CHAPTER 6

History as Science: Virtues and Promises of Technology in the Making of History

Gerben Zaagsma

Abstract This article examines key features of the discourses surrounding the human-machine encounter in historical research as they have developed since the late nineteenth century. It specifically focuses on the promises made by technologically minded historians, the epistemic virtues they believed should be pursued, and how these virtues revealed competing ideas concerning the status of the discipline of history as a science. The article first discusses the role of promissory discourses in the adoption of technology in historical research. It then examines three distinct periods: (1) the first decades of the twentieth century, when mechanically enabled source reproduction took off; (2) the period from the late 1950s until the advent of the personal computer in the early 1980s, when machine-aided quantitative data processing and analysis emerged; and (3) the period since the advent of the personal computer and Internet, including our current era of "digital history", when working with digital archives became a central concern.

Keywords digital history – history of historiography – epistemic virtues – promises – history of knowledge

In 1906, the German Byzantine scholar Karl Krumbacher noted that, contrary to knowledge regarding the application of photography in the "natural sciences", neither the educated public nor scholars were sufficiently informed about "the outstanding role of photography in the philological and historical sciences". In an attempt to remedy this situation, he subsequently set out to explain the promise of its application in the realms of textbook production, facsimile reproduction, and research, confidently announcing the end of the "stage-

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coach era of gathering scientific materials".[1] Photography, according to Krumbacher, not only offered practical benefits but would also lead to increased scientific rigour and accuracy. Krumbacher's vision of what photography did or could do for the discipline of history, along with his lament about its limited uptake, will sound familiar to anyone interested in the history of digital history or in the role of technology in the history of historiography more generally.

Over the past two decades, the praxeological turn in the history of the humanities has prompted scholars to increase their focus on the making of historical knowledge and the role of technology therein.[2] More recently, the history of digital history has emerged as a new avenue of research.[3] Nevertheless, we still know little about the futures envisioned by practitioners such as Krumbacher and what they can reveal about the human-machine encounter in the discipline of history. Krumbacher's example demonstrates that the adoption of new technologies, in this case photography, was accompanied by promises and expectations emphasising practical benefits, such as saving time, while also highlighting their ability to reinforce, and even help constitute, epistemic virtues such as objectivity, reproducibility, accuracy, and rigour. Discourses surrounding the adoption of new technologies could thus never be separated from debates on the methodological and epistemological foundations of history as a discipline.

Starting in the late 19th and early 20th centuries, historians began using photography, photostats, and microfilm for reproduction purposes, followed

1 Karl Krumbacher, *Die Photographie im Dienste der Geisteswissenschaften* (Leipzig: B.G. Teubner, 1906), 2.

2 See a special issue of the now defunct German journal *Zeitenblicke* probing the link between (cultures of) technology and the history of historiography: "Historizität, Materialität und Narrativität: Zum Zusammenhang von Technikkultur und Historiographiegeschichte", *Zeitenblicke* 10, no. 1 (2011), https://www.zeitenblicke.de/2011/1/; as well as the seminal article by Markus Friedrich, "Vom Exzerpt zum Photoauftrag zur Datenbank. Technische Rahmenbedingungen historiographischer Forschung in Archiven und Bibliotheken und ihr Wandel seit dem 19. Jahrhundert", *Historische Anthropologie* 22, no. 4 (2014): 278–298. See also Gerben Zaagsma, "Facing the History Machine: Toward Histories of Digital History", *History of Humanities* 9, no. 2 (September 2024): 451–491, especially 461–463.

3 For an overview, see Gerben Zaagsma, "Facing the History Machine". Two recent conferences have explored histories of digital history: Revolutionary, Disruptive, or Just Repeating Itself? Tracing the History of Digital History (23–25 October 2024, German Historical Institute, Paris), https://dhdhi.hypotheses.org/category/tagungen-2/dhiha9, and History of Digital History between East and West (5–6 February 2026, Centre for Contemporary and Digital History, University of Luxembourg), https://zenodo.org/records/18416407. Conference proceedings from both events are currently being prepared for publication in the book series *Studies in Digital History and Hermeneutics* (De Gruyter Brill), https://www.degruyterbrill.com/serial/sdhh-b/html.

by the adoption of mechanical aids, analogue and digital computing for information, and data processing as well as data analysis. The proponents of these technologies made a range of promises and raised specific expectations concerning their capabilities, thereby seeking to encourage and shape their adoption.[4] While ease of use, availability, and costs all conditioned the uptake of new technologies, the invoked epistemic virtues and the projected desired futures reveal what was understood to be at stake in epistemological terms. As Jasanoff and Kim have argued in their work on sociotechnical imaginaries, "imaginations of desirable and desired futures correlate, tacitly or explicitly, with the obverse-shared fears of harms that might be incurred through invention and innovation, or of course the failure to innovate".[5]

A historical perspective on the visions brought on by new technologies thus helps reveal competing ideas regarding the kind of science that history was imagined to be, while at the same time illuminating the scholarly self-understanding of historians embracing mechanical aids and computing. Epistemic virtues are an important, albeit not the only, lens through which to examine these questions, as they reveal ideas about what constitutes the epistemic core of the discipline as well as the scholarly persona of the historian. From the nomothetic versus ideographic debates in the 19th century, the debate inspired by C.P. Snow's *Two Cultures* (1959), and current debates on history as data science, the question of technology and the making of history has centred on what makes history a science.[6]

In this article, I seek to identify key features of the discourses surrounding the human-machine encounter in historical research since the late nineteenth century. I specifically focus on the visions that were put forward, the virtues that were invoked, and the question of how these related to ideas regarding what made history a science. In what follows, I do not seek to be exhaustive but rather to present a discussion of key themes as they emerged in a representative selection of the literature. To do so, I first discuss the role of promissory discourses in the adoption of technology in historical research. I then examine three distinct periods: (1) the first decades of the twentieth

4 Mads Borup, Nik Brown, Kornelia Konrad, and Harro Van Lente, "The Sociology of Expectations in Science and Technology", *Technology Analysis & Strategic Management* 18, no. 3–4 (2006): 285–298.

5 Sheila Jasanoff, "Future Imperfect: Science, Technology, and the Imaginations of Modernity", in *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*, ed. Sheila Jasanoff and Sang-Hyun Kim (Chicago: University of Chicago Press, 2015), 1–34, 6.

6 Note that "science" may typically be cast in opposition to the "humanities" in Anglophone discourse. Yet, the seemingly more neutral German term *Geschichtswissenschaft* does not imply a less oppositional view with regard to the *Naturwissenschaften*.

century, when mechanically enabled source reproduction took off; (2) the period from the late 1950s until the advent of the personal computer in the early 1980s, when machine-aided quantitative data processing and data analysis emerged; and (3) the period since the advent of the personal computer and Internet, including our current era of "digital history", when working with digital archives and addressing the complexity of historical sources became key concerns.

Technologies, Practices, and Epistemic Virtues

By investigating the discourses accompanying the adoption of new technologies in historical research, we gain insight into the factors that shaped this adoption. These discourses reveal that technology was endorsed not only in practical terms (e.g., as it could shorten the time needed to acquire archival materials), but also because it was seen as capable of producing specific epistemological effects, such as increased accuracy. These effects were often framed in terms of how they could reinforce particular epistemic virtues, understood as "traits of character deemed necessary for the pursuit of epistemic goals such as knowledge and understanding".[7] Epistemic virtues not only emerge from internalised disciplinary values and standards, but also derive from the habitus and dispositions of individual scholars. The latter guide their perception of the world and the categories they view as important for describing it, such as class or gender, thereby shaping their research and its underlying assumptions. Epistemic virtues "inform and direct scientific practice."[8] They are also highly contextual and "better studied fully placed within the broader cultural realms they are necessarily part of – that is, in cultural backgrounds invoked by historians to explain the patterns of meaning historically attributed to their objects of study".[9] Finally, epistemic virtues underpin a

7 Herman Paul, *Historians' Virtues: From Antiquity to the Twenty-First Century* (Cambridge: Cambridge University Press, 2022), 3.

8 Jeroen van Dongen and Herman Paul, "Introduction: Epistemic Virtues in the Sciences and the Humanities", in *Epistemic Virtues in the Sciences and the Humanities*, ed. Jeroen van Dongen and Herman Paul (Cham: Springer International Publishing, 2017), 1–11, 7. See also Paul, *Historians' Virtues*, especially Chapter 3; Lorraine Daston, "Objectivity and Impartiality: Epistemic Virtues in the Humanities", in *The Making of the Humanities: Volume III*, ed. Rens Bod, Jaap Maat, and Thijs Weststeijn (Amsterdam: Amsterdam University Press, 2014), 27–43.

9 Van Dongen and Paul, "Introduction", 4. For a historical exploration of the virtue and promise of "exactitude", see Lisa Cronjäger, Aurea Klarskov, Antonia von Schöning, and

discipline's scientific status, even if their meanings change over time and are never uncontested.[10]

As shown by the example of Krumbacher, epistemic virtues are often aspirational; they envision a technology-enabled future state of the discipline that is worth striving for. What concerns us here, then, are the past futures of technology in the discipline of history.[11] When examined over time, these futures can be characterised by shrinking horizons of expectation as spaces of experience diminish.[12] Whereas Krumbacher, for instance, could draw on experiences gained by means of photography in the sciences, current experiments with artificial intelligence in historical research lack past experiences to build upon. Past experiences thus offer less and less help in guiding the use of new technologies and still less when it comes to framing expectations for the future, which as a result appears increasingly open.[13] This openness complicates what Joly and Le Renard refer to as the performance of technological path creation, which can be understood as the way in which actors' agency drives the uptake of a specific technology.[14]

Scholars in the field of science and technology studies have for a long time emphasised the constitutive nature of promissory discourses and expectations related to technology, their capacity to mobilise resources and people, as well as their power to enact desired futures.[15] Promises "are instrumental for creating a horizon of expectation where the new technology appears as a necessity—or something highly desirable".[16] Promises shape expectations and, as Joly and Le Renard argue, they involve creating legitimacy and credibility. Krumbacher sought to establish credibility by drawing on experiences

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Mario Wimmer, "Introduction – Forum: The Promises of Exactitude", *History of Humanities* 7, no. 2 (2022): 127–131, https://doi.org/10.1086/721304.

10 See, for example, Peter Novick, *That Noble Dream: The "Objectivity Question" and the American Historical Profession* (Cambridge: Cambridge University Press, 1988).

11 Reinhart Koselleck, *Futures Past: On the Semantics of Historical Time* (New York: Columbia University Press, 2004); Jeroen Puttevils, Max-Quentin Bischoff, Sara Budts, Elisabeth Heijmans, Sanne Hermans, and Nicolò Zennaro, "State of the Field: Histories of the Future", *History* 109, no. 384–385 (2024): 150–172. See also Zoltán Boldizsár Simon and Marek Tamm, "Historical Futures", *History and Theory* 60, no. 1 (2021): 3–22, 10 and footnote 22.

12 Reinhart Koselleck, "'Space of Experience' and 'Horizon of Expectation': Two Historical Categories", in Koselleck, *Futures Past*, 255–275.

13 Zoltán Boldizsár Simon and Marek Tamm, "The Opening of Historical Futures", *History and Theory* 63, no. 3 (2024): 303–318.

14 Pierre-Benoit Joly and Claire Le Renard, "The Past Futures of Techno-Scientific Promises", *Science and Public Policy* 48, no. 6 (2021): 900–910.

15 Borup et al., "The Sociology of Expectations"; Joly and Le Renard, "The Past Futures".

16 Joly and Renard, "Past Futures", 900.

gained in the natural sciences. In doing so, he aimed to reinforce the scientific status of his discipline while establishing legitimacy; photography could solve specific problems and offered new affordances that reinforced or even introduced specific epistemic virtues, such as accuracy, which were regarded as hallmarks of modern science.

Source Reproduction in the 1890s–1930s

Krumbacher is an important example of a broader phenomenon: around the 1870s, librarians and archivists began to experiment with photography as a new reproduction technology, soon to be followed by historians.[17] In his 1906 publication on *Photography in the Humanities*, Krumbacher sought to endorse its use by identifying three key advantages: accelerating scholarly work, satisfying general scholarly demands for rigorous methods and objective accuracy, and reducing costs.[18] To make his point, he invoked the history of transport as a metaphor by comparing the changes brought on by photography to the upheaval following the transition from stagecoach to railroad, noting that "the stagecoach era of the collection of scientific material is over."[19] Krumbacher's views illustrate a key point: new technology-inflected practices not only reduced labour and costs, they also contributed to achieving the epistemic virtues that scholars should aspire to, such as greater accuracy or, for Krumbacher, the "objectively more accurate reproduction of details" in the context of works of art.[20]

17 Markus Friedrich, "Vom Exzerpt Zum Photoauftrag zur Datenbank", 278–298; Monika Dommann, *Authors and Apparatus: A Media History of Copyright* (Ithaca, NY: Cornell University Press, 2019), Chapter 2.

18 Krumbacher, *Die Photographie*, 19–20.

19 Krumbacher, *Die Photographie*, 55. Original quote: "Ich will nicht den beliebten Vergleich zwischen Postkutsche und Eisenbahn heraufbeschwören; aber ein ähnlicher Umschwung liegt doch auch in unserem Falle vor: die Zeit, in der einzelne Gelehrte Jahrzehnte lang mühsame Reisen ausführten und sich Kollationen und Abschriften in umständlicher Weise von diesem und jenem zusammenbettelten oder kauften, um endlich ein ungleichwertiges und technisch ungleichmäßig zubereitetes Material für eine verhältnismäßig kleine Arbeit zu besitzen, die Postkutschenzeit wissenschaftlicher Materialsammlung ist vorbei."

20 Krumbacher, *Die Photographie*, 37, note 1. For similar promises with regard to increased accuracy, see also Otto Mente and Adolf Warschauer, *Die Anwendung der Photographie für die Archivalische Praxis* (Leipzig: Hirzel, 1909), 8; G.A. Evers, "Fotografie en Bibliotheekwezen", *Fotografie en Bibliotheekwezen* 1, no. 7 (1913): 225–256, 226.

Krumbacher's expectation of photography as heralding the end of an era in historians' gathering practices appears modest compared to the revolutionary potential that a 1920 *New York Times* article ascribed to the photostat, an early photocopying technique:

> In its brief period of existence it has become indispensable in the equipment of our larger metropolitan and university libraries, and has changed our whole method of advanced study. This is because it so often relieves the student of going abroad for research work; it makes it cheaper for him to import reproductions of the necessary books, manuscripts, maps, pictures, etc., than to study the originals in Europe. Moreover, these photostatic reproductions are just as clear as the originals—when they are not better-thanks to the combination of powerful prismatic lenses and sensitized paper in the work of the instrument. The work of a copyist with pen or typewriter is never sure to be accurate, and is several times as expensive as photostatic service.[21]

Here too, the practical advantage of acquiring remote materials went hand in hand with promises of greater accuracy compared to manual means of reproduction. However, as claimed in a survey by the Bibliographical Society of America, the lower cost of the photostat amplified these benefits and allowed for a "complete revolution in bibliographical and research work". Its utility in comparing editions would "do much to place bibliography among the exact sciences", while also making the hitherto irreproducible reproducible.[22] Such allusions to increased accuracy and precision as perceived benchmarks of scientific standing would become much more important after the Second World War.

With the arrival of microfilm in the 1930s, the promise of the comparatively costlier photostat quickly gave way to that of microphotography. As Krumbacher had done forty years earlier, American historian Lawrence Harper, too, invoked a transport metaphor when he, in 1946, claimed that the historian "has not advanced beyond the horse-and-buggy days. In fact, he is still back in

21 "The Photostat: A Revolutionary Aid to Research", *Current History* 12, no. 3 (1920).

22 George Watson Cole, "The Photostat in Bibliographical and Research Work—a Symposium", *The Papers of the Bibliographical Society of America* 15, no. 1 (1921). See also Kopp, who describes it as "perhaps the first technological development in the twentieth century to affect the scholarly researcher in the humanities", J.J. Kopp, "The Impact of Technology upon Medical History Research: The Past, the Problems, the Potential", *Bulletin of the Medical Library Association* 75, no. 4 (1987): 349–354, 349.

the pack-mule era."[23] Harper lauded the possibilities of microphotography to "revolutionise scholarly techniques", just as the invention of a "mechanical brain" had already done for the sciences, and he praised its potential for copying and reproducing while also suggesting a solution to the abundance of material that historians would have to confront in its wake.[24] Inspired by Vannevar Bush's vision of the memex, a microphotography-based machine library in which scholars could store, index, and retrieve information, he imagined the creation of digests of materials photographed on microfilm and indexed on punched cards, analogous to how lawyers used case digests.[25]

Like Harper, Murray Lawson, another American historian, promoted the use of punched cards to achieve the information retrieval vision of Vannevar Bush.[26] Lawson criticised how historians had a "literary view of their work" and an aversion to using machines, contending that a "growing realization of the inadequacies of the conventional tools of research" had finally made them more receptive to the "equipment and techniques in use in the business world". Like Harper before him, Lawson invoked Hubert Bancroft's advocacy of such "business methods" in the 1890s.[27] As the volume of scholarly output grew, and as microphotography enabled reproduction on a much larger scale than conventional photography or the photostat, both historians sought to address the challenges of abundance and information retrieval. Their arguments revealed an implicit ideal of completeness and an acute awareness of the problem of selectivity. This could be resolved by a technical solution that would save time spent on locating relevant literature and retrieving notes, while also facilitating the serendipitous discovery of relationships between variables in the data recorded on the punched cards.[28] The latter point foreshadowed a major shift that would occur in the late 1940s and 1950s. Whereas previous discourses had focused on the epistemic effects of applying new technologies to source *reproduction*, attention now shifted to the effects of applying them to the information contained *within* those sources. Alongside this shift

23 Lawrence Harper, "Microphotography and History", *Pacific Historical Review* 15, no. 4 (1946): 427–434, 427.

24 Harper was referring to the ENIAC, one of the first digital computers. See page 429, note 6, which refers to a *Newsweek* article about a demonstration of the ENIAC at the University of Pennsylvania.

25 Vannevar Bush, "As We May Think", *The Atlantic Monthly*, July 1945.

26 Murray G. Lawson, "The Machine Age in Historical Research", *The American Archivist* 11, no. 2 (1948): 141–149.

27 Lawson, "The Machine Age", 142.

28 Harper, "Microphotography", 433; Lawson, "The Machine Age", 144.

from largely extrinsic to intrinsic aspects of historical sources, familiar epistemic virtues acquired new meanings amid changing historical research practices.

From Source Reproduction to Data Processing

Starting in the late 1930s, some historians began to use punched card equipment to process historical data. William Aydelotte was one of the early American pioneers, and he published an extensive reflection in 1954 on the problems of applying statistical methods in historical research, as well as their epistemological benefits:

> In essence the method is a very simple thing: the arrangement in a convenient order of similar facts which are so numerous that, without such arrangement, their general purport could not be readily grasped. In other words, it serves to substitute an exact statement for a general impression. General impressions, though historians sometimes cling to them affectionately, are notoriously misleading. Even when they are based on considerable knowledge they may contain biases and preconceptions of which the writer is unaware. It is a common experience that facts which fit a previously formed theory or opinion strike the imagination more forcibly and are more easily remembered. A quantitative method helps the historian to escape from the catch-phrases and legends that have been built up about the past, to avoid imposing upon it contemporary patterns of thought, and to emancipate himself from his own preconceptions.[29]

As had been the case with Krumbacher, and to a large extent also with Harper and Lawson, Aydelotte was concerned with an abundance of information, but in a fundamentally different way. Where exactitude or objectivity were previously understood as material properties in relation to source reproduction, they were now virtues to be achieved through data processing, which stood in sharp contrast to the subjectivity of the historian. However, Aydelotte also noted that colleagues felt threatened by the methods he advocated: "People sometimes say to me, 'Your machine does your thinking for you', and one colleague even alluded to 'your history machine', apparently having in mind an assembly operation in which the role of the scholar was reduced to turning the switch to start the engines."[30] He rejected such views, noting that the

29 William O. Aydelotte, "A Statistical Analysis of the Parliament of 1841: Some Problems of Method", *Historical Research* 27 (1954): 141–155, 143–144.

30 Aydelotte, "A Statistical Analysis", 146.

machines did not think but merely arranged the data that still needed to be interpreted by the historian.

Aydelotte's claims foreshadowed those of the new political, economic, and social historians in the United States starting in the mid-1950s that, in their most aspirational form, would come to underpin a new scientific history in the following two decades.[31] However, these claims often came with caveats. When George Anderson lauded the use of "mechanical messiahs" in historical research and the advantages of punched cards for data processing, he cautioned that the conversion of historical sources to data on punched cards inevitably entailed the reduction and loss of unique characteristics: "The machine can call attention to significant similarities and to sharp differences; it can produce meaningful summaries; it can provide the foundation for the discernment of general trends; but it cannot accurately capture the quality of uniqueness."[32] Moreover, Anderson also articulated the fear that "historians as individual scholars may become the victims of the Frankensteins that have been devised to assist them", even though he pushed his colleagues to embrace the benefits of machine techniques.[33]

Historical computing as it emerged in the late 1950s largely centred on quantitative approaches and applications in historical research.[34] Insofar as quantification was enabled by computers, visions concerning quantification and the machine, or concerning method and tool, could not be neatly separated. Lee Benson, the foremost proponent of the new political history that emerged in the late 1950s, predicted that "by 1984, a significant proportion of American historians" would have come around to the view that "the main business of historians is to participate in the overall scholarly enterprise of

31 For a concise summary of different iterations of "scientific" history in relation to debates on quantification, see Lawrence Stone, "The Revival of Narrative: Reflections on a New Old History", *Past & Present* no. 85 (1979): 3–24, 5–6. For more general historical overviews, see Geoffrey Barraclough, *Main Trends in History* (New York: Holmes & Meier, 1979), Chapter 3; Peter Lengyel, ed., *Modern Historiography: How Much Science? How Much Art*. Special issue *International Social Science Journal* 33, no. 4 (Paris: Unesco, 1981); Georg G. Iggers, Q. Edward Wang, and Supriya Mukherjee, *A Global History of Modern Historiography* (Abingdon: Routledge, 2017), Chapter 3.

32 George L. Anderson, "Mechanical Aids in Historical Research," in *In support of Clio; essays in memory of Herbert A. Kellar*, eds. William B Hesseltine, and Donald R McNeil (Madison: State Historical Society of Wisconsin, 1958), 77–105, 100–101.

33 Anderson, "Mechanical Aids in Historical Research", 102–103.

34 Some of the discourses and historians mentioned below have also been discussed by Antonia von Schöning in the context of her analysis of cliometrics in the 1970s. See Antonia von Schöning, "Numbers Game or Scientific History? Exactitude and Justice in 1970s Cliometrics and in Digital History Today", *History of Humanities* 7, no. 2 (2022): 133–146.

discovering and developing general laws of human behavior".[35] In doing so, Benson appeared to endorse the covering-law model of historical explanation underpinned by machine-enabled quantification as its key method. In his view, historiographical progress was not only based on the systematic collection of numerical and non-numerical data and the creation of data archives for historical research, but also on historians' command of "the technology and techniques needed to test their theories".[36] Robert Zemsky sharply criticised what he considered to be an uncritical embrace of quantification, arguing that many quantitative historians ignored key epistemological dimensions of historical research and fell victim to what he dubbed the "dilemma of measurement". They "assume[d] that whatever the past has left us in a quantified format can be simply plugged into a statistical model developed by some behavioral scientist. The quantifier arms himself with the necessary computer programs, runs his correlations, generates his factor matrices, and then proclaims the virtue of a newly scientific history which takes as its own the methodology of the behavioral sciences."[37] Zemsky's criticism reveals that the stakes were not just methodological but also epistemological and touched upon the status, if not the *raison d'être*, of the discipline of history as a science.

Contrary to received wisdom, historians differed considerably in their application of quantitative methods. Many quantifiers would have recognised Lawrence Stone's warning that "historians may increasingly come to regard the computer as a threat to their intellectual predominance, and may retreat still further into the dark recesses of impressionistic methodology."[38] Yet, unlike Benson and many cliometricians, they were keenly aware of the limitations of quantification due to gaps in the historical record and the resulting problems of representativeness.[39] As Aydelotte remarked, "No serious student of methodology would contend that a disciplined approach can overcome the

35 Lee Benson, "Quantification, Scientific History, and Scholarly Innovation", *AHA Newsletter* 4, no. 11–16 (June 1966). Published in Lee Benson, *Toward the Scientific Study of History: Selected Essays* (Philadelphia: J.B. Lippincott, 1972), 98–105, see 99. Benson took inspiration from the earlier predictions by 19th-century historian Henry Buckle.

36 Benson, "Quantification", 102.

37 Robert M. Zemsky, "Numbers and History: The Dilemma of Measurement", *Computers and the Humanities* 4, no. 1 (1969): 31–40, 31, 33.

38 Lawrence Stone, "Prosopography", *Daedalus* 100, no. 1 (1971): 46–79, 73.

39 Leo F. Schnore, "Problems in the Quantitative Study of Urban History", in *The Study of Urban History: The Proceedings of An International Round-Table Conference of the Urban History Group at Murray Hall, University of Leicester on 23–26 September 1966*, ed. H.J. Dyos (London: Edward Arnold, 1968), 189–208, 197; Charles Tilly, "Computers in Historical Analysis", *Computers and the Humanities* (1973): 323–335, 328–329.

inherent frailties in the data".[40] Indeed, by the mid-1970s, the revolutionary zeal exhibited by the early American quantifiers had given way to a more critical approach to quantification and its limits.[41] A critical turning point was the fallout that followed the 1974 publication of *Time on the Cross* by Robert Fogel and Stanley Engerman, a cliometric account of the economics of slavery in the United States. This is not the place to revisit that debate, but the resulting backlash did much to increase the scepticism surrounding quantitative work among American historians.[42]

Both in the United States and Europe, much of the criticism of exaggerated promises made with regard to computer-aided quantification in the 1970s originated from quantifiers.[43] By the end of the 1970s, Stone, an early proponent of quantitative methods, castigated cliometricians who "specialize in the assembling of vast quantities of data by teams of assistants, the use of the electronic computer to process it all, and the application of highly sophisticated mathematical procedures to the results obtained". He argued that, "Doubts have been cast on all stages of this procedure", listing the reliability of data, coding errors, loss of detail, the incomprehensibility of research results, and the impossibility to verify these. These issues were added to all the questions that quantification could not answer as they "could not be measured by a computer."[44] Stone wrote scathingly that "in 1968 Le Roy Ladurie prophesied that by the 1980s 'the historian will be a programmer or he will be nothing'. The prophecy has not been fulfilled, least of all by the prophet himself."[45] He also poured scorn on the amount of funding allocated to overly ambitious projects delivering underwhelming results.

Like Stone, Fogel grew more cautious with regard to what technology could achieve in cliometric research: "successful application of cliometric methods

40 William O. Aydelotte, "Quantification in History", *The American Historical Review* 71, no. 3 (1966): 803–825, 816.

41 For an excellent summary, see Charlotte Erickson's review of four key American works in quantitative history from the early 1970s: Charlotte Erickson, "Quantitative History", *The American Historical Review* 80, no. 2 (1975): 351–365.

42 Robert W. Fogel and Stanley L. Engerman, *Time on the Cross: The Economics of American Negro Slavery* (London: Wildwood House, 1974). I discuss this in "Historicising Data and Data Practices in Historical Research", in *Engaging with Big and Small Historical Data, ed.* Pim Huijnen (Routledge, forthcoming). For overviews of the debate and the backlash, see, among others, Róbert Káli, "Debate over the 'Time on the Cross' – An Overview" (2017), https://www.academia.edu/31033695/Debate_over_the_Time_on_the_Cross_An_Overview. See also Ben Schmidt, "Two Volumes: The Lessons of Time on the Cross", *American Historical Association 2019*; Von Schöning, "Numbers Game".

43 See also Zaagsma, "Facing the History Machine", 476.

44 Stone, "The Revival of Narrative", 11–12.

45 Stone, "The Revival of Narrative", 13.

requires a deep and thorough knowledge of historical circumstances" and "No amount of mathematical wizardry or computer magic can shortcut this process. Efforts to do so have led to embarrassing failures."[46] Fogel, too, noted the unfulfilled promise of quantification: "The anticipated rout of traditional historians has not materialized and history has not been transformed into a science."[47] Yet while Fogel had become more circumspect following the fallout from *Time on the Cross*, the aspiration to turn history into "a science" had not vanished. What Fogel meant by history as a "science" becomes clear in a 1982 paper entitled "'Scientific' History and Traditional History".[48] Here, scientific history was synonymous with cliometrics, whose common denominator was the application of "the quantitative methods and behavioral models of the social sciences to the study of history". The models were the key defining characteristic, and they were always to be made explicit, while precision, generalisability, and verifiability were the virtues to strive for.

Fogel's ideas concerning history as a science were gently chastised by his former colleague at the University of Chicago, Deirdre McCloskey, who took him to task for what she saw as his parochial, Anglophone, "naïve and unscientific view of Science" and "aversion to the humanities".[49] For McCloskey, the bone of contention was *meaning*:

> But why should we as economic scientists care about the humanities? Here's why. Meaning is scientific, and science cannot be done without human meaning. Piling up "existence" theorems and "significant" results is meaningless. Counting something you should not or cannot meaningfully count is bad science, in every sense of "bad."
>
> You can't do good science without meaning. Bob and Doug [Robert Fogel and Doug North] often forgot this, or never let it into their scientific procedures. Unlike the physical sciences, and even the "positive-economics" end of the social sciences, the humanities—such as literary criticism in the Department

46 Robert W. Fogel, "'Scientific' History and Traditional History", in *Logic, Methodology and Philosophy of Science VI Proceedings of the 6th International Congress of Logic, Methodology and Philosophy of Science, Hannover, 1979*, ed. Laurence Jonathan Cohen (Amsterdam: North-Holland Publ. Co., 1982), 15–62, 51.

47 Fogel, "'Scientific' History", 50–51.

48 Fogel, "'Scientific' History".

49 Deirdre Nansen McCloskey, "Getting over Naïve Scientism c. 1950: What Fogel and North Got Wrong", *Cliometrica* 12, no. 3 (2018): 435–449, 441–445. McCloskey aims her remarks not only at Fogel but also at economist Douglas North, both of whom were awarded the 1993 Nobel Memorial Prize in Economics.

> of Literature and number theory in the Department of Mathematics and transcendence in the Department of Theology study meaning. In particular they study humanly meaningful *categories*, such as good/bad, lyric/epic, 12-tone/melodic, red giant/white dwarf, hominid/Homo sapiens, God/not, prime/not, smooth peas/wrinkled peas, exist/not. [...] Such humanistic and human categorization is a necessary initial step in a scientific argument intent on measurement.[50]

McCloskey's pointed criticism highlights that debates on measurement and its limitations were closely linked to historians' views on science. However, it is important to contextualise these American debates. A great deal of criticism of quantitative history in the 1960s and 1970s centred (and continues to do so to this day) on its most mathematical expressions as found in the work of a relatively small group of American new economic and political historians, often epitomised by *Time on the Cross*. Yet neither "quantification" nor modelling were confined to (American) economic, political, and social science history, as they also featured prominently in demographic and urban history. Moreover, such a reductionist take not only ignores the broad range of existing quantitative approaches, many of which would not meet cliometric standards, but also developments outside the United States. Charles Tilly, for example, has noted that "European and American [critics] of quantification and social-scientific models in history have sometimes portrayed them as quintessential expressions of American vulgarity and imperialism, [yet] the initial impulse to both has often come from Europe in fact, and their fullest versions have commonly appeared outside of the United States."[51] Indeed, whereas quantitative history took a backseat in the US in the late 1970s, Germany saw the founding in 1976 of QUANTUM – Association for Quantification and Methods in Historical and Sociological Research. Moreover, as Konrad Jarausch has documented, a wide range of international styles existed under the quantitative umbrella, which this article cannot cover.[52]

As suggested above, early quantifiers were not a singular group of predominantly positivist-aspiring *scientists*, and their claims as to what computers could achieve were similarly diverse. Nancy Fitch argued that, "In spite of their 'pseudo-positivist' assumptions, talented historians like Le Roy Ladurie

50 McCloskey, "Getting over Naïve Scientism", 445–446.

51 Charles Tilly, "The Old New Social History and the New Old Social History", *Review* (*Fernand Braudel Center*) 7, no. 3 (1984): 363–406, 378–379.

52 Konrad H. Jarausch, "(Inter)national Styles of Quantitative History", *Historical Methods: A Journal of Quantitative and Interdisciplinary History* 18, no. 1 (1985): 13–19.

never viewed the computer as more than a tool that could expand the range of evidence that historians could use in 'reconstructing' the past."[53] Nonetheless, certain myths persist: Le Roy Ladurie's aforementioned remark that "l'historien de demain sera programmeur ou il ne sera plus" still circulates as a prophecy today. Yet, ironically, it is often quoted out of its specific historical and spatial context, as Ladurie had observed that historians in the United States were far ahead in their application of computing in the field of quantitative history compared to their French colleagues.[54] The fact that his "prophecy" is still recycled today as a general prediction regarding the discipline seems to be more revealing of current needs to construct expectations than of Ladurie's original argument.

One final aspect should be added to this discussion of debates on quantification. While the impulse for measurement was always tied up with aspirations towards a scientific history, it could also be informed by outspoken ideological agendas. In the Eastern Bloc, the promise of the computer went hand in hand with explicit ideological aims and claims. Soviet pioneer Valentin Ustinov, for instance, lauded the computer for helping "enlarge the scope of the materials employed, to improve the quality of historical research, and to shorten the time requirements." However, for Ustinov those affordances not only pertained to historical research but ultimately served to "discover particular laws of the economic, political, and cultural development of society and to respond to the principal questions facing the social sciences: the paths to be followed in establishing the foundation for communism in material goods and technology, the shaping of communist societal relationships, and the upbringing of the new man."[55]

When Ustinov and his colleagues presented their "quantitative and machine methods" at the 13th International Congress of Historical Sciences in Moscow in 1970, they explicitly avoided emphasising their ideological significance. Instead, they stressed that quantitative analysis and "statistical verification" could help reveal errors and limitations in the data used to solve a given problem. This, in turn, elevated the scientific status of the discipline of history and

53 Nancy Fitch, "Statistical Fantasies and Historical Facts: History in Crisis and Its Methodological Implications", *Historical Methods: A Journal of Quantitative and Interdisciplinary History* 17, no. 4 (1984): 239–254, 240.

54 Emmanuel Le Roy Ladurie, "L'historien et l'Ordinateur", *Le Nouvel Observateur* (1968), published in *Le Territoire De L'historien* (Paris: Galimard, 1973), 11–14, 14. See also Gerben Zaagsma, "On Digital History", *BMGN – Low Countries Historical Review* 128, no. 4 (2013): 3–29, 9.

55 V.A. Ustinov, "The Solution of Certain Problems in USSR History by Electronic Computer", *Soviet Studies in History* 3, no. 2 (1964): 4–13, 4 and 13.

offered an indirect way of introducing ideological concerns, since Marx himself had once remarked that "only then does a science attain perfection when it manages to employ mathematics."[56] As British historian Paul Dukes noted in his review of the Moscow conference, to realise larger historical perspectives, historians needed "all the help (human and mechanical) they can get from the social sciences". He concluded with a poem by the poet Robert Rozhdestvensky that reflected Soviet aspirations: "History! You will become the most exact of sciences! You will! You must! We want it so."[57] Czech historian Jaroslav Purš echoed this aspiration when he contextualised the computer revolution in historical research by invoking Marx's ideas about mathematics and science. Purš observed that a "new scientific discipline, *historiometrics*, was born which studies continuities in historical processes, i.e., laws of development in both quantitative and qualitative terms."[58] Insofar as the main objective of historical research was considered to be establishing the laws of human behaviour and society, such ideas closely aligned with earlier calls by American historians such as Benson.

Digital Archives and the Complexity of Sources

I have examined at some length the debates on computer-aided quantification from the 1950s to the 1970s since they contained several fundamental characteristics that would recur in subsequent discourses about technology in historical research. Most significantly, they revealed how quantitative historical data processing was seen to serve epistemic virtues such as exactitude and objectivity, and thereby contribute to a scientification of history. In this final section, I discuss key developments starting in the 1980s, when the meaning of history as a science shifted. While early historical computing was limited to a relatively small group of historians with access to mainframe computing resources, the arrival of personal computers on the desks of historians

56 D.V. Deopik, G.M. Dobrov, J.J. Kahk, I.D. Kovalchenko, H.E. Palli, and V.A. Ustinov, *Quantitative and Machine Methods of Processing Historical Information: XIII. International Congress of Historical Sciences, Moscow, August 1–23, 1970* (Moscow: "Nauka" Publ. House, 1970), 13. The allusion to Marx's ideas about science and mathematics can be traced back to Paul Lafargue, "Karl Marx, Persönliche Erinnerungen", *Die Neue Zeit* (1890): 10–42, 13.

57 Paul Dukes, "History Congress in Moscow", *The Russian Review* 30, no. 3 (1971): 240–249, 249.

58 Jaroslav Purš, "Historiometrics, Historical and Cartographic Information, and Computers", *Historical Methods Newsletter* 7, no. 3 (1974): 134–144, 134.

in the 1980s dramatically increased their access to computing power and the potential to integrate it into historical research. Naturally, this expansion of the user base raised the question of how the new human-machine interaction would play out. After all, it was one thing to have to visit the university's computing centre to get mainframe access and time, which signalled a clear conviction regarding the potential of computing, but it was quite another thing to have that potential sitting on one's desk, ready to convince an uninitiated user.

With the human-machine encounter now inevitable for every historian, Richard Jensen discussed the potential of the "microcomputer revolution for historians" while wondering how broadly historians would adopt it.[59] While many historians did not venture beyond word processing, the international Westfield College conferences on History and Computing, held in 1986 and 1987, showcased a broad range of methods and applications across the discipline. The 1986 conference proceedings listed three characteristics of historical computing. First, the editors noted the increased methodological precision and rigour that computers demanded, albeit with the parallel danger that "computers can offer a deceptively reassuring sense of order where, in reality, no order exists". Many historians, however, had not yet fallen into this danger. Second, they observed the creation of a methodological and experiential common ground and, third, a shared understanding of logistical challenges that could generate a momentum for securing institutional resources for computer-aided research.[60]

The 1987 proceedings added that while "the cause of formalism and explicit theorisation" pre-dated "the modern computer era", it "has been boosted by the forward march of information technology".[61] The proceedings also highlighted new applications of data analysis and modelling; the potential for generalisation; data sharing; greater rigour through more systematic and formal approaches; and reproducibility.[62] As a result, the editors added, "history might be thought of as becoming more like the natural and social sciences, and indeed there are those who already speak in terms of historical science."[63] However, they stressed that this was not about *emulating* the social sciences: "Historical computing is not the same thing as social scientific

59 Richard Jensen, "The Microcomputer Revolution for Historians", *The Journal of Interdisciplinary History* 14, no. 1 (1983): 91–111, 91–92.

60 Deian Hopkin and Peter Denley, "Introduction", in *History and Computing*, ed. Peter Denley and Deian Hopkin (Manchester: Manchester University Press, 1987), ix–x, x.

61 Peter Denley, Stefan Fogelvik, and Charles Harvey, "Introduction", in *History and Computing II*, ed. Peter Denley, Stefan Fogelvik, and Charles Harvey (Manchester: Manchester University Press, 1989), x.

62 Denley, Fogelvik, and Harvey, "Introduction", ix–xi.

63 Denley, Fogelvik, and Harvey, "Introduction", xi.

history".[64] Here, they invoked Manfred Thaller's chapter in the proceedings in which he advocated for a theory of historical computing because "there *are* simply properties of history which make it different from other disciplines intellectually".[65] Thaller also argued that the testing of hypotheses through falsification, as practised in the social sciences, was not applicable in history:

> The whole concept of falsification has to change, therefore, if applied to the past: indeed, one might argue, we cannot falsify any hypothesis to begin with, as we never can isolate it completely for testing. What we can do, however, is finding out about the consistency of a certain number of interrelated hypotheses. A theoretical background for such an evaluation procedure would be one example of what a theory of historical computing should be about; and a prerequisite for the decision as to which quantitative methods are appropriate at which times. This should not discourage interdisciplinary discourse with the Social Sciences: rather it should make it more fruitful.[66]

Although historians engaged in computing may thus have differed in their views on the question of history and/as science, the potential of historical computing to reinforce practices such as formalisation, modelling, sharing, and collaboration, which could contribute to virtues such as rigour and objectivity, was widely recognised within the history and computing movement. Yet among the broader historical profession, these practices were anything but generally accepted. In his *Historian's Guide to Computing* from 1994, Daniel Greenstein argued that, "The use of computers in humanities teaching and research is still stigmatized for forcing measurement and a scientific outlook onto what is essentially a literary craft. Though understandable in the 1970s as a reaction to the 'new' history which was boldly overstating its claims, this view is no longer well founded".[67] Greenstein outlined four myths that, in his view, had to be addressed: (1) that measurement was anathema to historical questions and sources; (2) that computers forced a "scientific history which self-consciously sets out its research aims as testable hypotheses"; (3) that they "can only manage rigidly structured, unambiguous data and are thus unsuitable for most historical information"; and (4) that the necessary acquisition of

64 Denley, Fogelvik, and Harvey, "Introduction".

65 Manfred Thaller, "The Need for a Theory of Historical Computing", in *History and Computing II*, ed. Peter Denley, Stefan Fogelvik, and Charles Harvey (Manchester: Manchester University Press, 1989), 2–12, 2.

66 Thaller, "The Need for a Theory", 3–4.

67 Daniel Greenstein, *A Historian's Guide to Computing* (Oxford: Oxford University Press, 1994), 6

vocational skills forced historians to be data crunchers to the detriment of a "sensitivity to historical problems and to the vagaries of historical sources."[68]

The disconnect between historians engaged in computing and the broader profession is well-illustrated by the history of the international Association for History and Computing (AHC). Founded during the Westfield College conferences, it offered a platform for discussion and exchange by means of its conferences, workshops, proceedings, newsletter, and journal. Yet its struggle to gain a foothold within the profession at large was one of the reasons for its demise in the 2000s.[69] When a Dutch report entitled *Past, Present and Future of Historical Information Science* took stock of what the field of history and computing had achieved, the three authors – Onno Boonstra, Leen Breure, and Peter Doorn – argued that, while it had certainly been productive, "as a field of *scientific* study, the position of history and computing is far less favourable. With a few exceptions, methodological and technical problems have not been studied in a generic way, aiming at solutions that could be used in the entire field for a specific class of problems."[70] Like Thaller, they observed a divergence from the social sciences: having aligned with them in the 1970s and 1980s through a shared focus on inductive statistics, the field had turned to new exploratory data-analysis techniques that were better suited to historical data – and closer to "the traditional research methodology of historical science" (science here renders the Dutch *wetenschap*, like the German Wissenschaft, which covers all scholarly domains, not only the natural sciences).[71]

This closer alignment of new methods and techniques with the specific nature of historical research and its sources continued into the late 1990s and 2000s, as broadband Internet and mass digitisation ushered in a new era that came to be called *digital history*, a term Ed Ayers helped popularise. Writing in 1999, Ayers argued that the advent of new digital media in the 1990s had engendered "enhanced teaching, professional community building, experiments in hypermedia, and impressive digital archives" but that "what has not yet been demonstrated is that historians can create forms of narrative

68 Greenstein, *A Historian's Guide*, 6–36, 15, 30.

69 Zaagsma, "Facing the History Machine", 476–479.

70 Onno Boonstra, Leen Breure, and Peter Doorn, *Past, Present and Future of Historical Information Science* (Amsterdam: NIWI-KNAW, 2004), 91. See also Onno Boonstra, Leen Breure, and Peter Doorn, *Historische Informatiekunde: Inleiding tot het Gebruik van de Computer bij Historische Studies* (Hilversum: Verloren, 1990); Lawrence McCrank, *Historical Information Science: An Emerging Unidiscipline* (Medford: Information Today, 2001).

71 Boonstra, Breure, and Doorn, *Past, Present and Future*, 58, 69.

and analysis that adequately exploit the possibilities offered by these developments."[72] Ayers saw digital archives as enablers of "more complex, more literary, forms of narrative". Moreover, he advocated for revisiting "the promise of social science history" since the previous failure of the latter could now be remedied through the possibility of merging generalisation with particularity, the inclusion of a much wider range of textual sources than previous databases could offer, and much greater accessibility.[73]

The idea that "digital history" represented a new chapter in the human-machine encounter in historical research also animated the online conversation in the *Journal of American History* in 2008 under the title "Interchange: The Promise of Digital History". Here, too, handling abundance and complexity was identified as both a key promise and a significant challenge.[74] Though hardly new, engaging with the abundance and complexity of historical sources, including the uncertainty and ambiguity they present, has emerged as an important concern in the era of digital history, if not a key epistemic virtue. At the same time, the datafication of historical sources and the development of ever-more sophisticated tools have once again rekindled aspirations for a scientification of history, this time via data science.[75] How this will play out now that large language models and AI have entered historical research is still an open question, but the discussion about their promises is in full swing.[76]

Conclusion

As shown in this article, revolutionary promises and expectations regarding the potential of new technologies to reshape historical research practices and knowledge production were not new, nor were they confined to our current era of digital history. While this suggests continuity, important changes are found below the surface. New technologies shaped historical research in vari-

72 Edward L. Ayers, *The Pasts and Futures of Digital History* (1999).

73 Ayers, *The Pasts and Futures of Digital History*.

74 Daniel J. Cohen, Michael Frisch, Patrick Gallagher, Steven Mintz, Kirsten Sword, Amy Murrell Taylor, William G. Thomas III, and William J. Turkel, "Interchange: The Promise of Digital History", *The Journal of American History* 95, no. 2 (2008): 452–491.

75 Jo Guldi, *The Dangerous Art of Text Mining: A Methodology for Digital History* (Cambridge: Cambridge University Press, 2023); Luke Blaxill, "Why Do Historians Ignore Digital Analysis? Bring on the Luddites", *The Political Quarterly* 94, no. 2 (2023): 279–89; Matthew James Connelly, *The Declassification Engine: What History Reveals About America's Top Secrets* (New York: Pantheon Books, 2023).

76 See, for instance, Joshua Sternfeld, "AI-as-Historian", *The American Historical Review* 128 no. 3 (2023): 1372–1377.

ous ways, from offering practical benefits (such as greater accessibility of sources) to enabling epistemological gains (such as greater accuracy and objectivity). The practices arising from new technologies corresponded to distinct virtues related to different aspects of historians' research practices. Furthermore, the meanings attached to these virtues changed significantly over time and were not necessarily shared, nor were they seen as equally important. Finally, these virtues were shaped by factors outside the epistemic realm.

Krumbacher argued that the use of photography for source reproduction would not only dramatically alter the practices of historians in terms of gathering material, but also allow for greater accuracy and conformity to rigorous method. The quantifiers of the 1960s and 1970s were especially concerned with exactitude and objectivity, whereas, starting in the 1990s, the capacity to handle the complexity of historical data gained particular prominence. These practices, and the virtues they inspired and strengthened, mapped onto different steps in the historical research process, from gathering, processing, and analysis to dissemination. The meanings and importance attached to these virtues also differed: a cliometrician's understanding of objectivity as grounded in generalisable results clashed with a cultural historian's notion of objectivity as an acknowledgement of the particularities of the past. Moreover, as indicated by the example of historical computing in the Soviet Union, the epistemic virtues to be achieved may have been similar, while also being inspired by differing ideological aims.

As I have sought to show in this article, every discussion on the application of technology in historical research touched upon the fundamental question of what makes history a science and revealed competing ideas about whether, and how, it could achieve that status. While, in the age of source reproduction, the possibility of greater precision was tentatively linked to aspirations for the scientification of history, these aspirations only acquired real force with the advent of machine-aided quantitative history after the Second World War. Visions of history as science and the promises that accompanied them thus varied and were imbued with different ideological aims, but they all drew on adjacent disciplines such as political science, economics, and sociology. If history could become a science, it could never do so on its own terms. A decisive shift occurred in the age of the personal computer. Early examples of this reorientation include Thaller's advocacy for a theory of historical computing and source-oriented data processing; Boonstra, Breure, and Doorn's notion of historical information science; and Ayers' ideas about more complex digital narratives. Recent concerns regarding the ambiguity and uncertainty that characterise historical sources, as well as new modes of digital storytelling, echo these older ideas and, as diverse as they are, they represent a shared

aspiration, if not conviction: that history can become a science on its own terms.

As much as we can learn from studying how new technologies were applied in historical research, we can only gain a fuller understanding of the integration of new technologies into historical knowledge production by including the surrounding discourses. If practices tell us about what was possible, the promises and the virtues they expressed or responded to shed light on the extent to which these possibilities were recognised, embraced, or resisted. