eLetters

Origins of Terminology Pending Further Discovery

Zhiwen Hu¹², Jian Zhang³, Yongfeng Huang²*, Xun Wang¹

¹School of Computer and Information Engineering, Zhejiang Gongshang University, Hangzhou, 310018, China.
²Department of Electronic Engineering, Tsinghua University, Beijing, 100084, China.
³School of Electronic Science and Applied Physics, Hefei University of Technology, Hefei, 230009, China.

*Corresponding author. Email: yfhuang@tsinghua.edu.cn

Abstract:

The origins of terminology of the humanities, social sciences, and natural science are still pending further discoveries. The earliest usage track-down of a target term could provide an insightful and compelling argument for rigorous historical story, and finally help us penetrate to the essence of reality. However, many empirical extrapolated theories based on sole information source always turns out de facto knowledge illusions. Therefore, retaining a clear sense of the pros and cons of any retrospective information source is the necessary prerequisite to such scientific efforts.

One Sentence Summary: The origins of terminology are still pending further discoveries.

Main Text:

The article “Roots of software” (Science 288, 1169) highlighted that librarian and etymologist Fred R. Shapiro at Yale University, the editor of The Yale Book of Quotations, tracked down the earliest appearance of “software” via the JSTOR electronic journal archive (1). Later, the articles “You read it first in Science” (Science News, 9 December 2000) and “You read it here first” (Science 291, 39) reiterated that Shapiro’s findings sifted through in JSTOR – the origins of dozens of words, including “personal computer” (2) and “molecular biology” (3-7). Unfortunately, such punctuated approach and findings may unconsciously discourage any other predated historical evidence technically, mislead the later quotations in scientific literature and lexicography.

Terminologies have experienced explosive growth over the past decades, finding their ways in daily communication from academic-industrial sphere. However, their debutants are conventionally understood as nominal rather than substantial yet, as well as their coinages, diachronic discourse and lexical dynamics as the bedrock of scientific storytelling (8-13). To pursuit continuous introspection of previous multifarious findings, historians always find themselves buried in unending retrieval of tangled contingencies to pinpoint such inherent affiliations in pithy evidences. However, it is necessary to punctuate heuristic cautions of wrestling with information from retrospective sources and the reassembly of whole story.

Before the essence of reality reveals, we always have to turn to powerful tools available with imperfect information in the age of Web science. Noteworthily, we should never overestimate the power of JSTOR or any other dataset without cross validation in empirical research, as the JSTOR’s developers reminded (14). Undeniably, any sole information source can’t cover the amount of “dated written materials”. As a prototypical example, the earliest known occurrence of “personal
computer” didn’t debut in *Science* in 1968, since a predated count-example could stem back to Willis Howard Ware’s presentation on 5 October 1954 (15).

Due to the misjudgments of terminology’s debutants in textbooks, the history of science and technology might be redefined, which might result in discouraging us to reminisce those pioneers who have inaugurated induction and stimulation of creative inspiration.

**References and Notes:**

15. W. H. Ware, “The Digital Computer: Where Does it Go from Here?” (Rand Corporation, Santa Monica, California, United States, 1954). On the page 15 of this typescript, Ware mentioned that: “Medical diagnosis will be more certain as a result of machine assistance. A doctor needs no longer remember the symptoms of every conceivable disease. His personal computer can do it for him, printing a list of all diseases fitting a stated set of symptoms.” Incidentally, the original copy includes page 14 and page 14a.

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Supplementary Materials for

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*Corresponding author. Email: yfhuang@tsinghua.edu.cn

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Materials and Methods

The explosion of scientific knowledge is having considerable linguistic effect as the need to communicate new concepts forces the devising of new terms (1, 2). However, the origins of those common tongues are conventionally understood as nominal rather than substantial yet. Nowadays, the truth is that we don’t use those metalanguages precisely or even give them the same meanings etymologically across groups in the community (3). Eventually, therein semantic fuzziness and pragmatic ambiguity will inevitably result in serious communicative language failure and intergenerational effects (4–6). As a superb base for language vitality and diachronic change within the academic sphere, etymological research calls for a broader exploration from anthropological linguistics, historical narrative and sociocultural perspective (7, 8).

For historians, numerous well-posed questions rooted in diachronic discourse of scientific terminology, are still poorly understood. There are some open problems begging for answers, including but not limited to:

- When a specific term was first coined?
- Who did coin a specific term?
- What if the coiner is not a celebrity? (9)
- Did a specific term appear in any classified document first?
- Did a specific term appear in non-technical materials first?
- Did a specific term appear in non-text materials first?
- Was a specific English term borrowed from other languages?
- Does a specific English term tend to be the same in most languages?

To identify word coinages, diachronic discourse, and lexical dynamics, we always need to ask for powerful tools available with imperfect information in the age of Web science (10–12). As we continue to stockpile unexplained patterns, some have argued that correlation is threatening to unseat causation as the bedrock of scientific storytelling. It is necessary for us to punctuate heuristic cautions of wrestling with information from retrospective sources, cross validation, and the reassembly of whole story. Herein, we propose two theoretical frameworks for tapping into big data.

Framework: DQRM and APM

Over the past few years, data quality in the data deluge has become a principal concern for academic sphere. Some extreme claims by proponents of methodologist have prompted extensive debate on data quality review of retrievable information. For simplicity, a data quality review metrics (DQRM) enables the ability to identify and document emerging data issues, then initiate a workflow to remediate these problems (Table S1). DQRM defines 10 criteria classified in 3 dimensions, each criterion with 3 operational benchmarks.

The DQRM framework can be incorporated into routine promotion of trust level of data, as the ability to catch an issue is pushed further and further upstream until the point of data acquisition or recreation:

- Accuracy is the degree with which data values agree with an identified source of correct information, accuracy control and improvement require additional collection of primary data or external references.
- Lineage refers to the documentation of the ability to identify the originating source of any new or updated data element.
− Structuralization characterizes the consistency in the representation of similar attribute values, both within the same data set and across the data models associated with related context.
− Timeliness is the time expectation for accessibility of information.
− Currency is current with the world that information models.
− Consistency is the relationships between reported data and original records over time.
− Completeness is the expectation that certain attributes are expected to have assigned values in a data set. Control and improvement of completeness can naturally be plugged into the retrieval process either at the source.
− Accessibility involves an assessment of repeatability in the retrieval process.
− Deduplication combines the measurement of false matches and of false non-matches to control the volume of classified records.
− Data profiling involves information analysis for use in a data warehouse in order to clarify the structure, content, relationships, and derivation rules of the data.

