Alan Turing at 110 – and Oxford!

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London South Bank University

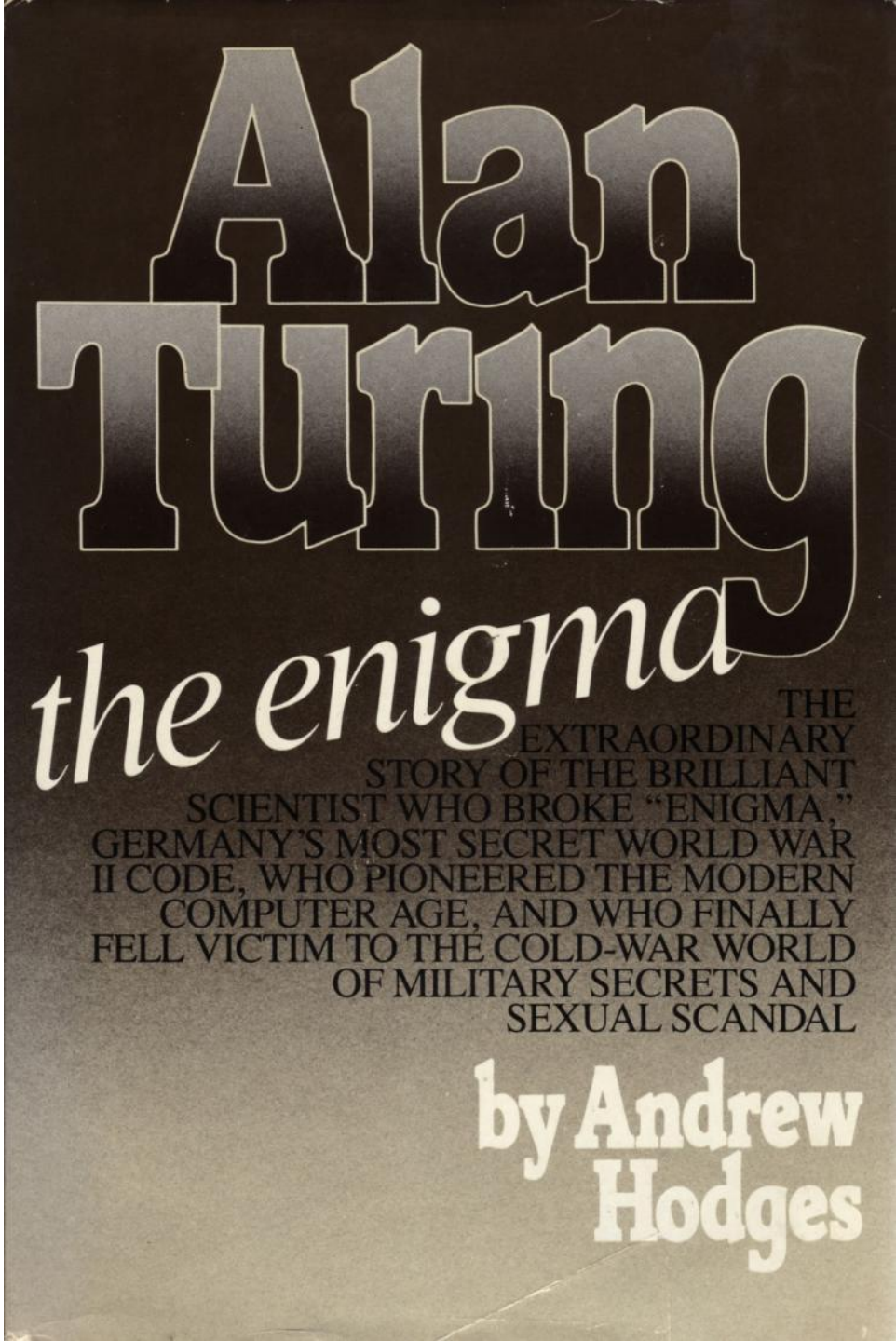
Overview

- **Alan Mathison Turing** OBE FRS (23 June 1912 – 7 June 1954)
- Polymath: mathematician, computer scientist, logician, cryptanalyst, philosopher, theoretical biologist, …
- Centenary meetings at Cambridge, Bletchley Park, Manchester, **Oxford**, etc., in 2012

Alan Turing: The Enigma

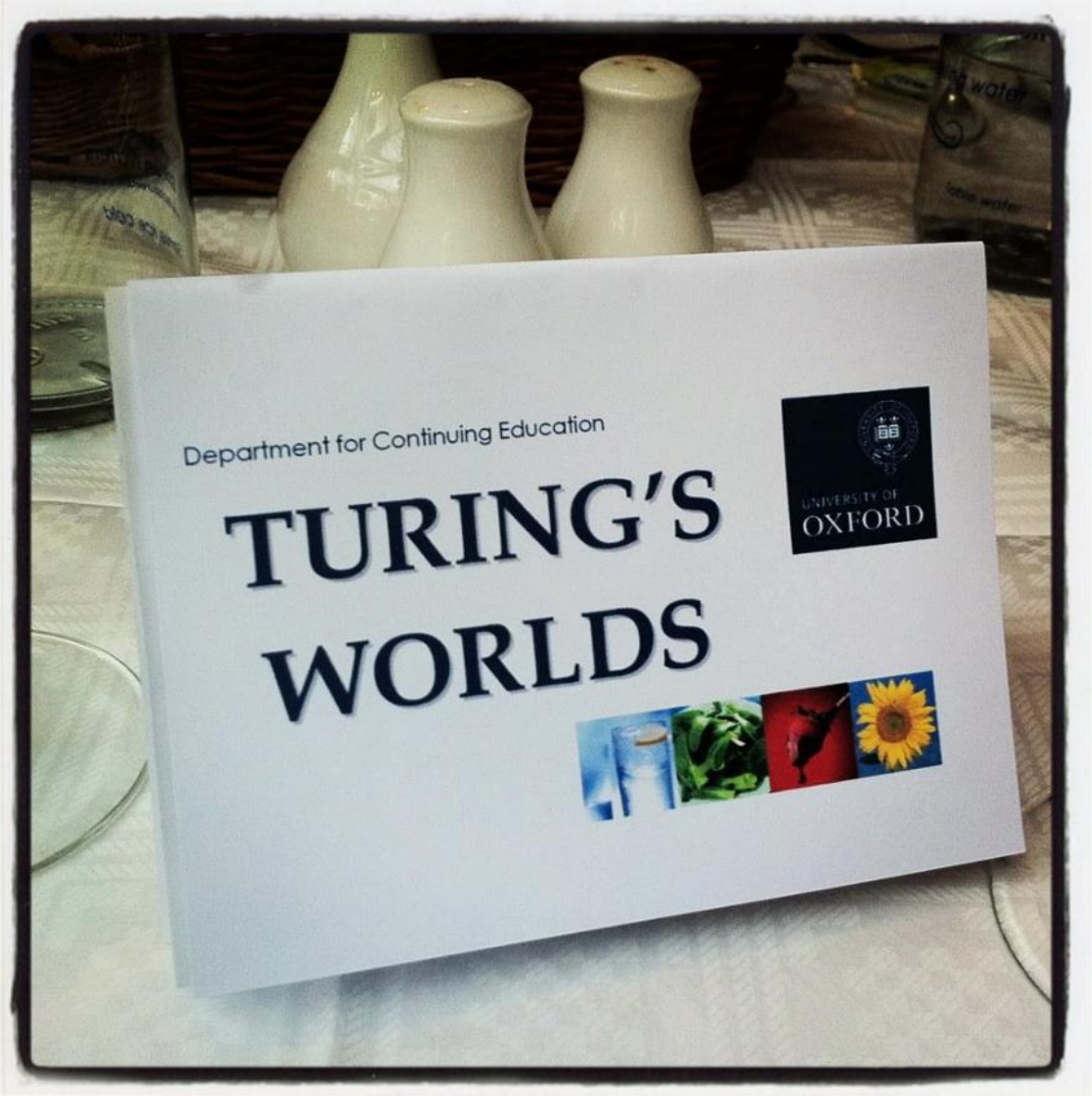
1st edition, 1983.
Centenary edition, 2012

Definitive biography by Andrew Hodges, Wadham College, Oxford



Turing's Worlds (23–24 June 2012)

Department of Continuing Education, Oxford

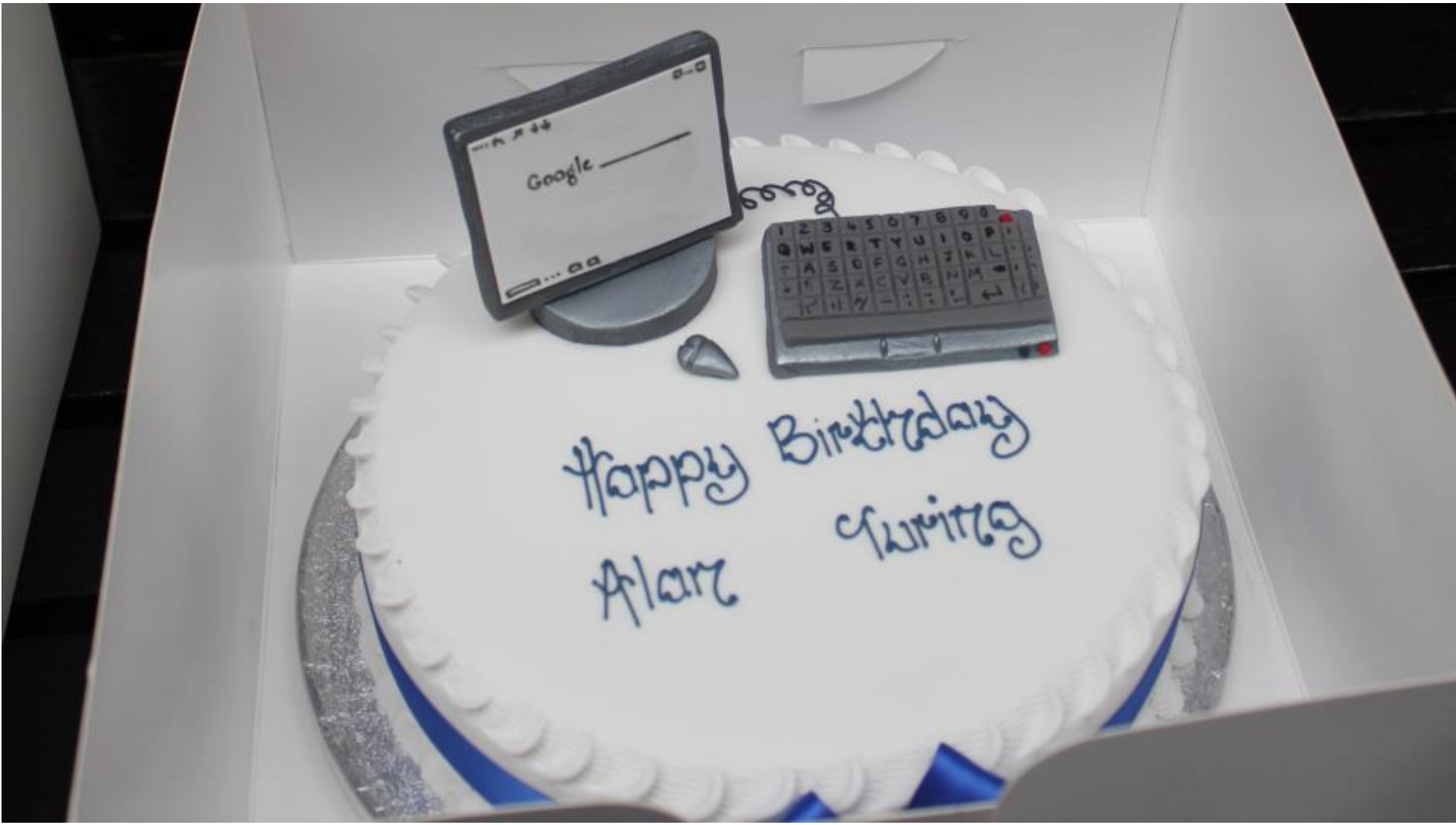


Turing's Worlds (23–24 June 2012)

Department of Continuing Education, Oxford

Happy Birthday Alan Turing! (2012)

Cake at Oxford centenary meeting



The Turing Guide (2017)

A collected set of 42 chapters on *Alan Turing*.
Co-editors (three with Oxford connections)

- *Jack Copeland* (University of Canterbury, New Zealand)
  – philosopher (DPhil student at Oxford)
- *Jonathan Bowen* (London South Bank University, England)
  – computer scientist (student and PRG researcher at Oxford)
- *Mark Sprevak* (University of Edinburgh, Scotland)
  – philosopher
- *Robin Wilson* (Open University / Oxford University, England)
  – mathematician

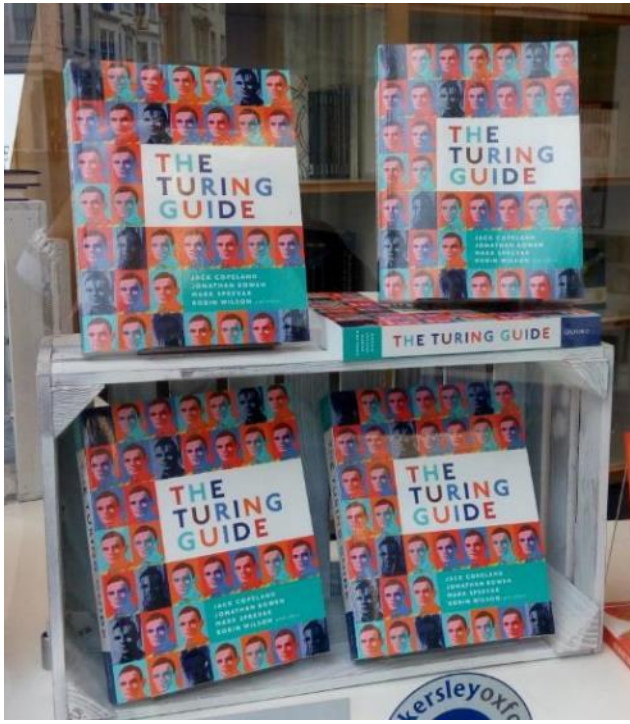
OXFORD
UNIVERSITY PRESS

Book contents

Foreword by Andrew Hodges

Eight parts:

1. Biography
2. The Universal Machine & Beyond
3. Codebreaker
4. Computers after the War
5. Artificial Intelligence & the Mind
6. Biological Growth
7. Mathematics
8. Finale



Display at Oxford University Press bookshop, High Street, Oxford

UK locations

Alan Turing was at:

- University of Cambridge [education, fellow]
- Bletchley Park [codebreaker, Bombe]
- National Physical Laboratory [ACE hardware]
- University of Manchester [Baby software]

Celebrated by these institutions but …

- University of Oxford? [no written primary evidence]

… until now!

