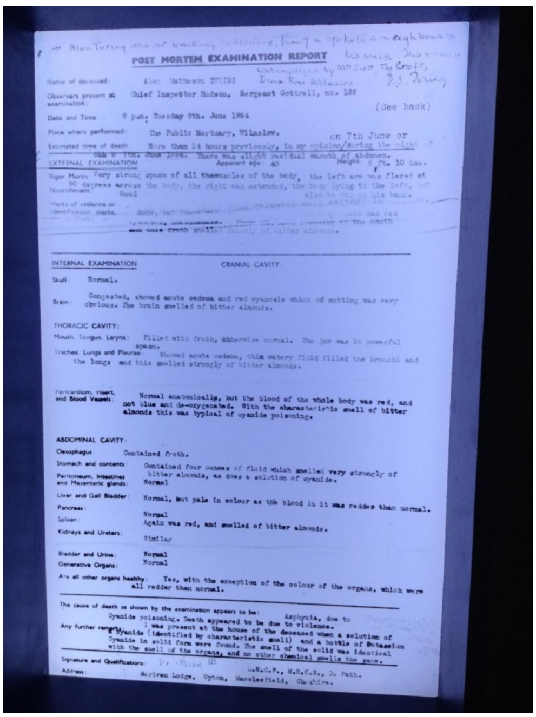
I knew nothing of the game between Princeton and Manchester until someone quoted me the article in Electronics. I certainly am interested in the possibility of making machines do this sort of thing, but it is not easy and there always seems to be something more important to be done. I wrote a short article on the subject for a little book which Feranti's are getting out to boost their machine, but at present I am afraid the printer's have the only copy. I would be quite willing to let it be reproduced but I don't know what they would think about it. Of course the machine is not itself a chess playing machine but a general purpose one which can in principle play chess as one of its many activities.

Yours sincerely,

Alan Turing Letter to B H Wood, editor of Chess magazine.

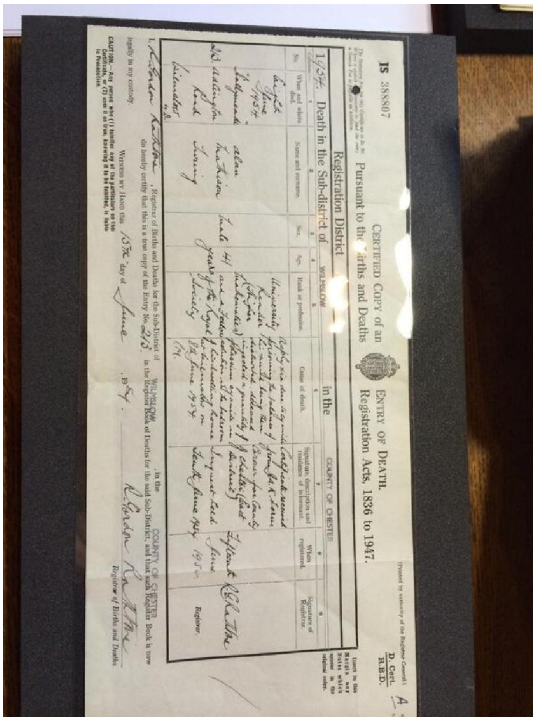
Alan Turing on a 2000 "millennium" stamp commemorating his 1937 theory of digital computing.

Slate statue of Alan Turing at Bletchley Park with the best-known image of Turing on the wall to the right.

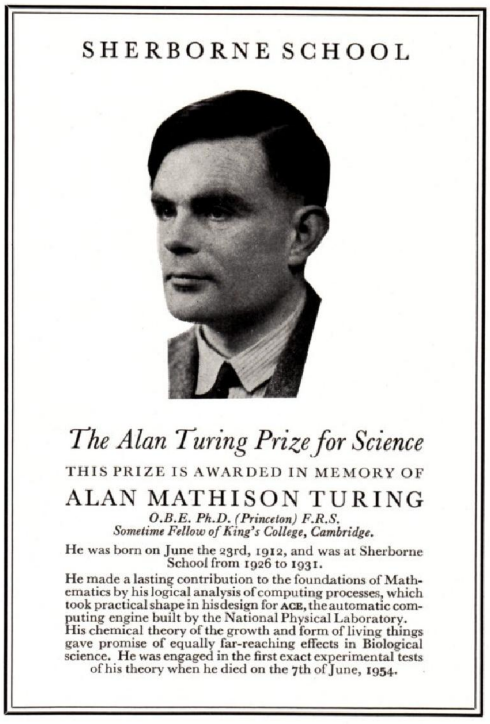


POST MORTEM EXAMINATION REPORT

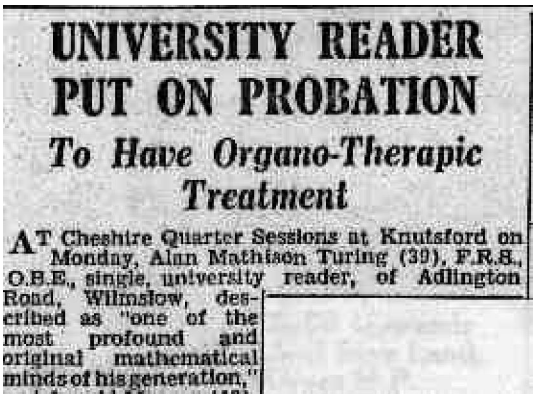
Post Mortem Examination report of Alan Turing.



Death Certificate of Alan Turing.



Alan Turing Prize for Science bookplate.

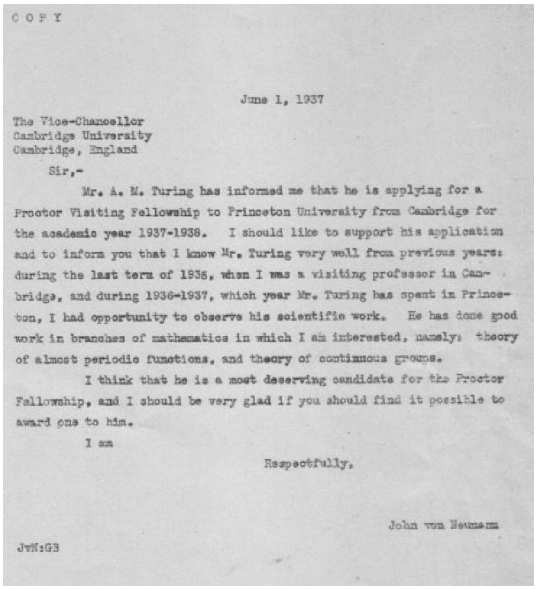


UNIVERSITY READER PUT ON PROBATION

To Have Organo-Therapic Treatment

AT Cheshire Quarter Sessions at Knutsford on Monday, Alan Mathison Turing (39), F.R.S., O.B.E., single, university reader, of Adlington Road, Wilmslow, described as "one of the most profound and original mathematical minds of his generation,"

The Turing residence at 22 Ennismore Avenue, Guildford.



COPY

June 1, 1937

The Vice-Chancellor
Cambridge University
Cambridge, England

Sir,-

Mr. A. M. Turing has informed me that he is applying for a Proctor Visiting Fellowship to Princeton University from Cambridge for the academic year 1937-1938. I should like to support his application and to inform you that I know Mr. Turing very well from previous years: during the last term of 1935, when I was a visiting professor in Cambridge, and during 1936-1937, which year Mr. Turing has spent in Princeton, I had opportunity to observe his scientific work. He has done good work in branches of mathematics in which I am interested, namely: theory of almost periodic functions, and theory of continuous groups.

I think that he is a most deserving candidate for the Proctor Fellowship, and I should be very glad if you should find it possible to award one to him.