On the other hand, as a qualitative index, each methodology could be imbedded into a general accuracy-performance matrix (APM) comparing with other counterparts for weighing the evidences (an exemplary example, see Fig. S1). Admittedly, each methodology has its own pros and cons:

1. The OED Online. As a principal historical dictionary, the OED Online is always used to trace historical usages and crucial developments of lexicons (13). But it is noted that OED Online might be still keen on “the policy of pre-scientific etymology”, and exclude the usage of neologisms from scientific communities, newspapers or other less respectable sources, even though they may be commonly used. Sir James A. H. Murray, the first editor of OED, was also reluctant to include scientific terms unless he felt that they were used widely enough. (14) Comparatively speaking, the OED Online has the disadvantage of less inclusion of multiple terms, slow-update frequency, etc.
2. JSTOR. Undeniably, JSTOR is a very powerful electronic journal archive. But retaining a clear sense of its pros and cons is the necessary prerequisite to the scientific consideration of any mission, as the authors reminded (15).
3. WOS. Web of Science (also known as Web of Knowledge) is an online scientific citation indexing service originally produced by the Institute for Scientific Information (ISI), now maintained by Clarivate Analytics. WOS provides a comprehensive citation search, and gives access to multiple databases that reference cross-disciplinary research for scientometrics and bibliometrics. But WOS usually are highly skewed towards high-profile journals.
4. Google Books Ngram Viewer. The fascinating diachronic corpora of Google Books could offer an unprecedented treasure trove. Culturomics, first coined on 17 December 2010 by Erez Lieberman Aiden and his colleagues, helped create the Google Ngram Viewer based on those over half-trillion-tokens corpora (16–18). The Google Ngram Viewer extends the boundaries of rigorous case-sensitive quantitative inquiry to a wide array of new phenomena spanning social sciences and digital humanities (19). But this culturomic approach still suffers from the uncontrolled bias from inaccurate optical character recognition (OCR), lexicons of prolific authors, (20), non-metadata organization dataset (21, 22), written languages, and etc.

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1 For example, in 1933, “bondmaid” made its debut, had taken nearly half a century to make that happen.
5. Wikipedia.org. The massive online encyclopedia Wikipedia is powered by an interaction of many people, in many roles, provides novel ways for scientists to interact with volunteers over the Web (11). But its pitfalls, from the reliability of its information to the organization of its entries, become quickly apparent to those who use it (23).

6. Newspapers.com. So far, newspapers.com is the largest online newspaper archive of historical newspapers from around the United States and beyond, dating from 1700s to the 2000s (24). It provides a unique view of the past and can help us understand and connect with the people, events and attitudes of an earlier time. It also suffers from OCR errors, non-metadata organization, dead links, and limited retrieval functionality.

7. Google.com. As the most used search engine on the WWW, Google Search could be used to hunt for historical clues and original evidences in publicly accessible documents, as well as translate foreign pages. But we should punctuate heuristic cautions of its accuracy and reliability, including Google Scholar (25). Therefore, the DQRM in conjunction with the APM could help historians to pinpoint the inherent affiliations in the retrieved missing history, and discern some universal tendencies cutting across effects of historical contingencies. Conspicuously, there are other potential collections could be incorporated into the above exemplary matrixes (12), like arXiv.org (26), ancestry.com (27), hathitrust.org (28), proquest.com, archives.com, newspaperarchive.com, congress.gov, and etc. Sometimes, as an ad hoc procedure, we have to ask for advice from experts to cross-check those frustrating missing pieces of historical proofs by personal communication.

Arguably, so many hasty conclusions on origin of scientific terminology are unreliable, say, “computer”, “personal computer”, “molecular biology” (see Fig. S2 and Fig. S3), and etc. The early usage track-down of “computer” and “personal computer”, as prototypical examples to test our theory in the later part of our inquiry, may provide an insightful and compelling arguments for the rigorous historical story to the extent of understanding the underneath nature of computer revolution.

Computer: one of the most common English word

Although “computer” has become one of the most common English word (29), its history, coinage and diachronic discourse are still poorly understood. According to the OED Online, the earliest known reference to “computer” dates back as far as 1613 in a Bernardine collection entitled “The Yong Mans Gleanings” by English writer Richard Braithwait (1588 – 1673). The excerpt can be read in the first chapter “Of the Mortalitie of Man”:

I haue read the truest computer Times, and the best Arithmetician that euer breathed, and he reduceth thy dayes into a short number: The daies of Man are threescore and ten. [I have read the truest computer Times, and the best Mathematician that ever breathed, and he reduced the days into a short number: The days of Man are 70 years.]

With the recent discovery, the early usage of “computer” could be stemmed back over 400 years, since it is conventionally understood as a 20th-century coinage. Until 1823, Charles Babbage (1791 – 1871) first proposed the mechanical computer “Difference Engine”, although he didn’t really assemble what most would consider as a present-day computer (30–32)². The first full-working

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² Errata for page 28: Babbage’s date of birth was 26 December 1791, and date of death was 18 October 1871, see Jevons (1871). Erratum for page 542: Babbage’s date of birth was 26 December 1791, see Wilkes (1975).
Difference Engine would not be built until 1991, which was guided by Babbage’s design notes. J. Presper Eckert and John Mauchly chose the purity and simplicity of the rediscovered Babbage's architecture, as demonstrated by the Harvard Mark-I.

On the other hand, it is a superb base for precision and clarity within the professional community (33). Sometimes, most of us do not care about the definitions of “computer” are rather different in different scenarios. According to the OED Online, “computer” was originally used to describe “a person who makes calculations or computations” rather than present-day “device for calculating”. Interestingly, “computer” referring to “an electronic device (or system of devices) which is used to store, manipulate, and communicate information”, has not found its way until 1940s, while “computer” as “a device or machine for performing or facilitating calculation” could date back to 1869. Similarly, a “calculator” – referring to as a person – dates as far back as the 14th century (circa 1380). Comparing with “mental calculator”, “computer” may be restricted to mean person who calculates on paper or tabulating instrument until 1907 (34–36).

