Alan Turing: The Life of a Freethinker

The Golden Thread · Part 2

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Foreword

Alan Mathison Turing (1912–1954) is known for the machine that carries his name, for breaking German naval codes at Bletchley Park and for the test that asks whether a machine can think. In The Golden Thread he appears for a different reason. Through his whole life he worked on one question: how mind, and later form, arises in matter. He came to that question at the age of seventeen, when his friend Christopher Morcom died, and he was still writing about it on postcards in the last months of his life.

In this series a freethinker is someone who sees a collective expectation failure before the rest, and who offers a new picture of the whole. Turing did this twice. In 1936 he showed that mathematics cannot be reduced to a mechanical procedure that decides every question. In 1952 he showed that biological form can arise by itself from an almost uniform state, without a plan and without a builder. Both results went against what his contemporaries expected.

The story follows three roads, in the same structure as the stories of Spinoza and Robert Rosen.

- **Part I · Turing and his time** follows his life: childhood, Sherborne, Morcom, Cambridge, Princeton, Bletchley Park, the computer, Manchester, the conviction and the death.
- **Part II · The roots** follows what he read and whom he met: Brewster, Eddington, Whitehead, Jeans, von Neumann, Newman, Church, Wittgenstein, Schrödinger, D'Arcy Thompson.
- **Part III · The ideas** follows the thread through his work: computability, the limits of mechanisation, the learning machine, morphogenesis, and the unseen world.

As in the earlier stories, three kinds of connection are distinguished. A **trace** is documented contact: a teacher and a student, a letter, a book that was read, an article that discusses another work. An **echo** is a shared form whose transmission has not been shown. **Descent** concerns family. Each connection also carries a degree of certainty: documented, probable, disputed or hypothesis.

Facts and dates were checked against at least two independent sources; calculations were redone. Where sources disagree, both are given. What could not be confirmed by a second source was left out.

Part I · Turing and his time

1. Childhood (1912–1926)

Year	Event	Sources
1912	Born 23 June in Maida Vale, London. Father Julius Turing served in the Indian Civil Service.	Sara Turing, *Alan M. Turing*; King's College Archive
1913–1926	Parents in India; Alan and his brother are placed with the Ward family in St Leonards-on-Sea. Prep school Hazelhurst. First chemical experiments.	Sara Turing; *More than our childhoods*
1922	Receives *Natural Wonders Every Child Should Know* by Edwin Tenney Brewster (1912). The book opened his eyes to science.	King's College Archive AMT/K/1/25; Open University

The connection is a **trace** (documented).

2. Sherborne and Christopher Morcom (1926–1931)

In 1926 Turing went to Sherborne School in Dorset. The headmaster wrote that a boy who wants only to be a scientific specialist is wasting his time at a public school (St Andrews MacTutor; Hodges).

In 1928 he became friends with Christopher Morcom, a year older. They shared mathematics, chemistry and astronomy (Old Shirburnian Society). In 1929 Morcom showed him the iodine clock reaction: iodate and sulphite in acid solution stay colourless for a while and then turn blue-black at once (Old Shirburnian Society; Fitzwilliam Museum). In November 1929 Turing wrote to his mother about Schrödinger's quantum theory and wrote a paper on "the reaction of sulphites and iodates in acid solution" (King's College Archive AMT/K/1/19).

The clock reaction is a sudden change of form from a uniform state. Twenty-two years later Turing's morphogenesis paper would describe exactly that kind of event. The link between the two is an **echo** (hypothesis).

Morcom died on 13 February 1930 of bovine tuberculosis, aged eighteen. Turing chose the four Digby Prize books that were awarded to Morcom posthumously: Eddington's *The Nature of the Physical World* and *The Internal Constitution of the Stars*, and Jeans's *Astronomy and Cosmogony* and *The Universe Around Us* (Old Shirburnian Society, primary source).

Prize	Year	Detail	Sources
Christopher Morcom Prize	1930	First award; experiment on sulphites and iodates; prize book *Mathematical Recreations* (Rouse Ball)	Old Shirburnian Society; Fitzwilliam Museum
Christopher Morcom Prize	1931	Second award	Old Shirburnian Society

Prize	Year	Detail	Sources
Digby Prize, Mathematics & Science	1930 and 1931	Founded 1868 by G.D. Wingfield Digby; Whitehead won it 1877–1879	Shirburnian Speak (primary)

In 1932, staying with the Morcom family, Turing wrote a short text, *Nature of Spirit*. A body holds a spirit; at death the spirit finds a new body (Old Shirburnian Society; Science Museum). This is the first written form of his question.

3. Cambridge (1931-1936)

Year	Event	Sources
1931–1934	King's College, Cambridge; first-class degree in mathematics	King's College
1934	Rediscovers the central limit theorem, already proved by Lindeberg in 1922	Welch; St Andrews
1935	Elected Fellow of King's, aged 22	King's College; St Andrews
1935	Max Newman's lectures on the foundations of mathematics introduce him to Hilbert's decision problem	King's College; CACM
1936	*On Computable Numbers, with an Application to the Entscheidungsproblem* (Proc. London Math. Soc., 1936–37)	Stanford Encyclopedia; Christie's

Turing called his model an "a-machine" (automatic machine). The name "Turing machine" was given by Alonzo Church in a 1937 review (Stanford Encyclopedia). Part III, chapter 11 discusses the content.

4. Princeton (1936-1938)

Turing went to Princeton as a graduate student under Church. He took his PhD in May 1938 with *Systems of Logic Based on Ordinals*. John von Neumann offered him an assistantship at $1,500 a year; Turing declined and returned to Cambridge (Princeton; i-programmer).

5. Wittgenstein and Bletchley Park (1939–1945)

In 1939 Turing attended Wittgenstein's lectures on the foundations of mathematics in Cambridge. The two disagreed on whether a contradiction in mathematics matters (Big Think; Bergen).

From 1939 to 1945 he worked at Bletchley Park: on the Bombe and on naval Enigma, in Hut 8, whose daily management was in the hands of Hugh Alexander (Bletchley Park; GCHQ). In spring 1941 he became engaged to his colleague Joan Clarke; he ended the engagement in late summer and they remained friends (GCHQ; St Andrews).

6. The computer and the runner (1945-1951)

Year	Event	Sources
1945–1948	National Physical Laboratory: design of the Automatic Computing Engine (ACE)	Bletchley Park; NPL
1947	Member of Walton Athletic Club; fifth in the AAA marathon in 2:46:03. The Olympic champion of 1948 ran 2:34:52; difference 11 min 11 s (recalculated)	Walton AC; Olympic records
1948	*Intelligent Machinery*: unorganised machines, the child machine, learning. Published only in 1969	gpbib; Wikipedia
1950	*Computing Machinery and Intelligence*, Mind 59: 433–460	OUP; Padua
1951	Fellow of the Royal Society (March); BBC radio talk *Can Digital Computers Think?* (15 May)	washington.edu; Swinton
1951	Letter to J.Z. Young: he is working on a mathematical embryology, not on the brain	Swinton

7. Manchester, conviction and death (1952–1954)

On 23 January 1952 Turing's house in Wilmslow was burgled. When he reported it, he acknowledged a relationship with Arnold Murray (APS; Open University). On 31 March 1952, at Knutsford Quarter Sessions, he pleaded guilty to gross indecency under Section 11 of the Criminal Law Amendment Act 1885. Sentence was postponed and he was placed on probation for twelve months, on condition of treatment at Manchester Royal Infirmary (text of the 2013 pardon; St Andrews MacTutor). He chose a year of oestrogen injections instead of prison (St Andrews MacTutor; liberate.gg).

From 1952 to 1954 he was in Jungian analysis with Franz Greenbaum, who did not regard homosexuality as something to be cured. Turing wrote down his dreams and became a friend of the Greenbaum family (turing.org.uk; Pink Triangle Trust). In July 1953 he sent the family a postcard from Corfu (RR Auction; Fine Books).

In March 1954 he sent Robin Gandy four postcards under the heading *Messages from the Unseen World*, on Eddington, the light cone and creation. One line reads: "Science is a Differential Equation. Religion is a Boundary Condition." (King's College Archive AMT/D/4; Quote Investigator)

Turing died on 7 June 1954; his housekeeper found him the next day. Cause: cyanide poisoning. The inquest returned suicide. The apple by his bed was never tested. Copeland argues that accidental inhalation is possible; his mother held to an accident (historycollection; History of Information). He was 41 (recalculated: born 23 June 1912, died 7 June 1954, sixteen days before his 42nd birthday; one source wrongly gives 42).

Year	Rehabilitation	Sources
2009	Apology by Prime Minister Gordon Brown	ITV; cs.umd.edu (PinkNews)
2013	Royal pardon, 61 years after the conviction (2013 − 1952)	pardon text; ITV
2017	"Turing law": posthumous pardon for more than 50,000 men	Bank of England; liberate.gg
2021	Turing on the £50 note	Bank of England

Part II · The roots

8. Reading at Sherborne

The Sherborne library registers are a primary source for what Turing read as a schoolboy (Sherborne archive; Hodges).

Author and work	Connection	Type	Sources
Brewster, *Natural Wonders Every Child Should Know* (1912)	Received 1922	trace, documented	King's Archive AMT/K/1/25
Eddington, *The Nature of the Physical World* (1928)	Read at school; used in *Nature of Spirit* (1932); still in his postcards of 1954	trace, documented	Hodges; Sherborne archive
Whitehead, *Science and the Modern World* (1925)	Borrowed February–March 1929	trace, documented	Sherborne loan register (primary)
Jeans, *The Universe Around Us* and others	Borrowed; chosen as Morcom's posthumous prize books	trace, documented	Sherborne archive; Old Shirburnian Society
Einstein, relativity	Read as a schoolboy	trace, documented	St Andrews
von Neumann, *Mathematische Grundlagen der Quantenmechanik* (1932)	Read 1932, probably as a Sherborne prize book; later met him in Princeton	trace, documented (prize book probable)	Hodges; King's Archive

Nature of Spirit (1932), Turing's first answer to Morcom's death, draws on Eddington (Hodges; Old Shirburnian Society).

9. Teachers and opponents

Person	Connection	Type	Sources
G.H. Hardy	Lectures in Cambridge; held that there is no algorithm for all mathematical problems	trace, documented	Welch
Max Newman	1935 lectures on Hilbert's decision problem; the occasion for *On Computable Numbers*	trace, documented	King's College; CACM
Alonzo Church	PhD supervisor 1936–38; named the model "Turing machine"	trace, documented	Stanford Encyclopedia
John von Neumann	Offered an assistantship in 1938; declined	trace, documented	Princeton; i-programmer
Ludwig Wittgenstein	1939 lectures; dispute on contradiction in mathematics	trace, documented	Big Think; Bergen
Kurt Gödel	Objected that Turing's argument on finite "states of mind" contained a philosophical error	trace (through publication), documented	Stanford Encyclopedia; Copeland

10. Schrödinger, D'Arcy Thompson and Goethe

Schrödinger. Turing wrote about Schrödinger's quantum theory in 1929. He knew *What is Life?* (1944) and looked for his own chemical explanation of form (Belgian Journal of Zoology; Metode). *What is Life?* is a node in this series for three reasons:

Fact	Sources
Three public lectures, 5, 12 and 19 February 1943, Trinity College Dublin; about 400 listeners; book 1944 (Cambridge University Press)	Wikipedia; Hernández, *Frontiers in Microbiology* 2022
Key concepts: aperiodic crystal, code-script, negative entropy, "order from order", and the expectation of "other laws of physics" in living matter	Chemistry World; Ball, *Nature*; the book itself (chapters 6 and 7)
Built on the model of Max Delbrück, who regarded the bacteriophage as the "hydrogen atom" of biology	AAAS; Encyclopedia.com (*Dictionary of Scientific Biography*); wissenschaft.de
Two mottos from Spinoza's *Ethics*: at the opening (IV, 67: *Homo liber nulla de re minus quam de morte cogitat*) and before chapter 6 (III, 2: *Nec corpus mentem ad cogitandum, nec mens corpus ad motum…*)	The book itself (Kaiserslautern PDF); Goodreads notes (two readers); *Ethics* text (sacred-texts)
Epilogue *On Determinism and Free Will*: "I" as the one who directs the motion of the atoms; Atman = Brahman; consciousness is singular	Cambridge Core; Havel; arXiv 2201.09663

Fact	Sources
Robert Rosen's *Essays on Life Itself* opens with "The Schrödinger Question"	Mikulecky; Ingram (table of contents)

So *What is Life?* links Spinoza (motto), Turing (reader) and Rosen (respondent). The Spinoza motto of chapter 6 states the parallel of mind and body; it is the same question Turing put in *Nature of Spirit*.

D'Arcy Thompson. Turing read *On Growth and Form* before the war; his copy is kept at Sherborne. In unpublished papers he placed his own morphogenesis in Thompson's line (Swinton; Franceschelli). Connection: **trace, documented**.

Goethe. Thompson's morphology stands in the tradition of Goethe's study of form. No evidence was found that Turing read Goethe directly. Connection Goethe → Turing: **echo via Thompson**.

Waddington and Child. Cited in the 1952 paper (Petitot). **Trace, documented.**

Greenbaum. Jungian analysis 1952–1954, dreams written down (turing.org.uk; Pink Triangle Trust). **Trace, documented.**

Part III · The ideas

11. Computability (1936)

Turing reduced a person calculating with pencil and paper to its simplest form: a tape of squares, a head that reads and writes one square at a time, a finite number of internal states and a table of rules. He showed that a universal machine exists that can imitate every other machine, and that no machine can decide for every machine whether it will ever print a given symbol. Hilbert's decision problem therefore has no general mechanical solution (Stanford Encyclopedia, "Turing Machines"; MacTutor).

The basis of the argument is the human computer, who has only a finite number of "states of mind". Gödel later called this a philosophical error: the mind is not bound to a fixed set of states (Stanford Encyclopedia; Copeland). The machine was Turing's model of a person following rules, not a claim that mind is a machine.

12. The limit of mechanisation (1939)

In his Princeton thesis Turing added an "oracle" to the machine: a step that cannot be carried out mechanically. He separated mathematical reasoning into intuition and ingenuity, and held that intuition cannot be fully mechanised (Princeton; Stanford Encyclopedia).

13. The learning machine (1947-1951)

In *Intelligent Machinery* (1948) Turing described unorganised machines that are organised by training, and a "child machine" that learns instead of being programmed (gpbib; Wikipedia). In *Computing Machinery and Intelligence* (1950) he replaced the question whether machines can think by the imitation game. A machine that is to be intelligent must be allowed to make mistakes.

The same paper lists objections. Objection nine is extrasensory perception. Turing wrote that "the statistical evidence, at least for telepathy, is overwhelming" (Mind 1950; Leavitt in *The Turing Guide*, ch. 32). Leavitt links this to S.G. Soal's card experiments of the early 1940s; the paper also contains a passage on spiritualism (OUP; Padua).

