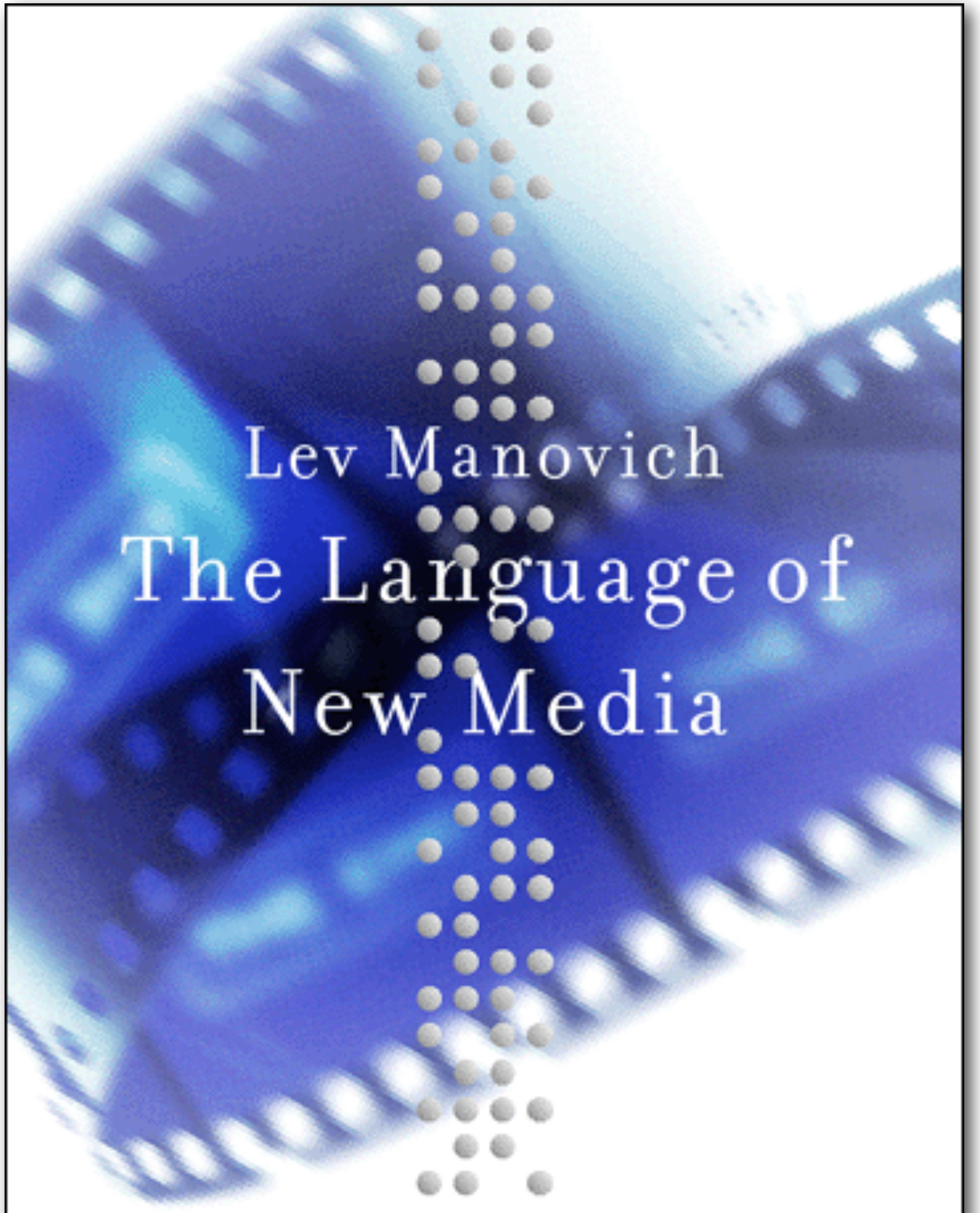
UMEÅ UNIVERSITET

Mediernas teori – doktorandkurs, HT 2014

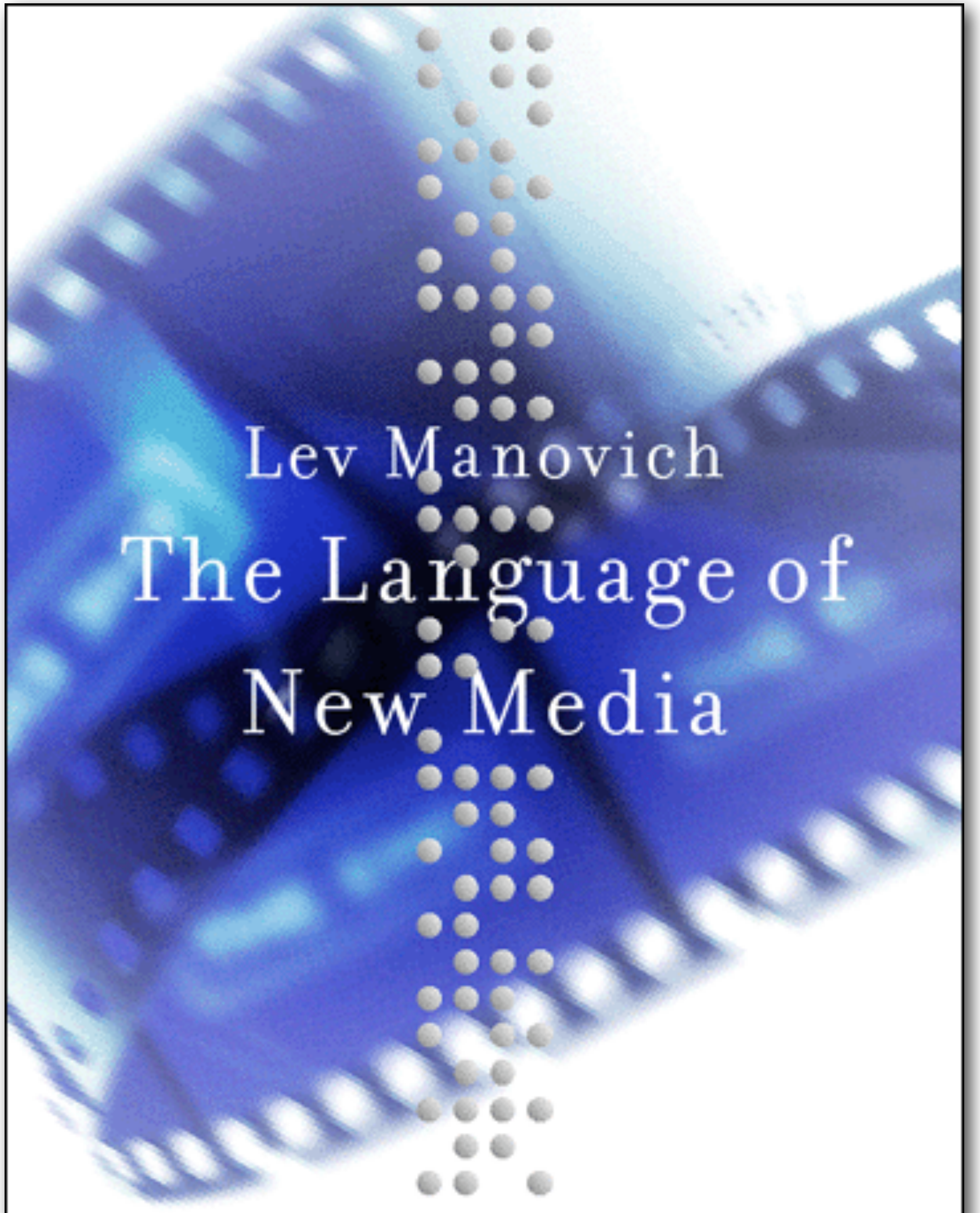
Prof. Pelle Snickars

7. Digital medieteori (Shannon, Turing & Bush)

Medier & datorer – parallella historier



Medier & datorer – parallella historier



Manovich trycker kring millenieskiftet 2000 på olika digitala utvecklingslinjer bakåt för att förstå "new media" – dvs, en analysmodell som inte blickar framåt.

Utgångspunkten tas i 1830-talet hos **Daguerre** (fotografi) och **Babbage** (Analytical engine) för att skissera den **mediala** och **datalogiska utvecklingen** vilka löper parallellt fram till cirka 1970 – varefter de alltmer glider samman. Datorn framstår därefter alltmer som ett **universalmedium** med förmåga att simulera alla andra medieformer.

1950-talets medieteoretiska linjer

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A. Torontoskolan (McLuhan)

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B. Cultural studies (Williams)

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C. Fransk semioik & strukturalism (Barthes)

1950-talets medieteoretiska linjer

A. Torontoskolan (McLuhan)

B. Cultural studies (Williams)

C. Fransk semioik & strukturalism (Barthes)

D. Informationsteori & cybernetik

Informationsteori & cybernetik

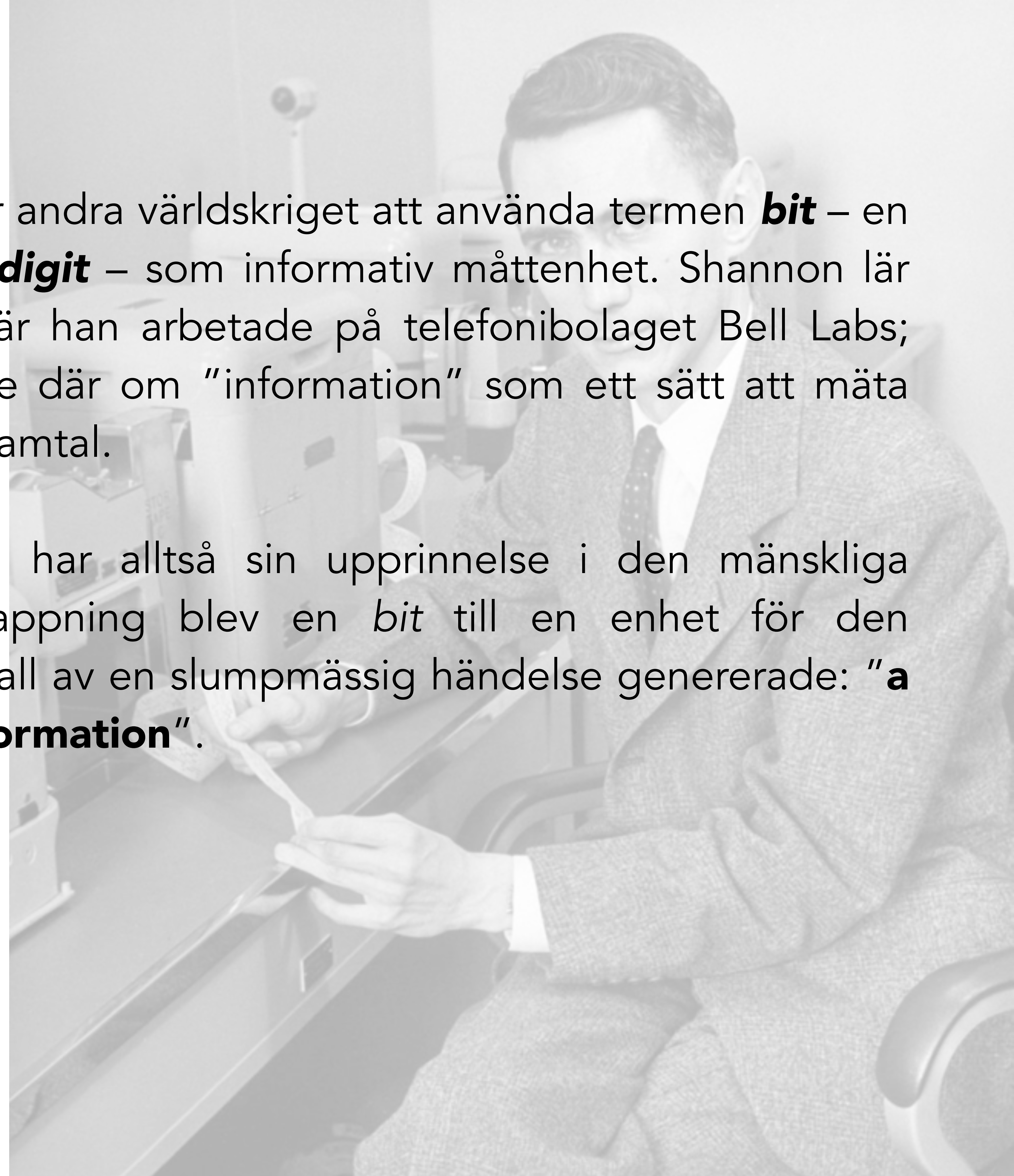
Dessa teoribildningar är inte mediala i strikt bemärkelse – snarare **datalogiska**. Men givet de senare årens medieutveckling där (i princip) alla **medier är kod**, så tillhör såvä informationsteori som cybernetik ett slags **för-digitala teoribildningar** som på högst olika sätt studerar datalogiska modeller – vilka ligger till grund för ”den digitala utvecklingen”.

Claude Shannon

Claude Shannon

Shannon började under andra världskriget att använda termen ***bit*** – en förkortning för ***binary digit*** – som informativ måttenhet. Shannon lär ha plockat upp den när han arbetade på telefonibolaget Bell Labs; telefoningenjörer talade där om "information" som ett sätt att mäta datamängder i telefonsamtal.