Oxford connections

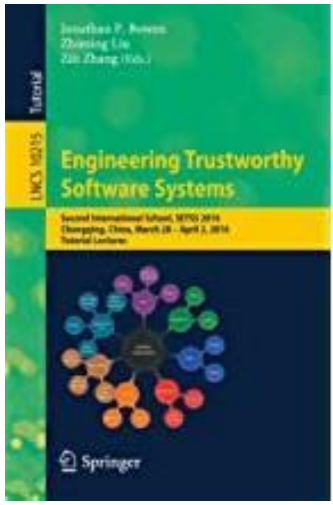
- Father, **Julius Mathison Turing** (1873–1947), scholar at Corpus Christi College, Oxford
- Turing family visited Oxford in summer 1924
- Turing could have followed his father to Oxford!

Oxford connections

- Security section of Government Code and Cypher School (GC&CS) at Mansfield College, Oxford in World War II
- "Varsity Line": Oxford–Bletchley–Cambridge
- Could Turing have visited from Bletchley Park in WWII?

Oxford visits by Turing?

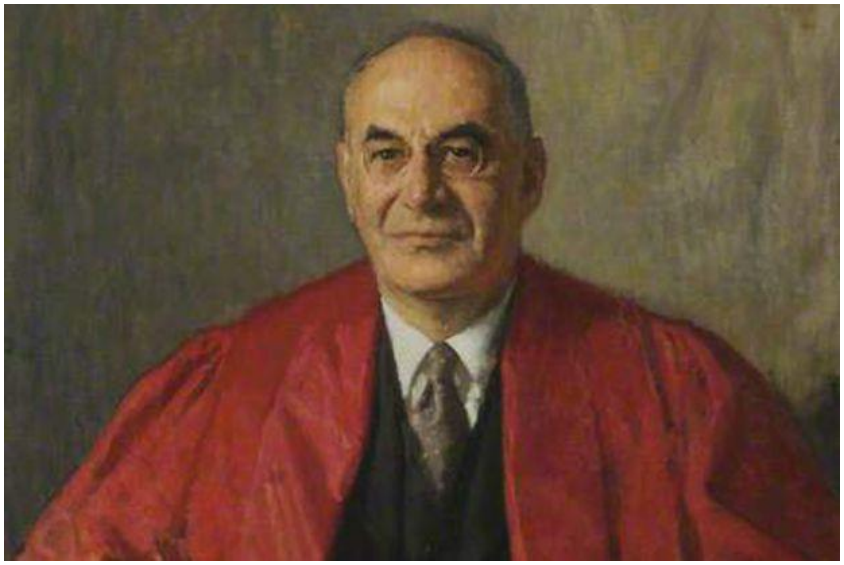
- Talks on **Alan Turing**, including at SETSS 2016 Spring School on Engineering Software Systems, Sothwest Univ., Chongqing, China
- **Jim Woodcock**, ex Oxford, now Professor of Software Engineering at the University of York in the audience



Bust of Alan Turing at Southwest University – paid for by students

Oxford visits by Turing?

- **Herbert Hart** (aka **H. L. A. Hart**, 1907–1992), at Bletchley Park during WW II, later Professor of Jurisprudence at Oxford during 1952–1968
- …after **Arthur Goodhart** (1891–1978), American jurist, at University College, Oxford, from 1931, later Master (1951–1963)

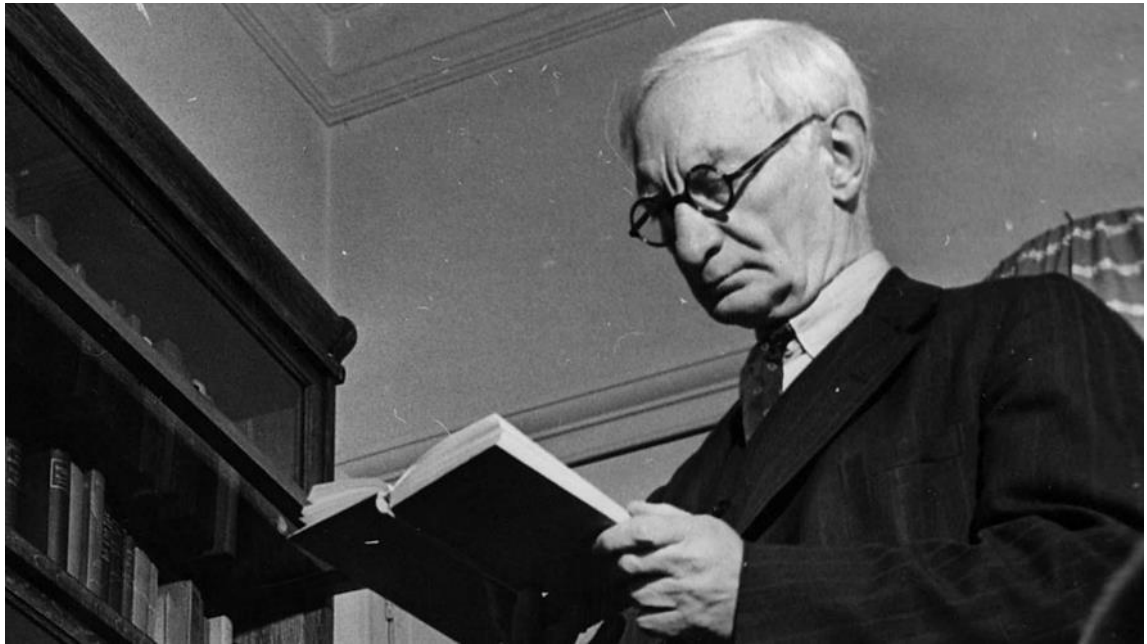


Oxford visits by Turing?

- Visit to University College, Oxford, for lunch during WWII by General **Dwight D. Eisenhower** (1890–1969) and others from Bletchley Park…
- …including Alan Turing…

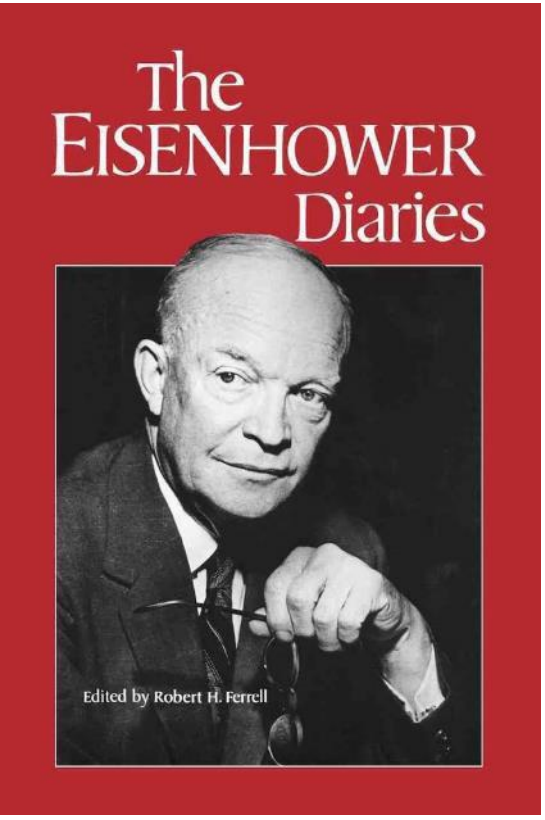
University College visit?

- University College archivist: Robin Darwall-Smith
- **Arthur Goodhart**: an Anglophile American, and friend of Eisenhower
- Sir **William Beveridge** (1879–1963), Master of University College (1937–1945) during WWII

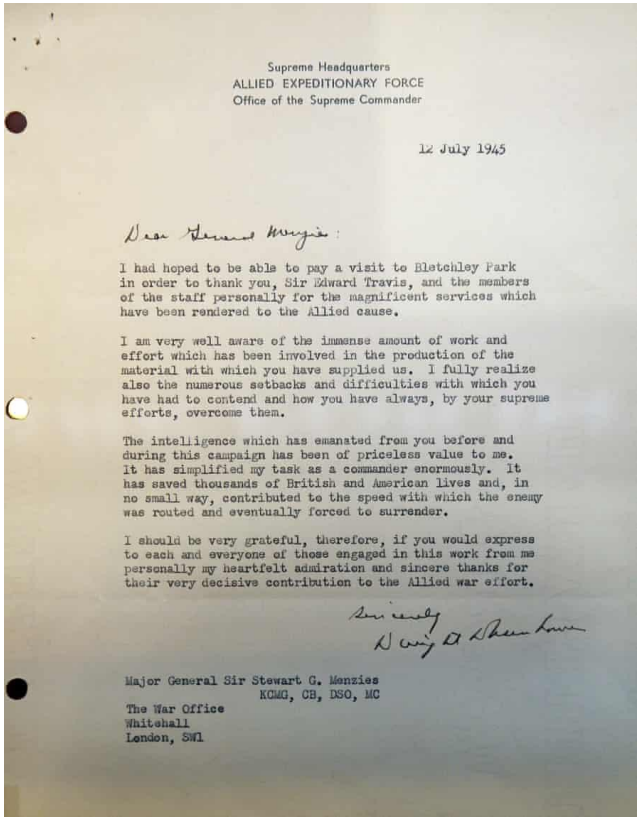


University College visit?

- Eisenhower archives and diaries, USA
- Eisenhower visited Oxford on 1 October 1942 …
- … and 16 April 1944 before D-Day



Eisenhower wrote to thank those at Bletchley Park on 12 July 1945



Supreme Headquarters
ALLIED EXPEDITIONARY FORCE
Office of the Supreme Commander

12 July 1945

Dear Edward Travis:

I had hoped to be able to pay a visit to Bletchley Park in order to thank you, Sir Edward Travis, and the members of the staff personally for the magnificent services which have been rendered to the Allied cause.

I am very well aware of the immense amount of work and effort which has been involved in the production of the material with which you have supplied us. I fully realize also the numerous setbacks and difficulties with which you have had to contend and how you have always, by your supreme efforts, overcome them.

The intelligence which has emanated from you before and during this campaign has been of priceless value to me. It has simplified my task as a commander enormously. It has saved thousands of British and American lives and, in no small way, contributed to the speed with which the enemy was routed and eventually forced to surrender.

I should be very grateful, therefore, if you would express to each and everyone of those engaged in this work from me personally my heartfelt admiration and sincere thanks for their very decisive contribution to the Allied war effort.

Sincerely
Dwight D. Eisenhower

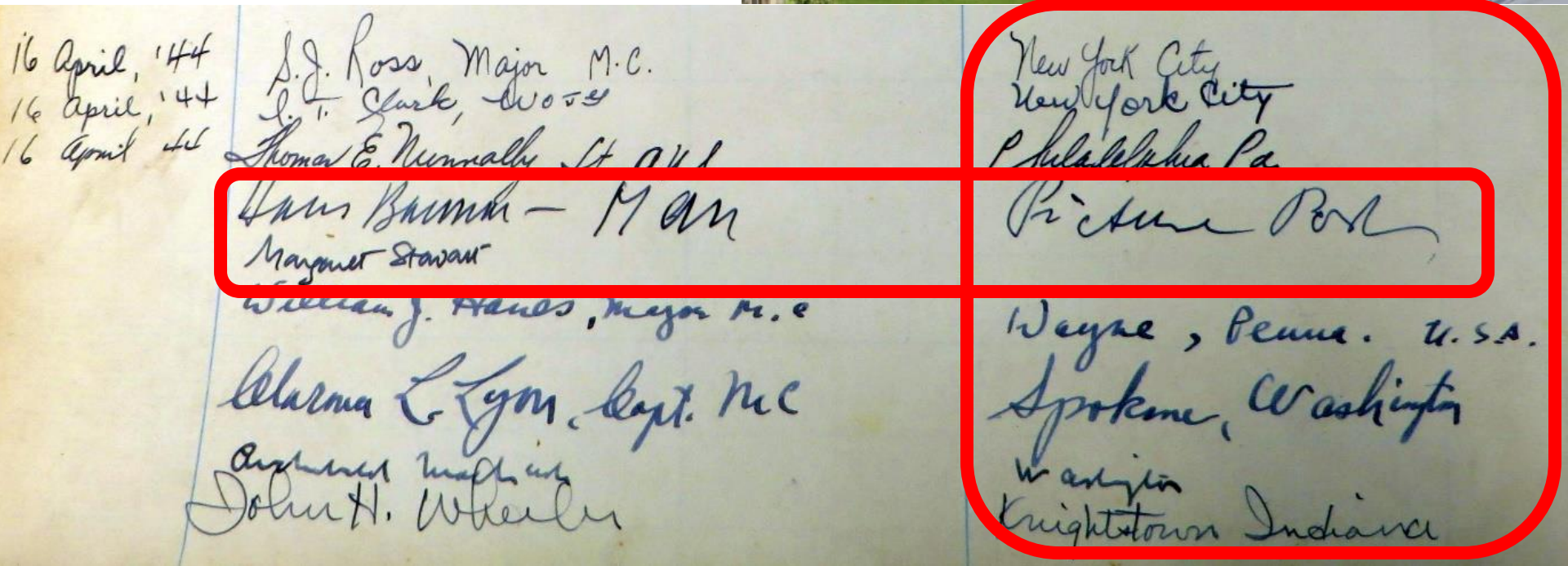
Major General Sir Stewart G. Menzies
KCMG, CB, DSO, MC
The War Office
Whitehall
London, SW1

University College visit?

- Beveridge archive, London School of Economics
- Pocket diaries – almost empty!
- Univ Master's Lodgings visitors' book…

Master's lodgings visit?

- 16 April 1944 entry in Master's Lodgings visitors' book
- American entries
- And *Picture Post*



Picture Post (6 May 1944)

Photos by **Hans Felix Sigismund Baumann** (1893–1985), aka **Felix H. Man**; text by **Margaret Stewart**

Sunday Tea With the Beveridges: The Moment Before the Guests Arrive
At the Master's Lodgings, University College, Oxford, Sir William and Lady Beveridge are having some American officers to tea. They do this every Sunday when they're at home.

THERE'S GOING TO BE ANOTHER BEVERIDGE REPORT

Sir William Beveridge has finished his report on Full Employment. He is sending it to the printers at the beginning of this month, and it should come out in June.

THE last Beveridge Report was an official one, ordered by the Government, when Arthur Greenwood was Minister in charge of Reconstruction affairs. The new Beveridge Report is an independent piece of work. He has done it on his own initiative. He has been advised by economists and statisticians in Oxford, Cambridge and London, he has talked to business men, and he has had the co-operation of the Trades Union Congress. The only people who have not co-operated—because they have not been allowed to—have been the civil servants. In fact, Sir William has not been officially in touch with the Civil Service since, as Chairman of an Interdepartmental Committee of civil servants, he signed his social insurance report on November 20, 1942. The idea of working on Full Employment came to Sir William Beveridge while he was still writing his Social Insurance Report. One of the major assumptions—Assumption C—on which his scheme for social security is based is "the maintenance of employment." He has now set out to show how this can be done.

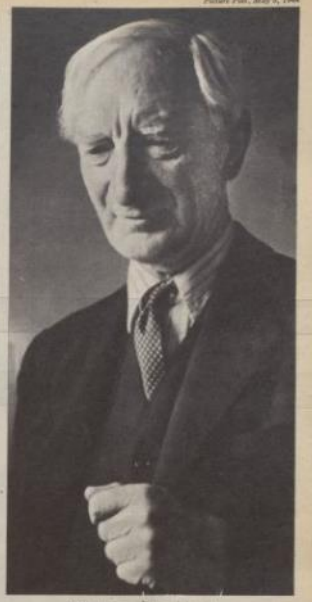
Beveridge is the world's leading expert in unemployment problems. As a civil servant in the Board of Trade in 1911 he was largely responsible for creating the present system of unemployment insurance and the network of employment exchanges. His book "Unemployment—a Problem of Industry" published in 1909 is still the classic text-book. He advised the Government on the Unemployment Act, 1934, and has since been chairman of the Unemployment Statutory Insurance Committee.

The "maintenance of employment" doesn't mean that nobody at any time will be unemployed. It means that there will always be vacant jobs for those out of work, and the degree of unemployment will depend on the mobility of labour. Unemployment Insurance will become, what it was originally intended to be, a benefit to tide over a period of waiting between jobs.

Beveridge thinks that unemployment can be kept

The Guests Are Shown Round
The Master takes Capt. Lyon and Major Ross round "Univ." and tells them its history. He has been Master since 1933

The Guests Wait for Tea-time
Five Americans have come to tea—three from New York, one from Philadelphia, one from California. Lady Beveridge's daughter, Mrs. Burn, is third from the right.



The Man with a Plan to Master Unemployment
Sir William Beveridge believes we could keep unemployment well below ten per cent. of the insured population. This was set as the danger limit in his famous Social Security Report.

The Last Corrections to His Report
In the Master's study, he goes through the typescript of his Unemployment Report.

The Unexpected Visitor
Dr. Noel Paton, looking round the college, meets a Master. Her relatives were undergraduates.

The Minutes of Relaxation: An Exchange of Views About America
Capt. Clarence Lyon, of Spokane, Washington, talks to Sir William about medical services in America and Britain. His host was in the States last year, and recalls his experiences.

has ten per cent. of the insured workers. ...rented a to ensure an adequate flow of spend... in the community, by businesses, by government ...l authorities. And the details will be ...ailed in his new Report.

...n the meantime, busy as he is, Sir William finds ...e a Sunday afternoon to entertain American ...ors stationed in Oxford. He and Lady Beve... do this every Sunday, and the Beveridge tea-... are famous on both sides of the Atlantic. ...e big, high-ceilinged room of the Master's ...ge, University College, Oxford—suitably ...ed in Logic Lane—American officers can ...e here. Sir William and Lady Beveridge have ...n a picture tour in the United States and they ...e anxious to do all they can to build up Anglo-...can understanding. This informal contact ...s very good way of doing it. In a tour of the ...ge, the Americans are impressed by its traditions ...ntinuity. Major Ross, from Long Island, says, "...ny one of these chairs is older than our whole country!" They see the mulberry tree planted by James II in the Fellows' Garden. They see the door where Shelley pinned up a pamphlet on "The Necessity for Atheism," for which act he was "sent down." They see the Hall, the Chapel, the kitchens and the Common room where the dons take their after-dinner port. The port, Sir William tells them, was famous even in Dr. Johnson's day.

Beveridge shows them round, has tea with them, and returns to the study where his book is in its final stages. He is a curiously isolated figure in British life. He is perhaps the greatest expert alive, and yet he is completely neglected by the country's leaders. His Social Insurance Report has lain on the shelf for nearly 18 months. His earlier scheme for fuel rationing was rejected in 1942.

Two questions must be asked—

Will the Government pay more attention to the Employment report than they did to earlier Beveridge reports? and What will Beveridge do next?

MARGARET STEWART.

University College visit?

- American soldiers visit **Beveridge** at the Master's Lodgings for tea on Sunday 16 April 1944
- **Beveridge** and **Eisenhower** both in Oxford
- No record of people signing in for lunch in Hall at University College
- Could there have been a secret lunch at the Master's Lodgings with **Eisenhower**, **Turing**, and other Bletchley Park personnel?
- **Robin Darwall-Smith**, University College archivist, thinks it entirely possible …
- …but sadly no written evidence

Other wartime and post-war visits?

- Weekend visit to Oxford with Joan Clarke (1917–1996)
- At Bletchley Park, briefly engaged to Turing
- Visiting her brother, Martin Clarke, previously a Fellow at King's College, Cambridge (Hodges)

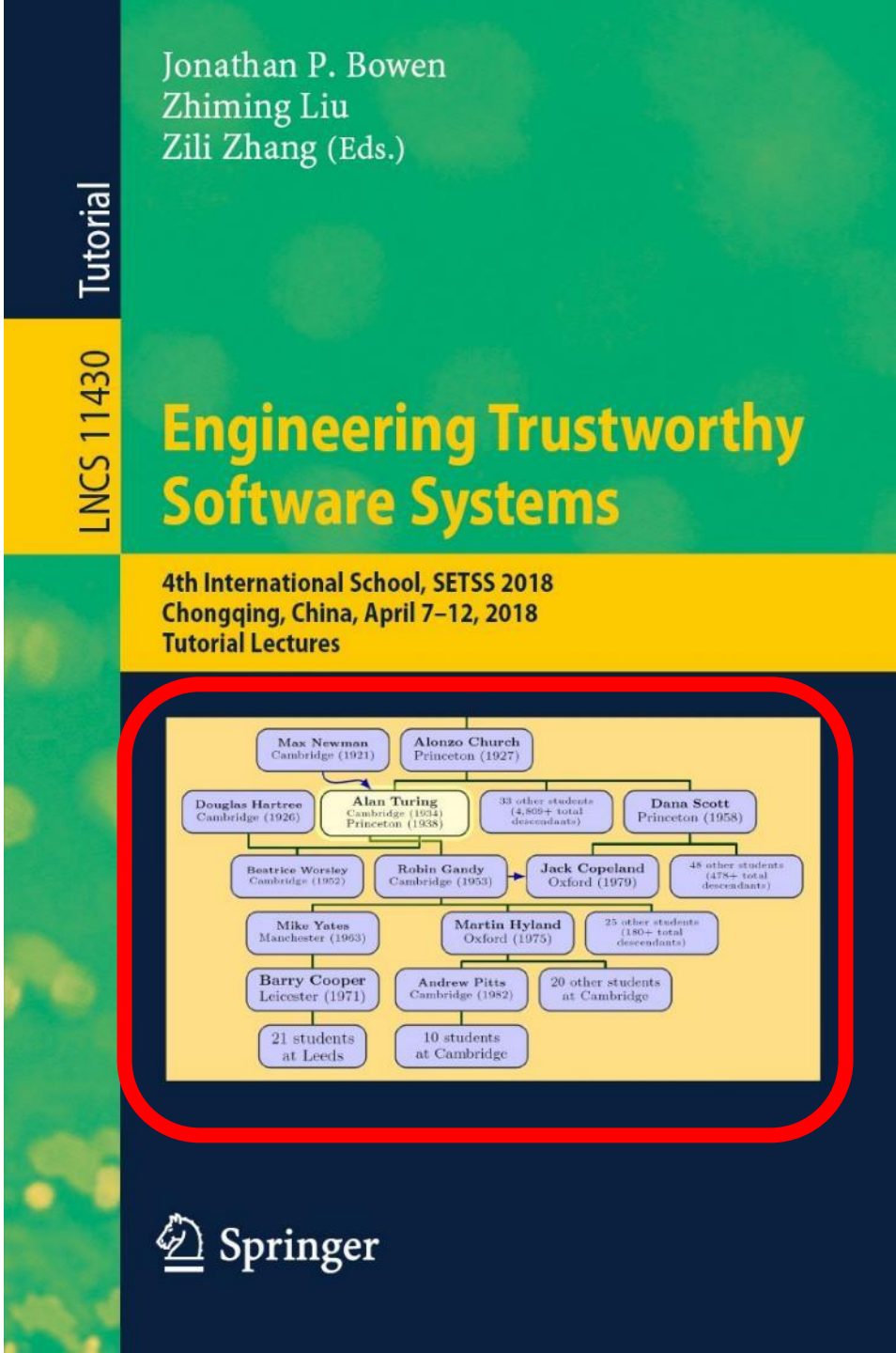
Other wartime and post-war visits?

- **David Champernowne** (1912–2000), former mathematics scholar with Turing at King's College
- Professor of Statistical Economics at Oxford (1948–1959)
- Collaborated with Turing on an early chess-playing program, *Turochamp*
- … some visits likely in Oxford (Hodges)

Turochamp v. Kasparov at the 2012 Alan Turing Centenary Conference, University of Manchester

