Computer history – The pitfalls of past futures

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Abstract

The historicization of the computer in the second half of the 20th century can be understood as the effect of the inevitable changes in both its technological and narrative development. What interests us is how past futures and therefore history were stabilized. The development, operation, and implementation of machines and programs gave rise to a historicity of the field of computing. Whenever actors have been grouped into communities – for example, into industrial and academic developer communities – new orderings have been constructed historically. Such orderings depend on the ability to refer to archival and published documents and to develop new narratives based on them. Professional historians are particularly at home in these waters – and nevertheless can disappear into the whirlpool of digital prehistory. Toward the end of the 1980s, the first critical review of the literature on the history of computers thus offered several programmatic suggestions. It is one of the peculiar coincidences of history that the future should rear its head again just when the history of computers was flourishing as a result of massive methodological and conceptual input. The emergence of the World Wide Web in the 1990s, which caught historians totally by surprise, led to an ahistorical, anthropological, aesthetic-medial approach to digitization. The program for investigating the prehistory of the digital age was rewritten in favor of explaining the development of communication networks. Computer systems and their concepts dropped out of history. This poses a problem for the history of computers, insofar as the success of the history of technology is tied to the stability of its objects. It seems more promising to us to not attribute the problem to the object called computer or to the "disciplinary" field, but rather to focus entirely on substantive issues. An issue-oriented technological history of the 21st century should be able to do this by treating the history of computers as a refreshing source of productive friction.

Developer discourses and obsolete futures

"Inventors" search for components for potential devices, cast a fresh eye on what they find, and seek to assemble the parts in a new way. "Developers," inventors' industry colleagues, may be more systematic in recovering useful parts for new devices. But both inventors and developers have a reasonably clear idea of what is to be created. They try to find und unwrap things that have possible future areas of application.

These hypothetical applications, conceived in the workshop or in the laboratory, are often later reengineered, both as devices and as solutions. Many tests are needed until the practical application approaches the hypothetical one. The utility of devices, substances, programs, and processes as imagined in the workshop or laboratory quickly becomes obsolete and is cast aside. It was a long way from Marconi's work on wireless torpedoes to the actuarial application of radiotelegraphy, which steamships used to transmit emergency call signals or to transmit and receive weather reports, although the "invention" was practically the same.[1]

Reengineering does not imply that technological designs were fantasies nor does it turn them into visionary products. Before a design is dismissed as the former or raised to the status of the latter, it must first build up even more radical expectations and withstand many failures. In other words, it takes time for an invention to become distinguishable from just another crazy idea and to find its proper place. Without reference to designs, technological developments have no future, and without anticipating the future, what is the point of development? Technologies that are considered to be unprecedented, like the programmable electronic computer, are particularly difficult to justify. Early advocates of computers had to be willing to explain the sterling future of their machines to all who would listen, over and over again, as well (and especially) to those who remained skeptical, perhaps with good reason.

With the past as the argumentative resource, very little could be achieved under these circumstances. However, estimates about what the future might bring were usually overtaken by the present more rapidly than expected. And in order to remain credible, they had to be continually projected into a new future, which is to say revised. At such times, computer technology was unexpectedly provided with a historical narrative. "Original[ly]," observed computer developers Murray L. Lesser and John W. Haanstra in December 1956, computers were created to process administrative tasks on a quasi-industrial scale. Lesser and Haanstra did not specify the details of this origin. But it was definitely situated in the past and could be addressed narratively. Most important is that origins are typically invoked precisely when a new future is being produced. At IBM this happened in 1956. Data processing would no longer be done in conveyor-belt fashion, with elaborately sorted, neatly stacked punched cards. The goal was emancipation from batch processing of uniform data and an attractive future for computers with random access to novel drum memories. This required creating a past that could be evoked by the word "original[ly]." The development of computers gives rise to historical interpretations, even history, because when developer discourse requires a new future, it must argue historically.[2]

In the 1960s, the history of computers also was the product of state-of-the-art computer operations: in data centers, it was inevitable that old and new machines would come together. Printers and punching devices for punch cards, which had been connected to the Hollerith machines used by data processors, shared space with drum memories, magnetic tape stations, and hard disks. The old functioned alongside, in front of, and behind the new (or vice versa), leading to operational expense and annoyance. In addition, the data centers of the 1960s kept and archived long registers of applications that had "burnt" the precious good of computing time. They kept job records, printed out reports on error messages and documented which programs had been used. What was kept in these listings was the operative history of a

[1] Garratt, G. R. M. (1994). The Early History of Radio. From Faraday to Marconi. London, Institution of Electrical Engineers; White, L., Jr. (1997). The Technical Act. The Act of Invention: Causes, Contexts, Continuities and Consequences. Technology and the West. A Historical Anthology from Technology and Culture. T. S. Reynolds and S. H. Cutcliffe. Chicago IL, University of Chicago Press: 67-82; Scholl, L. U. (1998). Marconi versus Telefunken. Drahtlose Telegraphie und ihre Bedeutung für die Schiffahrt. Sozialgeschichte der Technik. Ulrich Troitzsch zum 60. Geburtstag. G. Bayerl and W. Weber. Münster, New York NY, München, Berlin, Waxmann. 7: 277-286

[2] Gugerli, D. (2018). Wie die Welt in den Computer kam. Zur Entstehung digitaler Wirklichkeit. Frankfurt am Main, Fischer; Hollander, G. L. (1956). "Data processing with a quasi-random-access memory." Electrical Engineering 74(June 1955): 466-468; Lesser, M. L. and J. W. Haanstra (1957). The RAMAC Data-Processing Machine, New York NY, ACM Press.

computing center. This documented knowledge and data eventually went into those documents produced for evaluation purposes when new computing equipment was to be acquired. Computers did not forget their operational past and marked records with "time stamps," logged "interventions" by components and users, and recorded who had changed the valid version of an application program or operating system. Whenever operations stalled or the system crashed, the chronicle recorded in log files became the prerequisite for getting all interrupted processes running again.[3]

While data centers recorded their own operational activities, and developers needed an origin for their futuristic concepts, the computer industry developed an entire range of protohistoric orientation aids. In the 1950s and 1960s, several forms of self-historicization were discernible. The most popular and perhaps most obvious was genealogical numbering. Konrad Zuse's Z1, Z2, Z3, and in particular Z4 offer one such example. In naming this series of machines, which emerged out of the ruins of the Third Reich, Zuse wished to genealogically connect with the electronic and programmable computers of the post-war period.[4] The four Harvard computers known as Mark I–IV also relied on this family history technique. Machine numbering at IBM was somewhat more complex.[5] This was due on the one hand to the substantially larger product range, and on the other hand to the fact that some machines were assigned a number but were never built and remained paper tigers. Nonetheless, such machines not only brought an exuberant diversity to the devices but also dramatized the genealogical classification system. For thanks to the gaps and discontinuities in succession, the catalog reflected the promise of the future in the performance classes then available. The discontinuous numbering of the machine classes showed that IBM customers were on the right track and that development was also making remarkable leaps forward.[6]

Genealogies suggest aristocratic and entrepreneurial stability, may refer to adherence to standards, identify performance classes, and document resilience and industrial tradition. In the computer world, genealogies facilitated communication between those who manufactured, sold, programmed, and acquired computers, assuring these actors and the machines a place in the annals both of the computer industry and of the data processing centers. This labeling practice was also popular with programming languages and was evident early on in the case of FORTRAN. Preliminary versions of FORTRAN were already in existence by1954, but it was not until 1957 that a compiler was declared sufficiently market-ready to be

[3] Austrian, G. D. (1982). Herman Hollerith. Forgotten Giant of Information Processing. New York NY, Columbia University Press; Gugerli, D. and H. Mangold (2016). "Diskussionsforum: Betriebssysteme und Computerfahndung. Zur Genese einer digitalen Überwachungskultur." Geschichte und Gesellschaft 42(1): 144-174; Sandner, G. and H. Spengler (2006). Die Entwicklung der Datenverarbeitung von Hollerith-Lochkartenmaschinen zu IBM Enterprise-Servern von 1887 bis 2000, in 10 Epochen. Böblingen, Sandner. Eventually, printouts of logfiles made it into the central archives of a university: Universitätsarchiv Stuttgart, Z851. Logbücher CD-Terminals 1970 - 1983, Logbücher Großrechner u.a. Rechenanlagen 1969-1972 und 1980er Jahre, Betriebsübersicht und Statistik TR4 1966 - 1969, Forschungs- und Kooperationsprojekte 1970er bis um 2000.