Begreppet information har alltså sin upprinnelse i den mänskliga rösten. I Shannons tappning blev en *bit* till en enhet för den information som ett utfall av en slumpmässig händelse genererade: "**a unit for measuring information**".



Claude Shannon

Shannon betraktas ofta som en genial och egensinnig **datapionjär**. Som elektronikstudent under 1930-talet var han bland annat assistent åt Vannevar Bush på MIT där han och andra konstruerade en analog, mekanisk dator.

Det var också då Shannon skrev magisteruppsatsen, ”A Symbolic Analysis of Relay and Switching Circuits” (1937), i vilken han kombinerade **boolsk algebra med rigorös elektronisk logik**, ett koncept som alltsedan dess ligger till grund för det mesta inom elektronisk datadesign. Studentuppsatsen omtalas ibland som den viktigaste och kanske mest berömda under hela 1900-talet.

A Mathematical Theory of Communication

By C. E. SHANNON

INTRODUCTION

THE recent development of various methods of modulation such as PCM and PPM which exchange bandwidth for signal-to-noise ratio has intensified the interest in a general theory of communication. A basis for such a theory is contained in the important papers of Nyquist[1] and Hartley[2] on this subject. In the present paper we will extend the theory to include a number of new factors, in particular the effect of noise in the channel, and the savings possible due to the statistical structure of the original message and due to the nature of the final destination of the information.

The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have *meaning*; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem. The significant aspect is that the actual message is one *selected from a set* of possible messages. The system must be designed to operate for each possible selection, not just the one which will actually be chosen since this is unknown at the time of design.

If the number of messages in the set is finite then this number or any monotonic function of this number can be regarded as a measure of the information produced when one message is chosen from the set, all choices being equally likely. As was pointed out by Hartley the most natural choice is the logarithmic function. Although this definition must be generalized considerably when we consider the influence of the statistics of the message and when we have a continuous range of messages, we will in all cases use an essentially logarithmic measure.

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THE MATHEMATICAL THEORY OF COMMUNICATION

by Claude E. Shannon and Warren Weaver

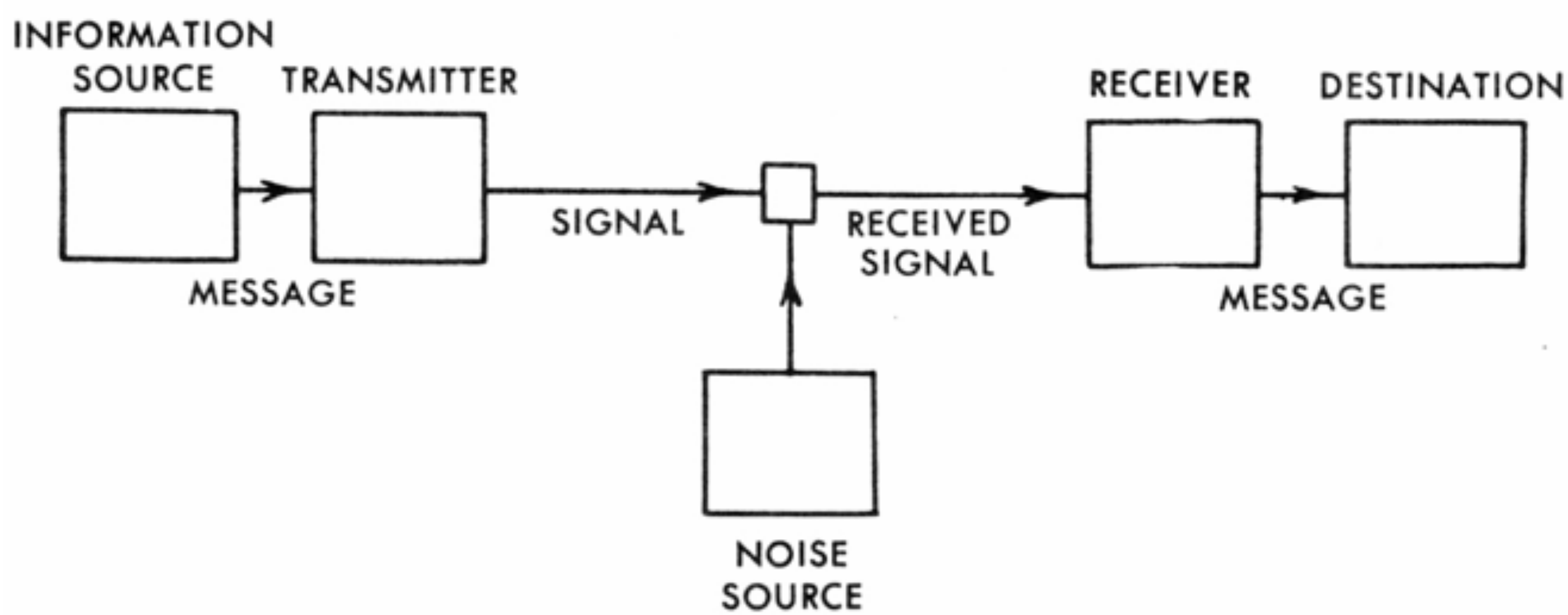


Fig. 1. — Schematic diagram of a general communication system.

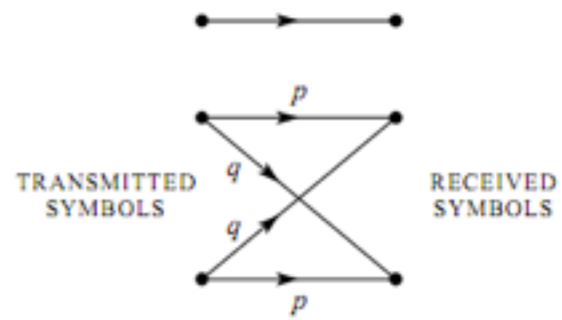


Fig. 11—Example of a discrete channel.

probabilities of using the first and second symbols)

$$H(x) = -P \log P - 2Q \log Q$$
$$H_y(x) = 2Q\alpha.$$

We wish to choose P and Q in such a way as to maximize $H(x) - H_y(x)$, subject to the constraint $P + 2Q = 1$. Hence we consider

$$U = -P \log P - 2Q \log Q - 2Q\alpha + \lambda(P + 2Q)$$

$$\frac{\partial U}{\partial P} = -1 - \log P + \lambda = 0$$
$$\frac{\partial U}{\partial Q} = -2 - 2 \log Q - 2\alpha + 2\lambda = 0.$$

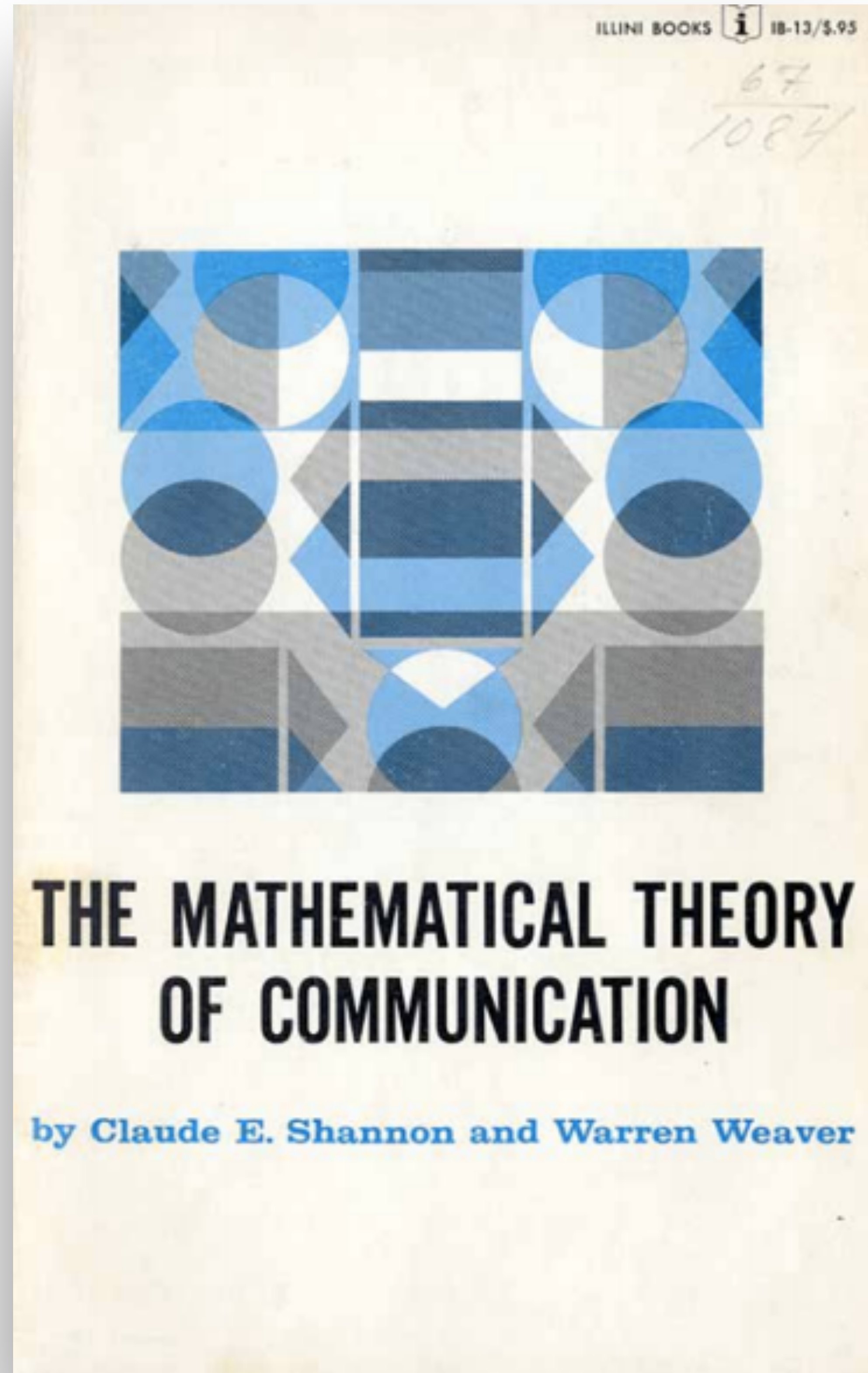
Eliminating λ

$$\log P = \log Q + \alpha$$
$$P = Qe^{\alpha} = Q\beta$$

Claude Shannon

Shannon lanserade i sin uppsats ett strikt **ingenjörsmässigt synsätt på information**. Han brydde sig inte ett dugg om vad den information han mätte egentligen betydde, eller vad den hade för kulturell innebörd. Sådana variabler försvårade nämligen undersökningens exakthet.

"Frequently the messages have meaning; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These **semantic aspects of communication are irrelevant to the engineering problem**."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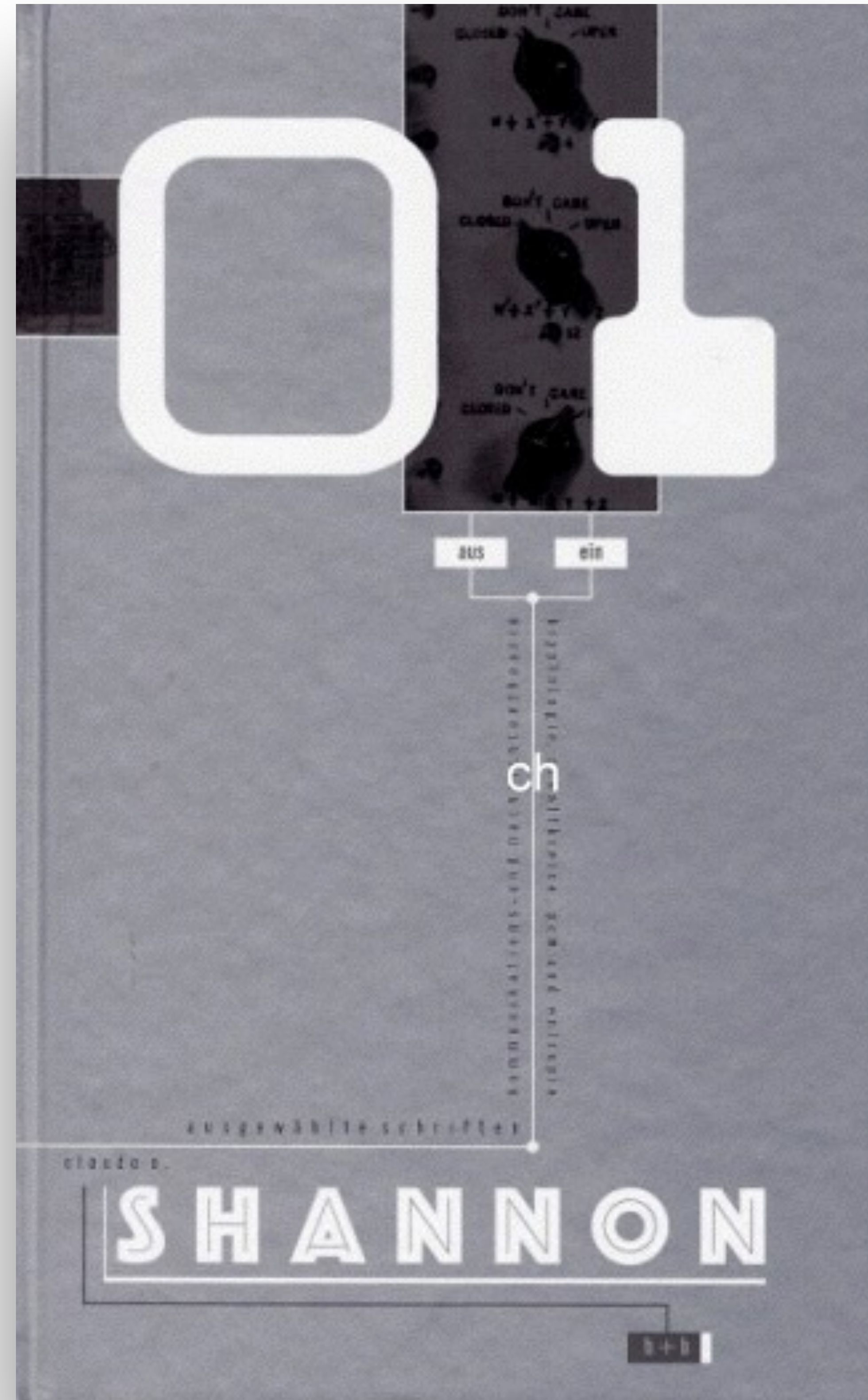
THE MATHEMATICAL THEORY OF COMMUNICATION
by Claude E. Shannon and Warren Weaver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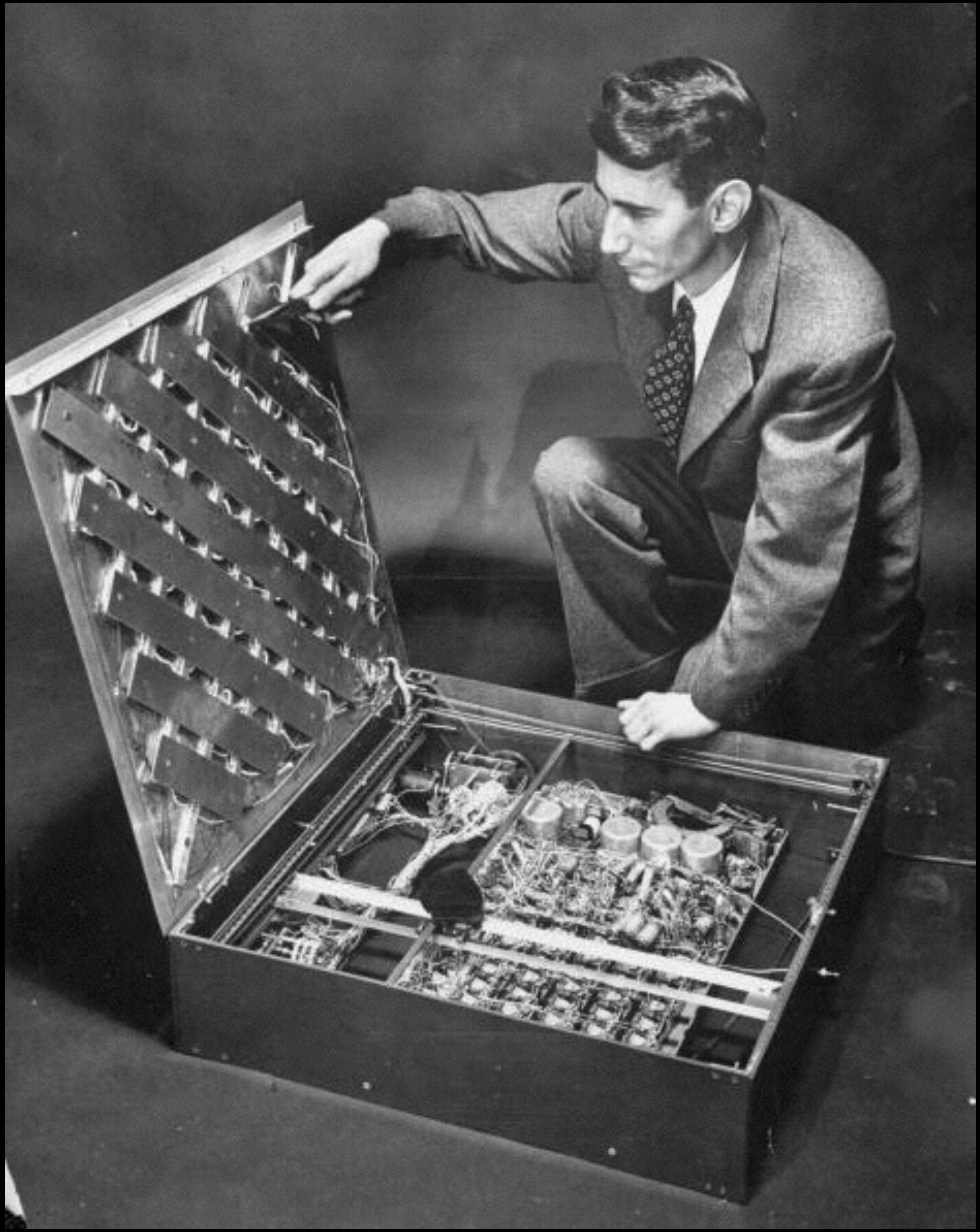
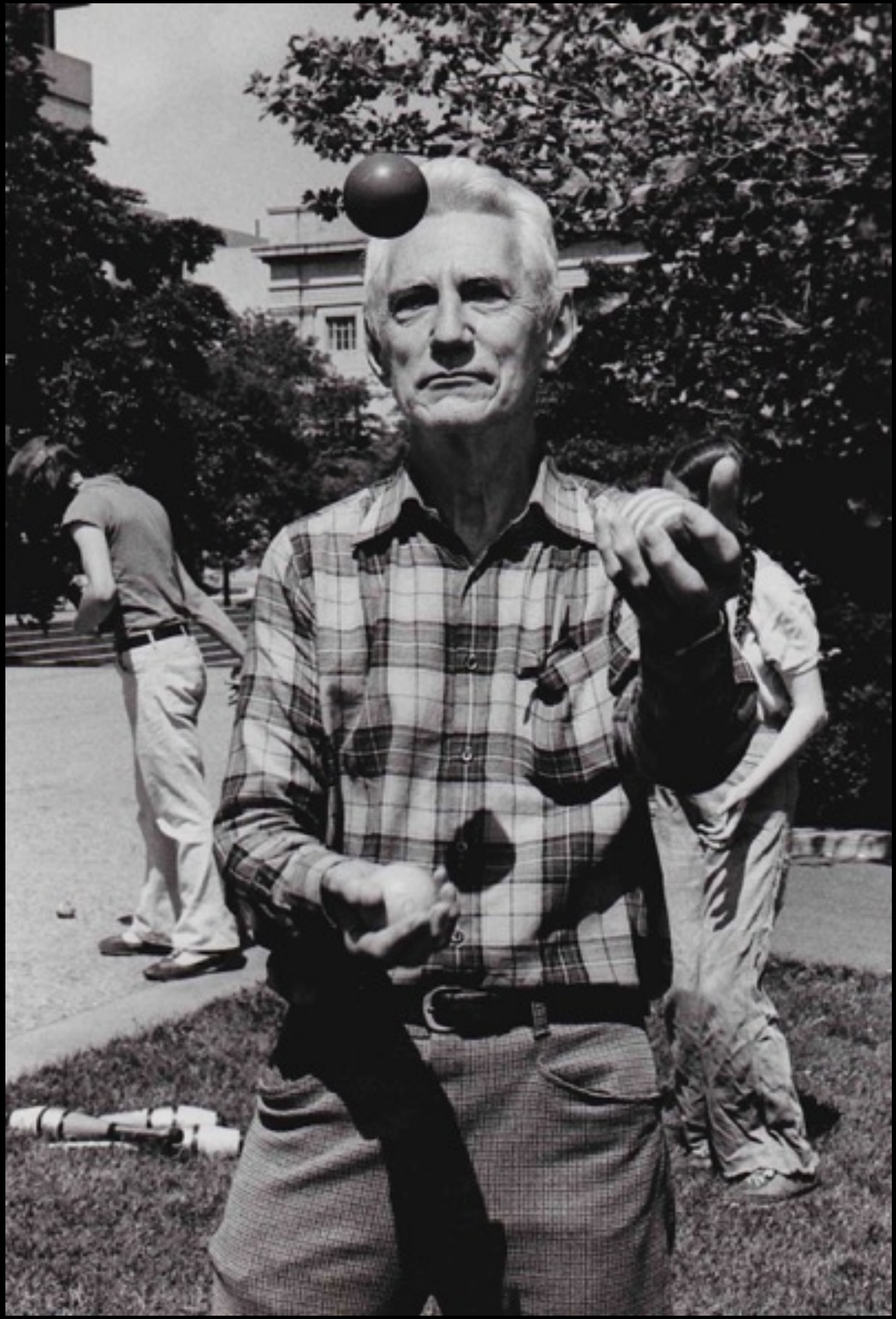
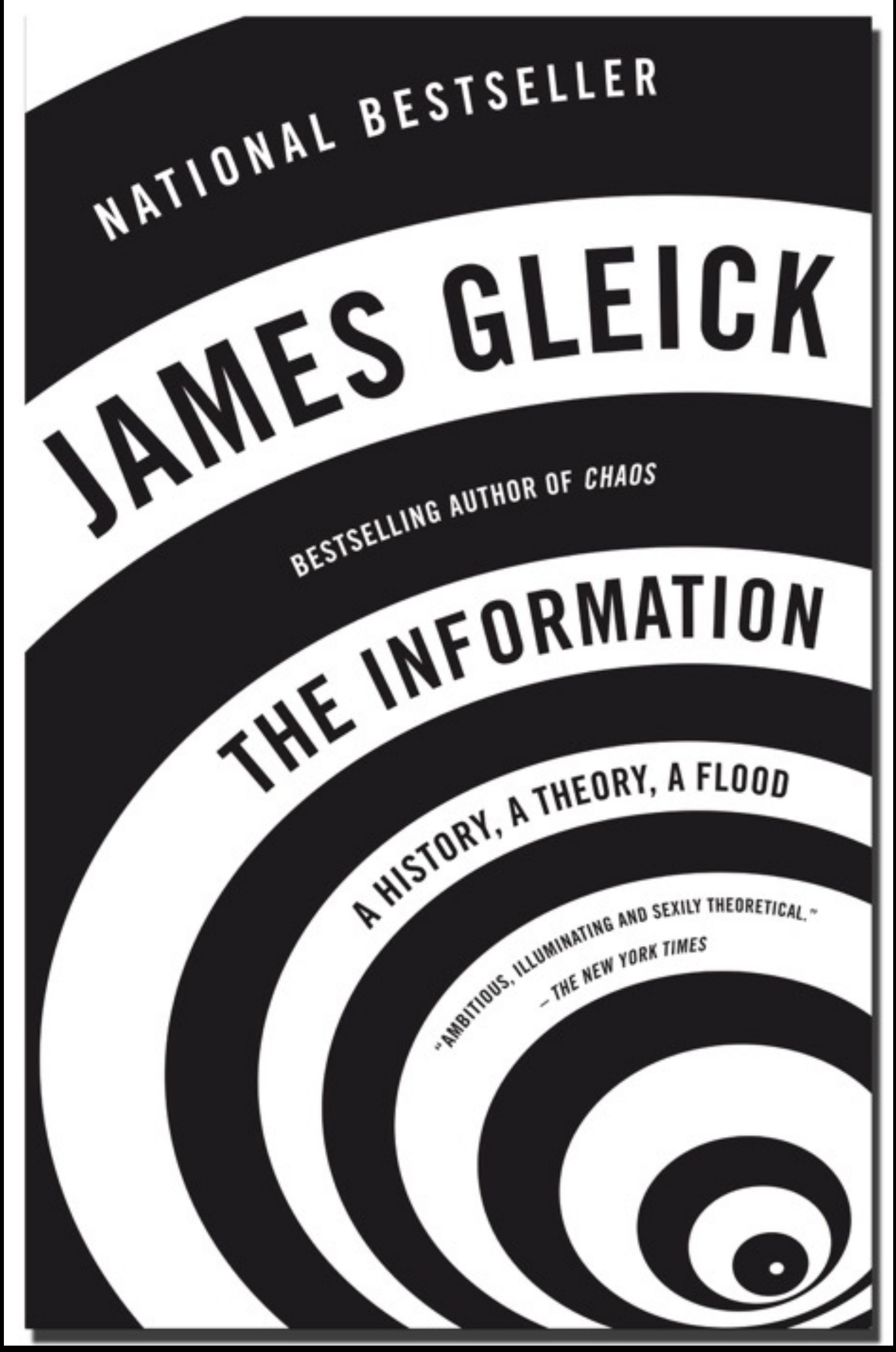
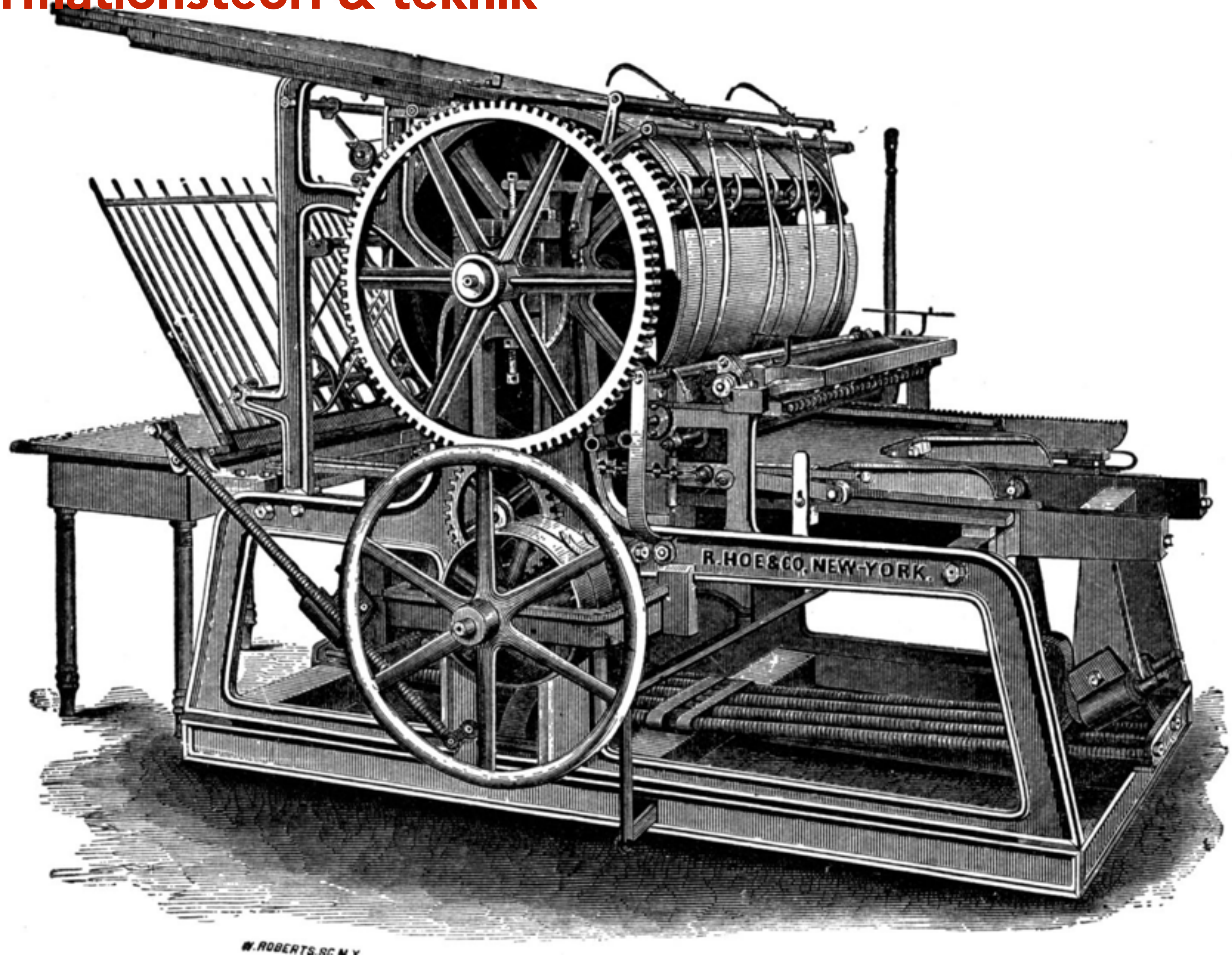
SHANNON






NATIONAL BESTSELLER
JAMES GLEICK
BESTSELLING AUTHOR OF *CHAOS*
THE INFORMATION
A HISTORY, A THEORY, A FLOOD
"AMBITIOUS, ILLUMINATING AND SEXILY THEORETICAL."
—THE NEW YORK *TIMES*

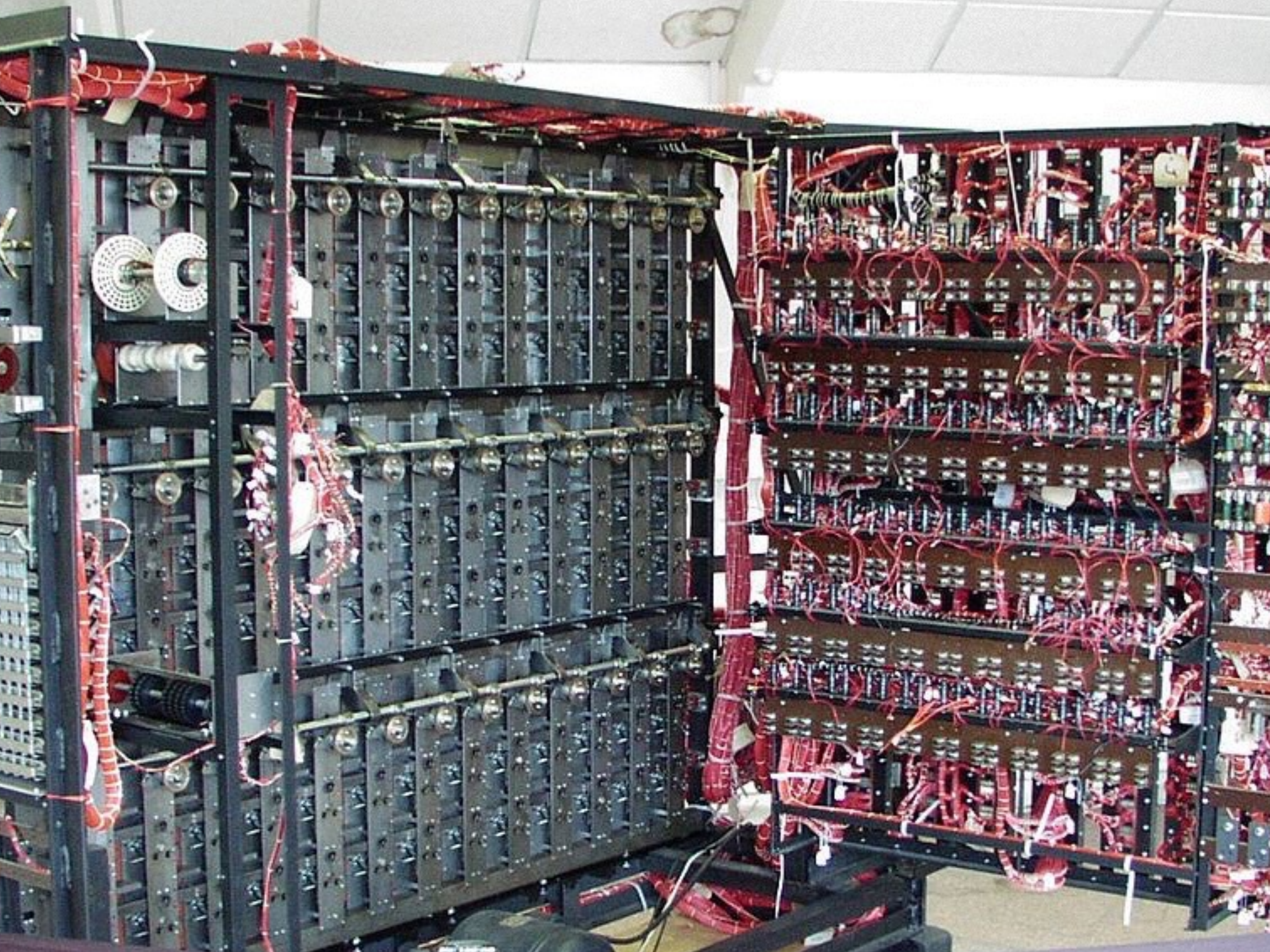
Informationsteori & teknik



Cybernetik, informationsteori & datorer

Dessa 1950-taletsidéer kring information, system och kontroll griper alla tillbaka på utecklingen av **datamaskiner** – vilken allt sedan andra världskriget får allt högre intensitet. Följer man Kittler är det kriget – ett **informationskrig** som drastiskt accentuerar den datalogiska utvecklingen.

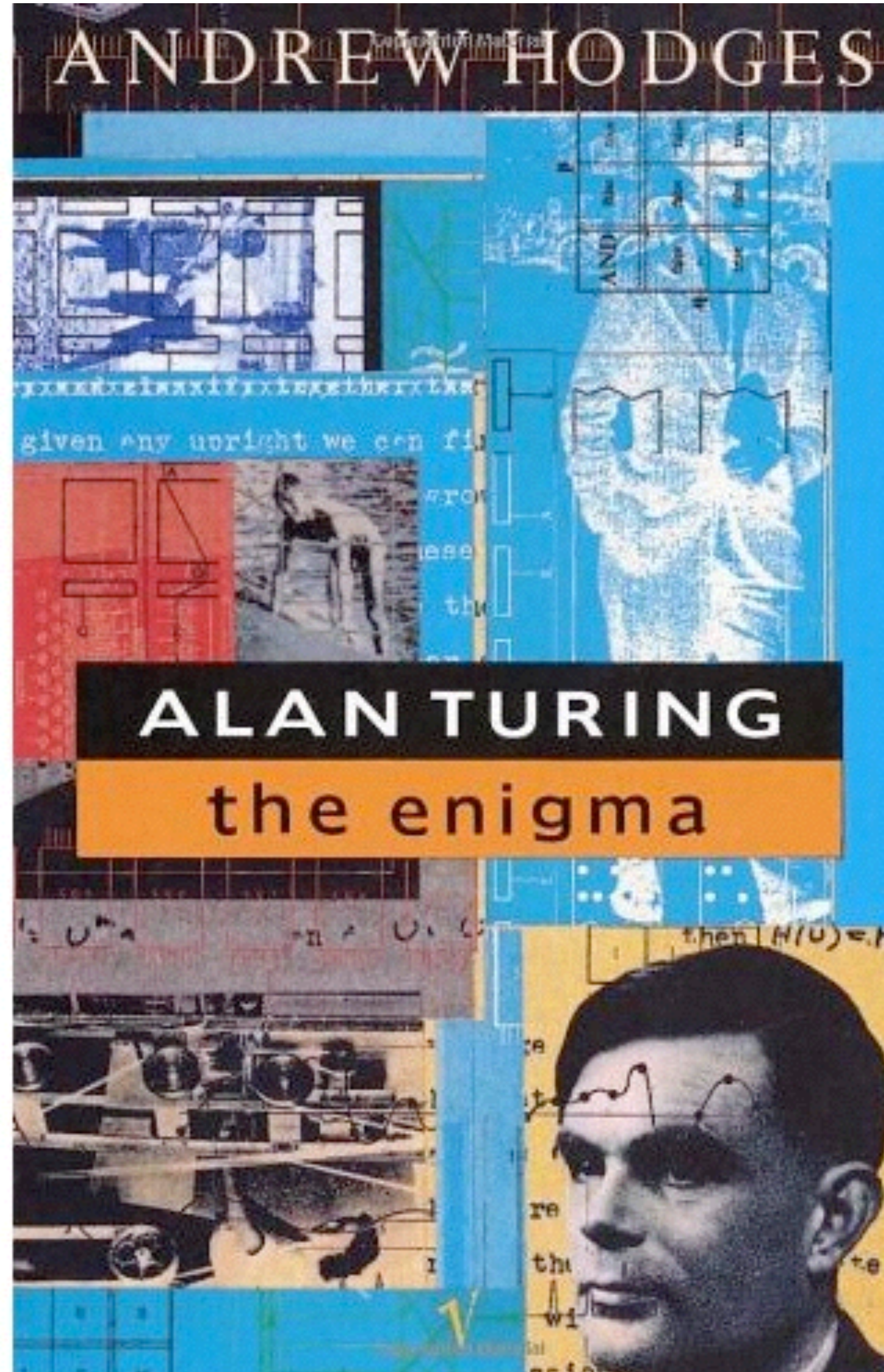

T259
Nur Glühlampen mit 12 mm
Durchmesser verwenden.



Alan Turing & kryptoanalys

I Bletchley Park utanför London knäcker Alan Turing den tyska Enigma-apparaten – genom en än mer sofistikerad apparat, *The Bombe*. ”The bombe searched for possible correct settings used for an Enigma message – rotor order, rotor settings and plugboard settings”. För varje sådant tillstånd (setting) fanns 10 upphöjt i 19 varianter – eller 10 upphöjt i 22 varianter – det vill säga, närmast en oändlig variation som enbart en maskin kude räkna fram.


THE
ALAN TURING MEM
ALAN MATHISON TURING


ANDREW HODGES
ALAN TURING
the enigma

ON COMPUTABLE NUMBERS, WITH AN APPLICATION TO THE ENTSCHEIDUNGSPROBLEM

By A. M. Turing.

[Received 28 May, 1936.—Read 12 November, 1936.]

The "computable" numbers may be described briefly as the real numbers whose expressions as a decimal are calculable by finite means. Although the subject of this paper is ostensibly the computable *numbers*, it is almost equally easy to define and investigate computable functions of an integral variable or a real or computable variable, computable predicates, and so forth. The fundamental problems involved are, however, the same in each case, and I have chosen the computable numbers for explicit treatment as involving the least cumbrous technique. I hope shortly to give an account of the relations of the computable numbers, functions, and so forth to one another. This will include a development of the theory of functions of a real variable expressed in terms of computable numbers. According to my definition, a number is computable if its decimal can be written down by a machine.