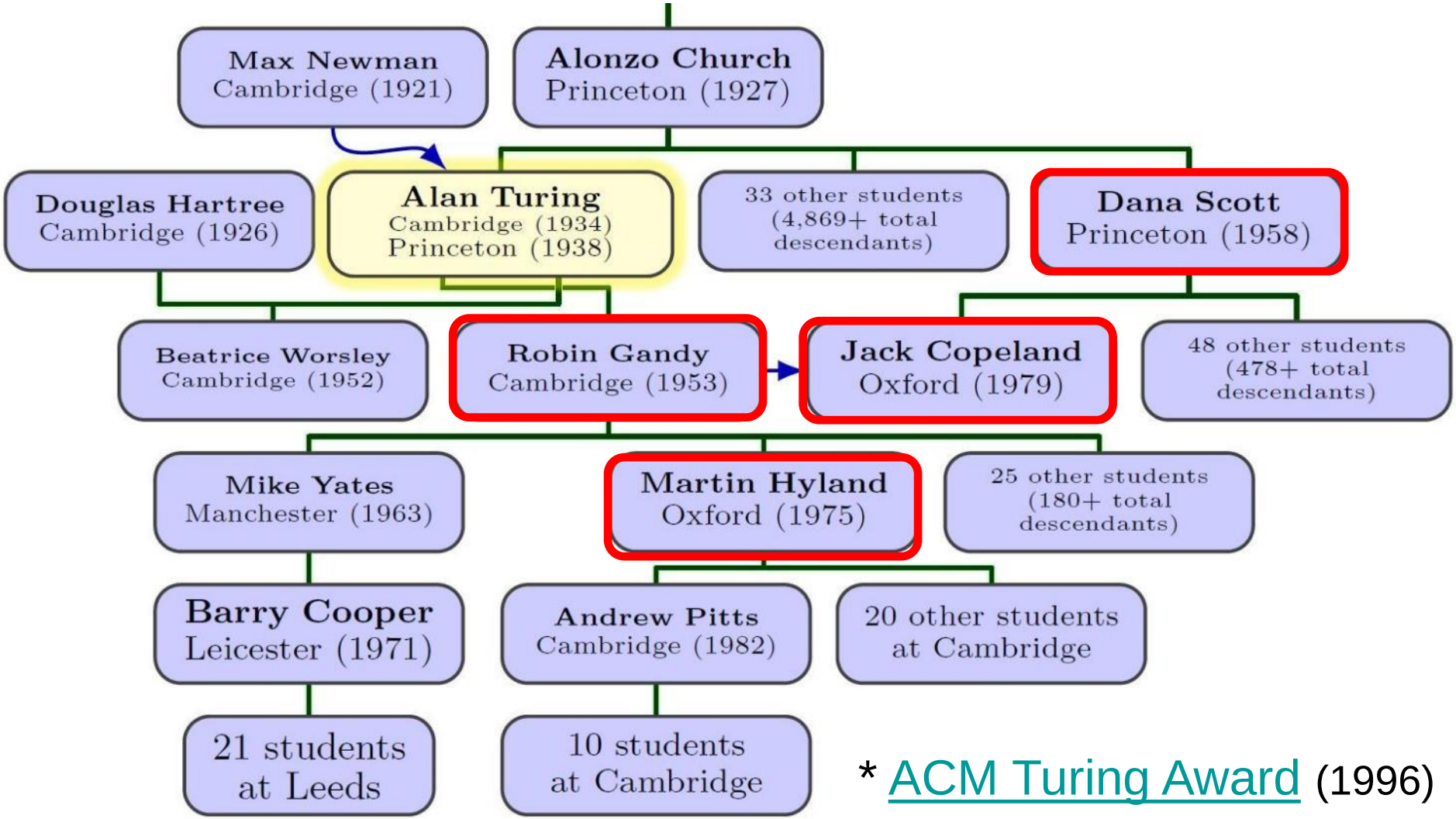
Turing's academic adviser tree

- Talk on **Alan Turing**, SETSS Spring School on Engineering Software Systems, Chongqing, China, 2018
- Based on the [Mathematics Genealogy Project] (MGP) database



Academic advisor tree

Later at Oxford: Dana Scott*, Robin Gandy (1919–1995), …



* ACM Turing Award (1996)

Robin Gandy (1919–1995)

- British mathematician and logician
- PhD student of **Turing** at Cambridge
- Studied at King's College, Cambridge (like Turing)
- Worked on radio intercept equipment at Hanslope Park (north of Bletchley Park) in WWII
- Turing worked there too on speech encipherment
- They became lifelong friends and associates

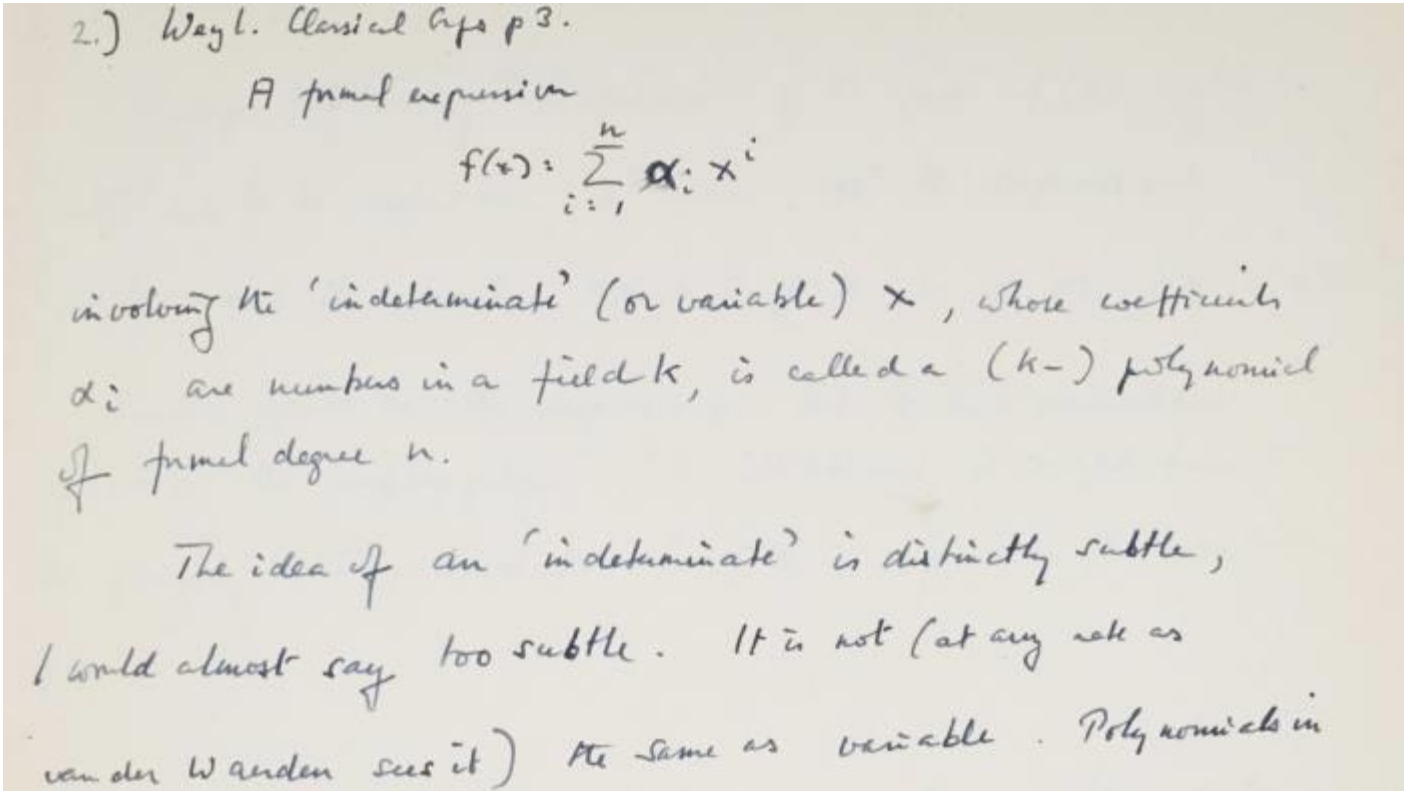
Robin Gandy
(1919–1995)

Poem from Turing to Gandy

Hyperboloids of wondrous Light;
Rolling for aye through Space and Time;
Harbour those Waves which somehow Might;
Play out God's holy pantomime.

Turing notebook, 1942 (sold April 2015)

- Handwritten during WWII
- Given to **Robin Gandy** after Turing's death
- Sold at Bonhams, New York for $1,025,000 (£700,850)!



2.) Weyl. Classical Grps p 3.

A formal expression

$$f(x) = \sum_{i=1}^{n} \alpha_i x^i$$

involving the 'indeterminate' (or variable) x, whose coefficients α_i are numbers in a field k, is called a (k-) polynomial of formal degree n.

The idea of an 'indeterminate' is distinctly subtle, I would almost say too subtle. It is not (at any rate as van der Waerden sees it) the same as variable. Polynomials in

Robin Gandy (1919–1995)

- Later Fellow of Wolfson College, Oxford (1969–1986)
- Reader in Mathematical Logic at the Oxford Mathematical Institute
- Emeritus Fellow (1986–1995)
- Robin Gandy Buildings

Robin Gandy (1919–1995)

- Centenary celebration at Wolfson College, Oxford (just pre-COVID)
- Many former colleagues …
- … and me! … **Samson Abramsky** FRS, Oxford

Dana Scott (b. 1932)

- American logician
- Domain theory
- Semantics of programming languages
- Mathematical Institute, Oxford (1972–1981)
- Collaborated with **Christopher Strachey** (1916–1975), leader of the Programming Research Group, Oxford, in the 1970s
- Scott-Strachey approach to denotational semantics
- 1976 ACM Turing Award for automata theory

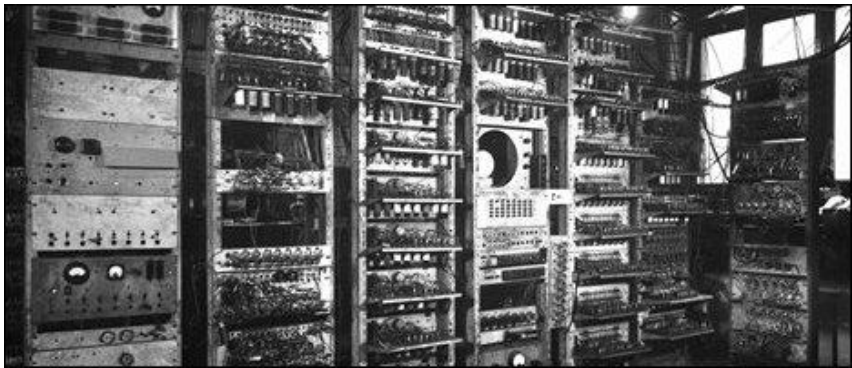
Christopher Strachey (1916–1975)

- British computer scientist
- Member of the Strachey family
- Studied at King's College, Cambridge (like Turing)
- Draughts program for the Pilot ACE at NPL
- Worked with **Turing** at Manchester
- First computer music on Manchester Mark II
- First director of the Programming Research Group, Oxford (1965–1975)
- First professor of computer science at Oxford
- Distinguished Fellow of the BCS

Earliest computer music

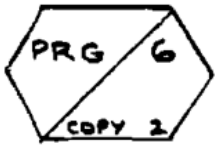
- Recorded in 1951 by the BBC at the University of Manchester
- On Ferranti Mark 1 computer
- Tunes: *God Save the King*, *Baa Baa Black Sheep*, part of *In the Mood*
- Written by **Christopher Strachey**, colleague of Turing
- Restored in 2016

Copeland, J. & Long, J. (2017). Computer music, chapter 23. In *The Turing Guide*, Oxford University Press.



Manchester computer

Scott & Strachey



- Early PRG-6 monograph (1971)
- Mathematical semantics of programming languages
- Scott-Strachey approach to denotational semantics

TOWARD A MATHEMATICAL SEMANTICS FOR COMPUTER LANGUAGES

by

Dana Scott

and

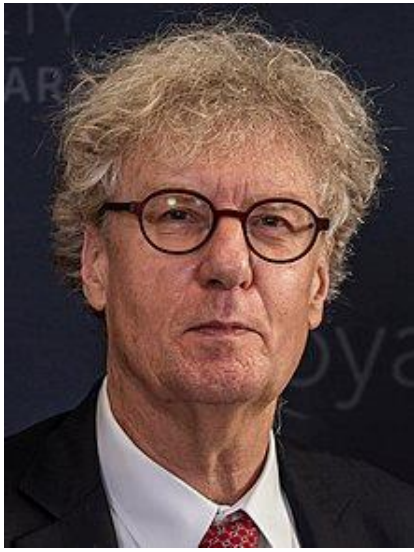
Christopher Strachey

Oxford University
Computing Laboratory
Programming Research Group-Library
8-11 Keble Road
Oxford OX1 3QD
Oxford (0865) 54141

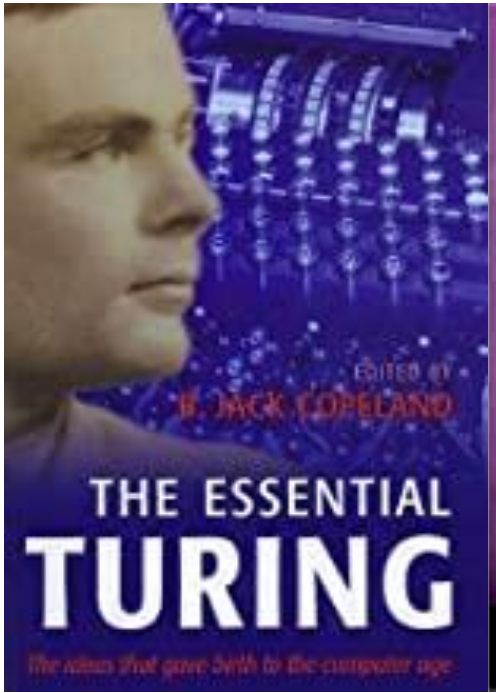
Oxford University Computing Laboratory

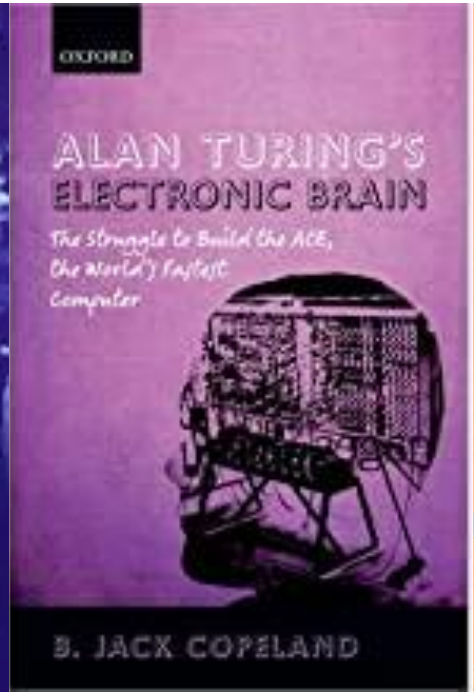
Programming Research Group

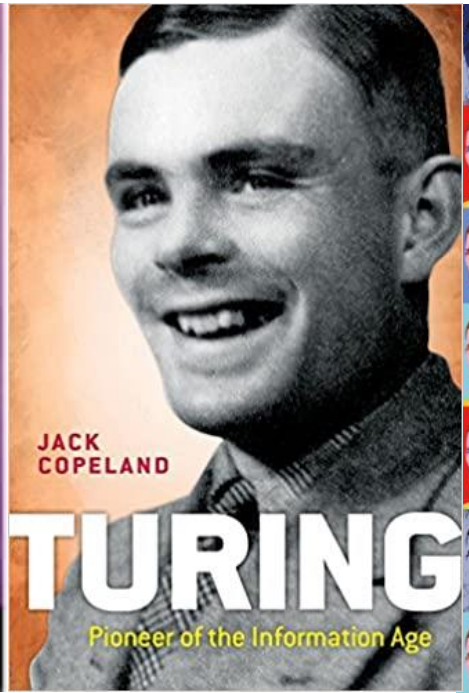
Jack Copeland (b. 1950)

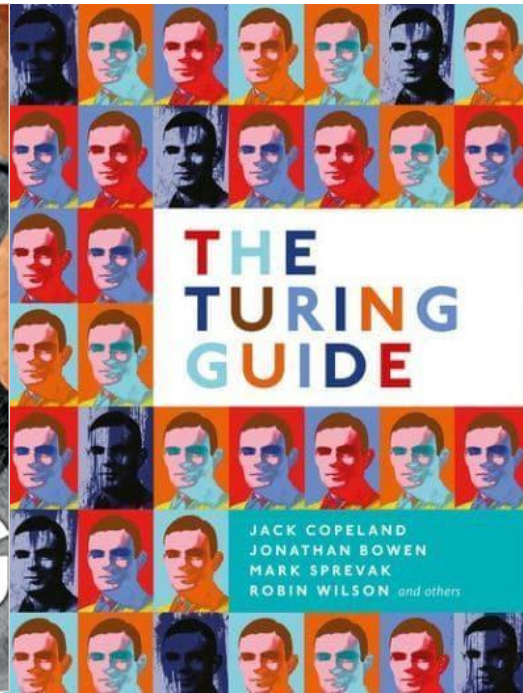


- British philosopher
- Based in New Zealand
- Oxford DPhil (logic) under **Dana Scott**
- Turing scholar (many books)







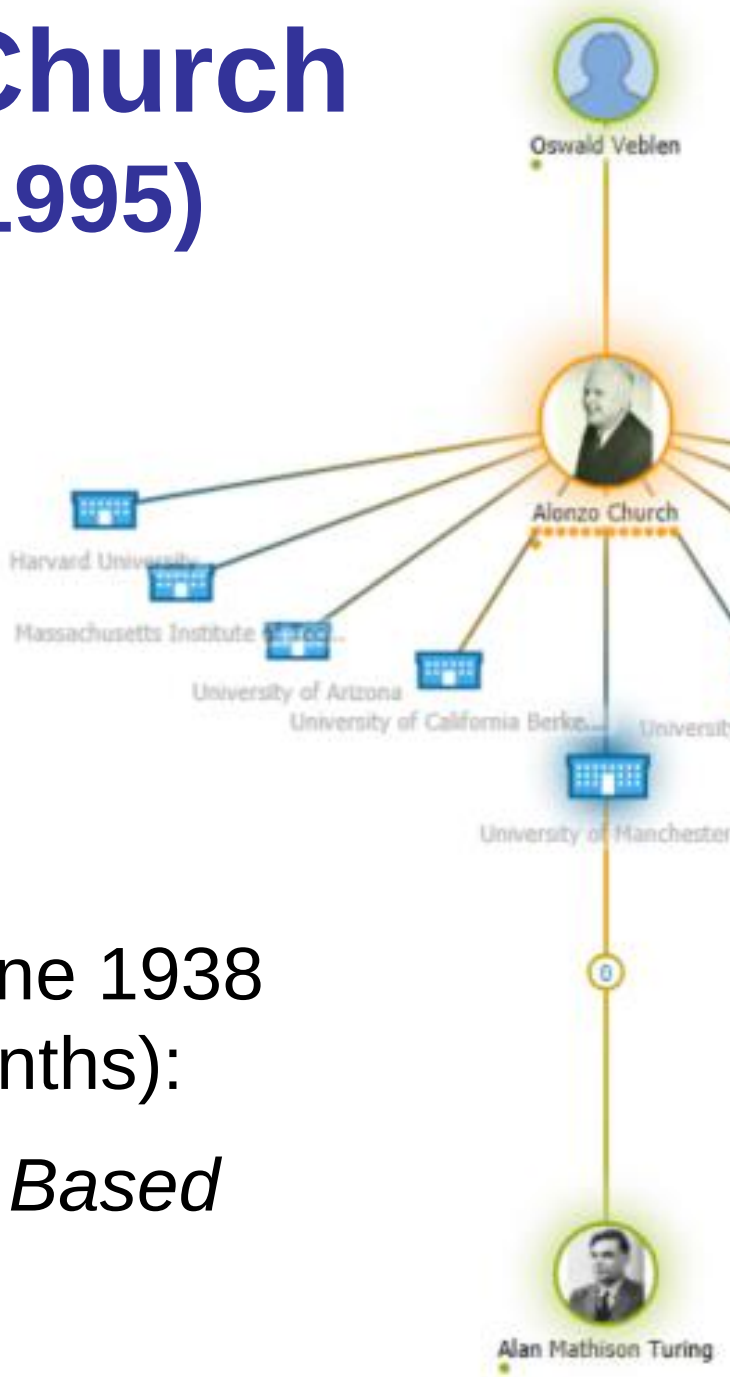


Alonzo Church (1903–1995)

Supervisor of Turing at Princeton University, USA (Sept. 1936 – July 1938)

Turing: PhD in June 1938 (only 1 year 9 months):

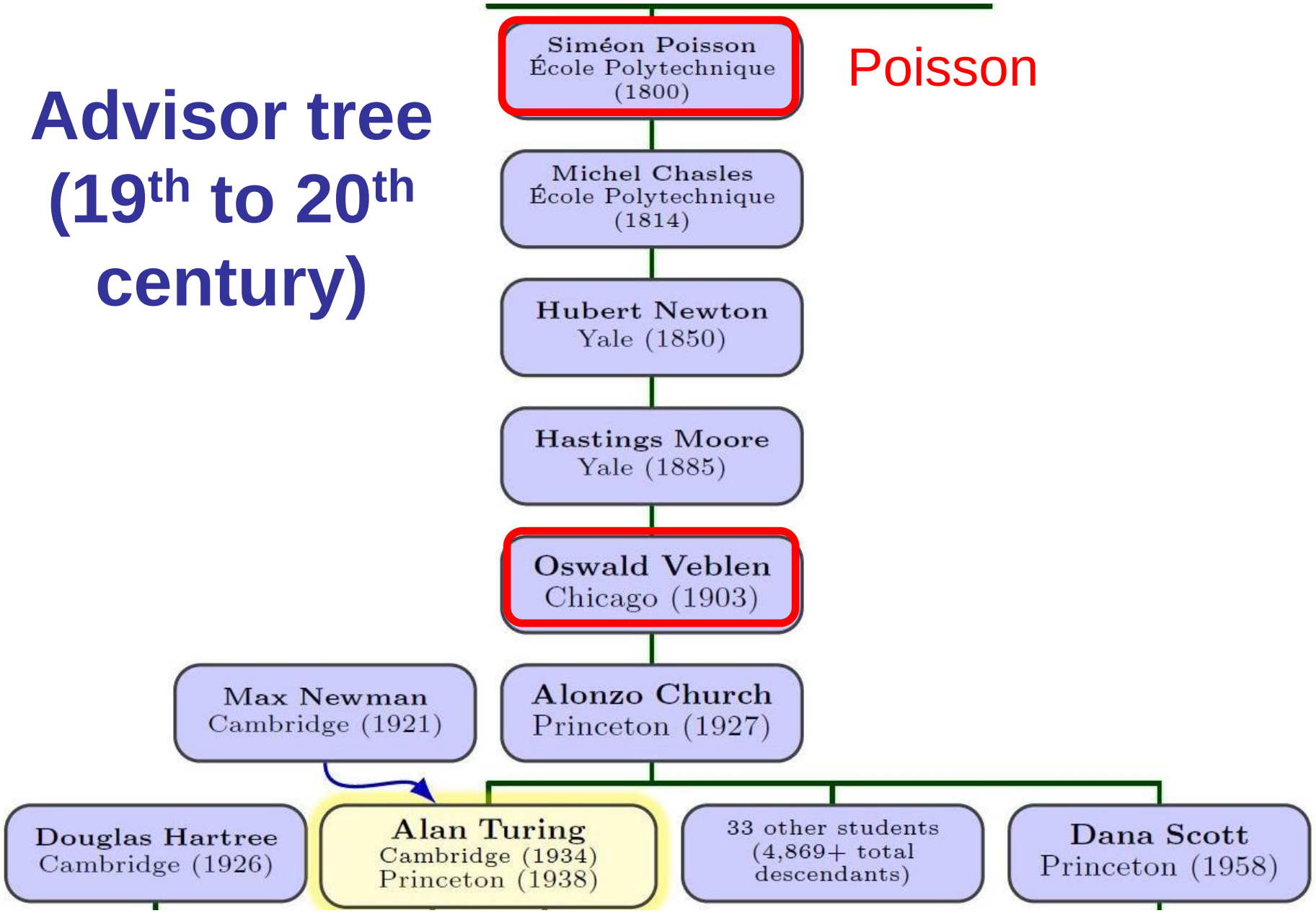
Systems of Logic Based on Ordinals



The Church–Turing thesis

- **Alonzo Church** and Turing
- Undecidability of the Entscheidungsproblem ("decision problem")
- Two independently developed approaches
- Turing could have stayed at Princeton, but... WWII

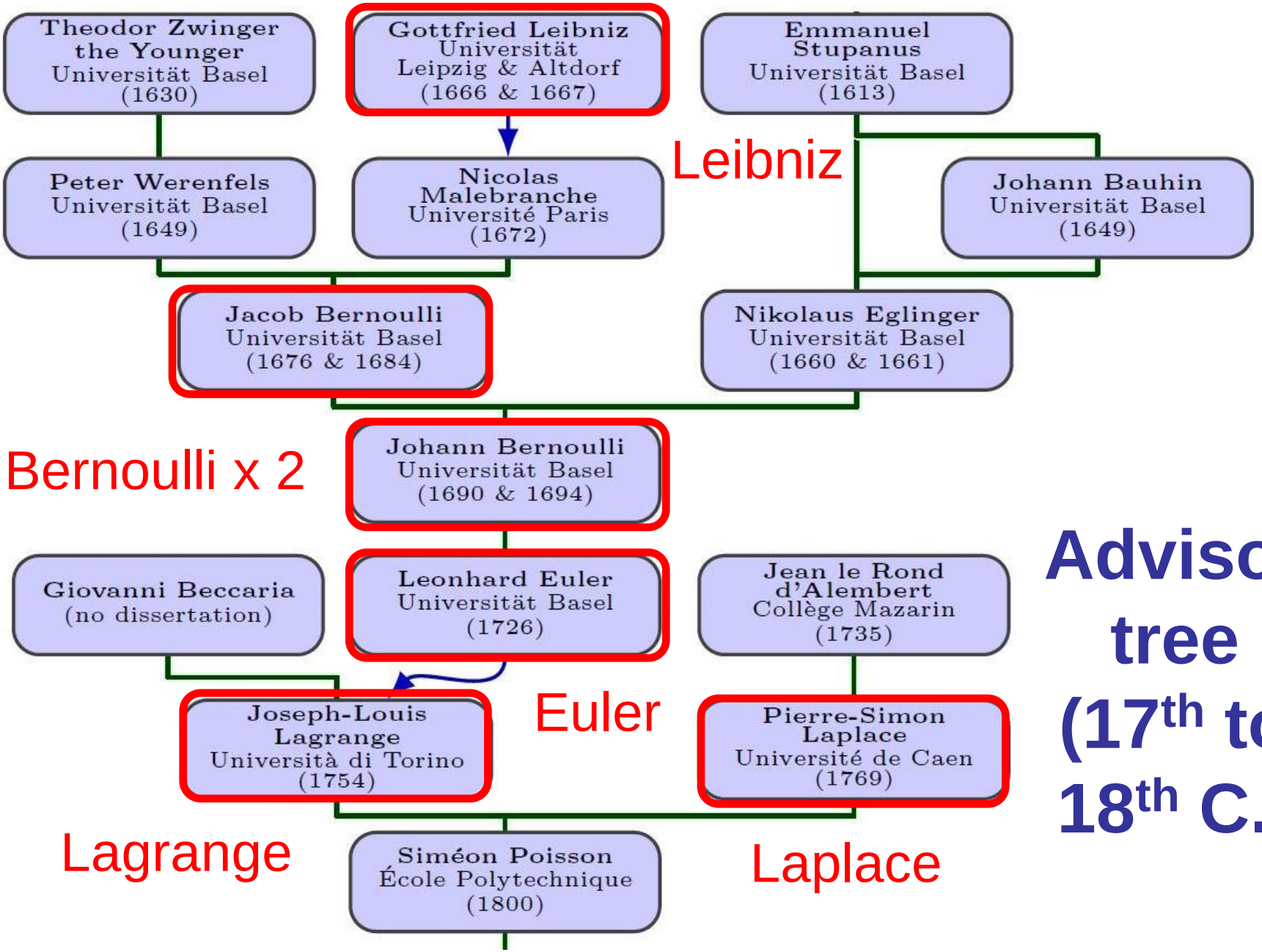
Advisor tree (19th to 20th century)



SETSS 2018, from the Mathematics Genealogy Project

Oswald Veblen (1880–1960)

- American mathematician and topologist
- Taught at Princeton (1905–1932)
- Helped organize the Institute for Advanced Study (IAS) at Princeton (1932)
- **Albert Einstein** at the IAS (1933–1955)
- … after visits to Oxford in 1931 & 1933
- **Kurt Gödel** visited IAS in 1934
- Turing in Princeton for PhD (1936–1938) …
- Could Turing & Einstein have met?

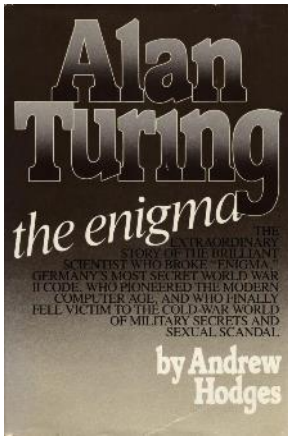


Advisor tree (17th to 18th C.)

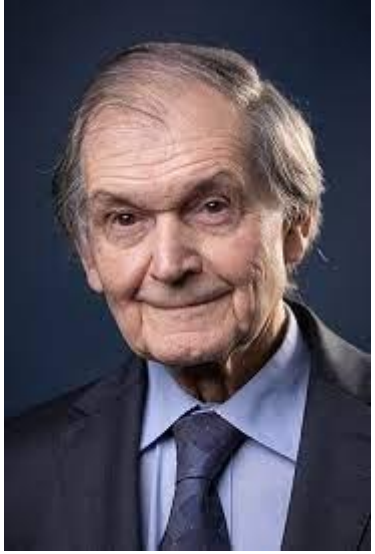
SETSS 2018, from the Mathematics Genealogy Project

Further Oxford influences

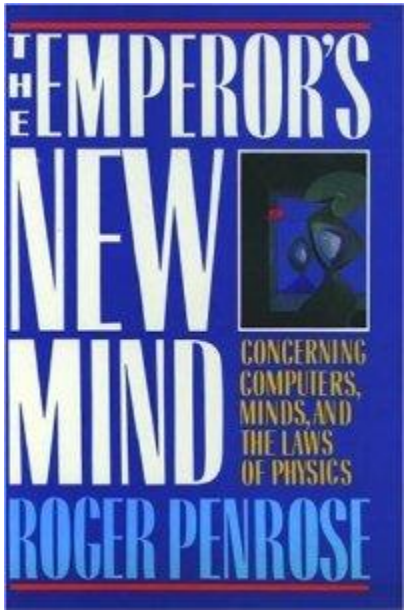
- Roger Penrose OM FRS, Rouse Ball Professor of Mathematics at Oxford (AI and computability)
- Andrew Hodges, Turing's biographer (1983/2012)
- Philip Maini FRS, Mathematical Institute (mathematical biology)
- Christopher Strachey (1916–1975), founder of the PRG, colleague of Turing at Manchester
- Samson Abramsky FRS FRSE, Christopher Strachey Professorship (computer science)
- Alan Turing Institute data science researchers (www.oxford-turing.ox.ac.uk)



Roger Penrose (b. 1931)



- British mathematician and physicist
- Emeritus Rouse Ball Professor of Mathematics, Oxford
- *The Emperor's New Mind* (1989)
- Variant of Turing's halting problem
- Has worked with **Andrew Hodges**, Turing's biographer
- Nobel Prize in Physics (2020)



Turing and formal methods

Turing's legacy – program proving:

- A.M. Turing (1949). "Checking a Large Routine". In *Report of a Conference on High Speed Automatic Calculating Machines*, Univ. Math, Lab., Cambridge, UK, pp. 67–69.
- F.L. Morris & **C.B. Jones*** (1984). An Early Program Proof by Alan Turing, *IEEE Annals of the History of Computing*, 6(2):139–143.
- **Cliff Jones*** (2014). *Turing and Software Verification*. Technical Report CS-TR-1441, Newcastle University, UK.

* DPhil under Tony Hoare at the PRG, Oxford (1981)

Friday, 24th June.

Checking a large routine. by Dr. A. Turing.

How can one check a routine in the sense of making sure that it is right?

In order that the man who checks may not have too difficult a task the programmer should make a number of definite assertions which can be checked individually, and from which the correctness of the whole programme easily follows.

Consider the analogy of checking an addition. If it is given as:

```
 1374
 5906
 6719
 4337
 7768
------
26104
```

one must check the whole at one sitting, because of the carries.

But if the totals for the various columns are given, as below:

```
 1374
 5906
 6719
 4337
 7768
------

 3974
 2213
------
26104
```

the checker's work is much easier being split up into the checking of the various assertions 3 + 9 + 7 + 3 + 7 = 29 etc. and the small addition

```
 3794
 2213
------
26104
```

This principle can be applied to the process of checking a large routine but we will illustrate the method by means of a small routine viz. one to obtain n without the use of a multiplier, multiplication being carried out by repeated addition.

At a typical moment of the process we have recorded r and s = n r for some r, s. We can change s r to (s+1) r by addition of r. When s = r+1 we can change r to r+1 by a transfer. Unfortunately there is no coding system sufficiently generally known to justify giving the routine for this process in full, but the flow diagram given in Fig.1 will be sufficient for illustration.

Each 'box of the flow diagram represents a straight sequence of instructions without changes of control. The following convention is used:

(i) a dashed letter indicates the value at the end of the process represented by the box:

(ii) an undashed letter represents the initial value of a quantity.

One cannot equate similar letters appearing in different boxes, but it is intended that the following identifications be valid throughout

s	content of line 27 of store
r	" " " 28 " "
n	" " " 29 " "
u	" " " 30 " "
v	" " " 31 " "

It is also intended that u be s r or something of the sort e.g. it might be (s+1) r or s r-1 but not e.g. $s^2 + r^2$.

In order to assist the checker, the programmer should make assertions about the various states that the machine can reach. These assertions may be tabulated as in fig.2. Assertions are only made for the states when certain particular quantities are in control, corresponding to the ringed letters in the flow diagram. One column of the table is used for each such situation of the control. Other quantities are also needed to specify the condition of the machine completely: in our case it is sufficient to give r and s. The upper part of the table gives the various contents of the store lines in the various conditions of the machine, and restrictions on the quantities s, r (which we may call inductive variables). The lower part tells us which of the conditions will be the next to occur.

The checker has to verify that the columns corresponding to the initial condition and the stopped condition agree with the claims that are made for the routine as a whole. In this case the claim is that if we start with control in condition B and with n in line 29 we shall find a quantity in line 31 when the machine stops which is r (provided this is less than 2^{40}, but this condition has been ignored).

He has also to verify that each of the assertions in the lower half of the table is correct. In doing this the columns may be taken in any order and quite independently. Thus for column B the checker would argue, "From the flow diagram we see that after B the box $v' = u$ applies. From the upper part of the column for B we have u = r. Hence $v' = r$ i.e. the entry for v i.e. for line 31 in C should be r. The other entries are the same as in B".

Finally the checker has to verify that the process comes to an end. Here again he should be assisted by the programmer giving a further definite assertion to be verified. This may take the form of a quantity which is asserted to decrease continually and vanish when the machine stops. To the pure mathematician it is natural to give an ordinal number. In this problem the ordinal might be $(n - r)\,\omega^2 + (r - s)\,\omega + k$. A less highbrow form of the same thing would be to give the integer $2^{80}(n - r) + 2^{40}(r - s) + k$. Taking the latter case and the step from B to C there would be a decrease from $2^{80}(n - r) + 2^{40}(r - s) + 5$ to $2^{80}(n - v) + 2^{40}(r - s) + 4$. In the step from F to B there is a decrease from $2^{80}(n - r) + 2^{40}(r - s) + 1$ to $2^{80}(n - r - 1) + 2^{40}(r - r + s) + 5$.

In the course of checking that the process comes to an end the time involved may also be estimated by arranging that the decreasing quantity represents an upper bound to the time till the machine stops.

"verification"

"assertions"

"dashed" after states

Checking a large routine

- “In order to assist the checker, the programmer should make assertions about the various states that the machine can reach.”
- “The checker has to verify that the … initial condition and the stopped condition agree with the claims that are made for the routine as a whole.”
- “He has also to verify that each of the assertions … is correct.”
- “Finally the checker has to verify that the process comes to an end.”

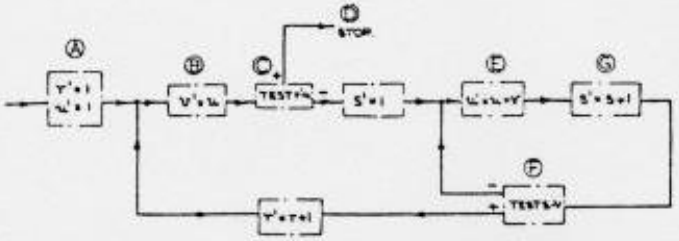


FIG. 1

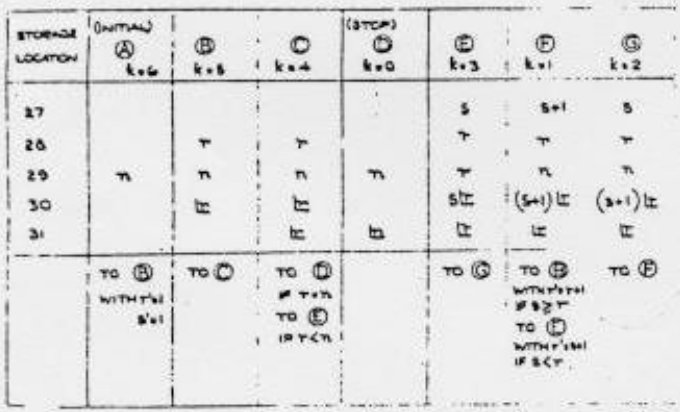
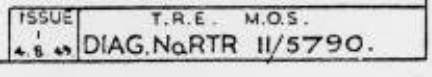


FIG. 2



An Early Program Proof by Alan Turing

F. L. MORRIS AND C. B. JONES

The paper reproduces, with typographical corrections and comments, a 1949 paper by Alan Turing that foreshadows much subsequent work in program proving.

Categories and Subject Descriptors: D.2.4 [**Software Engineering**]—correctness proofs; F.3.1 [**Logics and Meanings of Programs**]—assertions; K.2 [**History of Computing**]—software
General Terms: Verification
Additional Key Words and Phrases: A. M. Turing

Introduction

The standard references for work on program proofs attribute the early statement of direction to John McCarthy (e.g., McCarthy 1963); the first workable methods to Peter Naur (1966) and Robert Floyd (1967); and the provision of more formal systems to C. A. R. Hoare (1969) and Edsger Dijkstra (1976). The early papers of some of the computing pioneers, however, show an awareness of the need for proofs of program correctness and even present workable methods (e.g., Goldstine and von Neumann 1947; Turing 1949).

The 1949 paper by Alan M. Turing is remarkable in many respects. The three (foolscap) pages of text contain an excellent motivation by analogy, a proof of a program with two nested loops, and an indication of a general proof method very like that of Floyd. Unfortunately, the paper is made extremely difficult to read by the large number of transcription errors. For example, all instances of the factorial sign (Turing used $\underline{n}$) have been omitted in the commentary, and ten other identifiers are written incorrectly. It would appear to be worth correcting these errors and commenting on the proof from the viewpoint of subsequent work on program proofs.

Turing delivered this paper in June 1949, at the inaugural conference of the EDSAC, the computer at Cambridge University built under the direction of Maurice V. Wilkes. Turing had been writing programs for an electronic computer since the end of 1945—at first for the proposed ACE, the computer project at the National Physical Laboratory, but since October 1948 for the Manchester prototype computer, of which he was deputy director. The references in his paper to 2^{40} are reflections of the 40-bit "lines" of the Manchester machine storage system.

The following is the text of Turing's 1949 paper, corrected to the best of our ability to what we believe Turing intended. We have made no changes in spelling, punctuation, or grammar.

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Turing Text

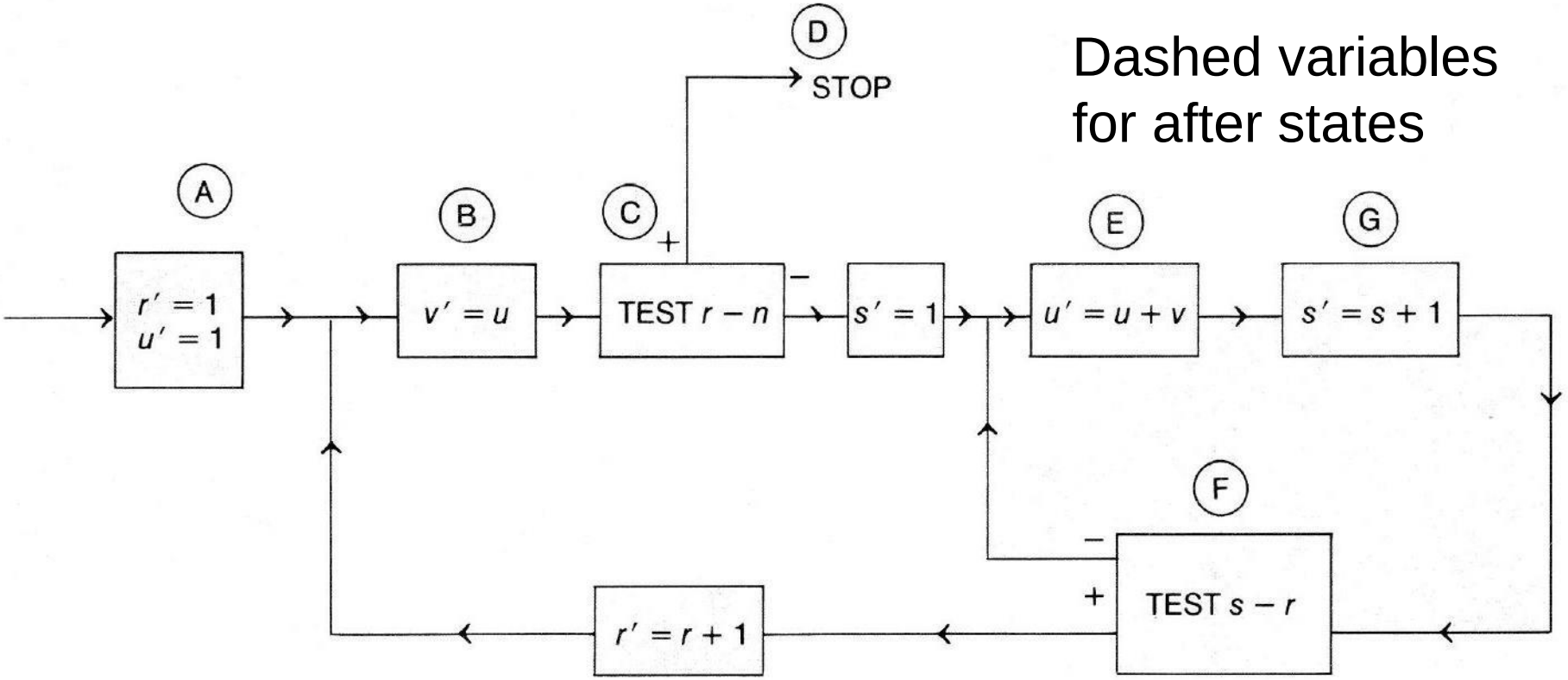
Friday, 24th June [1949]

Checking a large routine by Dr A. Turing.

How can one check a routine in the sense of making sure that it is right?

In order that the man who checks may not have too difficult a task the programmer should make a number of definite assertions which can be checked individually, and from which the correctness of the whole programme easily follows.

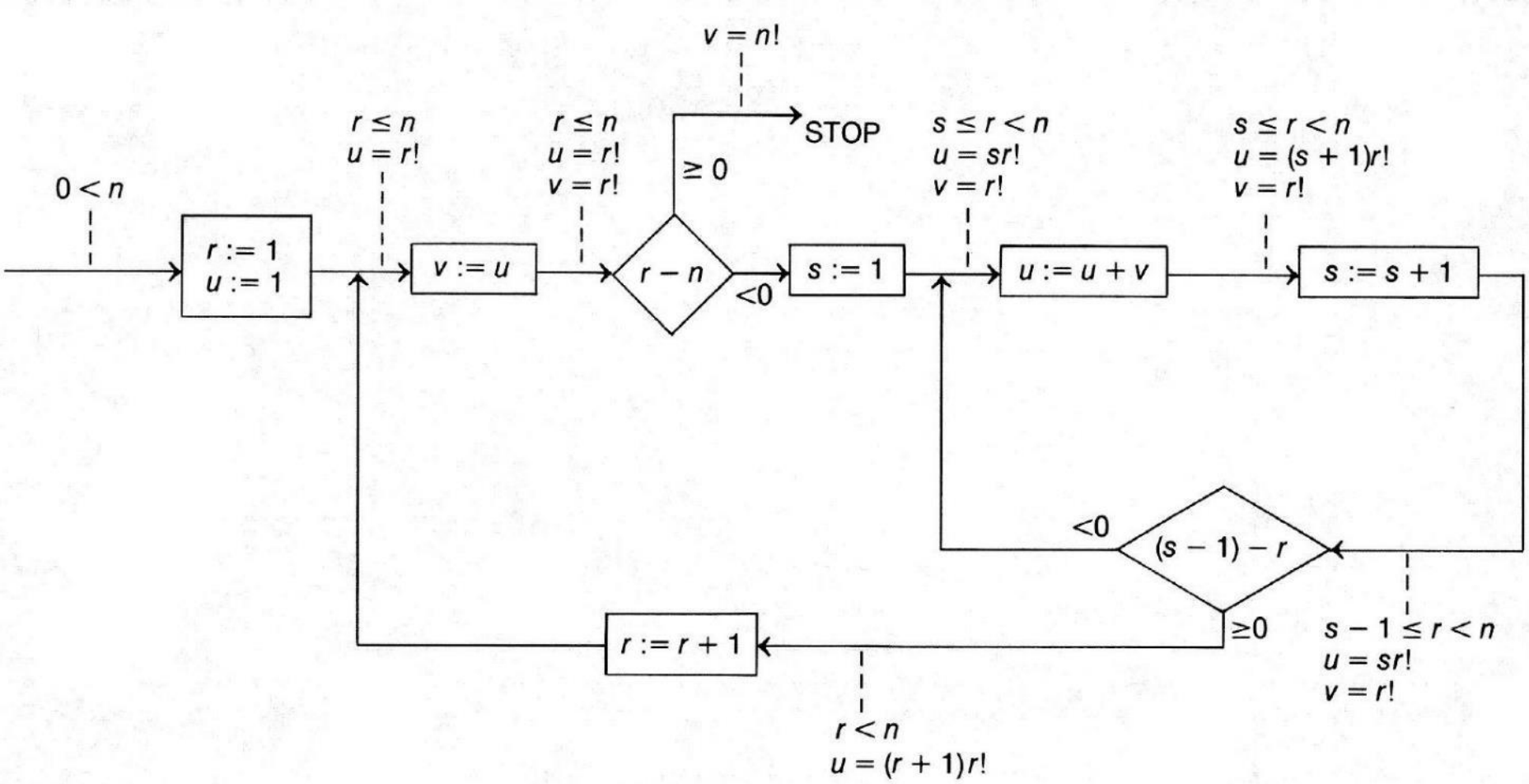
Dashed variables for after states



STORAGE LOCATION	(INITIAL) (A) $k = 6$	(B) $k = 5$	(C) $k = 4$	(STOP) (D) $k = 0$	(E) $k = 3$	(F) $k = 1$	(G) $k = 2$
27					s	$s + 1$	s
28		r	r		r	r	r
29	n	n	n	n	n	n	n
30		$\lfloor r$	$\lfloor r$		$s \lfloor r$	$(s + 1) \lfloor r$	$(s + 1) \lfloor r$
31			$\lfloor r$	$\lfloor n$	$\lfloor r$	$\lfloor r$	$\lfloor r$
	TO (B) WITH $r' = 1$ $u' = 1$	TO (C)	TO (D) IF $r = n$ TO (E) IF $r < n$		TO (G)	TO (B) WITH $r' = r + 1$ IF $s \geq r$ TO (E) WITH $s' = s + 1$ IF $s < r$	TO (F)

Turing and program proving

Modernized flow diagram, with assertions



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1967 Floyd, R. W. 1967. "Assigning Meaning to Programs." *Proc. of Symposia in Appl. Math. 19.* (Also in S. T. Schwartz (ed.), *Mathematical Aspects of Computer Science*, Providence, American Mathematical Society, 1967.)

1947 Goldstine, H. H., and J. von Neumann. 1947. "Planning and Coding of Problems for an Electronic Computing Instrument." Report of U.S. Ord. Dept. In A. Taub (ed.), *Collected Works* of J. von Neumann, New York, Pergamon, Vol. 5, 1965, pp. 80–151.

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1963 McCarthy, J. 1963. "A Basis for a Mathematical Theory of Computation." In P. Braffort and D. Hirschberg (eds.), *Computer Programming and Formal Systems*, Amsterdam, North-Holland, 1967, pp. 33–70.

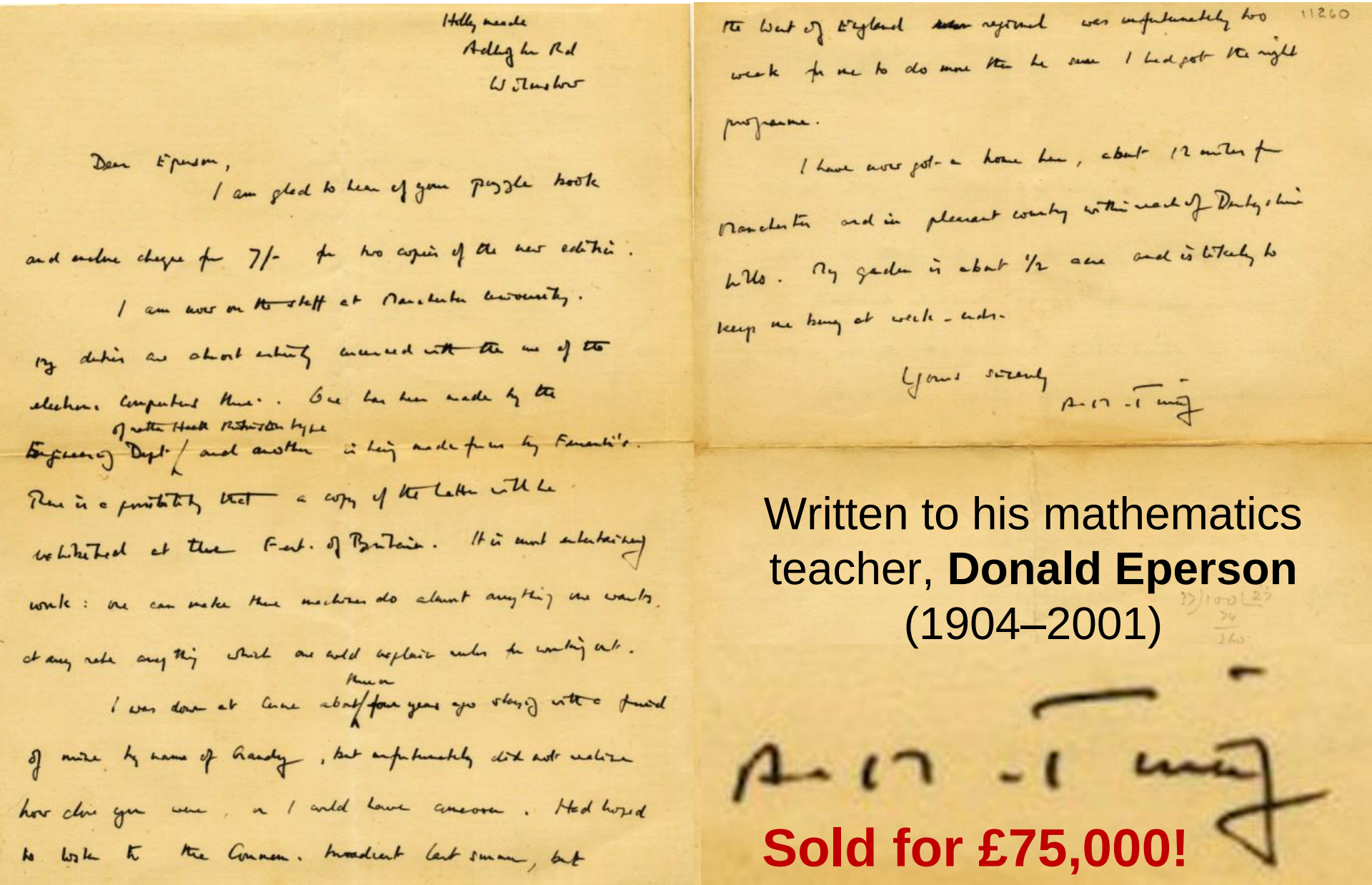
1966 Naur, P. 1966. Proof of algorithms by general snapshots. *BIT 6*, 4, 310–316.

1949 Turing, A. M. 1949. "Checking a Large Routine." In *Report of a Conference on High Speed Automatic Calculating Machines*, Univ. Math. Lab., Cambridge, pp. 67–69.

Turing's influence on program proving

- **Aad van Wijngaarden** was at the Cambridge meeting – but no known influence (1949…)
- **Robert Floyd** rediscovered ideas similar to those of Turing (published 1967)
- **Tony Hoare** (later at Oxford) developed these further (published 1969)
- Had Turing lived longer, perhaps formal methods would have developed more rapidly

Turing letter, c.1949 (sold 15 November 2017)



Holly Meade
Adlington Rd
Wilmslow

Dear Epperson,

I am glad to hear of your puzzle book and enclose cheque for 7/- for two copies of the new edition.

I am now on the staff at Manchester University. My duties are about entirely connected with the use of the electronic computer there. One has been made by the Engineering Dept. / and another is being made for us by Ferranti's. There is a possibility that a copy of the latter will be established at the Nat. Phys. Lab. It is most interesting work: one can make these machines do almost anything one wants, at any rate anything which one could explain under the heading of work.

I was down at Cambridge about four years ago staying with a friend of mine by name of Gandy, but unfortunately did not realize how close you were, or I could have come over. Had hoped to talk to the Cambridge Mathematical Society, but

the West of England [illegible] was unfortunately too 11260
weak for me to do more than be sure I had got the right programme.