14. Morphogenesis (1951–1954)

In 1951 Turing wanted to "grow a brain" rather than model one, and turned to embryology (letter to J.Z. Young; Swinton). *The Chemical Basis of Morphogenesis* appeared in 1952 (Phil. Trans. R. Soc. B 237: 37–72). Two substances that react with each other and diffuse at different rates can turn an almost uniform state into spots or stripes; small disturbances are amplified (Embryo Project Encyclopedia; Woolley and Baker in *The Turing Guide*, ch. 34).

The model is the iodine clock of 1929 on a larger scale: form arises from uniformity, without a builder. Turing was working on Fibonacci numbers in the arrangement of leaves (phyllotaxis) when he died; the work remained unfinished (Swinton; Turing Archive). Bernard Richards later checked the theory against radiolaria (*The Turing Guide*, ch. 35).

Robert Rosen published "Turing's morphogens, two-factor systems and active transport" in 1968 (Bulletin of Mathematical Biophysics 30/3: 493–499). He showed that Turing's model belongs to the same family as the two-factor models of his teacher Rashevsky. Rosen's later critique of mechanism was aimed at Church's thesis in its physical form, not at Turing (see *Robert Rosen: The Life of a Freethinker*).

15. The unseen world (1954)

The four postcards of March 1954 return to the reading of 1929: Eddington, the light cone, creation. The thread is complete.

Stage	Year	Form of the question	Sources
1	1930–1932	How does a body hold a spirit? (*Nature of Spirit*)	Old Shirburnians; Science Museum
2	1936	A computing person has finitely many states of mind	Stanford Encyclopedia
3	1939	Intuition cannot be fully mechanised; the oracle	Princeton
4	1947–1950	An intelligent machine must fail and learn; telepathy taken seriously	gpbib; Mind 1950
5	1951	Grow a brain instead of modelling it	Swinton
6	1951–1954	Form arises by itself from uniformity	Phil. Trans. 1952
7	1954	*Messages from the Unseen World*	King's Archive AMT/D/4

Closing · The thread to the other stories

Node	Turing	Other story	Type
Spinoza	No direct reading found; shared position that mind and body run parallel	Spinoza (Part 0)	echo
Schrödinger, *What is Life?*	Reader; looked for his own chemical answer	Spinoza (motto), Rosen (first essay)	trace (Turing, Rosen); trace in print (Spinoza motto)
Church	Supervisor; named the machine	Rosen criticised Church's thesis	trace
Gödel	Objected to finite states of mind	Rosen: Gödel as symptom	trace
Rashevsky	Two-factor models related to Turing's morphogens	Rosen's teacher	trace (via Rosen 1968)
D'Arcy Thompson → Goethe	Turing places himself in Thompson's line	Goethe (planned)	trace (Thompson), echo (Goethe)
Eddington	From 1929 to 1954	—	trace
Wittgenstein	1939 lectures	Not shown for Rosen	trace

In the language of the series, Turing is yellow: the freethinker who looks for the intangible in the material and finds a precise form for it. Twice the

expectation of his time failed through him: that every mathematical question can be decided by a procedure, and that form needs a builder.

Sources

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- A. Hodges, *Alan Turing: The Enigma* (1983)
- B.J. Copeland, J. Bowen, M. Sprevak, R. Wilson (eds.), *The Turing Guide* (Oxford UP 2017): ch. 32 Leavitt, ch. 33 Boden, ch. 34 Woolley & Baker, ch. 35 Richards, ch. 41 Copeland & Sprevak
- King's College Cambridge, Turing Archive (AMT/K/1/19, AMT/K/1/25, AMT/D/4)
- Old Shirburnian Society; Shirburnian Speak; Sherborne School archive and library registers
- Stanford Encyclopedia of Philosophy: "Alan Turing", "Turing Machines", "The Church-Turing Thesis"
- MacTutor History of Mathematics (St Andrews): "Alan Turing"; Mathematicians of the Day, 31 March
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- R. Rosen, "Turing's morphogens, two-factor systems and active transport", Bull. Math. Biophys. 30 (1968) 493–499
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