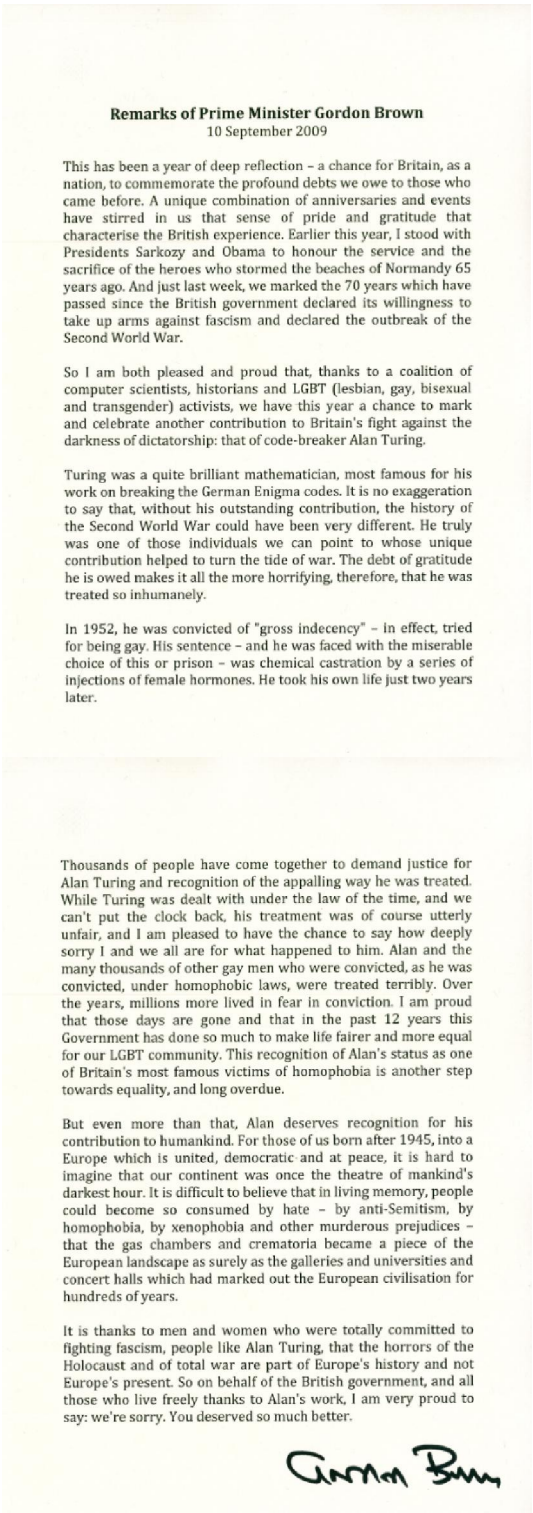
I am

Respectfully,

John von Neumann

JvN:G3

von Neumann's formal letter of reference dated June 1, 1937, supporting Turing's application for a Procter Fellowship at Princeton for the year 1937-38.



Remarks of Prime Minister Gordon Brown
10 September 2009

This has been a year of deep reflection – a chance for Britain, as a nation, to commemorate the profound debts we owe to those who came before. A unique combination of anniversaries and events have stirred in us that sense of pride and gratitude that characterise the British experience. Earlier this year, I stood with Presidents Sarkozy and Obama to honour the service and the sacrifice of the heroes who stormed the beaches of Normandy 65 years ago. And just last week, we marked the 70 years which have passed since the British government declared its willingness to take up arms against fascism and declared the outbreak of the Second World War.

So I am both pleased and proud that, thanks to a coalition of computer scientists, historians and LGBT (lesbian, gay, bisexual and transgender) activists, we have this year a chance to mark and celebrate another contribution to Britain's fight against the darkness of dictatorship: that of code-breaker Alan Turing.

Turing was a quite brilliant mathematician, most famous for his work on breaking the German Enigma codes. It is no exaggeration to say that, without his outstanding contribution, the history of the Second World War could have been very different. He truly was one of those individuals we can point to whose unique contribution helped to turn the tide of war. The debt of gratitude he is owed makes it all the more horrifying, therefore, that he was treated so inhumanely.

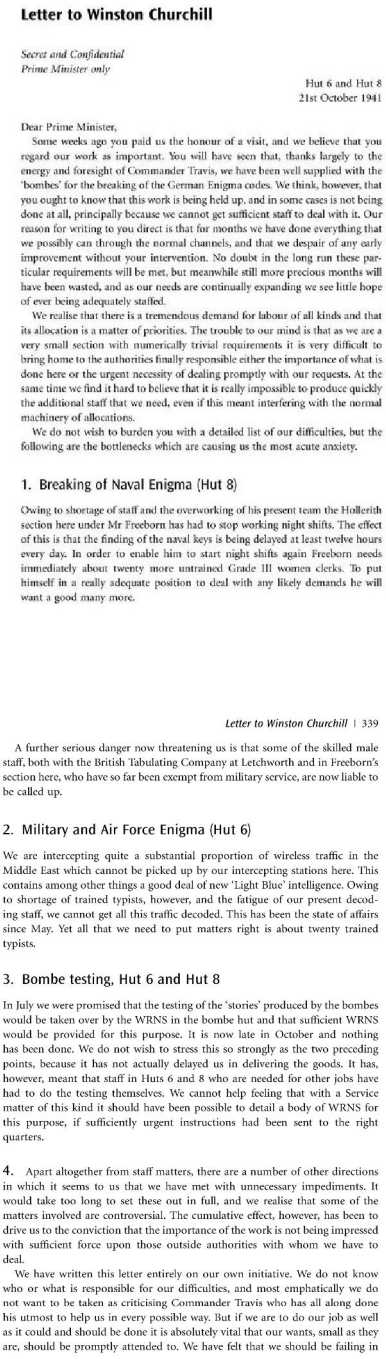
In 1952, he was convicted of "gross indecency" – in effect, tried for being gay. His sentence – and he was faced with the miserable choice of this or prison – was chemical castration by a series of injections of female hormones. He took his own life just two years later.

Thousands of people have come together to demand justice for Alan Turing and recognition of the appalling way he was treated. While Turing was dealt with under the law of the time, and we can't put the clock back, his treatment was of course utterly unfair, and I am pleased to have the chance to say how deeply sorry I and we all are for what happened to him. Alan and the many thousands of other gay men who were convicted, as he was convicted, under homophobic laws, were treated terribly. Over the years, millions more lived in fear in conviction. I am proud that those days are gone and that in the past 12 years this Government has done so much to make life fairer and more equal for our LGBT community. This recognition of Alan's status as one of Britain's most famous victims of homophobia is another step towards equality, and long overdue.

But even more than that, Alan deserves recognition for his contribution to humankind. For those of us born after 1945, into a Europe which is united, democratic and at peace, it is hard to imagine that our continent was once the theatre of mankind's darkest hour. It is difficult to believe that in living memory, people could become so consumed by hate – by anti-Semitism, by homophobia, by xenophobia and other murderous prejudices – that the gas chambers and crematoria became a piece of the European landscape as surely as the galleries and universities and concert halls which had marked out the European civilisation for hundreds of years.

It is thanks to men and women who were totally committed to fighting fascism, people like Alan Turing, that the horrors of the Holocaust and of total war are part of Europe's history and not Europe's present. So on behalf of the British government, and all those who live freely thanks to Alan's work, I am very proud to say: we're sorry. You deserved so much better.

Gordon Brown



Letter to Winston Churchill

Secret and Confidential
Prime Minister only

Hut 6 and Hut 8
21st October 1941

Dear Prime Minister,

Some weeks ago you paid us the honour of a visit, and we believe that you regard our work as important. You will have seen that, thanks largely to the energy and foresight of Commander Travis, we have been well supplied with the 'bombes' for the breaking of the German Enigma codes. We think, however, that you ought to know that this work is being held up, and in some cases is not being done at all, principally because we cannot get sufficient staff to deal with it. Our reason for writing to you direct is that for months we have done everything that we possibly can through the normal channels, and that we despair of any early improvement without your intervention. No doubt in the long run these particular requirements will be met, but meanwhile still more precious months will have been wasted, and as our needs are continually expanding we see little hope of ever being adequately staffed.

We realise that there is a tremendous demand for labour of all kinds and that its allocation is a matter of priorities. The trouble to our mind is that as we are a very small section with numerically trivial requirements it is very difficult to bring home to the authorities finally responsible either the importance of what is done here or the urgent necessity of dealing promptly with our requests. At the same time we find it hard to believe that it is really impossible to produce quickly the additional staff that we need, even if this meant interfering with the normal machinery of allocations.

We do not wish to burden you with a detailed list of our difficulties, but the following are the bottlenecks which are causing us the most acute anxiety.

1. Breaking of Naval Enigma (Hut 8)

Owing to shortage of staff and the overworking of his present team the Hollerith section here under Mr Freeborn has had to stop working night shifts. The effect of this is that the finding of the naval keys is being delayed at least twelve hours every day. In order to enable him to start night shifts again Freeborn needs immediately about twenty more untrained Grade III women clerks. To put himself in a really adequate position to deal with any likely demands he will want a good many more.

Letter to Winston Churchill | 339

A further serious danger now threatening us is that some of the skilled male staff, both with the British Tabulating Company at Letchworth and in Freeborn's section here, who have so far been exempt from military service, are now liable to be called up.

2. Military and Air Force Enigma (Hut 6)

We are intercepting quite a substantial proportion of wireless traffic in the Middle East which cannot be picked up by our intercepting stations here. This contains among other things a good deal of new 'Light Blue' intelligence. Owing to shortage of trained typists, however, and the fatigue of our present decoding staff, we cannot get all this traffic decoded. This has been the state of affairs since May. Yet all that we need to put matters right is about twenty trained typists.

3. Bombe testing, Hut 6 and Hut 8

In July we were promised that the testing of the 'stories' produced by the bombes would be taken over by the WRNS in the bombe hut and that sufficient WRNS would be provided for this purpose. It is now late in October and nothing has been done. We do not wish to stress this so strongly as the two preceding points, because it has not actually delayed us in delivering the goods. It has, however, meant that staff in Huts 6 and 8 who are needed for other jobs have had to do the testing themselves. We cannot help feeling that with a Service matter of this kind it should have been possible to detail a body of WRNS for this purpose, if sufficiently urgent instructions had been sent to the right quarters.