Obviously, according to the OED Online, the timeline profiling of the sense development of “computer” demonstrates that “computer” was used to describe people who did computing from 1613 to 2001. Was “computer” actually a formal job title? How long did the then-current meaning last into the era of electronic computer?

In fact, “computer” as a formal professional post appears in recruitment advertisements, may date back to 1893. In 1893, a series of recruitment advertisements about a vacancy in the position of “computer”, published in Science by the Nautical Almanac office, Navy Department (37–44). In 1897, the Nautical Almanac office recruited three vacancies for the position of computer again, but only men are eligible (45). The typescript manuscript from NASA Langley Archives documents the women who performed the mathematical calculations for the NASA Program in the 1940s, prior to the advent of mechanical computers (46). The Lesser-Known Women: A Biographical Dictionary also provides detail information about the accomplishments of those women often ignored in history (47). After that, many evidences was approached to recover that missing history (48–52). In 2015, Katherine Coleman Goble Johnson, who worked as a “computer” from 1953 to 1958, was awarded the Presidential Medal of Freedom by President Barack Obama (51). The American biographical drama film Hidden Figures, based on the non-fiction book Hidden Figures: The Story of the African-American Women Who Helped Win the Space Race, had a limited release on December 25, 2016, by 20th Century Fox, before going wide in the United States on January 6, 2017.

Origins of the common computerese pending further discovery

Today, the origins of the common computerese are still pending further discoveries (53), no exception for “personal computer”. In 2000, Fred R. Shapiro, the editor of The Yale Book of Quotations (54), proposed a research tool—the JSTOR electronic journal archive, by which he explored the early emergence of term “personal computer” as far back as 1968 (55). Before that, almost as a known fact, the term “personal computer” is considered by many to be coined by Henry Edward Roberts (September 13, 1941 – April 1, 2010), the owner of Micro Instrumentation Telemetry Systems. Popular Electronics ran a cover story on his Altair 8800 in January 1975 (56–59), which predated the record in the May 1976 issue of Byte (55).

Arguably, this contentious finding seems to be unreliable, if any antedated counter-example appeared (Table S2). Noteworthily, we should never overestimate the functions of JSTOR or any sole information source, without cross validation in empirical research. JSTOR can’t cover the
amount of “dated written materials”, especially books, dissertations and thesis, proposals, magazines, newspapers, memorandums, pamphlets, and other miscellaneous pertinent documents.

Even worse, Barry Cipra highlights that Fred Shapiro tracked down the earliest print appearance of dozens of words via the JSTOR archives (55, 60). Unfortunately, the case is not as Cipra expected, the earliest print appearance of “personal computer” didn’t debut in Science at all (Table S2). Constance Holden also highlights that Shapiro’s finding – the origin of the word “software” in January 1958 – sifted through in JSTOR (61, 62), but this is not the case either.

Unfortunately, such punctuated approach and findings (55, 60–63), may unconsciously encourage many to rule out any other predated historical evidence technically, mislead the later quotations in scientific literature and lexicography. In response to those similar problems and reassemble the rich story, the following sections would be unfolded chronologically for easy references.

Year 1968

The emphasized evidence by Shapiro and Cipra, the double-page advertising in the 4 October 1968 issue of Science shows that HP 9100A is a personal computer indeed:

The new Hewlett-Packard 9100A personal computer. (64)(p. 6)

This advertising, which also ran in other journals de facto, at the very least, Scientific American (65). This unmentioned evidence could be also retrieved from JSTOR. It antedates the “earliest” record of circa 1976 featured in the OED Online by nearly 8 years. Better still, Charles (Chuck) H. House, the former Corporate Engineering Director of HP, who was inducted into the Computer Hall of Fame in 1982, gave a presentation at the HPW ’86 Proceedings of the ACM Conference on “The history of personal workstations” (Session 7: 1:00-2:00), Palo Alto, California, USA, January 9-10, 1986 (66). House claimed that:

Scientific computing systems for individuals were pioneered early at Hewlett-Packard, beginning with the 9100A Desktop Calculator in 1968. (p. 157)

It just turns out that the HP 9100A Desktop Calculator, as HP’s first scientific computing systems for individuals, was early introduced into the personal computer market with a hefty price $4900 in late 1968 (56, 67), coupled with the House’s credible witness testimony:

So it's really kind of a different look at things, although it is true that we did both pioneer and sell personal computers…Our first calculator was the 9100A…This was the predecessor to the $400 calculator; it was priced at a hefty $4900. Introduced in 1968, it performed transcendental functions, log functions, all of the trigonometric functions, and it did so in a powerful, interesting key-per-function way, in a very small package. It helped launch HP into the computer business, certainly the personal computer business, somewhat to our astonishment. (68)(pp. 403-404)3

It is worth mentioning that the HP 9100A featured the cover of the September 1968 issue of Hewlett-Packard Journal. In this monograph, HP first revealed the details of how the model 9100A was developed by a fascinating series (69–73).

In September 1968, another unheeded contemporaneous documentation of “personal computer”, comes from the article entitled “The Computer Game” published in the American Scientist (74). In this article, as an underrepresented minority case, John D. Meng remained skeptical about the individual usage of computer:

The average suburban housewife does not yet need her own, personal computer. (p. 415)

Year 1967

Journal AWWA, published continuously since 1914, is the flagship publication of the American Water Works Association (AWWA). The Journal AWWA monthly column, Percolation and Runoff, provides news briefs, vignettes, tongue in cheek musings about issues, trends, politics and events as they relate to both AWWA and the water industry in general. In February 1967, the feature column published a news brief about computer, in which anonymous author(s) summarized the status quo and trends of computing techniques, and looked forward to the future scenario:

By that time [1976], no doubt, everyone will be able to afford a personal computer, so that he can play himself back or print himself out at will (75). (p. 36)

The National Tax Association (NTA), founded in 1907, is the leading association of tax professionals dedicated to advance understanding in the theory and practice of public finance. On 25 October 1967, Mr. Daniel M. Holland (also known as Dan Holland)(1920 – 1991) was invited to attend the Annual Conference on Taxation under auspices of NTA in Hawaii, USA (76). At this annual meeting, Mr. Holland was a nominated member of the Executive Committee on Interstate Allocation of Business Taxes. He was also a former professor of finance at Massachusetts Institute of Technology, and the editor of the National Tax Journal from 1966 to 1991. In 1993, the Daniel M. Holland Medal was created by the NTA in memory of his lifetime achievement in the study of public finance.