I have now got a house here, about 12 miles from Manchester and in pleasant country with a view of Derbyshire hills. My garden is about ½ acre and is likely to keep me busy at week-ends.

Yours sincerely

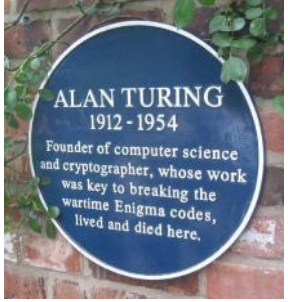
A. M. Turing

Written to his mathematics teacher, **Donald Eperson** (1904–2001)

A. M. Turing

Sold for £75,000!

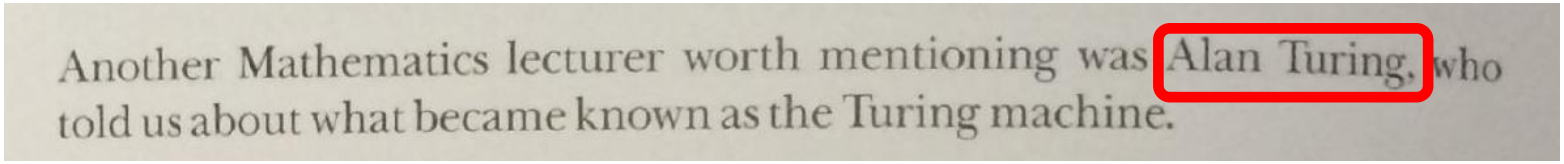
Blue plaque (27 July 2019)



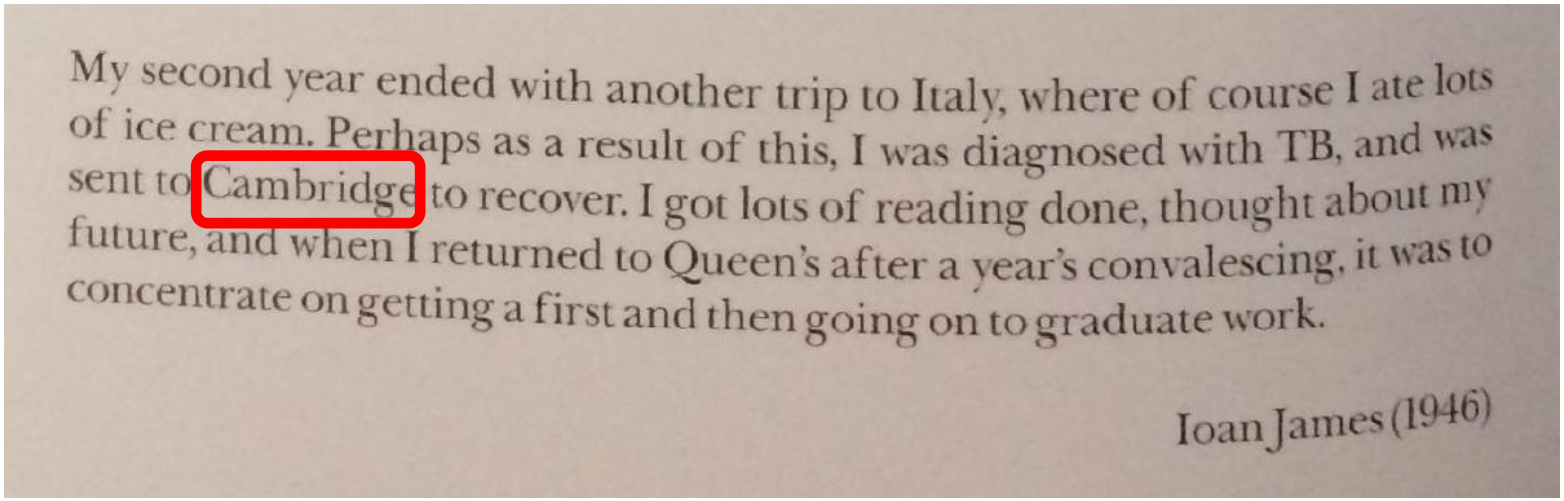
Joan Clarke (later Murray) moved to 7 Lakesfield, Headington Quarry, Oxford, in 1991

Oxford History of Mathematics Forum (2020)

- **Chris Hollings** (forum co-organizer)
- **Ioan James** mathematics student at Oxford
- *The Queen's College Record*, December 2017:


Another Mathematics lecturer worth mentioning was Alan Turing, who told us about what became known as the Turing machine.

- But:


My second year ended with another trip to Italy, where of course I ate lots of ice cream. Perhaps as a result of this, I was diagnosed with TB, and was sent to Cambridge to recover. I got lots of reading done, thought about my future, and when I returned to Queen's after a year's convalescing, it was to concentrate on getting a first and then going on to graduate work.

Ioan James (1946)

- So was the lecture on Oxford or Cambridge…?

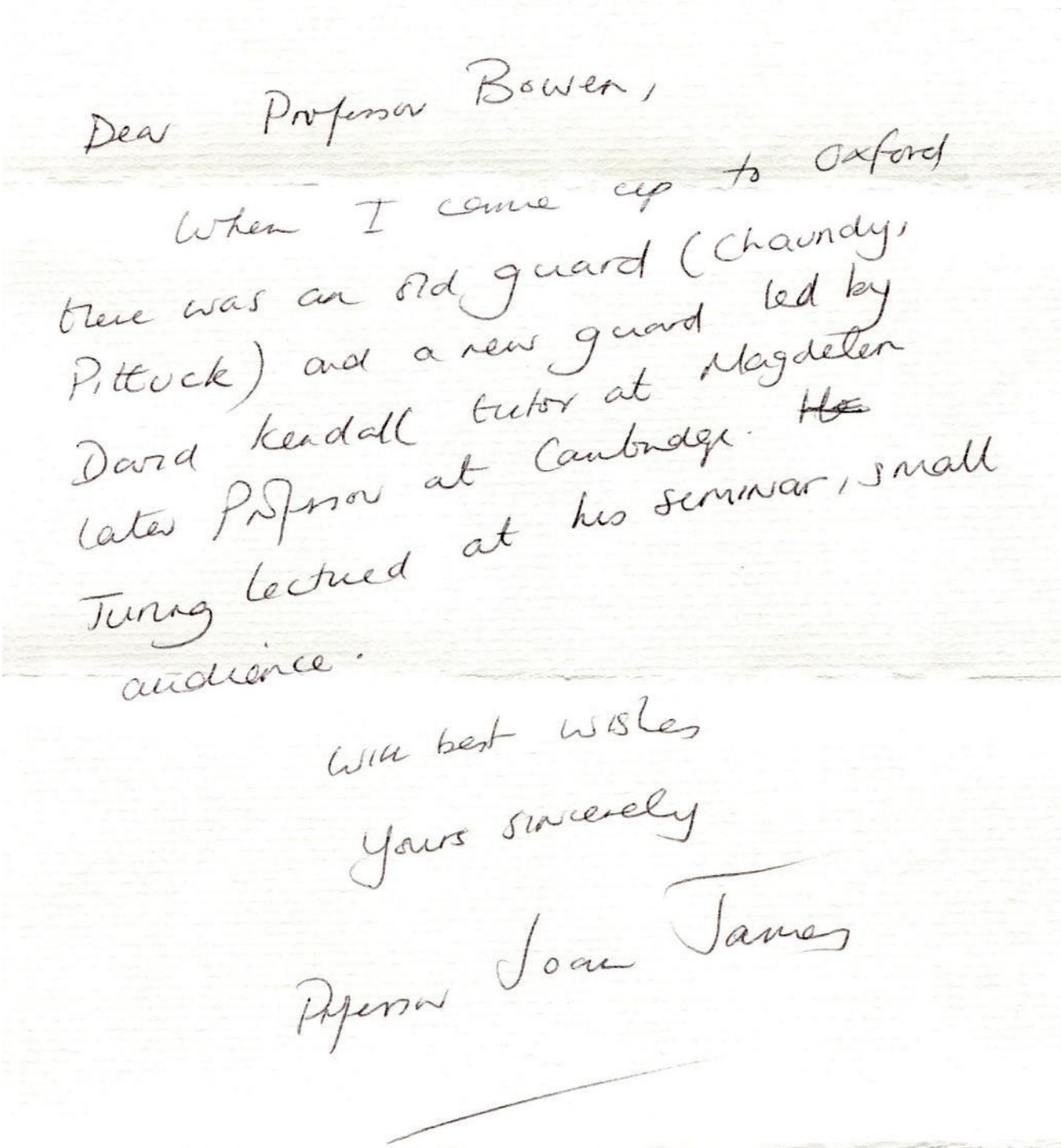
Ioan James FRS (b. 1928)

- British mathematician (topology)
- Student at Queen's College, Oxford
- Reader in pure mathematics (1957–1969)
- Research fellow at St John's College, Oxford
- Savilian Chair of Geometry at the University of Oxford (1970–1995)
- President of London Mathematical Society (1984)

Ioan James letter

I wrote via St John's College…

Reply in Feb. 2021: written evidence of Turing in Oxford



Dear Professor Bowen,

When I came up to Oxford there was an old guard (Chaundy, Pittuck) and a new guard led by David Kendall tutor at Magdelen later Professor at Cambridge. ~~He~~ Turing lectured at his seminar, small audience.

With best wishes

Yours sincerely

Professor Joan James

Correspondence with Ioan James

- Was a Fellow at St John's College, Oxford
- Not on email! College closed for the pandemic in 2020!
- Handwritten letter (postmarked 18 February 2021, Oxford), confirming talk by Turing at Oxford, hosted by David Kendall FRS (1918–2007), later a professor in Cambridge
- Subsequently confirmed by email (1 January 2022) to be at Magdalen College, Oxford, in 1950

David Kendall FRS (1928–2007)

- British statistician & mathematician
- University of Oxford (1946–1962)
- Fellow at Magdalen College, Oxford
- Hosted Turing lecture in 1950 at Magdalen
- (Humphry Bowen studying for a chemistry DPhil at Magdalen, 1949–1953)

Article on Alan Turing and Oxford

- J.P. Bowen, “Alan Turing and Oxford”. *Resurrection: The Journal of the Computing Conservation Society*, 97, pp. 1–18, Spring 2022.
- https://www.computerconservationsociety.org/resurrection/res97.htm#e (web version)
- https://www.computerconservationsociety.org/resurrection/pdfs/res97.pdf (PDF version)
- https://ccsoc.org/turingox.pdf (full version with references)

Computer ◆ Conservation ◆ Society

Epitaph

“A sort of scientific Shelley.”

– Sir **Geoffrey Jefferson** FRS (1886–1961)
Professor of Neurosurgery at Manchester

Pet Shop Boys – The Proms

- Royal Albert Hall, London, 23 July 2014
- World premiere of "*A Man from the Future*"
- Tribute to Alan Turing

The Imitation Game
(2014 film)

- Historical *drama* film on the life of Alan Turing
- Starring **Benedict Cumberbatch** & **Keira Knightley**
- Based on the biography *Alan Turing: The Enigma* by **Andrew Hodges**

Filming at
King's Cross
Station, London
October 2013

"Alan Turing law"
(31 January 2017)

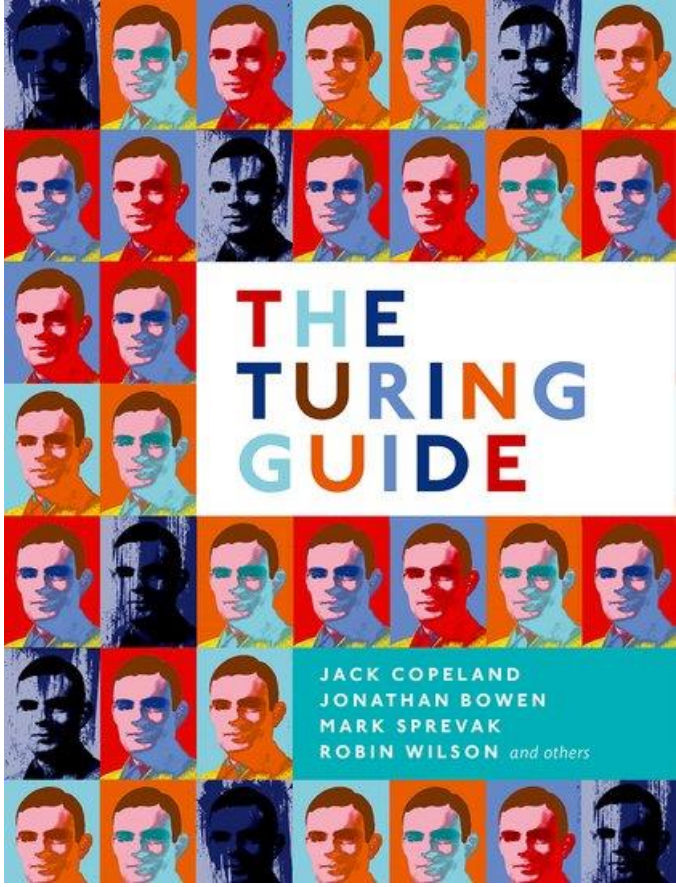
- UK *Policing and Crime Act 2017*
- General pardon for gay men
  – 50 years after 1967 legislation
- Imagine if Turing had been born 20 years later…

£50 note

Issued on Turing's 109th birthday
23 June 2021

Thank you
Alan Turing

110 yesterday!



Prof. Jonathan Bowen

FBCS, FRSA

jonathan.bowen@lsbu.ac.uk

www.jpbowen.com

Museophile

London South Bank University