4. Apart altogether from staff matters, there are a number of other directions in which it seems to us that we have met with unnecessary impediments. It would take too long to set these out in full, and we realise that some of the matters involved are controversial. The cumulative effect, however, has been to drive us to the conviction that the importance of the work is not being impressed with sufficient force upon those outside authorities with whom we have to deal.

We have written this letter entirely on our own initiative. We do not know who or what is responsible for our difficulties, and most emphatically we do not want to be taken as criticising Commander Travis who has all along done his utmost to help us in every possible way. But if we are to do our job as well as it could and should be done it is absolutely vital that our wants, small as they are, should be promptly attended to. We have felt that we should be failing in

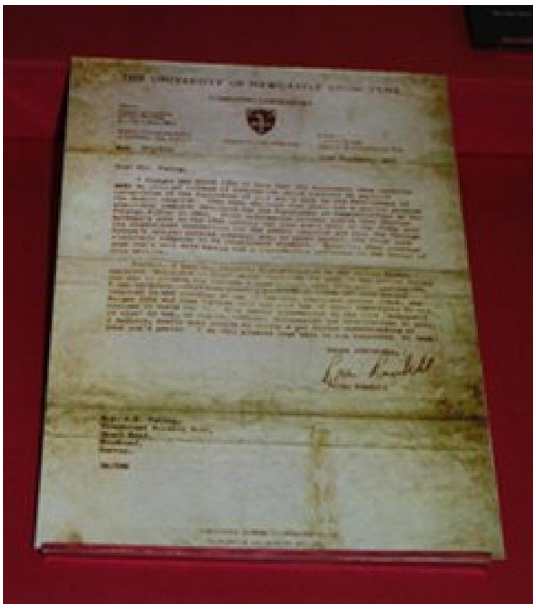
The complete text of Gordon Brown's apology to Alan Turing.

340 | *Alan Turing et al.*

our duty if we did not draw your attention to the facts and to the effects which they are having and must continue to have on our work, unless immediate action is taken.

We are, Sir, Your obedient servants,
A M Turing
W G Welchman
C H O'D Alexander
P S Milner-Barry

Alan Turing's letter to Churchill.

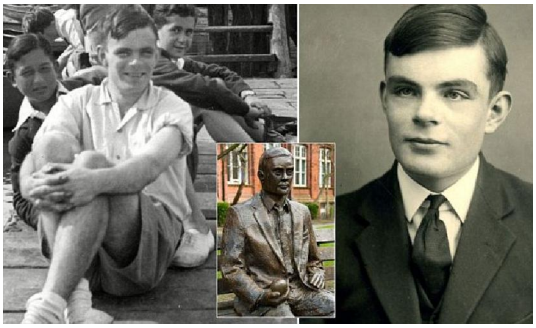


Brian Randell Letter to Alan Turing's mother.

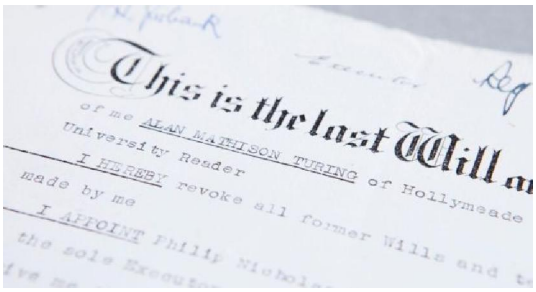
Alan Turing's belongings from school and university days.

The Turing Bombe Rebuild Project, Bletchley Park Museum.

Alan Turing Teddy Bear, Bletchley Park Museum.

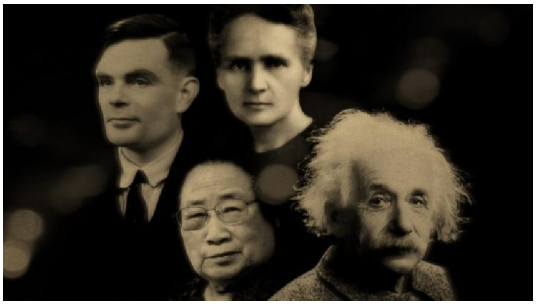


Bletchley Park: Mansion: Turing's Blade.



The will of Alan Turing.

Letter written by Turing on solitaire.



Alan Turing's Possessions.

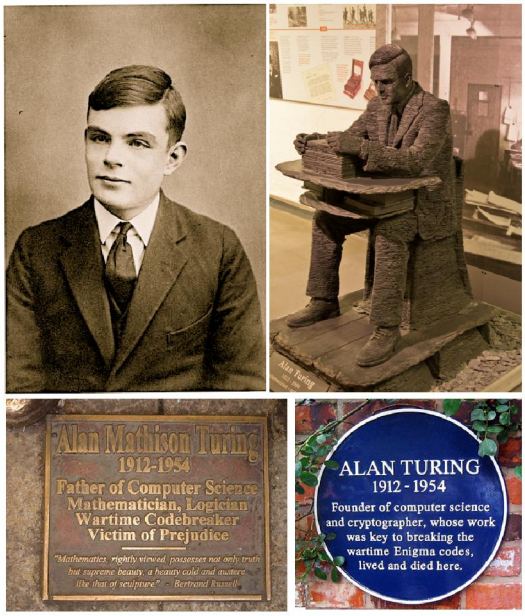
Ethel Sara Turing (nee Stoney) in her old age. She died in 1976 aged 95.

Alan Turing monument in Sackville Gardens.

Alan Turing has been crowned the greatest person of the 20th Century by BBC viewers.

Turing was injected with Stilboestrol - a synthesized form of oestrogen.

Statement of apology by the Prime Minister, Gordon Brown, 10 September 2009:... a quite brilliant mathematician... whose unique contribution helped to turn the tide of war... horrifying that he was treated so inhumanely...



Alan Turing quotes

CRG researchers confirm that a mathematical theory first proposed by Alan Turing in 1952 can explain the formation of fingers.

"Sometimes it is the people no one can imagine anything of who do the things no one can imagine."
-- **Alan Turing**

"We can only see a short distance ahead, but we can see plenty there that needs to be done."
-- **Alan Turing, Computing machinery and intelligence**

"I'm afraid that the following syllogism may be used by some in the future.
Turing believes machines think
Turing lies with men
Therefore machines do not think
Yours in distress,
Alan"
-- **Alan Turing**

"I believe that at the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted."
— Alan Turing, Computing machinery and intelligence

"Those who can imagine anything, can create the impossible."
-- **Alan Turing**

"Sometimes it is the people who no one imagines anything of who do the things that no one can imagine."
-- Alan Turing

"If a machine is expected to be infallible, it cannot also be intelligent."
-- **Alan Turing**

"Finding such a person makes everyone else appear so ordinary…and if anything happens to him, you've got nothing left but to return to the ordinary world, and a kind of isolation that never existed before."
-- **Alan Turing**

"The original question, 'Can machines think?' I believe to be too meaningless to deserve discussion."
--Alan Turing, Mechanical Intelligence: Collected Works of A.M. Turing

"A very large part of space-time must be investigated, if reliable results are to be obtained."
-- **Alan Turing**

"Sometimes it is the people no one imagines anything of who do the things that no one can imagine."
-- **Alan Turing**

"Do you know why people like violence? It is because it feels good. Humans find violence deeply satisfying. But remove the satisfaction, and the act becomes hollow."

-- **Alan Turing**

"It is possible to invent a single machine which can be used to compute any computable sequence."

-- **Alan Turing**

"We are not interested in the fact that the brain has the consistency of cold porridge."

--**Alan Turing**

"It is not possible to produce a set of rules purporting to describe what a man should do in every conceivable set of circumstances."

-- **Alan Turing, Computing machinery and intelligence**

"The works and customs of mankind do not seem to be very suitable material to which to apply scientific induction."

-- **Alan Turing, Computing machinery and intelligence**

"We like to believe that Man is in some subtle way superior to the rest of creation. It is best if he can be shown to be necessarily superior, for then there is no danger of him losing his commanding position."

-- **Alan Turing, Computing machinery and intelligence**

"Can machines think?"... The new form of the problem can be described in terms of a game which we call the " imitation game." It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart front the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. He knows them by labels X and Y, and at the end of the game he says either "X is A and Y is B" or "X is B and Y is A." The interrogator is allowed to put questions to A and B... We now ask the question, "What will happen when a machine takes the part of A in this game?" Will the interrogator decide wrongly as often when the game is played like this as he does when the game is played between a man and a woman? These questions replace our original, "Can machines think?"

-- **Alan Turing, Computing machinery and intelligence**

"I've now got myself into the kind of trouble that I have always considered to be quite a possibility for me, though I have usually rated it at about 10:1 against. I shall shortly be pleading guilty to a charge of sexual offences with a young man. The story of how it all came to be found out is a long and fascinating one, which I shall have to make into a short story one day, but haven't the time to tell you now. No doubt I shall emerge from it all a different man, but quite who I've not found out."

--**Alan Turing**

"The popular view that scientists proceed inexorably from well-established fact to well-established fact, never being influenced by any unproved conjecture, is quite mistaken. Provided it is made clear which are proved facts and which are conjectures, no harm can result. Conjectures are of great importance since they suggest useful lines of research."