During the 3rd general conference session of Higher Education in Taxation (10:30 a.m.-12:00 noon), he gave an oral presentation entitled “Tax Education for the Businessman” (77, 78). Prof. Holland pointed out the real matters of higher education and taxation for the businessman, and underlined that:

Indeed, they [executives] would be well advised to avoid pre-empting a portion of the limited storage capacity of their own personal computer with this information [the Internal Revenue Code].(78)(p. 255)

Year 1966

On 7 June 1966, the news brief entitled “Pocket Computers Predicted” was published in The Globe and Mail (79). It covered an international seminar on computers in Waterloo on 6 June 1966, and mentioned that:

The day when personal computers will be carried by the average person to take the drudgery out of life is foreseen by Professor Steven A. Coons, of the Massachusetts Institute of Technology. (p. B9)

As one of the 100 designers from North America who were attending the seminar, Steven Anson Coons had further anticipation in the interview after the seminar:
Nor is it too improbable to look toward the day when such a personal computer could take down the data in an interview and at the end produce an outline in readable form. (p. B9)

*The Globe and Mail*, a Toronto-based newspaper owned by the Woodbridge Company, is Canada's most widely read newspaper on weekdays and Saturdays. And Prof. Coons (March 7, 1912 – August 19, 1979) is considered “the father of computer graphics”(80, 81).4

On 20 June 1966, a feature article by the paper's columnist Charles Greville, was published in *Daily Mail* (82). Greville reported the third congress of the International Federation of Automatic Control in London with 1700 world-wide automation experts, and highlighted that:

Among the Britons will Dr. Jeremy Bray, M.P., who will read a paper on “A Continuously Updated Dynamic Optimisation System.” My personal computer translates this roughly as a system that takes account of varying conditions, and makes the machine do its job accordingly. (p. 4)

*The Daily Mail* is a British daily middle-market tabloid newspaper, published in London and owned by the Daily Mail and General Trust.

Orville L. Freeman (May 9, 1918 – February 20, 2003) was the U.S. Secretary of Agriculture from 1961 to 1969 under Presidents John F. Kennedy and Lyndon B. Johnson. On 1 November 1966, he was invited to address before the National Symposium of Better Management Information and Reporting, organized by the National Archives and Records Service of General Services Administration in Washington, D.C. Secretary Freeman delivered a speech with assigned topic “Management Information-Blueprint for Tomorrow” (83).5 In this far-sighted remark, he pictured an attractive scenario in the immediate future:

Information devices will undoubtedly multiply. Computers, for example, will be smaller, more powerful, less expensive. Computing power will be available to anyone who needs it, or wants it, or can use it. There will be small personal computers connected to large central facilities. Learning to use a computer will be as simple as learning to drive a car. (p. 1143)

Later, in March 1967, the *Public Administration Review* published the excerption of this speech draft with the same title, in the column “*Currents and Soundings: From the Professional Stream*”(84).

**Year 1965**

On 22 March 1965, *The Wall Street Journal* advertised for the Model Engineering and Manufacturing Corp (MEMECOR) with a title “*This is Memcor*” (85). This advertising introduced the Montek Division of Memcor, which is located at Salt Lake City, Utah, USA, saying:

A research, development and production organization in the West’s most modern instrument plant, specializing in TACAN equipment, communications systems, nucleonics, personal computers, and a line of solid state control systems. (p. 10)

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4 This is an editorial in memoriam, see Hatvany (1979). This is a foreword in memoriam, see Hatvany et al. (1982).
The Memcor’s headquarters was based on Huntington, Indiana, USA. A tactical air navigation system, commonly referred to as by the acronym TACAN, is a navigation system for military aircraft.\(^6\)

On 16 April 1965, the advertising on ASCA was published in the No. 3668 issue of *Science*:

52 weeks a year ASCA searches all U.S. Patents and ASCA searches the scientific literature in all disciplines picking out only those current items specifically related to your own particular interests and ASCA reports these findings to you by mail on a personal computer printout.\(^{86}\)(p. 310)

Herein, ASCA is the acronym for Automatic Subject Citation Alert, and that snippet was advertised for weekly clipping services offered by the ISI personal alert system (ASCA)\(^{87–89}\).\(^7\)

As the first computer-based system available for selective dissemination of information (SDI), the commercial service debuted in 1965. Eugene Eli Garfield (September 16, 1925 – February 26, 2017) and Irving H. Sher (July 10, 1924 – December 19, 1996) created this early prototype for Research Alert of ISI, and it dealt with the huge body of scientific and scholarly literature for the first time \(^{87}\).

What’s worth noticing is that the American linguist Garfield built his reputation for founding the *Science Citation Index* (SCI), *Journal Citation Reports*, *Patent Citation Indexing*, *Index Chemicus*, and *Current Contents*, and the magazine *The Scientist* \(^{90–93}\). He also has made unique contributions to the occurrence of bibliometrics and scientometrics. In the same vein, the versatile scientist Sher, who was one of the driving forces to establish ISI, should never be forgotten \(^{88, 94}\).

**Year 1964**

In March 1964, the advertising on the EAI PACE TR-48 was published in the *American Scientist*, which could be retrieved from JSTOR, claimed that:

The TR-48 is a fully transistorized analog computer providing more computing capacity, accuracy and operating convenience in a compact, medium-priced package than any design previously available…Here, then, is a personal computer designed (and priced) for every engineering or research laboratory.”\(^{95}\)

In December 1961, the PACE TR-48 with up to 48 amplifiers and a cost of around $25,000, was manufactured and produced by EAI (Electronic Associates Inc.), Long Branch, New Jersey, USA \(^{96, 97}\). The TR-48 filled gap of the well-known PACE family between smaller TR-10 and larger 231R, and aimed for market in engineering and research groups.