[4] Bauer, F. L. and H. Wössner (1972). "The "Plankalkül" of Konrad Zuse. A Forerunner of Today's Programming Languages." Communications of the ACM 15(7): 678-685; Bruderer, H. (2010). Konrad Zuse und die ETH Zürich. Zum 100. Geburtstag des Informatikpioniers Konrad Zuse (22. Juni 2010). Zürich, ETH Zürich; Füssl, W., Ed. (2010). 100 Jahre Konrad Zuse. Einblicke in den Nachlass. München, Deutsches Museum; Güntsch, F.-R. (2004). Konrad Zuse und das Konzept des Universalrechners. H. D. Hellige. Berlin, Springer: 43-58.

[5] Bashe, C. J., L. R. Johnson, J. H. Palmer and E. W. Pugh (1986). IBM's Early Computers. Cambridge MA, MIT Press; Cohen, B. I. and W. Aspray (2000). Howard Aiken and the Dawn of the Computer Age. R. Rojas and U. Hashagen. Cambridge MA, MIT Press: 107-120; Postley, J. A. (1998). "Mark IV: Evolution of the Software Product, a Memoir." IEEE Annals of the History of Computing 20(1): 43-50; Williams, M. R. (2000). "Makin' Numbers. Howard Aiken and the Computer." Technology and Culture 41(4): 823-825.

[6] Bashe, C. J., L. R. Johnson, J. H. Palmer and E. W. Pugh (1986). IBM's Early Computers. Cambridge MA, MIT Press.

delivered together with IBM 704 machines. The fact that FORTRAN was followed in 1958 by a language called FORTRAN II meant two things: FORTRAN now had to be called FORTRAN I, and the expectation was that FORTRAN III lay within the realm of expectations. But every genealogical legitimation also entails risks. FORTRAN III never did see the light of day, whereas FORTRAN IV was published between 1962 and 1966, in different versions. It followed that the FORTRAN world was going to have to be reorganized to replace the obsolete genealogical system with a generalizable chronological system. As it happened, the further development of FORTRAN IV, labeled x3.9-1966, was named FORTRAN 66 and immediately ISO-certified. FORTRAN 77 did not appear until 1978. A successor planned for 1982, long vaguely referred to as FORTRAN 8x, was certified as FORTRAN 90 in 1991. All this did little to clear up matters but at least made chronological sense.[7]

The vendor-independent programming language ALGOL 60, developed in a series of international meetings between 1957 and 1963, was designed from the outset to have an easy-to-follow chronological system. But the system was short-lived, and ALGOL 68 provoked a schism among programming language developers. In 1970, Niklaus Wirth (a member of the notorious ALGOL 68 opposition) published his own programming language under the name "Pascal" – a move considered insubordination by the members of the programming guild who relied on international committee work. "ALGOL 68" did have a nice, scientific ring to it. But with "Pascal," and its powerful evocation of mathematics and history, Wirth had switched to a branding surely intended to be interpreted as *invention of tradition* by a community reliant on the academic merits of its field.[8]

Much more abstract than the genealogical and chronological classification systems was a fourth, quasi-scientific classification method for computers developed in the 1960s and known as Moore's law. It ignored the machine type, manufacturer, application type, and architecture of a computer and relied solely on the annual growth rate of processor performance. According to Gordon Moore, an electrical engineer employed by Fairchild Semiconductor, this rate was doubling approximately every 1.5 years. It enabled Moore to put the computer industry, which was particularly susceptible to disruptive twists and turns, on a continuous path of growth that sprang from the observable past, influenced the present, and helped steady the future. But there was one thing Moore's law could not do: it could not allow any compartmentalization.[9] Each processor was basically equal to its predecessor and its successor. Processors could be included in his geometric series, and some may have become better known than others. But Moore's curve makes no allowance for milestones, discontinuities, or exceptional delays. Everything runs a little too smoothly.

Anyone looking to argumentatively bridge a longer period of time, and who required breaks and qualitative leaps to do so, and yet still wished to speak for the entire industry, was forced to resort to a more or less archaic principle that classified computers according to their basic electronic components. One referred to electromechanical, electronic, and transistorized generations of computers. This enabled an argumentative flexibility that required neither

[7] Backus, J. (1998). "The History of Fortran I, II, and III." IEEE Annals of the History of Computing 20(4): 68-78; Chivers, I. D. and M. W. Clark (1985). "History and Future of Fortran." Data Processing 27(1): 39-41; Greenfield, M. N. (1982). "History of Fortran Standardization." Afips Conference Proceedings 51: 817-&; Heising, W. P. (1964). "History and Summary of Fortran Standardization. Development for the ASA." Communications of the ACM 7(10): 590; Muxworthy, D. T. (1972). "Standard Fortran. Short History." Computer Bulletin 16(4): 211-212.

[8] Wirth, N. (1970). The Programming Language Pascal. Zürich, ETH Zürich.

[9] Ceruzzi, P. E. (2005). "Moore's Law and Technological Determinism. Reflections on the History of Technology." Technology and Culture 46(3): 584-593.

flagging interruptions in homogeneous growth rates nor familiarity with the genealogical and chronological circumstances of individual companies or programming traditions.[10]

Computer science and historical organizing principles

The quest for historicity in the field of computer development is obviously not just a professional hazard of historians. Historicity has arisen for many and different reasons. No matter how interested *digital societies* (i.e., associations, user communities, or developer communities) are in developing a totally different future, they have always had a vital interest in historical orientation and rely heavily on monitoring, reporting, and documentation, and thus on archives.[11] Ever since these societies formed, they have created backups and printed collections of commands and instructions. They have produced and circulated evaluations in committees, collected and commented on conference papers, and subjected them to critical peer review.[12]

Digital societies began to reckon with their own past early on, and used it as an argumentative resource. But producing a future that was explicitly different from the past was also playing with fire, especially in computer-based public spheres. Anyone who could say how things had been in the past or "originally" soon came under suspicion of no longer wishing to shape the future. As a result, it took quite a long time for some computer specialists to use their memories of original intentions not merely as a launch pad for future designs, but to classify the state of the art. In so doing, they dispensed with the time-honored "But I say unto you" and instead adopted (mostly at the end of their career or when switching from industry to academia) a culture of argumentation relieved of the declamation that had served the computer industry as a source of legitimacy. The history that is the product of developer discourses is frequently a sign of development of its representatives and communities.

The case of the British computer scientist Brian Randell is an excellent illustration of such an "origin" in the history of the computer. Randell was one of the first computer specialists to look into the origins of digital computers. From 1957 to 1964, he was employed by the Atomic Power Division of the English Electric Company, where he developed compilers for ALGOL 60. He then worked at IBM's T.J. Watson Research Center in Yorktown Heights, and later in San José, California, on computer architectures, operating systems, and system development methods. Randell was thus used to being at the forefront when, in 1969, he moved from the area of industrial development to academic teaching and research at Newcastle University. He may have found another library there, like the one he remembered from his studies at Imperial College. In any case, while preparing his inaugural lecture at Newcastle, he stumbled on some work by the Irish accountant Percey Ludgate. Written many decades earlier, the work

[10] Denning, P. J. (1971). "Third Generation Computer Systems." ACM Computing Surveys 3(4): 175-216; Postley, J. A. and H. Jackabson (1966). The Third Generation Computer Language. Parameters Do the Programming Job. Data Processing. D. P. M. Association. Los Angeles CA. 11: 408-415; Press, L., J. Rothenberg and J. Carlstedt (1979). "The Next Generation of Personal Computers. A Position Paper." SIGPC Note 1(4): 7-17; Williams, M. R. (2000). A Preview of Things to Come. Some Remarks on the First Generation of Computers. The First Computers. History and Architectures. R. Rojas and U. Hashagen. Cambridge MA, MIT Press: 1-16.