-- **Alan Turing, Alan Turing: The Enigma**

Alan Turing--Report Card Teachers' Comments, 1926-1931

Subject: **Mathematics**

1926. *Works well. He is still very untidy. He must try to improve in this respect*

1927. *Very good. He has considerable powers of reasoning and should do well if he can quicken up a little and improve his style.*

____. *A very good term's work, but his style is dreadful and his paper always dirty.*

____. *Not very good. He spends a good deal of time apparently in investigations in advanced mathematics to the neglect of his elementary work. A sound ground work is essential in any subject. His work is dirty.*

____. *Despite absence he has done a really remarkable examination (1st paper). A mathematician I think.*

____ *I think he has been somewhat tidier, though there is still plenty of room for improvement. A keen & able mathematician.*

1928. *Easily the best mathematician in the set. His position is caused by untidiness and carelessness due largely to impatience to let on something great as soon as he has seen his way through a problem.*

____. *This term has been spent, & the next two terms will have to be spent, in filling in the many gaps in his knowledge & organising it. He thinks very rapidly & is apt to be "brilliant", but unsound in some of his work. He is seldom defeated by a problem, but his methods are often crude, cumbersome & untidy. But thoroughness & polish will no doubt come in time.*

1929. *His work on Higher Certificate papers shows distinct promise, but he must realize that ability to put a neat & tidy solution on paper – intelligible & legible – is necessary for a first-rate mathematician.*

1930. *He has faced the uninspiring task of revision & consolidation of his previous knowledge with determination, and I think he has succeeded in improving his style of written work, which is more convincing & less sketchy than last year. If he does not*

get flustered & relapse into slip-shod work, he should do very well in the H.C. this year.

____ A really able mathematician. His trouble is his untidiness & poor style, but he has tried hard to improve in this. He sometimes fails over a simple problem by trying to do it by complicated methods, instead of by an elementary one.

1931. *He has done some post-scholarship reading without encountering any serious difficulties. He should be able to take the Higher Certificate next July in his stride.*

____. He has gone on with his reading as well as revising the elementary work for the Higher Certificate, & I expect him to get a Distinction with ease. He has my best wishes for an equally successful career at Cambridge.

Subject: **Natural Science**

1926. *He is keen & has a natural bent for science, but his work is badly spoilt by extreme untidiness.*

Subject: **English.**

1926. *Without being lazy, he seems to do his work rather perfunctorily. I should like to see rather more life in him.*

1928. *His English work is becoming less feeble. He undoubtedly has brains, but is only slowly learning to apply them to subjects for which he has little interest.*

1930. *His reading is too deliberate. On paper he is usually sensible.*

Subject: **Chemistry**.

1930. I*f the questions suit him, he is certain of getting a scholarship: but I do not feel that his knowledge is sufficiently all-round to make him independent of luck in the examination.*

Subject: **Physics**.

1928 *He has done some quite good work by himself in my room. Good work.*

1930. *He has done some excellent work, mostly strict training for his scholarship examination. I can only hope Cambridge will think as well of him as I do.*

1931. *He continues to take a genuine interest in physics.*

House Report

1927 *He is frankly not one who fits comfortably for himself into the ordinary life of the place – on the whole I think he is tidier.*

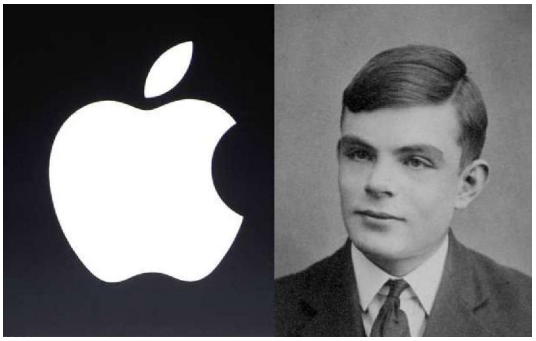
____. No doubt he is a strange mixture: trying to build a roof before he has laid the foundations. Having secured one privileged exemption, he is mistaken in acting as if idleness and indifference will procure further release from uncongenial subjects.

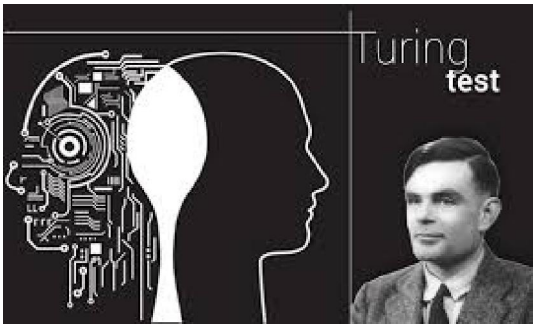
____. Rather more tidy: & the one paper I looked over of his was certainly better than I expected in neatness. He certainly has ideas & imagination.

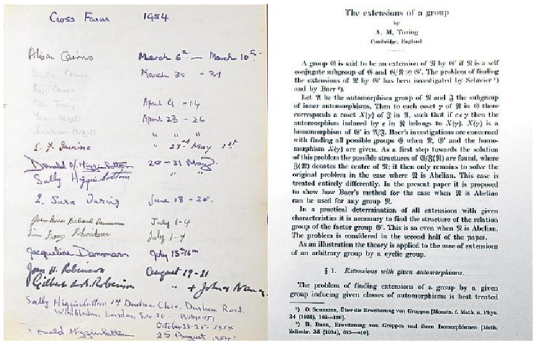
____. I have seen cleaner productions than this specimen, even from him. No doubt he is very aggravating: &he should know by now that I don't care to find him boiling heaven knows what witches' brew by the aid of two guttering candles on a naked wooden window sill. However he has borne his afflictions very cheerfully: & undoubtedly has taken more trouble, e.g. with physical training. I am far from hopeless.

1928. *Satisfactory. I am very glad that he is sociable & makes friends: & he seems unselfish in temper. He is certainly ambitious.*

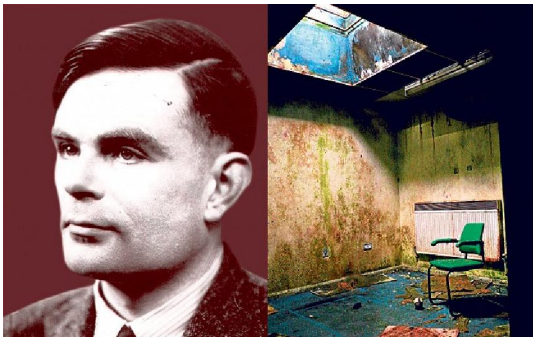
1931. *He has had an interesting career, with varied experience: & brought it to a very successful close. I am grateful to him for his essentially loyal help: & I hope he will reap further reward at King's, both in work & friendships.*



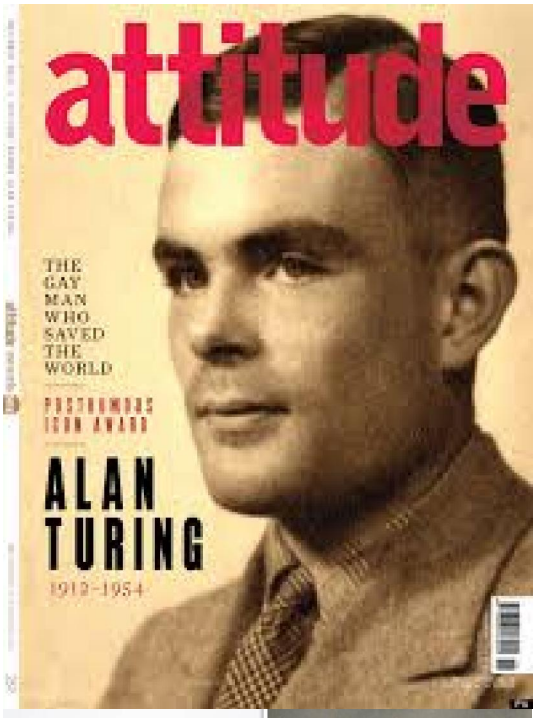


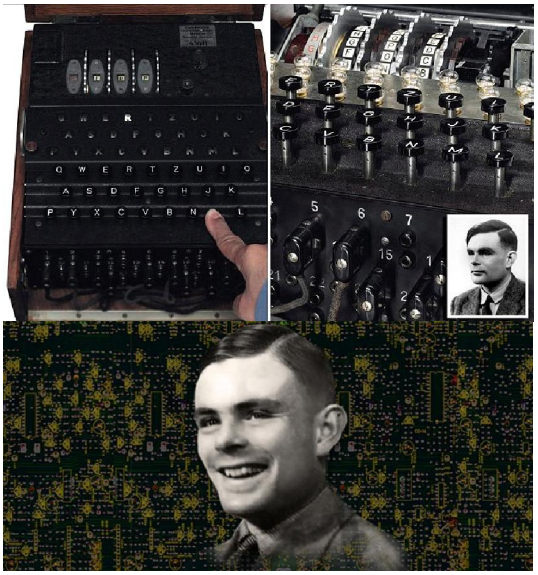


Alan Turing's secret papers.