As the most complete desktop analog computer at that time, TR-48 was even geared up to meet the challenge of the *Apollo program* for simulation of test spaceflight systems, and it featured in

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the 31 August 1962 issue of the *Apollo Monthly Progress Report.* In Chapter “Instrumentation” (General Order 7124) of an unclassified copy, the following notes go:

> The fabrication and development of test logic simulation and switching circuits for use with the in-flight test system has continued, and the roll simulator for TR-48 computer is under construction. The miniature control and display system bread broad model is being modified to improve performance and increase reliability. (p. 35)

On the occasion of preparations advance for the 200th anniversary of Canada Confederation, forecasters from the fields of government, education, science, industry, transportation, communications and finance made predictions about the world of 2064, which were sealed into the foundation stone of the Royal Bank of Canada building in downtown Toronto. As a part of that, on 29 May 1964, a news brief by the Ontario Minister of Education William Grenville Davis (also known as Bill Davis) was published in *The Globe and Mail* (98). Mr. Davis imagined the computer-dominated routine scenario in 2064:

> With immediate access to a personal computer, or a central computer with a vast storehouse of information and skills, it would seem the height of folly to persist in attempts to implant such information and skills in humans...but all calculations and mathematical manipulations may be done better by computer...including the universal machine-based language of commerce and diplomacy. (p. B4)

Mr. Davis was appointed Minister of Education on October 5, 1962, the 18th Premier of Ontario on March 1, 1971, and held the position until his resigning in 1985. In 2012, he ranked the second-place on the “list of Canada's best premiers” by the Institute for Research on Public Policy's magazine *Policy Options* (99).

On 20 November 1964, the news brief entitled “Pocket Translator Computer Prospect” was published in *The Globe and Mail* (100). During the second half of the 1964 Reith lectures on the British Broadcasting Corp. network in London on 19 November, the chairman of Elliott Automation Ltd. Leon Bagrit forecasted the development of extremely small computers:

> It is now possible to envisage personal computers, small enough to be carried in the car or even in the pocket. (p. B14)

**Year 1963**

On 11 June 1963, in a letter to the twelfth president of the University of California Clark Kerr (which could be retrieved from hathitrust.org), the 3rd chancellor of University of California at Los Angeles (UCLA) Franklin David Murphy (January 29, 1916 - June 16, 1994) suggested implementation of a quarter calendar rather than a trimester calendar on behalf of the faculty of UCLA:

> A thoughtful decision in this matter [the calendar of the quarter system] obviously must be a synthesis of a number of factors, both practical as well as philosophical. As I have prayerfully fed these several issues into my personal computer, I have

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concluded that I will recommend the quarter system for the following reasons and with the following caveats. (101)(p. 9)

Today, the Franklin D. Murphy Sculpture Garden at UCLA still remains a world-famous permanent sculpture exhibition, and Murphy Hall has also been named in his honor.

On 1 July 1963, Steven G. Vandenberg (July 15, 1915 – August 27, 1992), the Dutch-American behavior geneticist, published an article entitled “Teaching Behavioral Scientists How To Use Their Brains” in Behavioral Science (102, 103).10

Once the interest there the instructor could follow through in a second semester with the book by Cooley and Lohnes [Cooley, W. W., & Lohnes, P. R. Multivariate procedures for the behavioral sciences. New York: Wiley, 1962.] on multivariate analyses as preparation for the student’s personal computer experience, as a research assistant, or in connection with his own thesis.(102)(p. 247)

Behavioral Science, is an official journal of the Mental Health Research Institute, University of Michigan. It is currently known as Systems Research and Behavioral Science, as the official journal of the International Federation for Systems Research. At that time, Dr. Vandenberg was named editorial director of the Computers in Behavioral Science department of Behavioral Science (104).

Year 1962

Another unfolded print documentation of the phrase “personal computer” could stem back to the legendary John William Mauchly (August 30, 1907 – January 8, 1980). Dr. Mauchly was the co-inventor of the ENIAC, EDVAC, BINAC, and UNIVAC, in conjunction with John Presper Eckert (April 9, 1919 – June 3, 1995)(105–107).11 On 24 February 1962, the news-letter reported that:

The forerunner of the personal computer, a portable model which Dr. Mauchly calls SkeduFlo, was displayed at the Plant Maintenance and Engineering Show in Philadelphia. This revolutionary device is an important first step.(108)

Interestingly, in line with the 1962 heuristic prophecy of Mauchly, in July 1962, his co-inventor Eckert also predicted confirmedly that “the computer will revolutionize marketing in the future by pretesting products before they appear in the home, the store or factory” (109). He further envisioned:

There will be no miserable flops paraded before the public to tarnish a company’s reputation. The computer will even have charted the times at which the product will reach its peak, will have matured, and when it will be dead. (109)(p. 80)

Later, another solid evidence can be found in the news-letter of 18 August 1962, reporting:

Add a personal portable computer to the usual ‘slipstick’ or slide rule of engineering students. Engineering students at Case Institute of Technology this

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10 The manuscript was received October 30, 1962, first published on 1 July 1963, and online published on 17 Jan. 2007 by John Wiley & Sons, Inc., see Vandenberg (1963).
11 ENIAC (the first general purpose electronic digital computer), EDVAC (the first computer designed with the stored-program principle as a central feature), BINAC (a stored-program computer designed for the Northrop Aircraft Company), and UNIVAC (the first commercially available computer in USA).
fall will be using self-powered analogue computers that will integrate and add, substract and multiply, carrying the computing laboratory to wherever the young engineer does his work. The apparatus consists of six cigarette-package-sized units. Cost: $300 each set. A National Science Foundation grant of $60,000 is financing the experiment.\(^{(110)}\)

On 3 November 1962, *The New York Times* featured a particularly bold headline: “Pocket Computer May Replace Shopping List: Inventor Says Device Could Tell Grocery in Advance What Customer Needs.” Here, we may never figure out who coined the term “pocket computer” with the intent of pocket-size computers for individuals, but Dr. Mauchly predicted such a device further:

There is no reason to suppose the average boy or girl cannot be master of a personal computer.\(^{(111)}\)

Established in 1851, *The New York Times* with worldwide influence and readership is considered the “newspaper of record” of the United States. It is widely available in the United States, and its circulation outside the New York market began as early as 1910.\(^{(13)}\)

*Year 1959*

In the May-June 1959 issue of *Datamation*, a double-page advertising provided the first glimpse of the PACE TR-10 by EAI, to a broader public \(^{(112)}\). The advertising featured the first fully transistorized analog computer—EAI PACE TR-10 model with miniaturization design, which could become a low-price, high-speed, high-accuracy general purpose analog computer:

Your ‘personal computer’ for higher creativity. Because of its minimum size and extremely low price, the TR-10 can become your own personal analog computer.