[11] We use the term "digital society" as a form of self-description. It has been used by societies that delegate their functions and services to networks and computers. Over the last four decades "digital society" eventually replaced older forms of societal self-descriptions, such as the consumer, information or knowledge society. Gugerli, D. and D. Zetti (2018). "Digitale Gesellschaft (Rohfassung). Beitrag zum Historischen Lexikon der Schweiz." Preprints zur Kulturgeschichte der Technik.

[12] Gugerli, D. (2018). Wie die Welt in den Computer kam. Zur Entstehung digitaler Wirklichkeit. Frankfurt am Main, Fischer.

dealt with issues relating to programming machines. The approach struck Randell as surprisingly familiar.[13]

Randell's interest in Ludgate made history a source of distinction for computer science as a nascent subject. He wished to ensure that the history of science (not history of technology) would one day deal with the matter in a professional manner. Randell may well have assumed that computer science would first have to be stabilized as an academic subject (so it could then be discovered by the history of science). Or, conversely, perhaps he assumed that the thoroughly contentious academic professionalization of his field could be accelerated if it had a decent past.

Randell's anthology of basic texts, published in 1973, obviously had classical claims. However, what was presented under the title "The Origins of Digital Computers" did not reckon, as Darwin did, with a development *principle* that produced different types of computers. Instead, Randell was searching for heterogeneous contexts of origin from which the present-day, "modern digital computer" as such emerged.[14] An audience interested in technical details about the emerging computer sciences encountered neither a natural history nor a theory for explaining contemporary diversity, but rather the documentation of a forgotten but diverse past intended to stabilize what had been achieved to date. To this end, Randell embarked on a quest for elements from which a concept of the modern computer could be assembled. His quest began with Charles Babbage's and Ada Lovelace's soon-to-be famous "analytical engine," for which he found a description from 1837, and ended with another British machine, the Electronic Delay Storage Automatic Calculator (EDSAC), which went into operation in 1949. Randell regarded this year as the start of the present-day, following a more than century-old, highly complex and somewhat curious development history, whose protagonists often had no idea how "it" could be done or how to solve their problems with elegance.[15]

The particularly striking thing about Randell's collection was neither the beginning nor the aim of the history. What is surprising is that Alan Turing was actually treated as a nonentity. Initially, as Randell later explained, he had not even planned to mention Turing. After all, Turing had never actually developed a machine. In 1936, he had written a very theoretical design for a general-purpose machine, but nothing concrete or tangible had emerged from it. In the first edition of "The Origins," at the insistence of his British colleagues, Donald Michie wrote two cursory pages on Turing. Although at the time Randell himself was also and very cheerfully ensconced in theory at Newcastle, he clearly did not think that his work would not (as Turing's apparently had not) lead to anything concrete. Turing was worth mention in 1973. But due to his exclusively theoretical interest, he was not considered one of the forefathers of digital computers.[16]

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[13] Ludgate, P. E. (1909). "On a Proposed Analytical Machine." Scientific Proceedings, Royal Dublin Society 12(9): 77-91; Randell, B. (1971). "Ludgate's Analytical Machine of 1909." Computer Journal 14: 317–326.

[14] Randell, B. (2012). A Turing Enigma. CONCUR 2012 - Concurrency Theory. M. Koutny and I. Ulidowski. Heidelberg, Dordrecht, London, NewYork NY, Springer: 23-36, p. 23.

[15] Campbell-Kelly, M., B. I. Cohen and W. Aspray (2000). Past into Present. The EDSAC Simulator. The First Computers. History and Architectures. R. Rojas and U. Hashagen. Cambridge MA, MIT Press: 397-418; Nofre, D. (2015). "Review: It Began with Babbage. The Genesis of Computer Science by Subrata Dasgupta." Technology and Culture 56(2): 537-538; Randell, B., Ed. (1975 (1973)). The Origins of Digital Computers. Selected Papers. Berlin, Heidelberg, New York NY, Springer, pp. viii-ix.

[16] Randell, B. (2012). A Turing Enigma. CONCUR 2012 - Concurrency Theory. M. Koutny and I. Ulidowski. Heidelberg, Dordrecht, London, NewYork NY, Springer: 23-36, p. 24.

Nor as such was he suitable material as a figurehead of computer science. Indeed, his place among the ranks was only assured after confirmation of the suspicion that Turing had met John von Neumann during the war, and that Max Newman and Tommy Flowers had used Turing's design to build an electronic computer at the British Post Office Research Station. Encrypted messages from the German Wehrmacht had been decoded in legendary Bletchley Park. This suspicion was confirmed despite the British government's policy on secrecy and was published as a sensational bit of news in 1976 by Randell at a conference on the history of computers in Los Alamos.[17]

Now, Randell's findings made it possible to say, contrary to expectations, that Turing's work had actually produced something useful. Moreover, perhaps the undisputed American computer supremacy of the 1970s was not the product purely of the nuclear physicists at Los Alamos and their atomic bomb. At any rate, the prevailing genealogy of machines and inventors began to look a little shaky. Turing and von Neumann could no longer be consulted. Konrad Zuse, who had heard Randell's revelations in Los Alamos, was terrified and remained silent. The next logical step then was to consult old documents, i.e., to engage in historical research.

The discovery of a British computer linked to Turing during the Second World War unsettled the family history of computers and their inventors. But the updating of Turing as a figure was useful, and not only for British scientists.[18] In every category of apparatus – from mainframes to midicomputers to microprocessed-based machines – Turing appeared to have contributed principles of transnational importance. The *Turing machine* linked the computer with the fundamental cultural technologies of reading and writing, and the *Turing test* made it possible to evaluate the relationship between humans and machines. Moreover, the *historical Alan Turing*,[19] who had managed to avoid even his mother's biographical grasp, had become accessible to computer history, all the while remaining surrounded by an aura of secrecy, enigma, and of outsiderness. He was therefore ideally suited for both the undocumented beginnings and the anthropological interpretation of the calculating human vis-à-vis his machine.[20]

The fact that the history of the computer had become a zone of conflict in the 1970s had obvious consequences for its function as a source of orientation and argumentation. Clearly national claims to the creation myth of the computer would now have to be reassessed. But Randell's discovery was above all grist to the mill for academic computer scientists. As theoreticians, they both preceded and followed the machine. Turing's 1936 paper "On Computable Numbers" predated Colossus. Von Neumann's "First Draft of a Report on the EDVAC," published in 1945, came after the development work. Both a documentable machine

[17] Randell, B. (1977). "Colossus. Godfather of the Computer." New Scientist 73(1038): 346-348; Randell, B. (2012). A Turing Enigma. CONCUR 2012 - Concurrency Theory. M. Koutny and I. Ulidowski. Heidelberg, Dordrecht, London, NewYork NY, Springer: 23-36; Randell, B. (2013). Uncovering Colossus. https://youtu.be/Yl6pK1Z7B5Q, BBC.
[18] Randell, B. (2012). A Turing Enigma. CONCUR 2012 - Concurrency Theory. M. Koutny and I. Ulidowski. Heidelberg, Dordrecht, London, NewYork NY, Springer: 23-36, p. 32.
[19] Turing, S. (1959). Alan M. Turing. Cambridge, W. Heffer; Hochhuth, R. (1987). Alan Turing. Erzählung. Reinbek bei Hamburg, Rowohlt; Hodges, A. (1983). Alan Turing. The Enigma. London, Burnett Books.
[20] Ceruzzi, P. E. (1985). "Review: Turing Man. Western Culture in the Computer-Age by David Bolter." Technology and Culture 26(2): 341-343.

history and an academically founded computer science were needed; both would come about.[21]

This evidence of theoretical relevance could easily have served to establish the ultimate supremacy of theory over practice. Yet computer science as a field was wisely very tentative about moving in this direction. The scramble over Turing, von Neumann, Zuse, and "their" computers could much better serve the discipline if "the machine" in general was accorded proper respect – venerated as a museum piece and eventually put out to pasture. In short: the monumental computer (sometimes called Colossus) had to become both the aim *and* origin of development. This would grant the theory the desired relevance and lead to a technologically attractive union of all elements of the computer community.