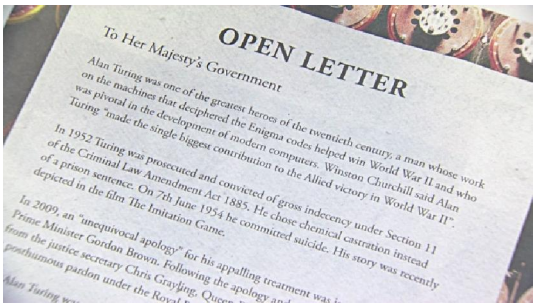


Alan Turing, who worked at Bletchley Park breaking codes. Plans are now afoot to restore Block C.

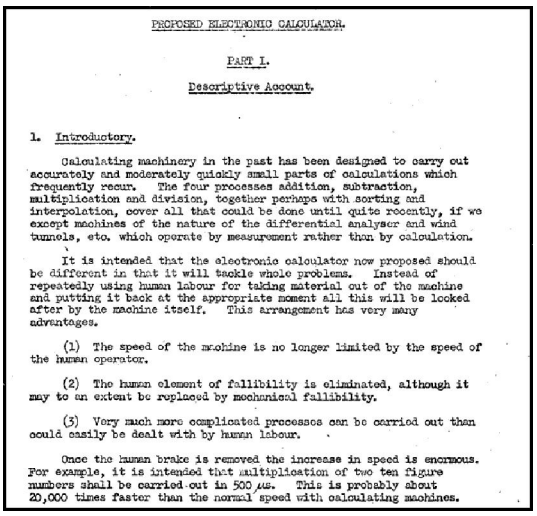




Turing was prosecuted in 1952 for homosexual acts, when such behavior was still criminalized in the UK. He accepted treatment with oestrogen injections (chemical castration) as an alternative to prison. Turing died in 1954, 16 days before his 42nd birthday, from cyanide poisoning.



Open letter asking the government to pardon 49,000 men who were prosecuted for being gay.



PROPOSED ELECTRONIC CALCULATOR.

PART I.

Descriptive Account.

1. Introductory.

Calculating machinery in the past has been designed to carry out accurately and moderately quickly small parts of calculations which frequently recur. The four processes addition, subtraction, multiplication and division, together perhaps with sorting and interpolation, cover all that could be done until quite recently, if we except machines of the nature of the differential analyser and wind tunnels, etc. which operate by measurement rather than by calculation.

It is intended that the electronic calculator now proposed should be different in that it will tackle whole problems. Instead of repeatedly using human labour for taking material out of the machine and putting it back at the appropriate moment all this will be looked after by the machine itself. This arrangement has very many advantages.

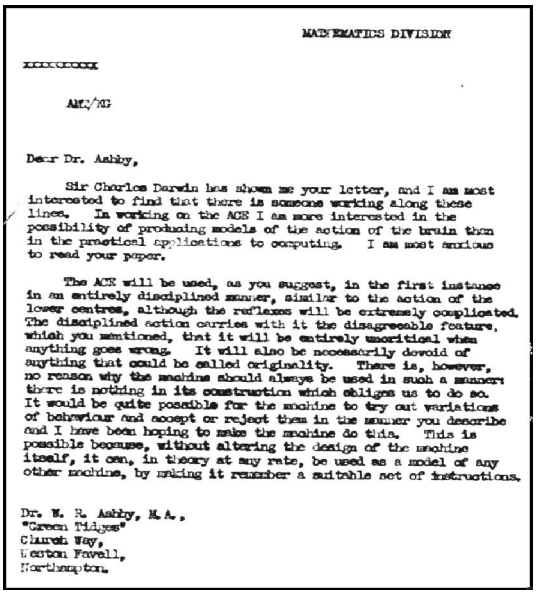
(1) The speed of the machine is no longer limited by the speed of the human operator.

(2) The human element of fallibility is eliminated, although it may to an extent be replaced by mechanical fallibility.

(3) Very much more complicated processes can be carried out than could easily be dealt with by human labour.

Once the human brake is removed the increase in speed is enormous. For example, it is intended that multiplication of two ten figure numbers shall be carried out in 500 μs. This is probably about 20,000 times faster than the normal speed with calculating machines.

Original manuscript of "Proposed Electronic Calculator," which was to become the Automatic Computing Engine (ACE).



MATHEMATICS DIVISION

xxxxxxxxx

AMT/KG

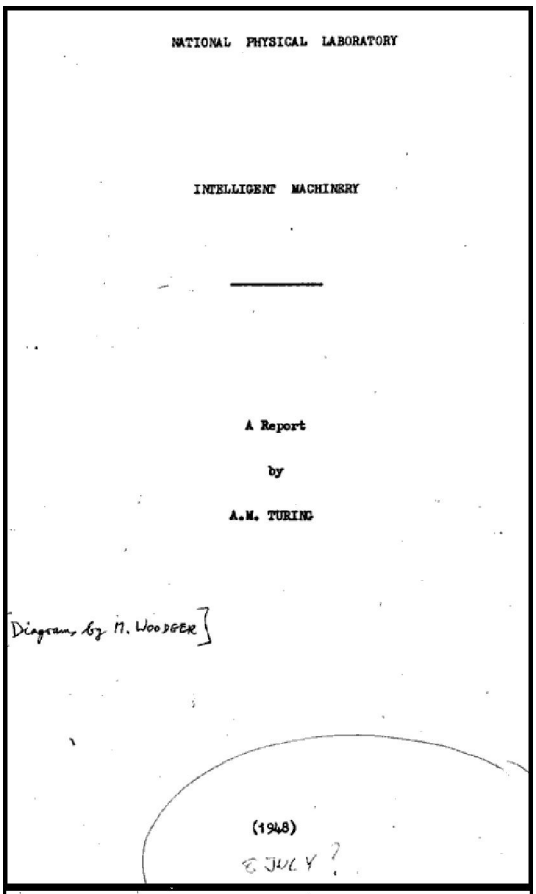
Dear Dr. Ashby,

Sir Charles Darwin has shown me your letter, and I am most interested to find that there is someone working along these lines. In working on the ACE I am more interested in the possibility of producing models of the action of the brain than in the practical applications to computing. I am most anxious to read your paper.

The ACE will be used, as you suggest, in the first instance in an entirely disciplined manner, similar to the action of the lower centres, although the reflexes will be extremely complicated. The disciplined action carries with it the disagreeable feature, which you mentioned, that it will be entirely uncritical when anything goes wrong. It will also be necessarily devoid of anything that could be called originality. There is, however, no reason why the machine should always be used in such a manner there is nothing in its construction which obliges us to do so. It would be quite possible for the machine to try out variations of behaviour and accept or reject them in the manner you describe and I have been hoping to make the machine do this. This is possible because, without altering the design of the machine itself, it can, in theory at any rate, be used as a model of any other machine, by making it remember a suitable set of instructions.

Dr. W. R. Ashby, M.A.,
"Green Tiles"
Church Way,
Weston Favell,
Northampton.

Letter from Turing to Sir W. Ross Ashby, describing how ACE could be used to mimic how the human brain works.



NATIONAL PHYSICAL LABORATORY

INTELLIGENT MACHINERY

A Report

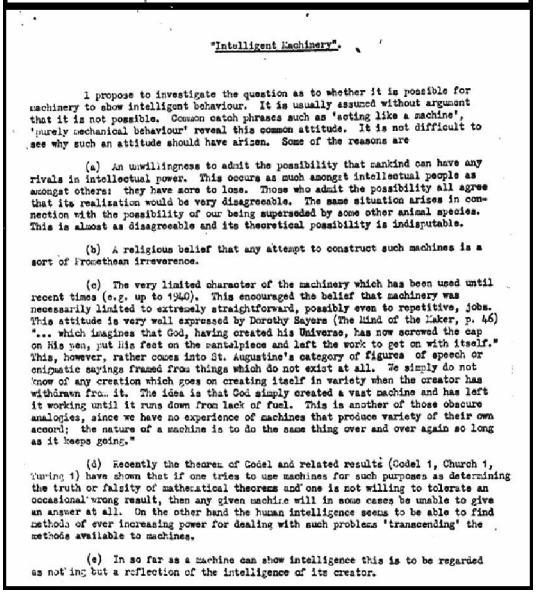
by

A.M. TURING

Diagram by M. WOODGER

(1948)

8 JULY ?



"Intelligent Machinery".

I propose to investigate the question as to whether it is possible for machinery to show intelligent behaviour. It is usually assumed without argument that it is not possible. Common catch phrases such as 'acting like a machine', 'purely mechanical behaviour' reveal this common attitude. It is not difficult to see why such an attitude should have arisen. Some of the reasons are

(a) An unwillingness to admit the possibility that mankind can have any rivals in intellectual power. This occurs as much amongst intellectual people as amongst others: they have more to lose. Those who admit the possibility all agree that its realization would be very disagreeable. The same situation arises in connection with the possibility of our being superseded by some other animal species. This is almost as disagreeable and its theoretical possibility is indisputable.

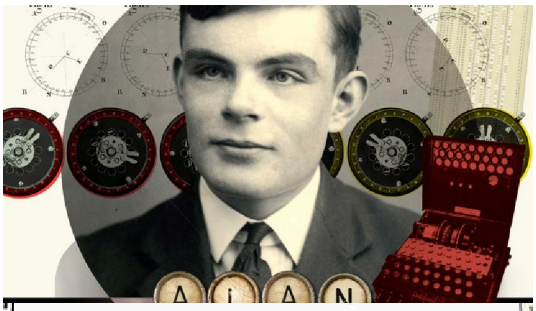
(b) A religious belief that any attempt to construct such machines is a sort of Promethean irreverence.

(c) The very limited character of the machinery which has been used until recent times (e.g. up to 1940). This encouraged the belief that machinery was necessarily limited to extremely straightforward, possibly even to repetitive, jobs. This attitude is very well expressed by Dorothy Sayers (The Mind of the Maker, p. 46) "... which imagines that God, having created his Universe, has now screwed the cap on His pen, put His feet on the mantelpiece and left the work to get on with itself." This, however, rather comes into St. Augustine's category of figures of speech or enigmatic sayings framed from things which do not exist at all. We simply do not know of any creation which goes on creating itself in variety when the creator has withdrawn from it. The idea is that God simply created a vast machine and has left it working until it runs down from lack of fuel. This is another of those obscure analogies, since we have no experience of machines that produce variety of their own accord; the nature of a machine is to do the same thing over and over again so long as it keeps going."

(d) Recently the theorem of Godel and related results (Godel 1, Church 1, Turing 1) have shown that if one tries to use machines for such purposes as determining the truth or falsity of mathematical theorems and one is not willing to tolerate an occasional wrong result, then any given machine will in some cases be unable to give an answer at all. On the other hand the human intelligence seems to be able to find methods of ever increasing power for dealing with such problems 'transcending' the methods available to machines.

(e) In so far as a machine can show intelligence this is to be regarded as nothing but a reflection of the intelligence of its creator.

A report written by Turing in 1948 titled "Intelligent Machinery" is the most detailed treating of artificial intelligence written before 1950. It was not published during Turing's lifetime.



CALCULUS TO SONNET

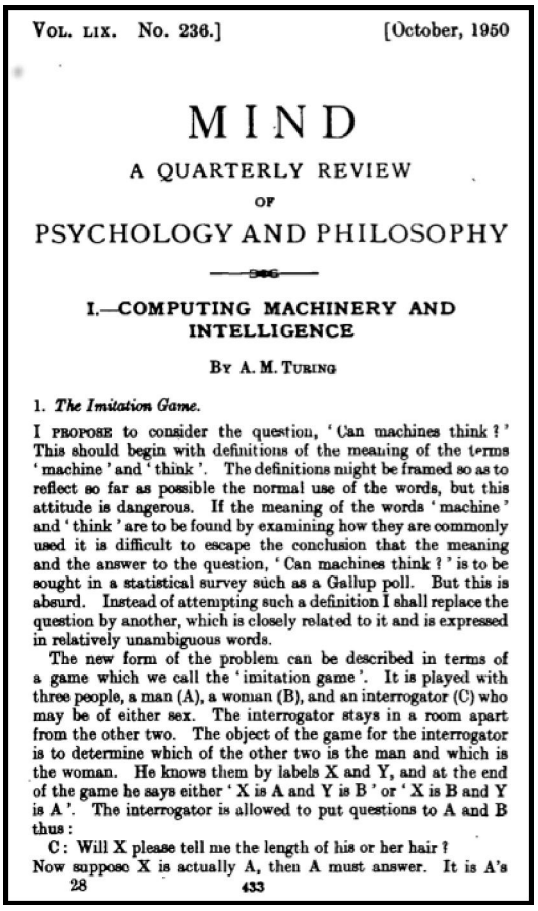
Mr. Turing said yesterday: "This is only a foretaste of what is to come, and only the shadow of what is going to be. We have to have some experience with the machine before we really know its capabilities. It may take years before we settle down to the new possibilities, but I do not see why it should not enter any one of the fields normally covered by the human intellect, and eventually compete on equal terms.

"I do not think you can even draw the line about sonnets, though the comparison is perhaps a little bit unfair because a sonnet written by a machine will be better appreciated by another machine."

Mr. Turing added that the university was really interested in the investigation of the possibilities of machines for their own sake. Their research would be directed to finding the degree of intellectual activity of which a machine was capable, and to what extent it could think for itself.

News of the experiments was disclosed by Professor Jefferson in the Lister oration reported in *The Times* yesterday.

Alan Turing quoted in 11 June 1949 edition of "The Times" (UK).



VOL. LIX. No. 236.] [October, 1950

MIND

A QUARTERLY REVIEW

OF

PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

BY A. M. TURING

1. *The Imitation Game.*

I PROPOSE to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think?' is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

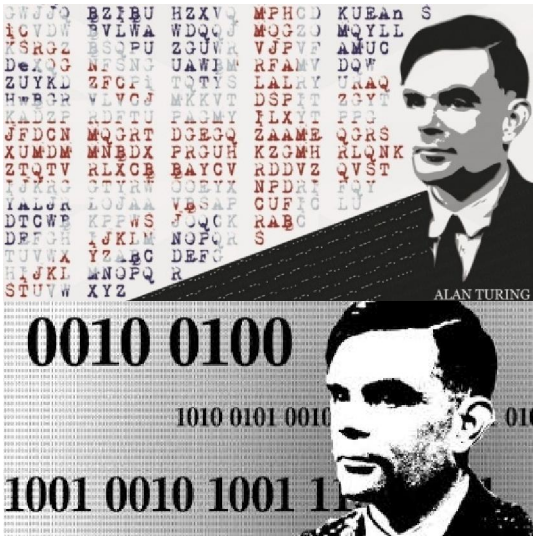
The new form of the problem can be described in terms of a game which we call the 'imitation game'. It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. He knows them by labels X and Y, and at the end of the game he says either 'X is A and Y is B' or 'X is B and Y is A'. The interrogator is allowed to put questions to A and B thus:

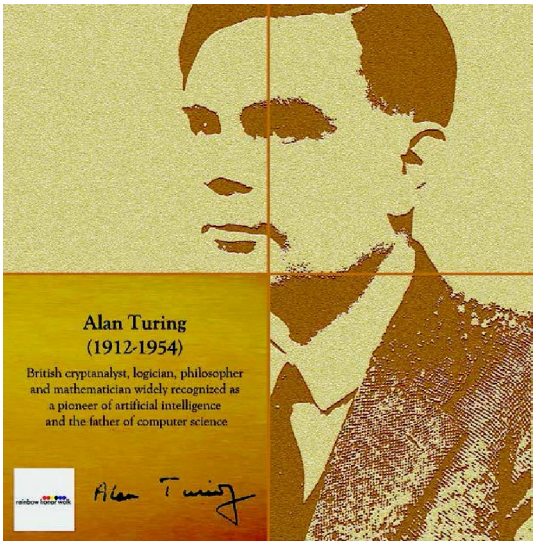
C: Will X please tell me the length of his or her hair?

Now suppose X is actually A, then A must answer. It is A's

28 433

First page of Turing's 1950 article "Computing Machinery and Intelligence," where the now famous "Turing Test" was introduced.





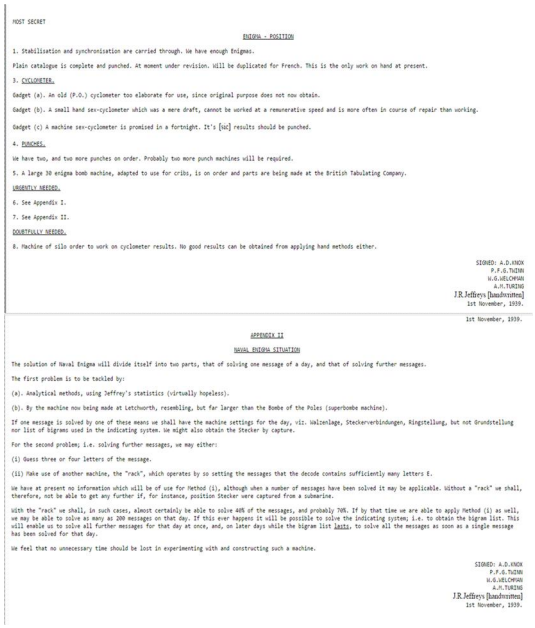
2009: APOLOGY

In August 2009, petition started urging the British Government to posthumously apologize to Alan Turing for prosecuting him as a homosexual. The petition received thousands of signatures. Prime Minister Gordon Brown acknowledged the petition, releasing a statement on 10 September 2009 apologizing and describing Turing's treatment as "appalling":

"Thousands of people have come together to demand justice for Alan Turing and recognition of the appalling way he was treated. While Turing was dealt with under the law of the time and we can't put the clock back, his treatment was of course utterly unfair and I am pleased to have the chance to say how deeply sorry I and we all are for what happened to him ...*

So on behalf of the British government, and all those who live freely thanks to Alan's work I am very proud to say: we're sorry, you deserved so much better."

In August 2009, petition started urging the British Government to posthumously apologize to Alan Turing for prosecuting him as a homosexual.



MOST SECRET

ENIGMA - POSITION

1. Stabilisation and synchronisation are carried through. We have enough Enigmas.

Plain catalogue is complete and punched. At moment under revision. Will be duplicated for French. This is the only work on hand at present.

3. CYCLOMETER.

Gadget (a). An old (P.O.) cyclometer too elaborate for use, since original purpose does not now obtain.

Gadget (b). A small hand sex-cyclometer which was a mere draft, cannot be worked at a remunerative speed and is more often in course of repair than working.

Gadget (c) A machine sex-cyclometer is promised in a fortnight. It's [sic] results should be punched.

4. PUNCHES.

We have two, and two more punches on order. Probably two more punch machines will be required.

5. A large 30 enigma bomb machine, adapted to use for cribs, is on order and parts are being made at the British Tabulating Company.

URGENTLY NEEDED.

6. See Appendix I.

7. See Appendix II.

DOUBTFULLY NEEDED.

8. Machine of silo order to work on cyclometer results. No good results can be obtained from applying hand methods either.

SIGNED: A.D.KNOX
P.F.G.TUTIN
H.G.WELCHMAN
A.M.TURING
J.R.Jeffreys [handwritten]
1st November, 1939.

1st November, 1939.

APPENDIX II

NAVAL ENIGMA SITUATION

The solution of Naval Enigma will divide itself into two parts, that of solving one message of a day, and that of solving further messages.

The first problem is to be tackled by:

(a). Analytical methods, using Jeffrey's statistics (virtually hopeless).

(b). By the machine now being made at Letchworth, resembling, but far larger than the Bombe of the Poles (superbombe machine).

If one message is solved by one of these means we shall have the machine settings for the day, viz. Walzenlage, Steckerverbindungen, Ringstellung, but not Grundstellung nor list of bigrams used in the indicating system. We might also obtain the Stecker by capture.

For the second problem; i.e. solving further messages, we may either:

(i) Guess three or four letters of the message.

(ii) Make use of another machine, the "rack", which operates by so setting the messages that the decode contains sufficiently many letters E.

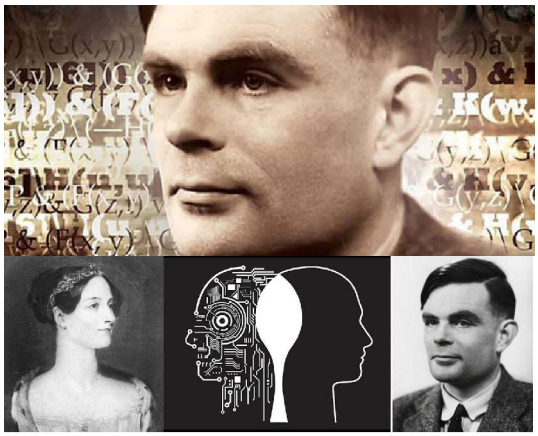
We have at present no information which will be of use for Method (i), although when a number of messages have been solved it may be applicable. Without a "rack" we shall, therefore, not be able to get any further if, for instance, position Stecker were captured from a submarine.

With the "rack" we shall, in such cases, almost certainly be able to solve 40% of the messages, and probably 70%. If by that time we are able to apply Method (i) as well, we may be able to solve as many as 200 messages on that day. If this ever happens it will be possible to solve the indicating system; i.e. to obtain the bigram list. This will enable us to solve all further messages for that day at once, and, on later days while the bigram list lasts, to solve all the messages as soon as a single message has been solved for that day.

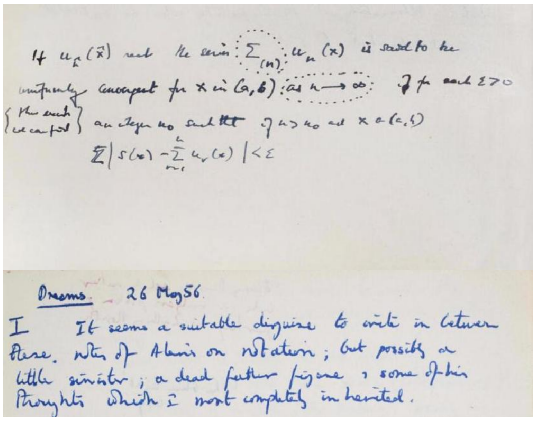
We feel that no unnecessary time should be lost in experimenting with and constructing such a machine.

SIGNED: A.D.KNOX
P.F.G.TUTIN
H.G.WELCHMAN
A.M.TURING
J.R.Jeffreys [handwritten]
1st November, 1939.

Enigma Report, 1939, Alan Turing Internet Scrapbook.



"Let us return for a moment to Lady Lovelace's objection, which stated that the machine can only do what we tell it to do."
- Alan Turing

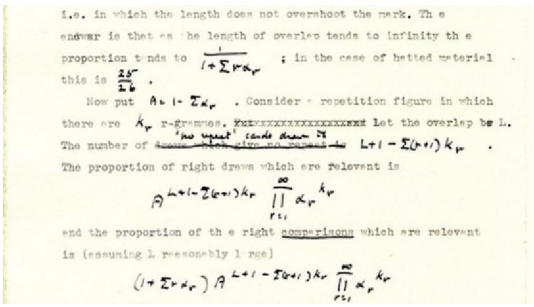


Alan Turing's Hand Scribbled Notebook.

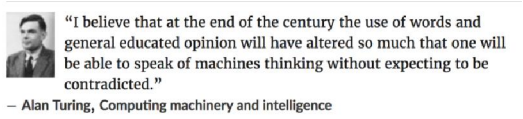
A University of Wolverhampton building has been renamed in honour of mathematician and wartime codebreaker Alan Turing.

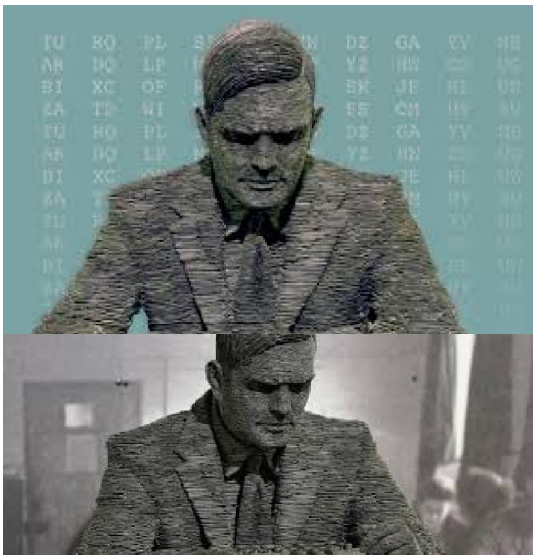
In 2009, the British Government issued this posthumous apology to Alan Turing but he was not pardoned.

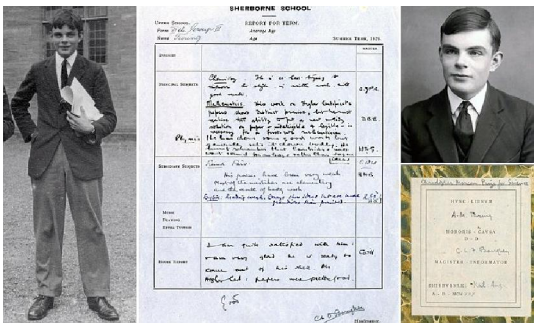
Papers belonging to and associated with Alan Turing.



Alan Turing's Secret Code-Breaking Essay.

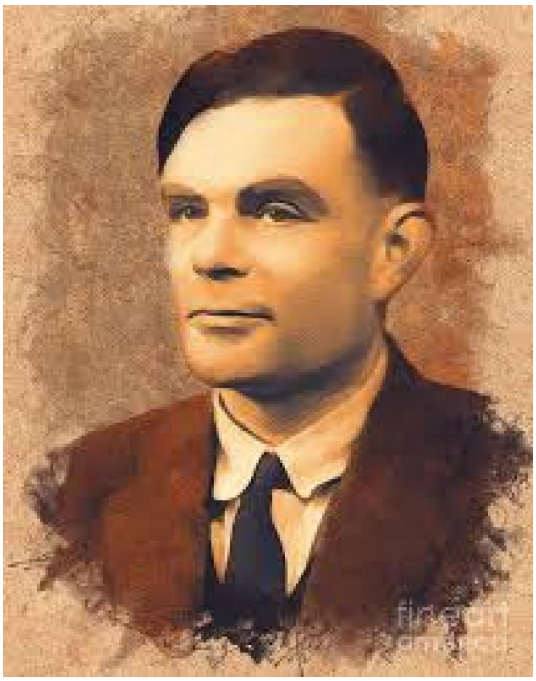




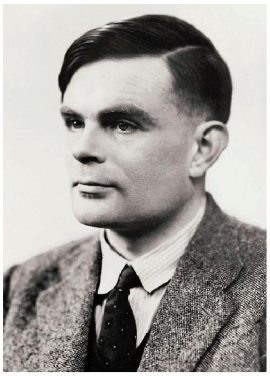


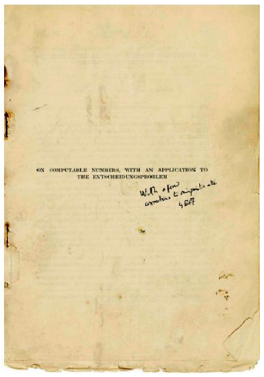
Biography

A short biography of Alan Turing is written by Andrew Hodges. This short biography, based on the entry for the written in 1995 for the Oxford Dictionary of Scientific Biography, gives an overview of Alan Turing's life and work. It can be read as a summary of the book **Alan Turing: The Enigma**.



Benedict Cumberbatch played Alan Turner in the 2014 American film, 'The Imitation Game'.





Movies

The movie The Imitation Game (2014) tried to show Turing's contributions during the World War II. It received an Oscar award for the Best Writing Adapted Screenplay in the 87th Academy Awards. The movie has some controversy attached to his historical accuracy.

Is Turing Test Passed?

No.

Even though large news sources claim that the Turing test was passed for the first time by Eugene Goostman (a chatbot made specifically to pass the Turing test), the replication of the test is considered far from the real Turing test.

Papers by Alan Turing

The list of papers published by Alan Turing during his life. This list is arranged in the chronological order.

- Equivalence of left and right almost periodicity (1935)
- Computability and λ-Definability (1937)
- On computable numbers, with an application to the Entscheidungsproblem (1937)
- Finite approximations to lie groups (1938)
- The extensions of a group (1938)
- Systems of logic based on ordinals (1939)
- The use of dots as brackets in Church's system (1942)
- Lecture to L.M.S. Feb. 20 1947 (1947)
- Rounding-off errors in matrix processes (1948)
- A practical form of type theory I (1948)
- Checking a large routine (1949)
- Computing machinery and intelligence (1950)
- Programmers' handbook for Manchester electronic computer. Mark II (1951)
- Intelligent machinery, a heretical theory (1951)
- Can digital computers think? (1951)
- Can automatic calculating machines be said to think? (1952)
- The chemical basis of morphogenesis (1952)
- Digital computers applied to games (1953)
- Some calculations of the Riemann zeta-function (1953)

The list of things named after Alan Turing

- Alan Turing Building, Manchester, England
- Alan Turing Centenary Conference, Manchester, England
- Alan Turing Institute, London, England
- Alan Turing law
- Alan Turing Memorial, Manchester, England
- Alan Turing sculpture, Eugene, Oregon, United States
- Alan Turing statue, Bletchley Park, England
- Alan Turing: The Enigma
- Alan Turing Year
- The Annotated Turing
- Church–Turing thesis
- Church–Turing–Deutsch principle
- Good–Turing frequency estimation
- Object-Oriented Turing (programming language)
- Turing-acceptable language
- Turing Award
- Turing (cipher)
- Turing College, Kent, England
- Turing completeness
- Turing computability
- Turing degree
- Turing Foundation, Amsterdam, Netherlands
- Turing Gateway to Mathematics, Cambridge, England
- The Turing Guide
- Turing House School
- Turing Institute, Glasgow, Scotland
- Turing jump
- Turing Lecture
- Turing machine
- Turing Machine (band)
- Turing (microarchitecture)
- Turing OS
- Turing pattern
- Turing Pharmaceuticals
- Turing Phone
- Turing (programming language)
- Turing reduction
- Turing Robot, China
- Turing Robotic Industries, San Francisco, California, United States
- Turing switch
- Turing table
- Turing tarpit
- Turing test
- Turing's Method
- Turing's proof
- Turing's Wager
- Turing+ (programming language)
- Turingery
- Turingismus
- Turmite
- Turochamp

Further Reading:

1. Computing Machinery and Intelligence By Alan Turing
2. Systems of Logic Based on Ordinals By Alan Turing
3. The Applications of Probability to Cryptography By Alan Turing
4. Turing's Treatise on the Enigma By Alan Turing
5. The Annotated Turing: A Guided Tour Through Alan Turing's Historic Paper on Computability and the Turing Machine By Charles Petzold
6. Turing, Father of the Modern Computer By B. Jack Copeland
7. Alan Turing's Automatic Computing Engine By B. Jack Copeland
8. Alan Turing By Geoff Wilkins
9. Turing Arts Symposium By Cate Dowd
10. A Bibliography of Publications of Alan Mathison Turing By Nelson H. F. Beebe
11. Alan Turing: His Work and Impact By Jan van Leeuwen
12. The Essential Turing By B. Jack Copeland
13. Mathematics in the Age of the Turing Machine By Thomas C. Hales
14. Letter to Alan Turing By Giuseppe Longo
15. The Legacy of Turing in Numerical Analysis By Felipe Cucker

16. Alan Turing: The Hidden Wartime Manuscript By the Father of Computing
17. Alan Turing and the Origins of Modern Gaussian Elimination By Froilán M. Dopico
18. Alan Turing and the Turing Award Winners By Luis Lamb
19. The Life and Intelligence of Alan Turing By Denbigh Starkey
20. The Incomputable Alan Turing By S. Barry Cooper
21. Alan Turing, Enigma, and the Breaking of German Machine Ciphers in World War II By Lee A. Gladwin
22. Alan Turing's Forgotten Ideas in Computer Science By Diane Proudfoot
23. Alan Turing "Founder of Computer Science" By Prof. Jonathan P. Bowen
24. The Ghost in the Quantum Turing Machine By Scott Aaronson
25. The Turing Test: Then and Now By Peter Hawke
26. Turing-Post Relativized Computability and Interactive Computing By Robert Irving Soare
27. Alan Turing, Computing, Bletchley, and Mathematics By Rod Downey
28. AM Turing's ACE Report of 1946 and other papers
29. Alan Turing and the Decision Problem By Richard Zach
30. On Computable Numbers, with an Application to the Entscheidungs problem By Alan Turing
31. The Chemical Basis of Morphogenesis By Alan Turing
32. Turing's Mathematical Work By P.D. Welch
33. Intelligent Machinery A Heretical Theory; reprinted in (Copeland 2004)
34. RO Gandy An Early Proof of Normalization By Alan Turing
35. An Early Program Proof By Alan Turing
36. On Alan Turing and the Origins of Digital Computers By B. Randell
37. The Genius of Alan Turing: The Computing Classical Model By Luís Homem
38. Alan Turing and the Other Theory of Computation (expanded) By Lenore Blum
39. Alan Turing's Chemical Theory of Phyllotaxis By M.D. Rueda-Contreras
40. ACM Turing Award Lectures: The First Twenty Years (1966 -- 1985)
41. Mathematical Logic By Alan Turing
42. Parsing the Turing Test By Gary Roberts
43. Thinking about Godel and Turing: Essays on Complexity, 1970 -- 2007
44. Turing (A Novel about Computation) By Christos Papadimitriou
45. Turing Option By Harry Harrison
46. Alan Turing: The Logical and Physical Basis of Computing By Andrew Hodges
47. Mind, Computing Machinery and Intelligence By A.M.Turing
48. Alan Turing and Number Theory
49. Alan Turing: The Enigma By Andrew Hodges
50. A Madman Dreams of Turing Machines By Janna Levin
51. Computing Over The Reals Where Turing Meets Newton
52. Die Turing Option By Marvin Minsky
53. Hypercomputation: Computing Beyond the Church − Turing Barrier
54. Thinking On The Web: Berners-Lee, Godel And Turing
55. Alan Turing and the Development of Artificial Intelligence
56. Can Digital Computers Think? By Alan Turing
57. Turing Machines, Computers, And Artificial Intelligence By Peter R. Krebs
58. Turing Machines with Sublogarithmic Space By Andrzej Szepietowski
59. The Automatic Computing Machine By Alan Turing
60. The Imitation Game By Graham Moore
61. Breaking Enigma By Jeremy Wright
62. Breaking Enigma and the U-boat Codes and the Legacy of Alan Turing
63. Alan Turing and Enigmatic Statistics By S. Barry Cooper
64. Letter to Norman Routledge By Alan Turing
65. The Genius Who Gave Us The Future: 100 years of Alan Turing
66. Turing and the Computer By Diane Proudfoot
67. Alan Turing at Bletchley Park in World War II By Tony Sale
68. Alan Turing: Life and Legacy of a Great Thinker By D Hofstadter
69. The Enigma Machine By Eric Roberts
70. The Military Use of Alan Turing By Andrew Hodges
71. Dr. Alan Turing "Father of Computer Science and Philosopher" By Paul Conn
72. What Kind of Turing Test Did Turing Have in Mind? By Jean Lassègue
73. Alan Turing (1912--1954) By Ong Marc-us
74. Sara Turing: Alan M. Turing, Cambridge University Press, 2012
75. Turing's Real Machines By Michael R. Williams
76. Number Theory II By Tom Leighton and Ronitt Rubinfeld
77. Alan Turing, the Politics of Sexual Science, and the Making of a Gay Icon

3/21/2017