(p. 29)

Here, the TR-10 was also the smallest in the PACE family, capable of solving tenth-order differential equations. The TR-10 became well known for its flexibility and robustness in the market. *Datamation*, founded by futurist Donald Prell, is a popular magazine of automatic information processing for business and science that was published in print form in the United States between October 1957 and February 1998, and has since continued publication in web-only format \(^{(113,114)}\). Today, *Datamation* is owned by QuinStreet Enterprise network, and continues to publish online enterprise technology news, analysis, and in-depth research and developer insights at datamation.com.\(^{(14)}\)

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\(^{(13)}\) The New York Times Timeline is available at: https://www.nytco.com/who-we-are/culture/our-history

\(^{(14)}\) Incidentally, *Datamation* magazine was first published in October of 1957 under the unwieldy title “Research & Engineering – The Magazine of Datamation.”
In June 1959, the same double-page advertising also ran in the Magazine *Aviation Week Including Space Technology* (115).15

**Year 1957**

The year 1957 was the annus mirabilis of IBM’s release of the first FORTRAN compiler, which greatly simplified general-purpose programming. In October, the technical report by Ralph E. Sliney, was published in the U.S. Strategic Air Command (SAC) magazine *Combat Crew*, which could be retrieved from hathitrust.org. Sliney claimed that:

That’s it! If you're a T-bird pilot you should have received your personal computer by now. As a favor to you, they were classified as expendable, so don’t be afraid to use them. (116)(p. 25)

Here, the T-bird, also known as Lockheed T-33 Shooting Star, is a subsonic American jet trainer aircraft. In this report, Mr. Sliney detailed the powerful characteristics of new fuel flight computer for T-33s and other light jets, type MB-8 (spec. MIL-C-25429), which was produced by Wright Air Development Center (WADC).16 The five-discs MB-8 with graphical tabulated charts could offer the flow of information about cruise control during a flight. Mr. Sliney, a captain in the Air Force Reserves, was the chief engineer of the design branch of the aircraft laboratory at WADC, Wright-Patterson Air Force Base, Ohio, and was responsible for supervising performance data on single-engine aircraft (116).

**Year 1954**

Predated those foregoing evidences, the earlier known occurrence of “personal computer” may stem back to Willis Howard Ware (August 31, 1920 – November 22, 2013) on 5 October 1954. Dr. Ware, the laureate of the IEEE Centennial Medal of 1984 and the IEEE Computer Pioneer Award of 1993, was an eminent computer pioneer emeritus with the RAND Corporation in Santa Monica, California.17 In the presentation, he mentioned that:

Medical diagnosis will be more certain as a result of machine assistance. A doctor needs no longer remember the symptoms of every conceivable disease. His personal computer can do it for him, printing a list of all diseases fitting a stated set of symptoms. (117)(p. 15)(Fig. S4)18

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16 WADC was renamed the Wright Air Development Division (WADD) in 1959 then the Aeronautical Systems Division (ASD) in 1961 and the Air Force merged the Air Research and Development Command with the Air Material Command to form the Air Force Systems Command.

17 The RAND Corporation is a nonprofit institution that helps improve policy and decision-making through research and analysis. RAND focuses on the issues that matter most such as health, education, national security, international affairs, law and business, the environment, and more. With a research staff consisting of some of the world’s preeminent minds, RAND has been expanding the boundaries of human knowledge for more than 60 years.

18 Personal communication with Amy Majczyk of the RAND Corporation. Incidentally, the original copy includes page 14 and page 14a.
Just nearly 4 months after the trailblazer of computer theory Alan Turing took his own life (118), this speech presented before the Los Angeles Section of the Institute of Radio Engineers, in which he examined the early field and trends of digital computing. He also discussed the characteristics, applications, the difficulties encountered in digital computing systems, their future trends in application, and the expected advances in the technique, physical hardware and in the logical organization of these computers. Essentially, a contemporary of Ware’s provident speech, digital computers has been instructed in many miraculous-sounding applications, for both special-purpose and general-purpose, such as translation machine, electronic brain, weather prediction, insurance arrangement, inventory-control, bank check management, and etc. (119, 120). Those pragmatic applications intrigue more and more trusting adherents and aggregate consequences.

1954-1968: A Timeline of Events

It is high time to reminisce about those pioneers, who inaugurated those relishable historical stories. More conveniently, as a supplement, a historiographical list is reassembled from the retrieval of multifarious and fragmentary snippets (Table S3).

First of all, to a certain extent, the early emergence of terminology “personal computer(s)” was the companion with commercial applications of digital computer, towards “personalization of computing” (121, 122). Nowadays, as described in the OED, personal computer is “a computer designed to be used by one person, esp. in a domestic setting.” From Table 1, it is easy to conclude that a majority of them were merely a theory in mind, and the rest of them still referred to as essential giant calculators rather than domestic-setting computers (123), but they would always shape anew our concepts of computer and terminal capability constantly. Besides, from Table 4, some pithy evidences well predate their early citations in the OED Online and other dictionaries, and first uncovered here. In this sense, the word entry of “personal computer”, as well as other terminologies (61, 62, 124), is ought to be duly scrutinized and revised within the realms of possibility. Last but not the least, existing Web-crawlers could not provide an acceptable level of precision and convenience for these scientific attempts yet (125). To forestall such difficulty, those pertinent documents about potential target terms should be also retrieved and scrutinized (126, 127).