In §§ 9, 10 I give some arguments with the intention of showing that the computable numbers include all numbers which could naturally be regarded as computable. In particular, I show that certain large classes of numbers are computable. They include, for instance, the real parts of all algebraic numbers, the real parts of the zeros of the Bessel functions, the numbers π, e, etc. The computable numbers do not, however, include all definable numbers, and an example is given of a definable number which is not computable.

Although the class of computable numbers is so great, and in many ways similar to the class of real numbers, it is nevertheless enumerable. In § 8 I examine certain arguments which would seem to prove the contrary. By the correct application of one of these arguments, conclusions are reached which are superficially similar to those of Gödel†. These results

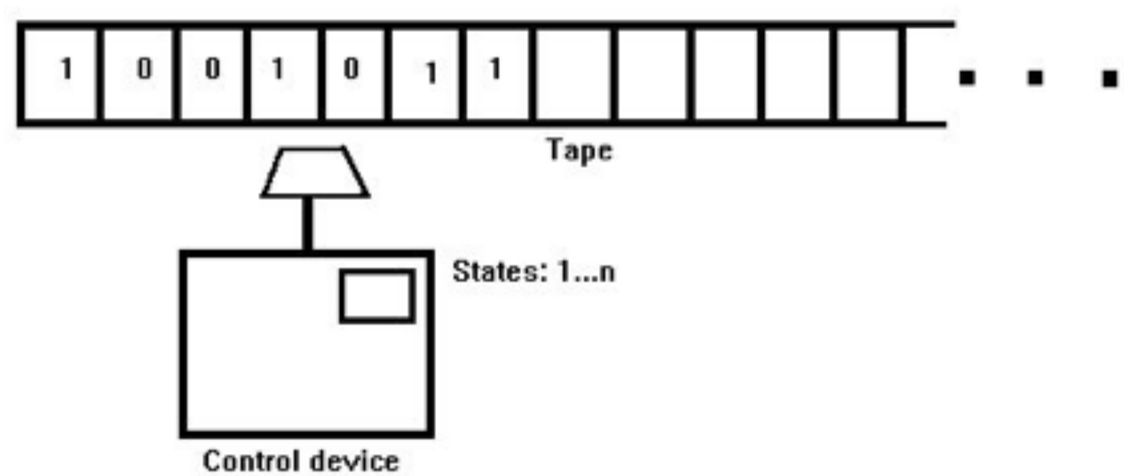
† Gödel, "Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme, I", *Monatshefte Math. Phys.*, 38 (1931), 173–198.

Turing – maskin & test

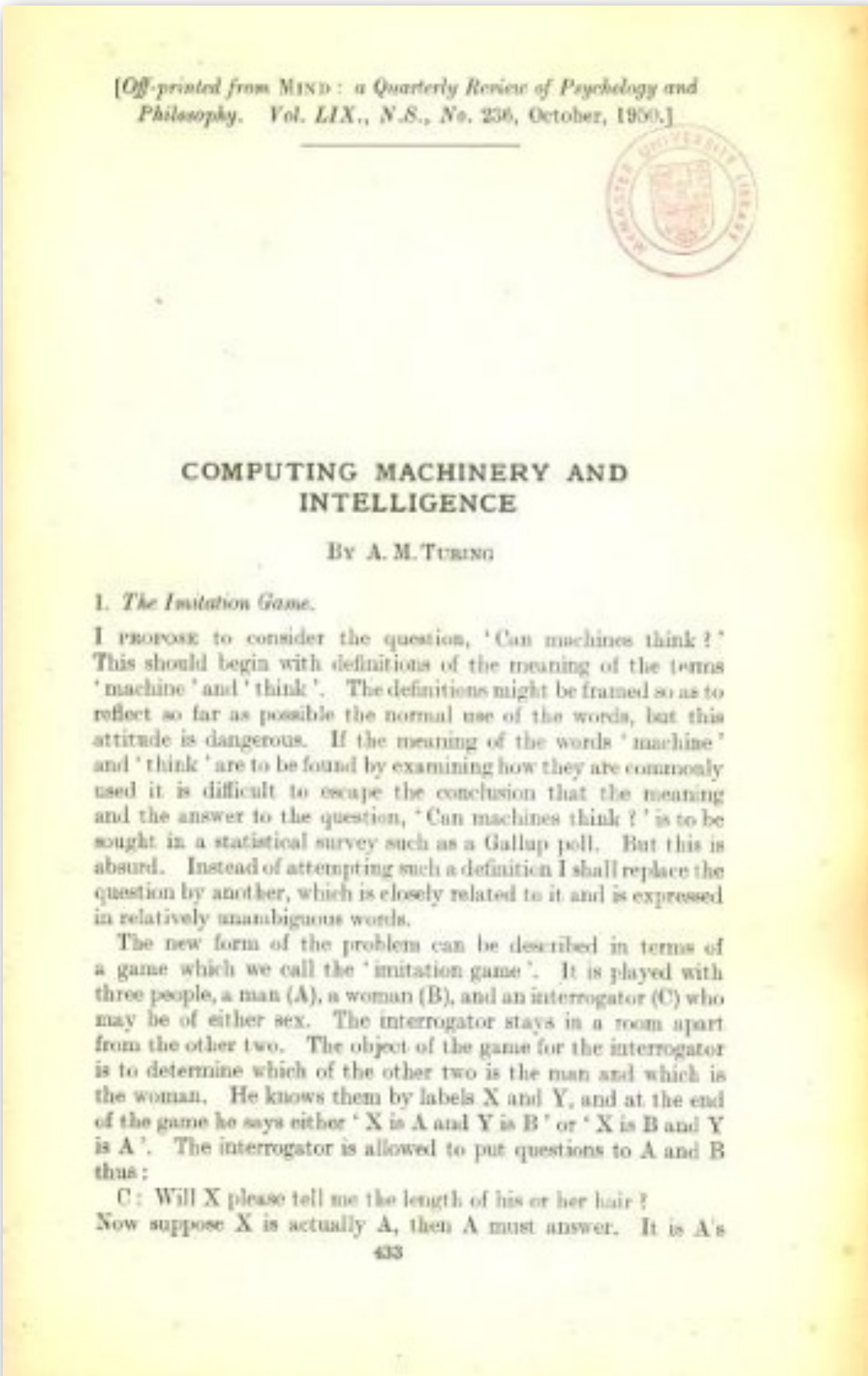
I ”On Computable Numbers” formulerar Turing den teoretiska grunden för all modern datateknik – i form av en hypotes. Turings bidrag till matematikens teori är, i korthet, en kombination av mekanik och talteori – ”shockingly industrial”, enligt samtidens Cambridgematematiker. I artikeln definierade han en abstrakt maskin, senare kallad **Turingmaskin**, som han förmodade kunde utföra varje räkneoperation som en människa eller en maskin var kapabel att hitta på.

Turing – maskin & test

Turing tänkte sig en helt abstrakt maskin – Turingmaskinen – vars låda kunde läsa och skriva på en tänkt remsa indelad i rutor. I varje ruta skrevs antingen **1 eller 0**, eller så kunde rutan förbli blank. Turingmaskinen var alltså helt rudimentär, men utgjorde likafullt prototypen för den moderna datorn.



Turing – maskin & test



[*Off-printed from* MIND: *a Quarterly Review of Psychology and Philosophy. Vol. LIX., N.S., No.* 236, October, 1950.]

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:

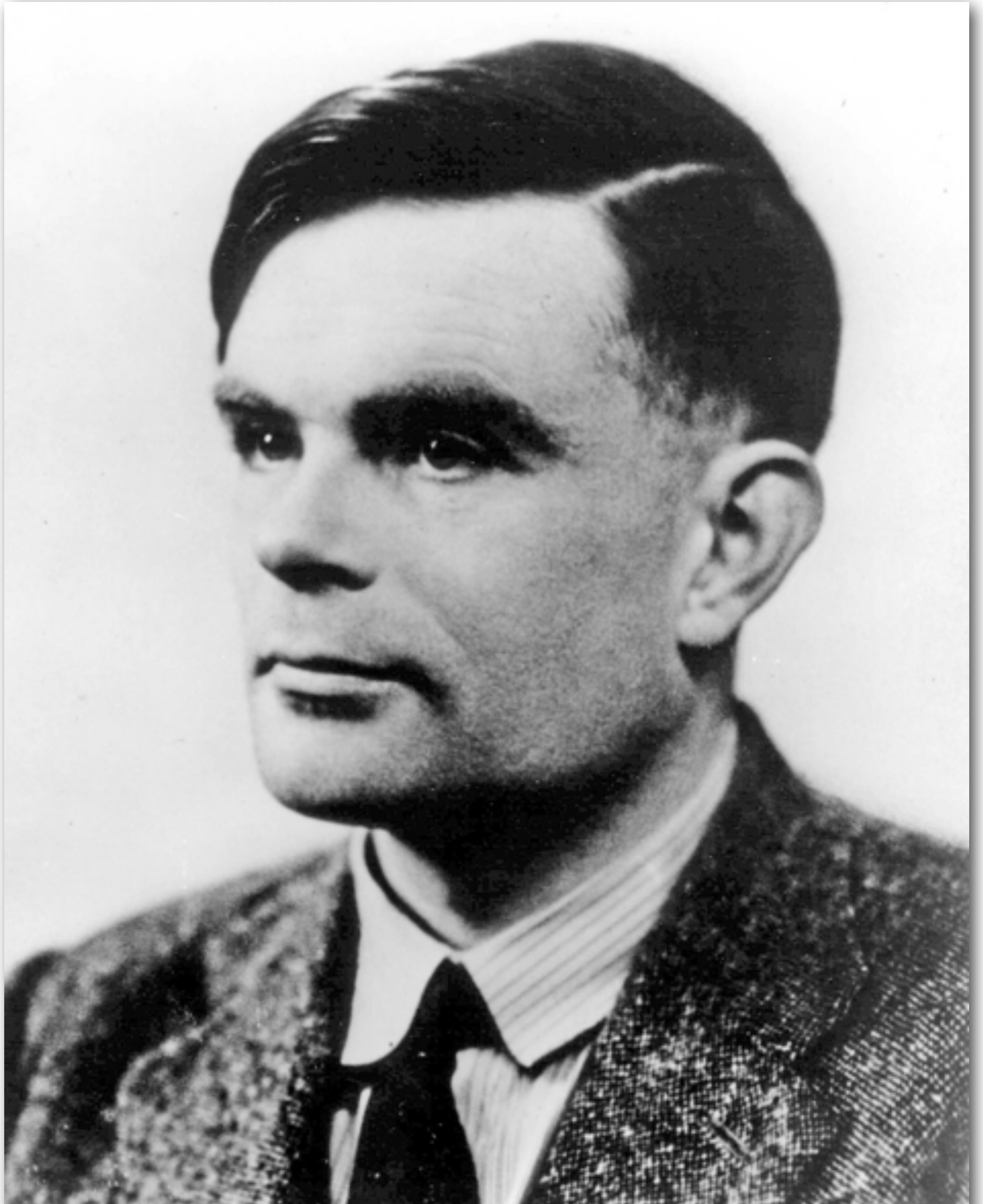
C: Will X please tell me the length of his or her hair?

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

433

I artikeln "Computing Machinery and Intelligence" från 1950 lanserade han vidare idén om det så kallade **Turingtestet**. I testet konverserar en domare genom en terminal dels med en människa, dels med en dator. Om domaren inte på ett tillförlitligt vis kan avgöra vilken konversationspartner som är människa och vilken som är dator anses den senare ha klarat testet. Det vill säga, om en person är oförmögen att skilja ett datasystems handlande från det beteende som en människa uppvisar, så måste detta system anses vara intelligent.

Turing – maskin & test



"it is not altogether unreasonable to describe digital computers as brains [...] I think it is probable for instance that at the end of the century it will be possible to programme a machine to answer questions in such a way that it will be extremely difficult to guess whether the answers are being given by a man or by the machine."

BBC-föredrag 1951, "Can Digital Computers Think?"

Mediehistorien som digital datahistoria

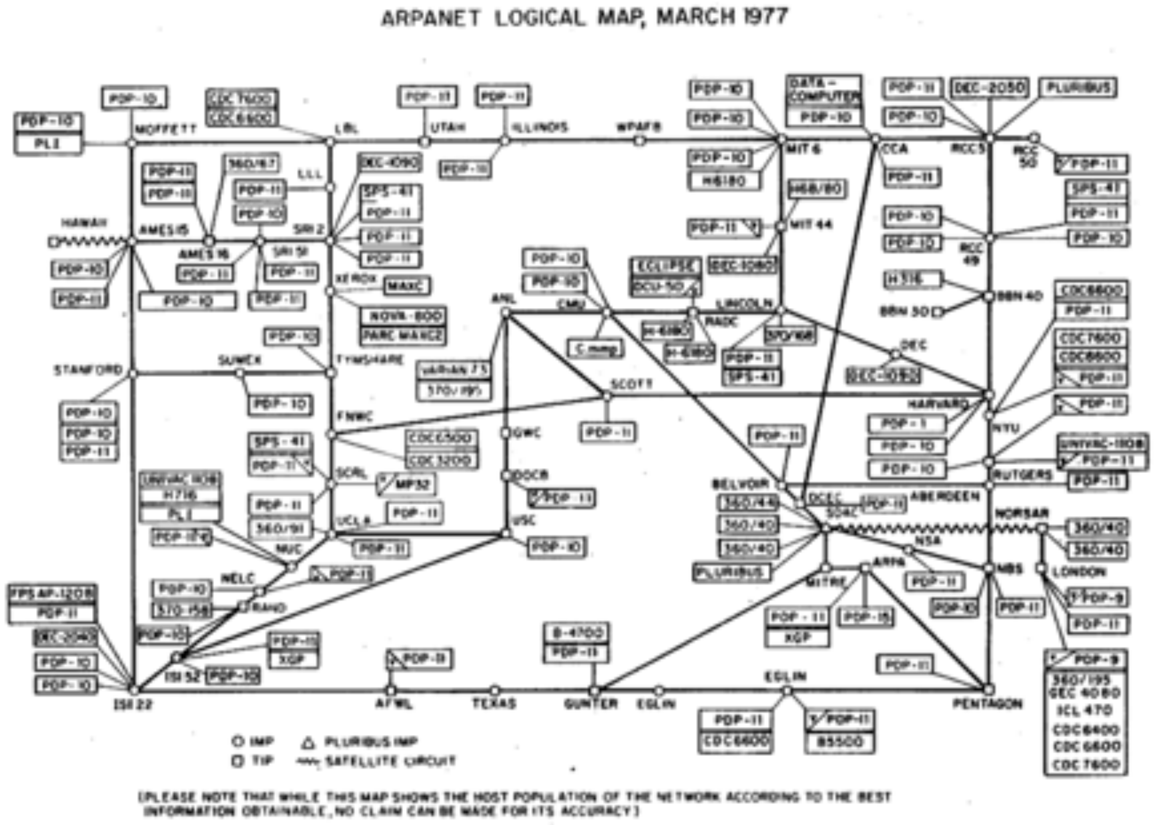
Mediehistorien som digital datahistoria

På ett generellt plan har det funnits tre sätt att beskriva informationssamhällets framväxt, och datorns eller datoriseringens historia. För det första existerar det en teknisk och vetenskaplig berättelse kring vakuumrör, reläer och transistorer – vilken sedermera uppgraderas till att handla mer om mjukvara och algoritmer.

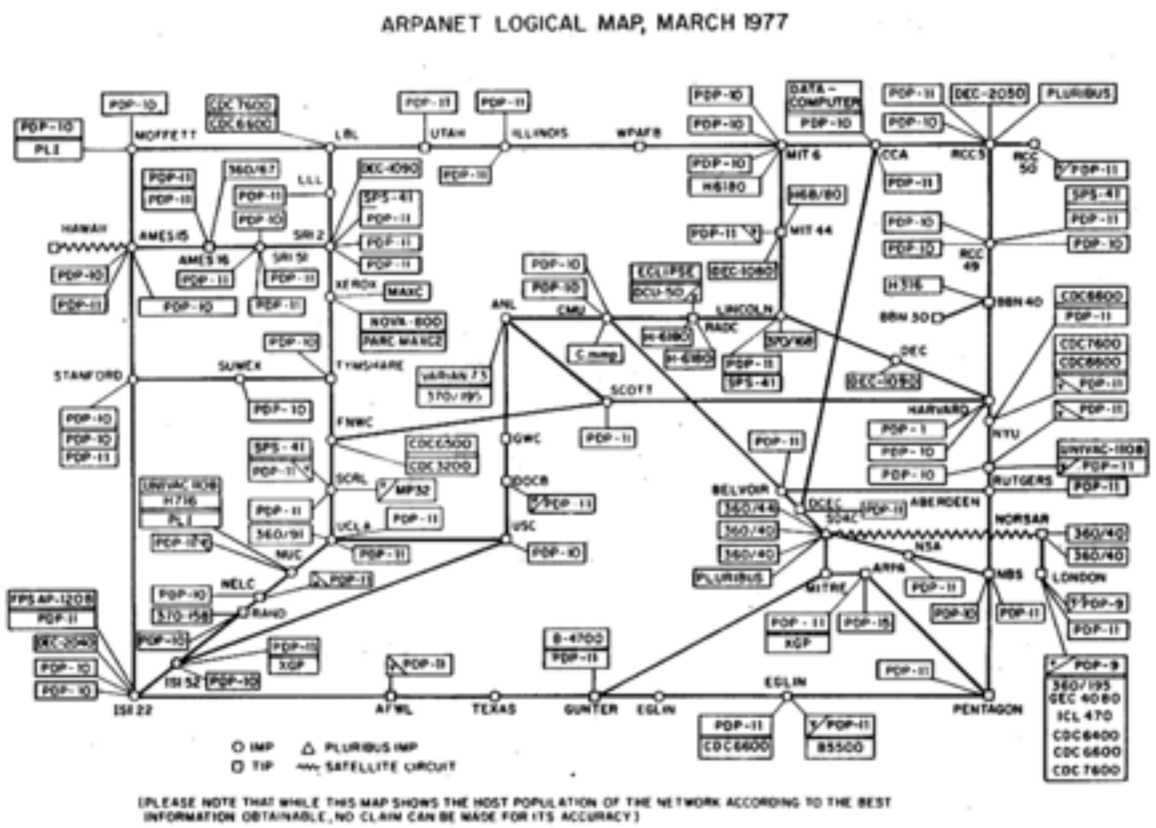
Långt mer populär är datorns ekonomiska historia; en berättelse om rikedom och förmögenheter som vinns – och förloras – med försäljning och marknadsföring av datorn och dess programvara som ständig ledstjärna.

Slutligen finns det en mer visionär datorhistoria med fokus på innovationer och datalogiskt nytänk, ett slags datorns idéhistoria.

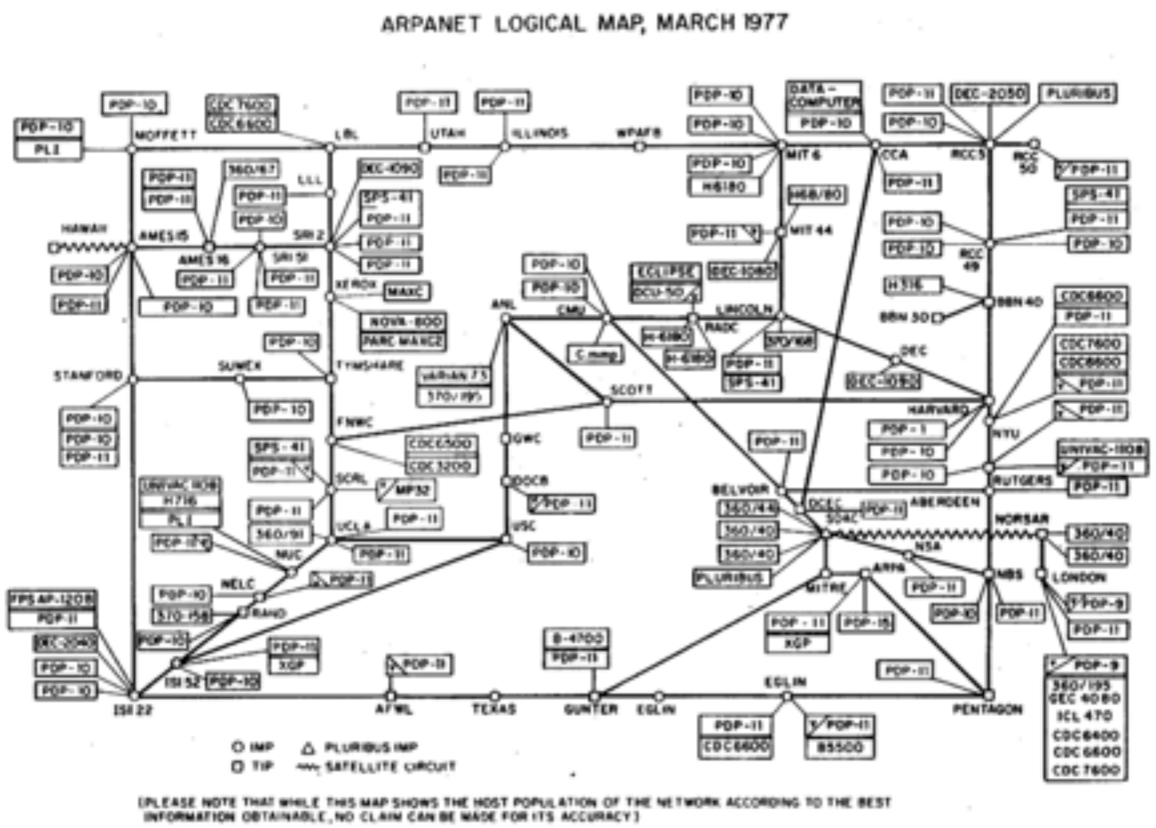
Mediehistorien som digital datahistoria

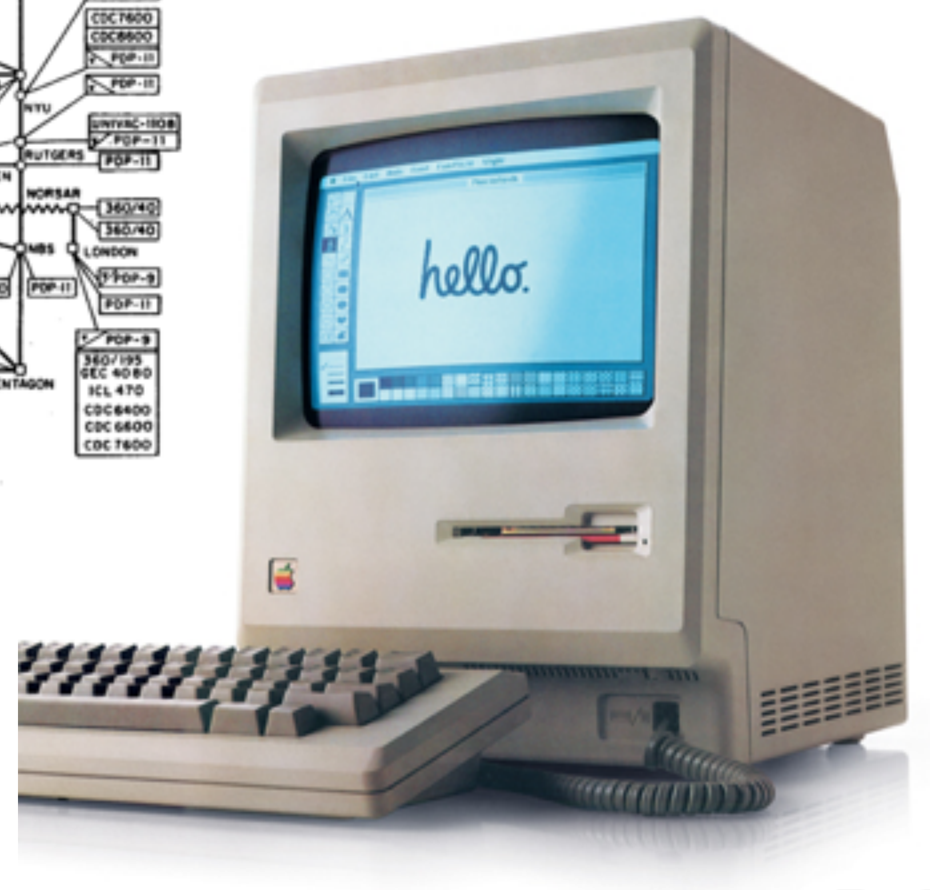


Mediehistorien som digital datahistoria



Mediehistorien som digital datahistoria





MICROSOFT

Mediehistorien som digital datahistoria

Mediehistorien som digital datahistoria

Den digitala utvecklingen ses oftast som blixtsnabb – samtidigt har datorn varit ett tämligen **trögt medium**, som funnits alltsedan 1940-talet.

I ett övergripande mediehistoriskt perspektiv har datorer omprogrammerats från att vara **siffermaskiner som processar data** – till att bli **kreativa verktyg för hur data gestaltas**.

Icke desto mindre har datorn alltid betraktats som ett **framtidsmedium** – vilket också gäller vår samtida diskurs kring *digitalisering*, vilken i regel beskrivs som en **framtidsbildande teknik**.

(*Reprinted from the Atlantic Monthly, July, 1945*)

AS WE MAY THINK

by VANNEVAR BUSH

As Director of the Office of Scientific Research and Development, Dr. Vannevar Bush has coördinated the activities of some six thousand leading American scientists in the application of science to warfare. In this significant article he holds up an incentive for scientists when the fighting has ceased. He urges that men of science should then turn to the massive task of making more accessible our bewildering store of knowledge. For years inventions have extended man's physical powers rather than the powers of his mind. Trip hammers that multiply the fists, microscopes that sharpen the eye, and engines of destruction and detection are new results, but not the end results, of modern science. Now, says Dr. Bush, instruments are at hand which, if properly developed, will give man access to and command over the inherited knowledge of the ages. The perfection of these pacific instruments should be the first objective of our scientists as they emerge from their war work. Like Emerson's famous address of 1837 on "The American Scholar," this paper by Dr. Bush calls for a new relationship between thinking man and the sum of our knowledge. — The Editor

This has not been a scientist's war; it has been a war in which all have had a part. The scientists, burying their old professional competition in the demand of a common cause, have shared greatly and learned much. It has been exhilarating to work in effective partnership. Now, for many, this appears to be approaching an end. What are the scientists to do next?

For the biologists, and particularly for the medical scientists, there can be little indecision, for their war work has hardly required them to leave the old paths. Many indeed have been able to carry on their war research in their familiar peacetime laboratories. Their objectives remain much the same.

It is the physicists who have been thrown most violently off stride, who have left academic pursuits for the making of strange destructive gadgets, who have had to devise new methods for their unanticipated assignments. They have done their part on the devices that made it possible to turn back the enemy. They have worked in combined effort with the physicists of our allies. They have felt within themselves the stir of achievement. They have been part of a great team. Now, as peace approaches, one asks where they will find objectives worthy of their best.

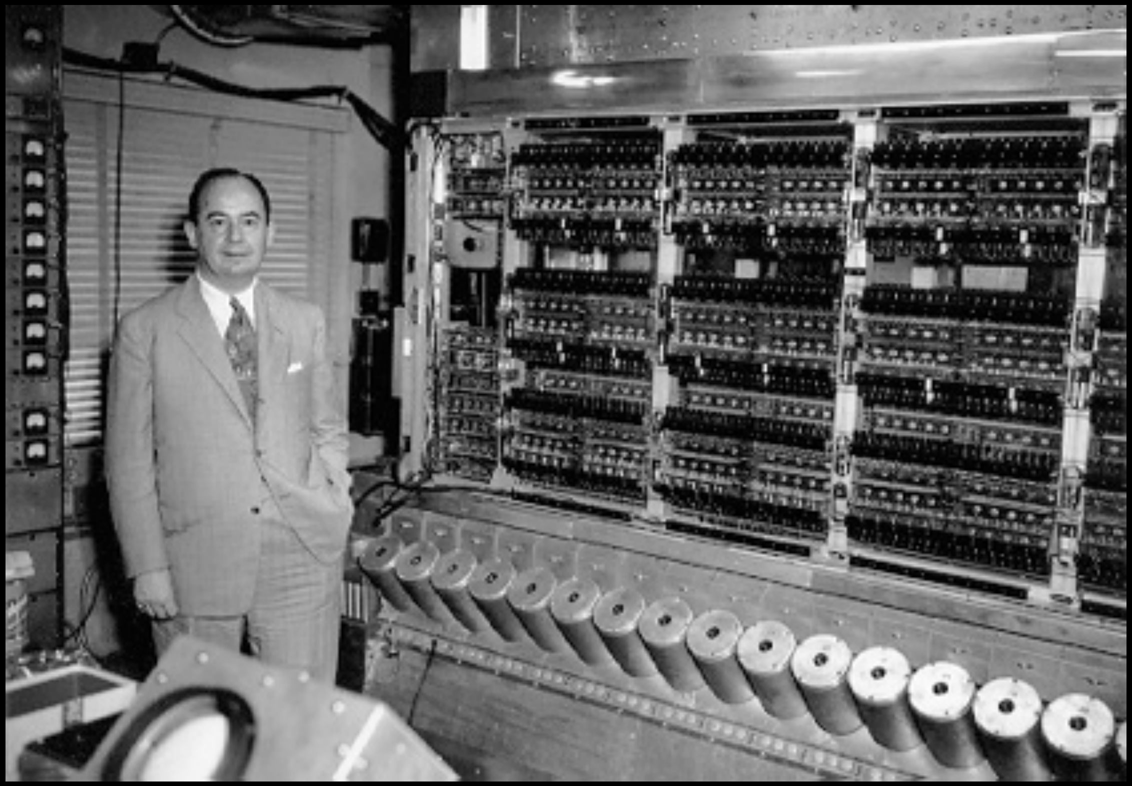
1

Of what lasting benefit has been man's use of science and of the new instruments which his research brought into existence? First, they have increased his control of his material environment. They have improved his food, his clothing, his shelter; they have increased his security and released him partly from the bondage of bare existence. They have given him increased knowledge of his own biological processes so that he has had a progressive freedom from disease and an increased span of life. They are illuminating the interactions of his physiological and psychological functions, giving the promise of an improved mental health.

Science has provided the swiftest communication between individuals; it has provided a record of ideas and has enabled man to manipulate and to make extracts from that record so that knowledge evolves and endures throughout the life of a race rather than that of an individual.

There is a growing mountain of research. But there is increased evidence that we are being bogged down today as specialization extends. The investigator is staggered by the findings and conclusions of thousands of other workers — conclusions which he cannot find time to grasp, much less to remember, as they appear. Yet specialization becomes increasingly necessary for progress, and the effort to bridge between disciplines is correspondingly superficial.

Professionally our methods of transmitting and reviewing the results of research are generations old and by now are totally inadequate for their purpose. If the aggregate time spent in writing scholarly works and in reading them could be evaluated, the ratio between these amounts of time might well be startling. Those who conscientiously attempt to keep abreast of current thought, even in restricted fields, by close and continuous reading might well shy away from an examination calculated to show how much of the previous month's efforts could be produced on call. Mendel's concept of the laws of genetics was lost to the world for a generation because his publication did not reach the few who were capable of grasping and extending it; and this sort of catastrophe is undoubtedly being repeated all about us, as truly significant



First Draft of a Report on the EDVAC

by

John von Neumann

Contract No. W–670–ORD–4926

Between the

United States Army Ordnance Department

and the

University of Pennsylvania

Moore School of Electrical Engineering
University of Pennsylvania

June 30, 1945

1.0 DEFINITIONS

2.0 MAIN SUBDIVISIONS OF THE SYSTEM

3.0 PROCEDURE OF DISCUSSION

4.0 ELEMENTS, SYNCHRONISM NEURON ANALOGY

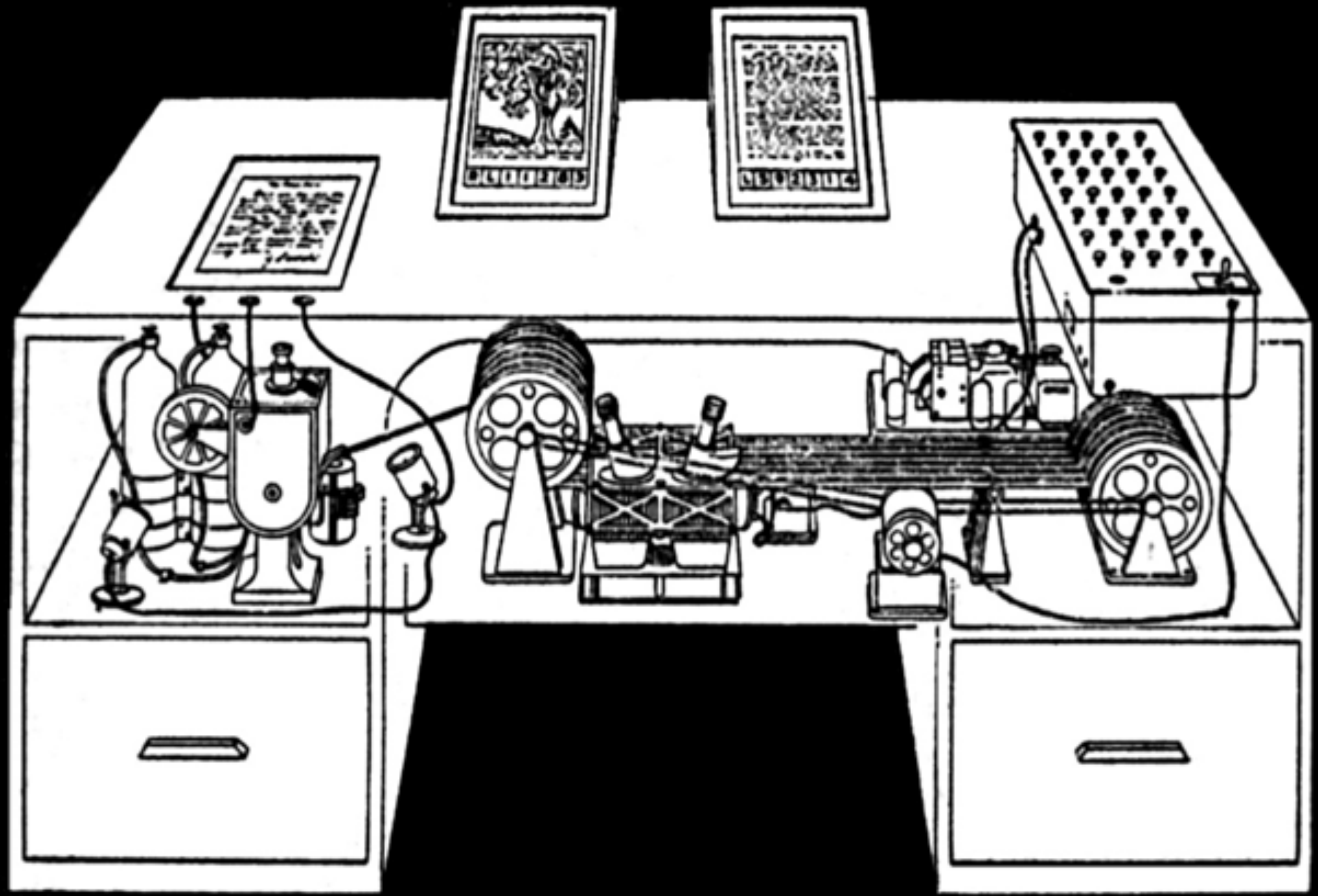
John von Neumann

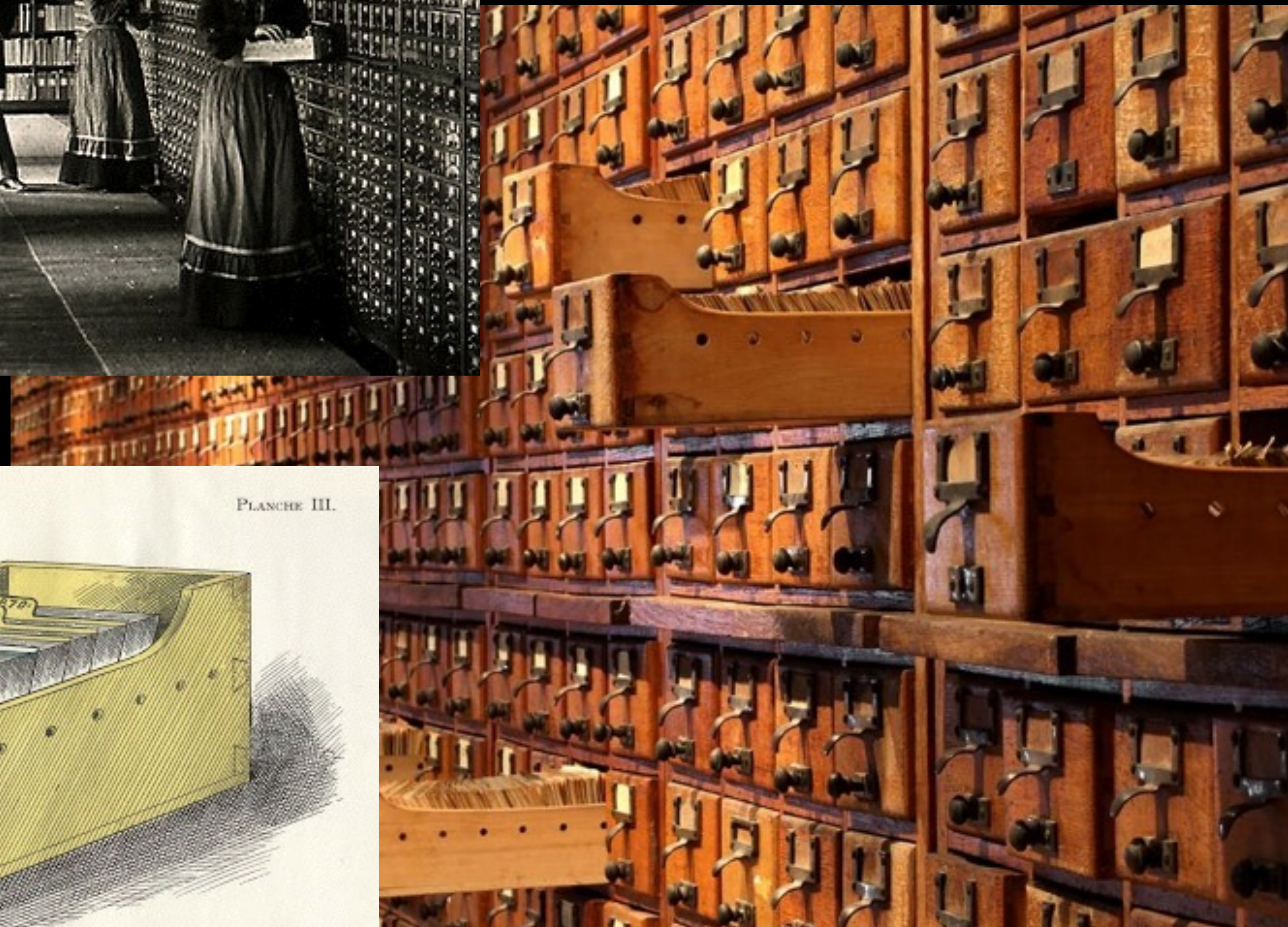
Utvecklandet av så kallad **von-Neumann-arkitektur** i form av en modell för hur en dator praktiskt fungerar – till skillnad från Turings hypotetiska maskin – som under nästan ett halvt sekel utgjorde grunden för all datarkitektur.

Datorn skulle för det första vara **programmeringsbar**, inte hårdkodad som tidigare via fysiska kopplingar och reläer. För det andra skulle **data och program båda lagras i datorns minne** – för att kunna återanvändas i olika sammanhang för olika uppgifter.

Redan här uppstår såtillvida idéer och föreställningar att datorer inte enbart var siffermaskiner – såsom de exempelvis kommer till uttryck hos **Bush och hans Memex-apparat**.

Bush & Memex





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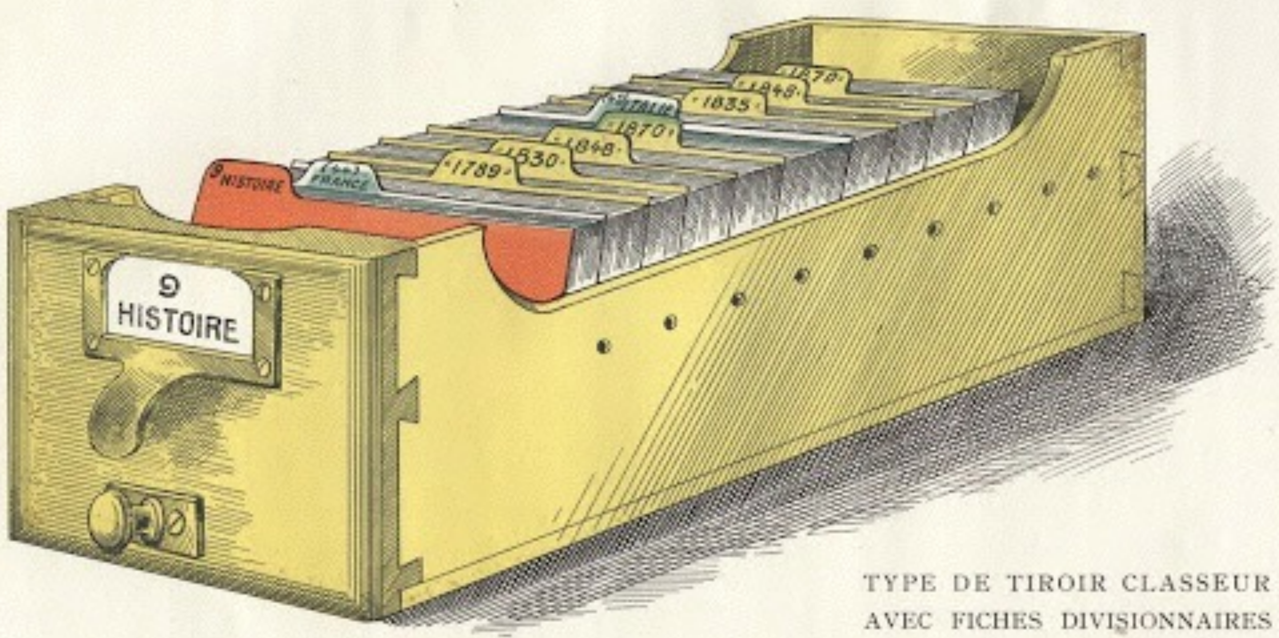
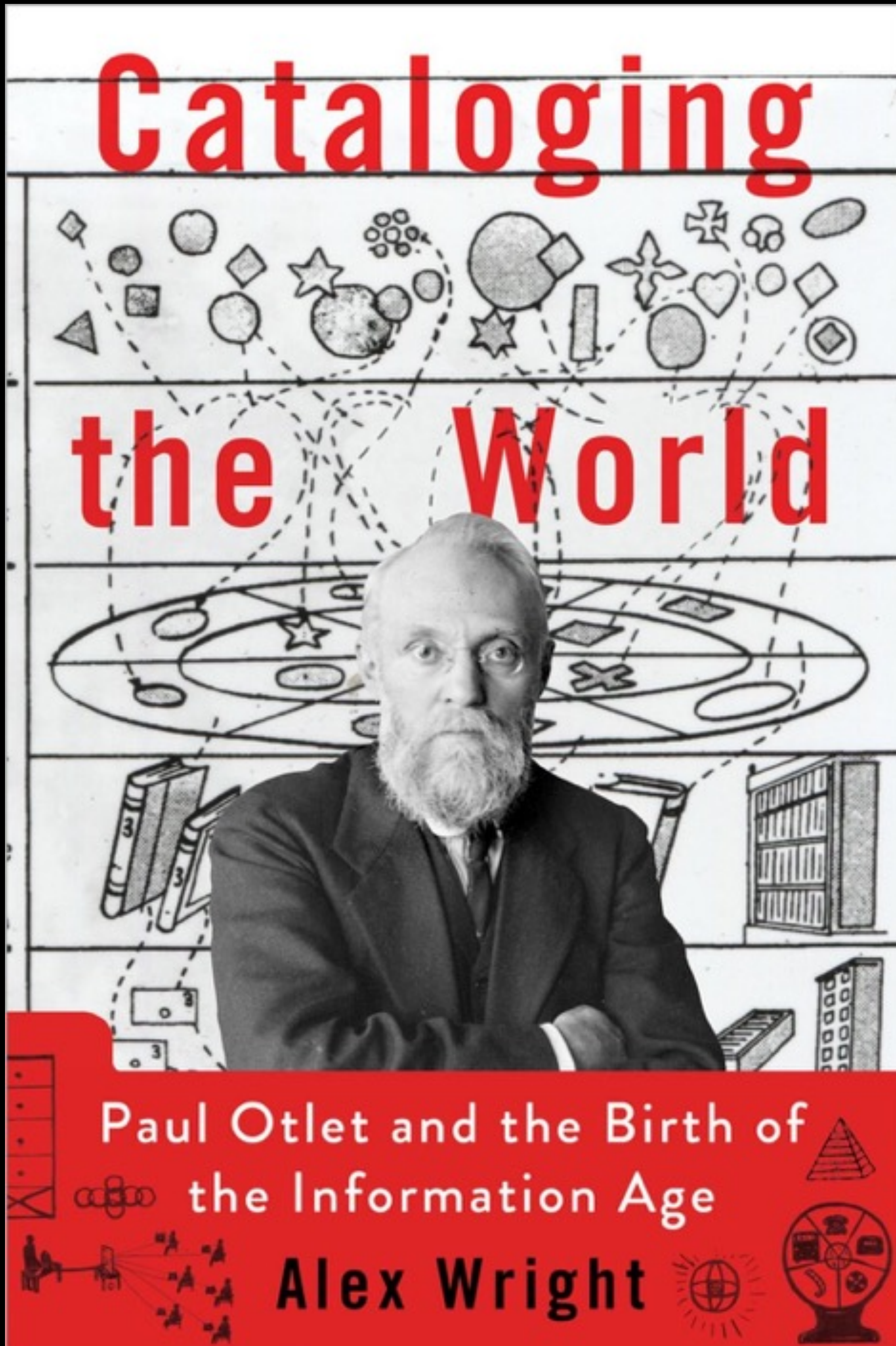


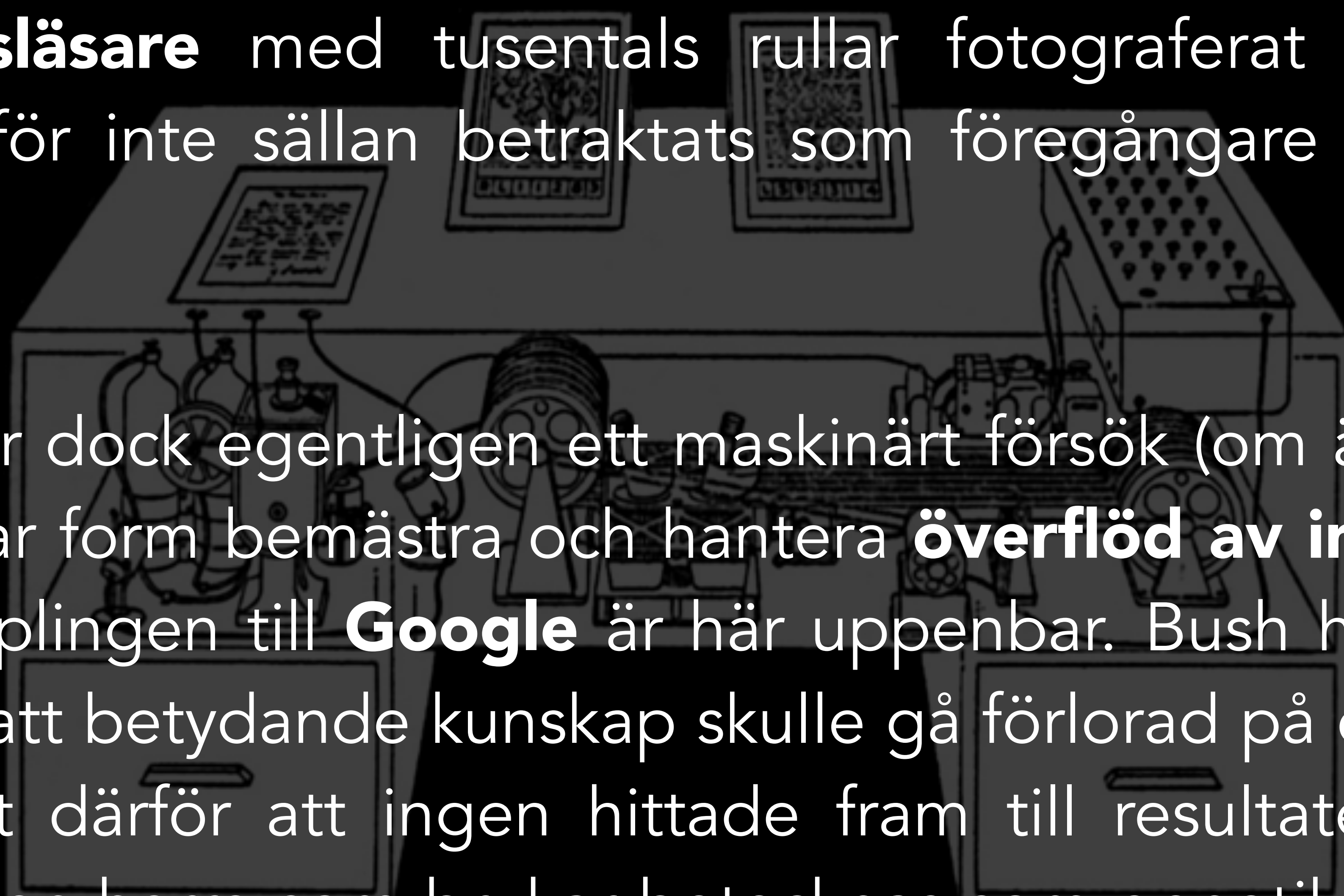
TYPE DE TIROIR CLASSEUR
AVEC FICHES DIVISIONNAIRES

La division principale 9 *Histoire* est indiquée par une fiche divisionnaire du premier cran, de couleur orange.

Les subdivisions de lieu (44) *France*, (45) *Italie*, sont indiquées par des fiches divisionnaires du deuxième cran, de couleur verte. — Les subdivisions de temps « 1789 », « 1830 », etc., sont indiquées par des fiches divisionnaires du troisième cran, de couleur jaune. — L'histoire de France, en 1789, est classée à 9 (44) « 1789 ».


Cataloging the World
Paul Otlet and the Birth of the Information Age
Alex Wright

Bush & Memex



Den hypotetiska Memex-apparaten var en sorts avancerad **mikrofilmsläsare** med tusentals rullar fotograferat vetande – vilken därför inte sällan betraktats som föregångare till dagens webb.

Memex var dock egentligen ett maskinärt försök (om än påhittat) att i skalbar form bemästra och hantera **överflöd av information** – och kopplingen till **Google** är här uppenbar. Bush hyste en en rädsla för att betydande kunskap skulle gå förlorad på ett närmast banalt sätt därför att ingen hittade fram till resultaten. Gregor **Mendel** – en herre som brukar betecknas som genetikens fader – och hans experiment med ärtsorter var till exempel länge förlorade för eftervärlden eftersom resultaten inte distribuerades på ett adekvat sätt.

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Bush & Memex

På ett snarlikt sätt oroade sig Bush 1945 (då han lanserade sin Memexmaskin) för den situation av **bristande vetenskaplig överblick** som uppstått bara under hans levnad.

Men, tillade han, ”svårigheten är inte så mycket att vi publicerar otillbörligt med hänsyn till omfattningen och mångfalden av dagens intressen, snarare att publiceringstakten ökats långt bortom vår nuvarande användningsförmåga”.

”**To make real use of the record**”, var trots allt vetenskapens kungstanke, och då fick inte tidigare resultat vara om intet – och framför allt inte tappas bort.

Memex

– tack.

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