Randell's collection was revised and reprinted in 1975 and 1982. "The Origins of Digital Computers," the history of their early development, also underwent change. The book was simultaneously historically and professionally effective. In his 2012 essay "A Turing Enigma," Randell recounted the story of how he selected texts and authors and in so doing (with no small amount of mischief) reinvented it. One year later, the BBC filmed Randell at the opening of an exhibition on the history of computers.[22] Behind him was Colossus, which had just been elaborately reconstructed, and in front of him a neat laptop, which he was using to give a presentation. What might be seen as a physical arrangement between a colossal past, a successful rehabilitation of the theory, and the current projection, culminated in a grand connection history between the secret and the published, the remembered and the existing, between software and hardware.[23] It was a history that was accessible to the computer world, because it easily and elegantly combined academic mathematical theory with industrial practice; and yet, as was the case between Charles Babbage and Ada Lovelace as well as between Alan Turing and Tommy Flowers, it reflected a successful collaboration involving shared tasks. It was a museum staging that repeatedly combined veneration of saints and the desire for enlightenment with entertainment.

Recording and documenting

The discovery of Britain's Colossus computers in 1976 was the apex of the search for the historical beginnings of computer science. That it came to light only then was easily explained by the fact that computer development had been kept secret during the war. The past intelligence work done during the Second World War haunted the increasingly professionalized computer science of modern times. It made the later discovery explosive, but it also provided a plausible explanation as to why entire computer complexes could vanish and be forgotten.

The existence of the Colossi in the 1970s called into question the inevitable loss of milestones in computer development. History apparently worked differently than assumed in computer development and application and could, using the right methods, raise computer

[21] Neumann, J. v. (1945). First Draft of a Report on the EDVAC. The Origins of Digital Computers. Selected Papers. B. Randell. Berlin, Heidelberg, New York NY, Springer: 355-364; Turing, A. M. (1937). "On Computable Numbers, with an Application to the Entscheidungsproblem." Proceedings of the London Mathematical Society 42: 230-265.

[22] Randell, B. (2012). A Turing Enigma. CONCUR 2012 - Concurrency Theory. M. Koutny and I. Ulidowski. Heidelberg, Dordrecht, London, NewYork NY, Springer: 23-36.

[23] Randell, B. (1977). "Colossus. Godfather of the Computer." New Scientist 73(1038): 346-348; Randell, B. (2013). Uncovering Colossus. https://youtu.be/Yl6pK1Z7B5Q, BBC.

science to an entirely new level. The discovery that computers had been built in Britain and then dismantled was only possible owing to Randell's use of historical research methods.

Contemporary computers and computer science were not without precedent, but possessed a narrative history that was the direct result of Randell's inquiries and research. The basis for his computer discovery was still isolated trouvailles, objects, and circumstantial evidence, as well as people who had developed computers. Randell increasingly disregarded the physical and abstract classification systems of computer development and abandoned the repositories carefully managed by information technology and transformed into digital spaces. The value of his research, indeed, the result, was the validation of configurations and relationships that were at odds with the familiar development stages and milestones of computer science. If the revelation of the once-vanished computers took the professional community and the interested public by surprise, it was at least as surprising that the future of the computer could be shaped within the work and argumentative space of the history of science, of all things.

The founding of a society to promote the history of computers was also broached in 1976 at the Los Alamos conference, right after the unveiling of the first new electronic computers. William Aspray, one of the first historians to study the history of computers, described the beginnings 30 years later. In Los Alamos, Arthur Norberg, a historian of science and technology from Berkeley, met printer manufacturer Erwin Tomash and his wife, Adele, at a "picnic away from the rest of the participants" where they talked about computer history for a long time. Norberg tried to persuade them to fund a museum for computer history.[24] He must have been thinking about the computer collections of the Smithsonian Institution in Washington, the Science Museum of London, and the Deutsches Museum in Munich. Digital Equipment Corporation (DEC), a Massachusetts-based computer manufacturer, also established a museum of computer history. The Tomashes rejected the idea of a museum because they thought the costs unaffordable.[25]

However, in talking to "industry friends" over the next few months, they managed to fundraise a significant amount. An archives and research center was founded in 1977. In 1980, the Charles Babbage Institute (CBI), as it was called, was affiliated with the University of Minnesota to bolster its academic orientation. The CBI provided bibliographies of computer history, created an archive, and established an oral history program under director Norberg. A book series reprinted texts on computer development since Charles Babbage. In 1985, for example, the Moore School Lectures of 1946 were published as volume 9 of the series. In the first two decades, historians interviewed 330 contemporary witnesses of computer development and, together with them, revisited bygone times of societies in which computers played an increasingly important role.[26]

The brief review of the paths and detours taken by the CBI when it was founded in the late 1970s reveals why a historiography of the computer was so quickly established in the United States. With the financial support of computer manufacturers, the decision was made to link the CBI to university research structures and to use methods from the humanities that brought to light texts, memories, and narratives as raw material for later investigations. With a firm

[24] Aspray, W. (2007). "Leadership in Computing History. Arthur Norberg and the Charles Babbage Institute." IEEE Annals of the History of Computing 29(4): 16-26, p. 17.

[25] Ibid., p. 17 f.

[26] Campbell-Kelly, M. and M. R. Williams, Eds. (1985). The Moore School Lectures. Reprint Series for the History of Computing. London, Los Angeles/San Fransisco CA, MIT Press and Tomash Publishers; Norberg, A. (2002). "Use of CBI's Research-Grade Oral Histories from CBI." Charles Babbage Institute Newsletter 24(3): 3-6.

focus on research into the history of the computer, an astonishing amount of output on paper and tape was archived and produced. Of particular note is that digital documentation was not emphasized in corpora building and that one object of investigation – software development – was omitted. Until the 21st century, the CBI thus remained remarkably close in its research practice to the program that the digital community had pioneered in the 1960s and 1970s in its quest for the origins of its discipline. The computer was at the center of these efforts, even more so than in contemporary computer science. The focal point was not the heterogeneity of existing computer models, but a machine that was conceived of as universal. The British "inventor" Charles Babbage, the patron saint of the foundation, institute, and book series, stood for what, around 1980, was the hopeful marriage of the history of industrialization and mathematics under the common umbrella of a technological history of the computer.

Prehistories of digitization

The first historians to deal with the volume of interviews, old lectures and papers, sources of mathematical history, electrical engineering, and what developers were thinking about the computer and its components came from the humanities. Paul E. Ceruzzi was an Americanist, and later a historian of technology. William Aspray was a philosopher of science. Nancy Stern was a historian of technology. They edited the historical documents and narratives into prehistories of the computer – and of computing.[27]

In 1982, an article by Stern appeared in the Journal of the Society for the History of Technology, in which she "propose[d] to examine the entrepreneurial activities" of J. Presper Eckert, Jr. and John William Mauchly. Between 1943 and 1951, Eckert and Mauchly had developed four computers: ENIAC, EDVAC, BINAC, and UNIVAC. After going through many boxes of archives and conducting several interviews, Stern came to the conclusion that judging success was not an easy thing to do. Although the early market launch of UNIVAC – a commercial digital computer – had put the two developers far ahead of their competitors, the real achievement was ushering in a new phase in computer history. Large companies had not been agile enough to commercialize digital computers, and the two engineers had willingly taken on the necessary risks. On the other hand, Eckert and Mauchly had been extremely naive and anything but successful as independent entrepreneurs. Despite Stern's focus on personalities and things, a "Colossus shock" was readily discernible.[28] Stern was in search of a novel and unique selling proposition for the early American digital computers, whose pride of place had been so thoroughly brushed aside by Randell. Moreover, by addressing the question of the innovative capacity of large companies, Stern took into consideration the contemporary early 1980s. By this account, UNIVAC was a forerunner of the personal computers that spread quickly around 1980.

Finally, in "Reckoners: The Prehistory of the Digital Computer, from Relays to the Stored Program Concept, 1935–1945," Paul E. Ceruzzi neatly summed up the 1980s' interpretation of the prehistory of the computer. Before 1935 there had been machines that could calculate and process information, "but they were neither automatic nor general in capabilities. They

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[27] Aspray, W. (2007). "Leadership in Computing History. Arthur Norberg and the Charles Babbage Institute." IEEE Annals of the History of Computing 29(4): 16-26, p. 18.

[28] Stern, N. (1982). "The Eckert-Mauchly Computers. Conceptual Triumphs, Commercial Tribulations." Technology and Culture 23(4): 569-582, p. 582.

were not computers." In the 1930s, when people used the word "computers," they were still referring to human beings. It was only after 1945 that the term "computer" definitively came to denote a machine that did calculations. From then on, computers developed and improved, and became cheaper and smaller. But their design did not change. Up to this point, Ceruzzi's line of argument was quite loose. Nevertheless, he concluded that the case study and period of investigation were well chosen and representative. The account of the period from 1935 to 1945, he wrote, chronicled a phase that spoke volumes about the history of the computer in the 1980s. "So the story of what happened in that ten-year period will reveal quite a bit of the entire history of the computer as it is known today."[29]

In a monograph titled "John von Neumann and the Origins of Modern Computing," published in 1990, William Aspray, too, focused on a decade that he considered significant for computer history. He began with 1943, the year in which von Neumann had written a Princeton colleague that in England he had developed "an obscene interest in computation" and would be coming home changed, "a better and impurer man."[30] Up to his death in 1957, von Neumann was making lasting contributions to the design, application, theory, dissemination, and legitimation of computing. Aspray based his investigation on, as he put it, the first careful evaluation of the rich archival legacy of Neumann and his peers. He was thus confident that the book presented a comprehensive and complete rehabilitation of the many different contributions that von Neumann had made to the history of computers and that it attracted its readers' attention to a historically based understanding of the concept of computing.[31]

That same year, Aspray also published "Computing before Computers," to which Ceruzzi contributed chapters on relay calculators and electronic calculators. In this case, the period of investigation was dramatically extended, and at the same time it was clear that for Aspray, the term "computing" meant not only computer-based calculation, but calculation in general, which had always been technologically based. Martin Campbell-Kelly wrote a chapter on punched-card machinery. The area of computer science was represented by Allan G. Bromley and Michael R. Williams. Their chapters covered "early calculation" – computers in antiquity and in the Middle Ages, the abacus in Europe and "the Orient," and slide rules, as well as Charles Babbage's "difference engine" and his "analytical engine." Analog computing devices such as planimeters and computers for air defense rounded out the ancestral gallery. In his introduction, Aspray stated that the purpose of the book was to not forget a "rich history that extends back beyond 1945. Since antiquity societies have had a need to process information and make calculations, and they have met this need through technology." The prehistory of calculating machines and societies was so easily forgotten for two reasons: a ubiquitous discourse around the computer revolution and the information age, and public awareness and the rapid development of the computer since the Second World War. The computer had led to fundamental changes "in the way we conduct business, perform scientific research, and spend our leisure time."[32]

The efforts of the researchers affiliated with the CBI to promote professionalization were aimed at establishing a computer historiography that included industry, mathematics, and

[29] Ceruzzi, P. E. (1983). Reckoners. The Prehistory of the Digital Computer, from Relays to the Stored Program Concept, 1935-1945. Westport, Greenwood Publishing Group Inc., Preface.
[30] Aspray, W. (1990). John von Neumann and the Origins of Modern Computing. Cambridge MA, MIT Press.
[31] Ibid., p. xv.
[32] Ibid., p. vii.

technology. At the same time developers' discourses were refined, as in the 1986 book "IBM's Early Computers." Historian of science I. Bernard Cohen contributed the foreword, in which he enthusiastically strove to persuade readers of the qualities of the book as a rare investigation of corporate history.[33] All too often, he wrote, histories of technology-based companies turned out merely to be company histories. Technological development was of peripheral interest. Now, all of the authors of "IBM's Early Computers" were documenting for the record a long era of development activity in the computer industry. They were, Cohen stated, keen to provide a chronicle of IBM's stages of technology development. "'IBM's Early Computers' is devoted primarily to technology; it endeavors to chronicle, understand, and interpret the technical stages of the transformation of IBM from a relatively small manufacturer and supplier of electric accounting machinery into a large and rapidly growing computer company." In other words, in the 1980s the developer community continued to occupy itself with history.[34] In the preface, the authors expressed their gratitude for the freedom they were given to develop a technical history "in accordance with our own guidelines."[35]

The period covered by "IBM's Early Computers" began after the Second World War and ended in the early 1960s. The authors – Charles J. Bashe, Lyle R. Johnson, John H. Palmer, and Emerson W. Pugh – examined management decisions at key (to them) moments to show how the computer had transformed IBM, the former manufacturer of punched-card accounting machines. They had scoured their own institution for earlier IBM-made computers and had made a discovery that to Cohen, a historian of science in the mid-1980s, seemed so distant and exotic as to warrant mention: the universal programmable computer of the 1960s and 1970s had had precursors.[36]

The precursors of the general-purpose computer were not distinguished by serial numbers but by their fields of application. Cohen further observed that IBM differentiated these machines from each other as strictly as it did the respective development departments. "One especially interesting theme of this book is the parallel but independent development, during the 1950s, of machines for scientific (or engineering) and business users. Only after a decade or so did it become widely practical to design and manufacture general-purpose computers that could function well in both domains."[37] In their search for predecessors of IBM's general-purpose computers, the authors encountered colleagues who had envisioned the future of their products exclusively either in science and engineering or in business, and who had increasingly forgotten this history. The final chapter of the 700-page book laid out the "architectural challenges" confronting IBM as an up-and-coming computer manufacturer from the 1940s to the 1950s. Here, "architecture" was understood to refer both to the organization of a company into departments and to the assembly of a computer from components. The double meaning of the architecture and the complex challenges it posed within the company were embodied by System/360, one of the "unified line" of products announced by IBM in 1964. According to Bashe et al., it was intended specifically to abolish the distinction between

[33] Bashe, C. J., L. R. Johnson, J. H. Palmer and E. W. Pugh (1986). IBM's Early Computers. Cambridge MA, MIT Press.
[34] Cohen, I. B. (1986). Foreword. IBM's Early Computers. C. J. Bashe, L. R. Johnson, J. H. Palmer and E. W. Pugh. Cambridge, Mass., MIT Press: xi-xiii, p. xi.
[35] Bashe, C. J., L. R. Johnson, J. H. Palmer and E. W. Pugh (1986). IBM's Early Computers. Cambridge MA, MIT Press, p. xvi.
[36] Ibid., p. xv.
[37] Cohen, I. B. (1986). Foreword. IBM's Early Computers. C. J. Bashe, L. R. Johnson, J. H. Palmer and E. W. Pugh. Cambridge, Mass., MIT Press: xi-xiii, p. xii.

"computers for science and computers for accounting" within IBM. Bashe et al. had published the prehistory of the IBM system and the system at IBM.[38]

In Stern's book, as well as those by Ceruzzi and Aspray, and particularly in "IBM's Early Computers" by Bashe et al., the widespread success of personal computers and small start-up companies prompted questions about the industry's power to innovate. The PC stimulated the search for criteria that would make it possible to distinguish the development stages of "the computer." Which brings us to another contemporary book that made a claim in 1984 that the authors considered sensational: even the PC had a history.

Paul Freiberger and Michael Swain portrayed the development of the personal computer quite differently than Stern, Ceruzzi, Aspray, and Bashe et al. had tried to do, namely, as the story of a revolution carried out by a few and later more and more by heroes. Charles Babbage served the two journalists as the conventional starting point of the narrative about the computer's unprecedented ascent. A few pages later other inventors followed: Hermann Hollerith, Alan Turing, and John von Neumann. Turing was accorded an appearance as the conceptual inventor of the universal computer. For Turing "envisioned a machine designed for no other purpose than to read coded instructions describing a specific task and to follow the instructions to complete its own design."[39] It was Neumann who first turned the vision into reality. "The instructions became programs, and his concept, in the hands of another mathematician, John von Neumann, became the general-purpose computer."[40]

Here, the prehistory of the computer, which had caused so many headaches for developers and historians, was formulated regardless of the state of research. But Freiberger and Swain, would not have been following the discussions of their colleagues writing in computer science and historiography, either. Their story, and thus the book's story as well, began only – or rather, already – on page 17, which is where they first mention DEC. In this section of their story, they let readers know that DEC would challenge giant IBM with smaller and cheaper computers. Accordingly, the first hero to make an appearance in the book was an innovative DEC employee named David Ahl, whose mission would prove epochal because, according to Freiberger and Swain, he was the first to rebel against existing structures. He eventually left DEC, frustrated by what he considered the many wrong decisions made by management. To Freiberger and Swain, he and many others had done exactly the right thing: "Had the personal computer revolution waited for the mainframe computer and minicomputer companies to act, it might still lie in the future."[41]

Titled "Fire in the Valley," this compilation of Freiberger's and Swain's Californian business acumen, considered the IBM PC launched in 1981 as a replica of earlier personal computers. IBM's success in the PC market was consequently not based on the company's own efforts at innovation. IBM's marketing savvy as explained in "Fire in the Valley" was the reason why, at the start of the 1980s, even the creative start-up companies themselves saw their sales market in office applications and showed that the marketing of history was the order of the day. Freiberger and Swain's account of the mavericks conquering the world from Silicon Valley struck a chord that would be sounded repeatedly later on. Despite all the claims of having invented or found a completely new computer history, "Fire in the Valley" is one of a piece

[38] Bashe, C. J., L. R. Johnson, J. H. Palmer and E. W. Pugh (1986). IBM's Early Computers. Cambridge MA, MIT Press, p. 582.
[39] Freiberger, P. and M. Swaine (1984). Fire in the Valley. The Making of the Personal Computer. Berkeley, McGraw-Hill, p. 6.
[40] Ibid.
[41] Ibid., p. 21.

with other hagiographic accounts of inventors.[42] It also supports the popular narrative of computer historiography. The book makes it plain that computer history had become a resource that could be used almost arbitrarily to serve the next revolution. In the mid-1980s, PC narratives had to suppress that the fact that the PC industry, too, had a penchant for strict formatting and command sequences, fought over processes and protocols, and loved bureaucracy.[43] In other words, the history of entrepreneurial decision making, which at the time was being painstakingly reconstructed in the case of IBM, was left out.

Historiographical batch processing

A few years later, in a 1988 essay titled "The History of Computing in the History of Technology," historian Michael S. Mahoney produced a constructive and critical review of the current historiographic program. From the very outset, he left no doubt that computer historiography itself was part of the development of information processing. "We live in an 'information society', an 'age of information.' Indeed, we look to models of information processing to explain our own patterns of thought."[44] However, the history of computers did not come into the events and discussion of the history of science and technology. In contrast, wrote Mahoney, a look at the research literature on computer history showed that the people who wrote it were hardly addressing the questions that historians of technology were asking. He suggested integrating computer history into the history of technology from two directions: "The history of computing should use models from the history of technology at the same time that we use the history of computing to test those models."[45]

Mahoney summed up "computing's present history" as a form of batch processing.[46] He sorted all the literature he knew according to the way the authors dealt with history and computers. One pile consisted of books purporting to be historical research literature. The literature on computing – like Aspray, Mahoney referred to the history of computing – consisted of investigations that focused, first, on hardware and, second, on the prehistory and early history of the computer. Contrary to the self-perception of its authors, however, the latter was only casually historical, at least insofar as it addressed the history of the 20th century or wished to take a broader perspective.[47]

A second, sizable pile consisted of accounts written by people who had once been involved in the developments they described. The format of this pile was very varied. Mahoney was familiar with a variety of publications ranging from routine reports, collections of groundbreaking essays and retrospectives, to biographies of people and machines, to corporate histories. Mahoney included Brian Randell's work in this pile as well as Bashe et al.'s "IBM's Early Computers." These "insider" histories were full of expertise and "facts and firsts." Mahoney was critical of the authors accepting as technical givens what a more critical

[42] Reid, R. H. (1997). Architects of the Web: 1000 Days that built the Future of Business. New York, John Wiley & Sons; Ichbiah, D. (1993). Die Microsoft Story. Bill Gates und das erfolgreichste Software-Unternehmen der Welt. München.
[43] Freiberger, P. and M. Swaine (1984). Fire in the Valley. The Making of the Personal Computer. Berkeley, McGraw-Hill, p. 297 f.
[44] Mahoney, M. S. (1988). "The History of Computing in the History of Technology." Annals of the History of Computing 10(2): 113-125, p. 1.
[45] Ibid., p. 2.
[46] Ibid.
[47] Ibid.

investigation might have concluded to be choice and decision making: “This literature represents for the most part ‘insider’ history. While it is first-hand and expert, it is also guided by the current state of knowledge and bound by the professional culture. That is, its authors take as givens (often technical givens) what a more critical, outside viewer might see as choices.”[48] Reading these reports, one loses sight of alternatives, because the authors subordinated everything to knowledge that they had exclusively at the time they were writing. They lost touch with the time they were writing about.

A third pile comprised texts that Mahoney labeled as “written by journalists.” Since the 1950s, journalists had been writing material that captured the essence of people and institutions and portrayed them so vividly that they found an audience. Journalists had “an eye for the telling anecdote.” But they also tended to emphasize the out-of-the-ordinary, the sensational, and the epochal in relation to people and lines of research, which boosted the popularity of microcomputers and artificial intelligence.[49]

Mahoney found these reports difficult to distinguish from a fourth pile of texts concerned with the effects of computers on society. This literature tended toward facile pronouncements about the present that were difficult to distinguish from utopian dreams. But what was most obvious here was the simplification of history. Computers were removed from past time periods in order to instrumentalize history. History was thus not examined, but it served the purpose of contemporary social criticism. “Some of this literature rests on a frankly political agenda; whether its modes and models of analysis provide insight depends on whether one agrees with that agenda.”[50]

A discussion space had apparently emerged since 1976 centered on computers, in which computer history was examined from many perspectives (politics, society, technology, business, culture) and for a long time, using research methods tried and tested in the history of technology. Mahoney’s sorting unearthed resources that computer historians could take from the literature cited and analyze profitably: anecdotes, facts, technical knowledge, and political strategies. From the limitations he described, it was also very easy to make out what Mahoney found regrettably lacking in some or all of the books, which he regarded as sources to be mined for computer historiography: information about choices and alternatives, insight into the past and a glimpse of the ordinary, and not least, authors with a commitment to history.

Closed worlds

Even after the critical *and* systematic examination of the field of computer history, a number of studies appeared which, as they lacked doctrinal unity, all made use of a professional arsenal of methods from other disciplines, thus attracting not only attention but also well-deserved respect. Donald MacKenzie’s “Inventing Accuracy” is a remarkable book for the history of computers in several respects. His subject, nuclear missile guidance, refers to the computer-historical past of ballistics and the atomic bomb. The book poses the simple question of what must be computed for and by autonomous flying missiles – whether digitally in advance or during flight with electromechanical devices. However, due to the diverse body

[48] Ibid.
[49] Ibid., p. 3.
[50] Ibid.

of knowledge at play in this technology, there are neither dominant theories nor outsized personalities, neither genealogical nor teleological inevitability.[51] Rather, it has always been about the selection and combination of different forms of knowledge and technical processes.

"Inventing Accuracy" transcends machine boundaries, disciplinary boundaries, attentional boundaries, and groups of actors to show how a blackbox was conceived, a technical revolution developed, a weapons system transformed, and technical facts reconstructed. With remarkable aplomb, MacKenzie has since written a number of essays and books in which society and computers are woven into a finely textured fabric. By refraining from dealing with only one particular form of computing, MacKenzie succeeds in presenting very differentiated sociotechnical problem areas – from "computer-related accidental deaths" to the autopoietic effect of mathematical descriptions on the dynamics of the financial markets.[52]

Paul Edwards' "The Closed World: Computers and the Politics of Discourse in Cold War America" appears to have been written much closer "to the computer." But the impression is deceptive. What Edwards delivers is an "implicit critique of existing computer historiography" already made explicit in the preface. It is not about progress and revolution, he maintains, but rather about contingency and multiple determination. Technological change should be treated as a technological choice, "tying it to political choices and socially constituted values at every level." Thus, technology is depicted as a product consisting of complex interactions "among scientists and engineers, funding agencies, government policies, ideologies, and cultural frames."[53]

Both MacKenzie and Edwards approach "the computer" with respect to its operational requirements and effects; these can be both distributed and centralized, but they are never distributed for obvious, quasi-natural reasons, but rather as the result of a political, strategic, or cultural choice. The computer disperses, becomes ubiquitous, and forms a system that is highly integrated within the social context of action where computing, sorting, and interaction occur. The analysis thus also reflects a context that was shaped by the development dynamics of computer-aided networks and distributed computing.

"Taking God out of Mathematics and Putting the Body Back In"[54] was Brian Rotman's goal in a 1993 essay on the ghost in Turing's machine. Rotman boldly pointed out the corporeality of abstractions and symbolic operations, even those of mathematics. And he did so with explicit reference to the work of Alan Turing. For the history of mathematics, this was thrilling. Curiously, the history of computer technology has hardly changed the computer, even though Edwards and MacKenzie very effectively demonstrated how closed disciplinary worlds could undergo productive change by importing new methods and perspectives. The substantial interest of many representatives of the humanities in corporeality, materiality, and artifacts would also have helped pave the way for the history of computer technology. The fact that so little happened was due both to the historical context and to the hesitancy of the history of technology as a field.[55]

[51] MacKenzie, D. A. (1990). Inventing Accuracy. An Historical Sociology of Nuclear Missile Guidance. Cambridge MA, MIT Press.

[52] MacKenzie, D. A. (2006). An Engine, not a Camera. How Financial Models Shape Markets. Cambridge MA, MIT Press.

[53] Edwards, P. N. (1996). The Closed World. Computers and the Politics of Discourse in Cold War America. Cambridge MA, London, MIT Press, p. xiii.

[54] Rotman, B. (1993). Ad infinitum. The Ghost in Turing's Machine. Stanford CA, Stanford University Press.

[55] Gumbrecht, H. U. and K. L. Pfeiffer (1988). Materialität der Kommunikation. Frankfurt a.M., Suhrkamp.

Future without past

And yet, in the 1990s, when digital society was on the rise, it was easy to imagine that computers had a history and that there could be a future in working with that history. But history changed far too quickly in the mid-1990s. Together with the explosive growth of the World Wide Web, a vision emerged of "humans" always "surrounded" by "media and technology." In accordance with Mahoney's motto "hype hides history," nearly everything that might have constituted computer history tumbled back into oblivion.[56] What was now reported about virtual space in media theory and philosophy, and literary studies, was all geared toward establishing norms, an identity, an aesthetic sensibility, and a future orientation. If you believed what you heard, then everything was evaporating – history, society, theory, space, and of course the library. Cyborgs were crowding into cyberspace, this "specific elsewhere;" the piano was becoming a hypertool; and even the Hollywood dream factory was vanishing into the Internet. Technology-oriented culture and media scientists focused fully and ahistorically on what had "always" been or what had been "ever since," for example, the invention of movable type or the wing telegraph.[57] This enabled mediation of the space between the latest newswire reports as plain text and Heideggerian aphorisms, between media mythologizing of the Big Bang and allusions to the current convergence of all media. People were not really astonished when, in 1993, Friedrich Kittler situated "the last historic act of writing" in 1978. He based his claim on his reading of a 1990 issue of DOS magazine. At the time, "a team of Intel engineers laid a few dozen square meters of drawing paper on empty garage floors in Santa Clara to plot out the hardware architecture of their first integrated microprocessor."[58]

Under these circumstances, there was nowhere for computer history to retreat to. Computers were too heterogeneous to serve as stable historical objects for embarking on yet another journey through the past. By now, the computer was somehow physically, conceptually, and procedurally everywhere simultaneously, a moving target that left many traces but whose replication was no longer palpable. Admitting that it had never been so would have undone the original narrative of the highly integrated universal machine.

Nonetheless, 1996 saw the publication of "the book" whose first edition put a number of obstacles in the way of an otherwise freewheeling history of computers. Subsequent editions met the string of new futures with ever more curious classifications of history into different "computer ages" and continued undauntedly to string together further materials for the purpose of computer historiography. From edition to edition the book became louder, more colorful, more confusing, and less conceptual. But it was required reading for anyone who needed references for things that in the 1990s were common knowledge in the history of computers, in the household, and at the office. At the same time, these were things that generally were considered completely foreign to the science of the history of technology and history. So while readers might have been searching the book for clues to "operating system"

[56] Mahoney, M. S. (2011). Histories of Computing. Cambridge MA, Harvard University Press, p. 120.

[57] Turkle, S. (1995). Life on the Screen. Identity in the Age of the Internet. New York NY, Simon & Schuster; Bolter, J. D. and R. A. Grusin (1998). Remediation. Understanding New Media. Cambridge MA, MIT Press; Manovich, L. (2001). The language of new media. Cambridge, Mass., MIT Press.

[58] Kittler, F. A. (1993). Es gibt keine Software. Draculas Vermächtnis. Technische Schriften. F. A. Kittler. Leipzig, Reclam: 225-242, p. 226. Here we ignore the role that computers have played in media studies, as well as the philosophical claim of media studies to history.

or "batch processing," they also encountered odd errors and mistakes. For example, a "Mrs. John W. Mauchly" found her way into history as the wife of a professor, but without her own first name and without evidence of her mathematical education. The book was thus yet another source to be mined, not one to be read for pleasure. You had to plow through it and "process" it, so at least you knew right away what could be done at least a little bit better. For example, it was quite clear that no research had yet succeeded in prompting a rethink of the commonplaces about programmers. The book, which was reissued many times without corrections but simply extended to include the most recent period, was modestly stimulating.[59]

The history of computers thus remained largely irrelevant for the history of technology, and what was obvious for the history of technology was of no interest whatsoever to the history of computers. When the history of technology began to innovate and to address artifacts and discourses, computer history tried to free itself from machine genealogies and interviews with contemporary witnesses. Moreover, neither the history of computers nor the history of technology could look to the history of economics as a source of protection. In 2001, when the eminent corporate historian Alfred D. Chandler looked back on the just concluded 20th century as an era of electronics, historians of technology should have taken note immediately. But the journal Technology and Culture waited a full five years before publishing a review. Obviously, computer historiography had failed to keep Chandler reliably informed about its research aims and findings.[60] Not that the aims were any secret: "Until recently, the history of computing in these fields has been written in terms of the machine and its impact (revolutionary, of course) on them. The emphasis has lain on what the computer could do rather than on how the computer was made to do it," stated Michael S. Mahoney on a somewhat sober note at the end of his career.[61]

According to Mahoney, the operational prerequisites and impact of historical computers could perhaps still be decentered by focusing on "communities, or bodies of shared disciplinary practices, who embraced the new device and helped to shape it by adapting it to their needs and aspirations" instead and then following the history of these groups. This acknowledges the role of the user, evokes the popular interdisciplinarity of science policy, and makes concessions to the science and technology studies community, which had been recounting such histories in its lectures for more than 30 years in the place of philosophy of science, which had long since been retired.[62] It was also another attempt to finally transcend the border between the analog and digital eras and thus to get closer to the original, but probably also present-day, universal computers. The focus on computers remained intact, even when people began to speak of communities and software, and no longer was it museum collections that had to be maintained, but websites.[63]

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[59] The reference is to Campbell-Kelly, M. and W. Aspray (2004). Computer. A History of the Information Machine. New York NY, Westview Press.

[60] Chandler, A. D., Jr. (2003). Inventing the Electronic Century: The Epic Story of the Consumer Electronics and Computer Industries. Cambridge, Free Press; Ensmenger, N. (2006). "Review: Inventing the Electronic Century. The Epic Story of the Consumer Electronics and Computer Industries by Alfred D. Chandler." Technology and Culture 47(3): 680-681.

[61]Mahoney, M. S. (2005). "The Histories of Computing(s)." Interdisciplinary Science Reviews 30: 119-135, p. 127.

[62] Ibid.

[63] See eniacinaction.com by Tom Haigh, one of Mahoney's hopes for a social history of the computer. For some years now, however, he has been reviving famous computers in documentary and tabular form, paying tribute to the IEEE computer pioneers and reprinting Mahoney's writings. Or read Fred Turner's unfortunate attempt to find the "actual" personnel of the "Internet revolution" of the 1990s in the counterculture of the 1960s (Turner, F. (2005). "Where the Counterculture Met the New Economy. The WELL and the Origins of Virtual Community." Technology and Culture 46(3): 485-512). Steward

To date, however, the peak of pessimism is marked by a short piece by William Aspray, who considered the entire history of the computer enterprise to have been a failure. Even the history of information had not really been influenced by the history of computers, because computer historians were not sufficiently familiar with the history of libraries, archives, museums, and information sciences.[64] Aspray states that, apart from James Cortada, nobody really cared about a general understanding of the information society. That seems a bit harsh. First, no one would claim an understanding of the information society based on Cortada's "How Computers Changed the Work of American Manufacturing, Transportation, and Retail" or "How Computers Changed the Work of American Financial, Telecommunications, Media, and Entertainment Industries." Second, Cortada reduced the computer to the processor (because anything else would be far too complicated), and his processor perspective contributed nothing to the understanding of computer development.[65] Cortada represents a computer salesman's perspective on past sales markets, and he was concerned with something that Mahoney would probably have classified as "impact studies": similar to thought games about the future, they separate "computing" from its history and use this history as a pretext for a – in this case techno-apologetic – commentary on society.

History of technology and promising questions

On closer inspection, the situation is not as dire as Aspray would have it. For there can hardly be a question of founding a scientific discipline based on the history of computers. Although the future is already emerging in the form of the discourse around contemporary digitalization and surveillance,[66] even anthropologically and ahistorically false conclusions, which assume that people do not change, are still suggested and very common. On the other hand, theory formation in computer science and the formerly so important supremacy of mind over matter or so-called humans over the universe can be approached in a much more relaxed way than was conceivable at the time when computer science and computer designers were searching for their origins. Nor is digital society a threat, but rather a reality that one can count on with confidence. The computer (and everything connected with it) is a historical fact and has a history.

The potential for uncertainty, on the other hand, arises in connection with the epistemology of computer-aided knowledge production. For what is at issue here are questions of autonomy and algorithmic data dependencies. In other words, what is at stake is the causality status of arguments and the justifiability of decisions – from astronomy to medicine to the digital humanities. This also applies to the history of computers: in computer-historical research practice, one cannot refuse computer-supported methods out of

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Brand attempted this in 1995, and since then it has been parroted by personal computer historians who count the age of the mainframe computers as the prehistory of the computer, Brand, S. (1995). "We owe it all to the hippies." Time 145(12): March 1st-March 1st.

[64] Aspray, W. (2015). "Information Society, Domains, and Culture." IEEE Annals of the History of Computing 37(2): 2-4.

[65] Cortada, J. W. (2004). The Digital Hand. How Computers Changed the Work of American Manufacturing, Transportation, and Retail Industries. Oxford, Oxford University Press; Cortada, J. W. (2006). The Digital Hand. How Computers Changed the Work of American Financial, Telecommunications, Media, and Entertainment Industries. Oxford, Oxford University Press.

[66] The history of computers shares this fate with the history of technology.

neoconservative snobbery; and for digital sources, they are absolutely indispensable.[67] In the near future, historians will no longer be constrained to do their digging only where lighting conditions are favorable.

But how, outside of the intrusion of the future into the present, can computer history develop promising topics? A renewed culture of questioning is called for, which in our opinion can be developed in various ways. It is relatively easy to reverse the dominant perspectives. In some cases this has been done successfully despite Aspray's pessimistic assessment. Martin Campbell-Kelly, Thomas Haigh, and others have stressed the importance of software in computer history despite the dominance of hardware. This also provided new answers to old questions, such as those concerning corporate culture, and the risks inherent in decision making and planning.[68] However, reversing perspective only works if, for example, the history of software is not written the way the hardware story was told. Nobody needs yet another tale of suffering but smart heroes (now called hackers because it's about software) or narratives about pioneers (now called first movers because they launched a killer app). No one really wants to be told again how former IBM engineers succeeded in founding a software empire thanks to having based it on universal standards. But now that the topics of human-machine interaction and competition have long since been squeezed dry, one might ask (as David Mindell has done) how astronauts could be so immobilized by the aid of computers and programs that they became passive, i.e., predictable spaceship cargo, unlike Neil Armstrong, who transformed the soft landing of Apollo 11 into a rodeo.[69] Similar changes of perspective are possible when calculators are not interpreted as automating devices but rather as tools to be used in transforming organizations; when computers are seen not as speed agents but rather in terms of their targeted application to slow processes, storage, traffic jams, and holding queues; and when intention is focused not on networking but on interruptions and incompatibilties, not on virtuality but on the materiality of cables and data centers, and not on equipment costs but on operating costs. Finally, the tiresome narrative of the colonization of the living world by the computer can be countered by broaching the civilization and colonization of the computer at a profit.

Somewhat more difficult to deal with, on the other hand, are the interdependencies, or what one might call sociotechnological relationships. The history of knowledge shows that (in particular) the circulation of knowledge, the interaction of knowledge actors, and the representation of knowledge can shake loose rigid disciplinary and protodisciplinary notions and lead to fruitful intellectual activity. For a computer history with revival potential for the history of technology, it is probably advisable to avoid teleological or technologically deterministic arguments. The dynamics of the field of the history of computers also bars posing questions about the big picture and the spread of big ideas out of pure longing for simple narratives or sheer lack of inspiration. But these dangers actually only exist where knowledge of the history of computer technology is meagre.

[67] Burdick, A. (2012). Digital Humanities. Cambridge MA, MIT Press. On the history of computing in the humanities and in the digital humanities, see Jones, S. E. (2016). Roberto Busa, S.J. and the Emergence of Humanities Computing. The Priest and the Punched Cards. New York, Routledge

[68] Haigh, T. (2002). "Software in the 1960s as Concept, Service, and Product." IEEE Annals of the History of Computing 24(1): 5-13; Haigh, T. (2006). ""A Veritable Bucket of Facts." Origins of the Data Base Management System." ACM SIGMOD Record 35(2): 33-49; Mahoney, M. S. (2008). "What makes the history of software hard." Ieee Annals of the History of Computing 30(3): 8-18; Campbell-Kelly, M. (2003). From Airline Reservations to Sonic the Hedgehog. A History of the Software Industry. Cambridge MA, MIT Press; Campbell-Kelly, M. (2007). "The History of the History of Software." IEEE Annals of the History of Computing 29(4): 40-51.

[69] Mindell, D. A. (2008). Digital Apollo. Human and Machine in Spaceflight. Cambridge MA, MIT Press.

What is particularly interesting in the history of computers is when tipping points emerge that reveal historical actors being surprised by their own actions. For example, when Apollo's computer developers were working on a navigational system aid for astronauts in space, they realized that they were in the process of turning the astronauts into a space-based operating crew for the computer. Such changes in perspective are not random events, but can be understood as unintended learning processes and reconceptualizations that emerge in the negotiation zones that are intrinsic to both development and implementation. Last but not least: the enormous importance of the project as a negotiation platform for the digital society is not only a heuristic gift to the history of computers, but also a therapeutically effective cure against any sign of lethargy in the history of technology. During a project, the course of events must be handled with imagination and incisive reasoning. Unholy alliances are expected to achieve impossible goals, and dramatic disruptions to open up new spaces. Consequently, even the vestiges of projects can be used to develop a productive source of friction and a living science of history. It isn't necessary to replumb the depths of Alan Turing's papers or to reconstruct the Whirlwind computer for the history of computers to succeed in injecting a breath of fresh air into the history of technology.

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