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20 Although scientific terminology tends to be the same in most languages, it may be worth mentioning that those certain unheeded but salient conditions should be widely recognized by etymologists. As a case in point hereby, many keywords, like appliance computer(s), home computer(s), microcomputer(s), individual computer(s), desktop computer(s), compact computer(s), personal electronic computer(s), personal vest-desk computer(s), personal minicomputer(s), workstation(s), my own computer(s), his own computer(s), her own computer(s), PC(s), digital computer(s) and etc., should be on the target list for scrutinization.
Fig. S1.
APM. Illustration on Accuracy-Performance Matrix of the common methodologies.

catalogue is made more valuable to the botanist, as well as to the cultivator, by Dr. Engelmann’s revised and largely new account of the True Grape-Vines of the United States, now brought up to thirteen species. The latest accession is of a very old species, *Vitis palmata* of Vahl, described in few words by this author from a plant which was cultivated in the Jardin des Plantes at Paris, perhaps a hundred years ago, which was also recognized as a species by the elder Michaux at the beginning of this century (for, although unpublished, it exists in his herbarium as *V. rubra*, but was merged by the witer of his Flora in the nearly allied *V. riparia*), he having collected specimens on the banks of streams in Illinois. Finally it has been detected by Mr. Eggert of St. Louis, on the banks of the Mississippi, above that town; and Dr. Engelmann has in this revision fixed its characters. Michaux’s name must have been suggested “by its bright red branches, from which the bark separates in large flakes.” For the identification of all the species, Dr. Engelmann adds a series of figures of seeds, thirty-three in number, in outline, of natural size, and a magnified view of the chalazal face of each, all drawn to scale. Considering the part which the American vines are to play in the future, it is fortunate that, at this early period of their cultivation and inter-breeding, and while they can be referred back to their wild types, they have been subjected to the close and prolonged scrutiny of such a critical investigator as Dr. Engelmann, and that he has taken care to publish successive monographical revisions, setting forth his latest additions to the stock of knowledge, which, from first to last, we mainly owe to him.

3. *The Law of Heredity: A Study of the Cause of Variation and the Origin of Living Organisms.* By W. K. Brooks, Associate in Biology, Johns Hopkins University. Baltimore: J. Murphy & Co. 1883. pp. 338, 12mo.—This small but full book, which we hasten to announce rather than to review, is perhaps the most considerable and the most ambitious contribution to the doctrine of the development of species which has appeared in this country. A discriminating and thorough critical notice of it could not be given in small space, and would require an amount of time and consideration which we cannot now afford. Heredity is the leading word of the title; but the second part of the title gives the key to the essay. It is a supplement to Darwinism on the speculative side, a contribution by a trained zoologist and comparative anatomist, with a genius for speculation, to what may be called molecular biology. The author understands natural selection—its weak points as well as its strong ones—is naturally attracted to pangenesis, and has built upon it his new theory of heredity; we should say rather of the cause or origin of variation. This is developed and expounded with a great wealth of illustration. The hypothesis is woven of the same tenuous material which forms the staple of Darwin’s pangenesis; but it seems to be better adapted for wear than the original fabric. Darwin
Fig. S3.
Molecular biology. William Thomas Astbury even forgot that he used to use the term "molecular biology" in his own Nature article on 2 February 1946.

analysis of geranylamine hydrochloride: the further away the observations are from the inner core, the more the spreading of the electron-density contours.

Lastly, the placing of the many atoms in such structures requires very heavy calculations. In the early stages of the analysis the difficulties can be met admirably by the use of the 'fly's eye', or by the Bragg and Lipson structure-factor graphs; but in the later stages it does seem that some professional computing assistance or new developments in machines are called for.

Though it would be rash to set an upper limit to the complexity of structure that might be handled by these methods, it must be confessed that the present outlook with regard to detailed solutions of protein crystals is not very hopeful. They give photographs directly comparable with those of single-crystal patterns and, in the case of the tobacco necrosis virus, for example, the triclinic unit cell (the largest yet measured) has dimensions 179 x 216 x 243 A. and contains molecules not far from 280 A. across. One can estimate that out to the observed spacing limit of 2 A., one might measure something like a million reflections; and even with crystals of 'small' proteins one can easily measure five or ten thousand reflections! The numbers of atoms involved are out of all proportion to the twenty-nine of cholesterol iodide—literally thousands —and no heavy atom known would control the phase angles. For protein crystals, however, one property that can assist in their investigation—that of containing large and variable amounts of liquid of crystallization. From vector maps given by crystals in various states of hydration, it is possible to show that the molecules are essentially rigid entities, and with some crystals it is possible to obtain also some limited information on the phase angles of reflections. In this way Perutz has shown that the haemoglobin pair has a four-layered structure. But even the thousands of available reflections do not take us down to the limit necessary to distinguish discrete atoms, and it is clear that great caution will have to be exercised in order to make sure of any interpretation in terms of exact chemical arrangement. At one extreme far more work is needed in the region between compounds already analysed and the proteins; while at the other we may hope that the lower limits of resolution of the electron microscope may be extended to check the accuracy with which we have deduced the graver structure of the protein molecule.

(3) The X-ray study of fibres—natural, artificial, and synthetic—has to do mostly with the structure and status of aggregation of giant molecules about which little precise is known, and among which progress is possible only in close collaboration with other physico-chemical methods of approach. Indeed, since the beginning of the century, the various techniques of observation of high polymers have grown up together, and though it is fair to say that since the 1920's X-rays have played a leading part, giving time and again just those geometrical and dimensional clues needed to co-ordinate the accumulated facts, it still remains that collaboration is essential if ever we are to cope successfully with the multitude of unresolved details. There is scarcely a more worthwhile task, however, if only for the sake of molecular biology, where perhaps more than anywhere else the great future of X-ray analysis lies. To say this is not to disparage technology either, for textiles and plastics too now draw their basic inspiration from the lessons of the natural macromolecules, and the greatest field in present-day chemistry, whether biological or industrial, forms in reality but a single subject, the science of chain-molecules.

It is convenient to subdivide this field into four principal and interrelated sections: polysaccharides, proteins, polynucleotides, and plastics. Cellulose is the polysaccharides-in-chief, and it has been a constant object of interest to the X-ray analyst ever since the close of the First World War. The chemical advances made by Harrow and his school combined with the X-ray interpretation first given by Sopp and Dore soon led to further important developments at the hands of Moyer and Mark and their co-workers, and altogether, since those days, it is beyond question that the contribution of X-ray methods to our knowledge of cellulose and its relatives has been invaluable. For a number of years the actual detailed shape of the molecular chain inferred from the X-ray patterns was almost certainly incorrect; but more recent considerations, especially those based on a comparative X-ray study of the new configuration discovered in lignin acid, the polysaccharides from seaweed, supported by the results of Cox and his collaborators working on sugars, have very probably put that right. We are left now with the extremely helpful conclusion that the intramolecular distances and interbond angles used in the structure of the polysaccharides are to a first approximation the same as those already found in simpler aliphatic molecules. It is still not possible to prove exactly where each atom is in the cellulose structure—in spite of great improvements in the X-ray photographs the diffraction data are really not sufficient for an exhaustive analysis—but models can now be constructed that must be quite near the truth.

The protein fibres (or more correctly the fibrous proteins), for all their great variety, have yielded to X-rays the somewhat unexpected result that they fall for the most part into only two main configurational families, the keratin-myosin-fibrinogen group and the collagen group, distinguished chiefly by the long-range elasticity of the former. In spite of considerable variations in chemical constitution within both groups, these two master plans are preserved throughout. In the keratin-fibrinogen group the unit of structure is a polypeptide grid the normal equilibrium configuration of which is buckled; that is, the main chains are thrown into a series of folds that lie in planes transverse to the cross-links; and the basis of the long-range elasticity is the capacity to unfold and refold. The essential structural problem is the nature of the intramolecular fold that characterizes the group; and accumulated evidence now points to a simple system of loose packing of the side-chains, with the polars on one side of the main chain and the non-polars on the other. Such a plan is sufficient to explain the observed striking unity amid chemical diversity, and in particular it offers against its proper molecular background the most satisfying general interpretation to date of muscular activity. The plan of the keratin-fibrinogen group is one of the fundamental ideas in the architecture; it represents a power of the cell of synthesizing elastic fibrous protein of a standard molecular form, yet the details of which can be adapted to as many ends as the processes of differentiation demand.

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Fig. S4.

**Personal computer.** Original copy of Willis H. Ware’s presentation at the Los Angeles Section of The Institute of Radio Engineers on 5 October 1954.

use of data handling machines in the inventory and accounting procedures. Although prices will be down, profits will be maintained as a result of the efficiencies arising from the machine processing of sales and purchasing information. Data supplied by the machines will be current to the minute, complete and accurate. This will be of inestimable value in the seasonal peak loads.

Business efficiencies will be further increased as a result of the widespread use of linear programming techniques solved with machine methods. All business scheduling problems will have been optimized in this way. Government will make extensive use of machines to handle routine paper work; other systems will assimilate current economic reports and prepare condensed digests for high executives. There will be significant advances in the theoretical sciences as a result of new and extensive calculations performed by the biggest and fastest machines. Weather forecasting will be done by numerical methods leading to accurate and prompt weather reports. Medical diagnosis will be more certain as a result of machine assistance. A doctor need no longer remember the symptoms of every conceivable disease. His personal computer can do it for him, printing a list of all diseases fitting a stated set of symptoms. The ability of a data handling system to process enormous volumes of information and to systematically search this data for correlations and trends, will provide tremendous advances to the behavioral sciences. There will be machines large enough and fast enough to simulate with complete realism large segments of an economy or an entire business. Personnel training may well become a process of essentially playing
Table S1.
Empirical data quality review metrics (DQRM).

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Intrinsic Dimensions</th>
<th>Contextual Dimensions</th>
<th>Crosscheck Dimensions</th>
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<td>Accuracy</td>
<td>Lineage</td>
<td>Structuralization</td>
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<td>L</td>
<td>M</td>
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<td>JSTOR</td>
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<td>H</td>
<td>H</td>
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<td>WOS</td>
<td>M</td>
<td>H</td>
<td>H</td>
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<td>Google.com</td>
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</table>

Note: L = Low; M = Moderate; H = High
Table S2.
The earliest print appearance of “personal computer” in different information sources.

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<thead>
<tr>
<th>Sources</th>
<th>Date of debut</th>
<th>Reference</th>
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<tr>
<td>OED Online</td>
<td>5 Oct. 1954</td>
<td>Ware (1954)</td>
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<tr>
<td>JSTOR</td>
<td>24 Feb. 1962</td>
<td>Anonymous (1962b)</td>
</tr>
<tr>
<td>Wikipedia.org</td>
<td>1983</td>
<td><em>PC Magazine</em></td>
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<td>Newspapers.com</td>
<td>3 Nov. 1962</td>
<td>Mauchly (1962)</td>
</tr>
<tr>
<td>Google.com</td>
<td>May-June 1959</td>
<td>Advertising (1959a)</td>
</tr>
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<td>hathitrust.org</td>
<td>Oct. 1957</td>
<td>Sliney (1957)</td>
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### Table S3.
Chronological list of documentation of “personal computer(s)” in English.

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<th>Source</th>
<th>Type</th>
<th>Pagination</th>
<th>Reference</th>
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<tr>
<td>5 Oct. 1954</td>
<td>Willis Howard Ware</td>
<td>Technical report</td>
<td>p. 15</td>
<td>Ware (1954)</td>
</tr>
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<td>Oct. 1957</td>
<td>Ralph E. Sliney</td>
<td>Journal article</td>
<td>p. 25</td>
<td>Sliney (1957)</td>
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<td>May-June 1959</td>
<td>Datamation</td>
<td>Advertising</td>
<td>pp. 28-29</td>
<td>Advertising (1959a)</td>
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<td>8 June 1959</td>
<td><em>Aviation Week Including Space Technology</em></td>
<td>Advertising</td>
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<td>Advertising (1959b)</td>
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<td>24 Feb. 1962</td>
<td>John William Mauchly</td>
<td>News Letter</td>
<td>p. 120</td>
<td>Anonymous (1962b)</td>
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<td>3 Nov. 1962</td>
<td>John William Mauchly</td>
<td>Newspaper article</td>
<td>p. 27</td>
<td>Mauchly (1962)</td>
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<td>11 June 1963</td>
<td>Franklin David Murphy</td>
<td>Letter</td>
<td>p. 9</td>
<td>Murphy (1963)</td>
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<td>1 July 1963</td>
<td>Steven G. Vandenberg</td>
<td>Journal article</td>
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<td>March 1964</td>
<td>EAI</td>
<td>Advertising</td>
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<td>29 May 1964</td>
<td>W. G. Davis</td>
<td>News brief</td>
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<td>16 Apr. 1965</td>
<td>ISI</td>
<td>Advertising</td>
<td>p. 310</td>
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<td>20 June 1966</td>
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<td>Feature Article</td>
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<td>1 Nov. 1966</td>
<td>Orville L. Freeman</td>
<td>Address</td>
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<td>Mar. 1967</td>
<td>Orville L. Freeman</td>
<td>Journal article</td>
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<td>Nov. 1968</td>
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<td>Advertising</td>
<td>pp. 58-59</td>
<td>Advertising (1968b)</td>
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References and Notes:


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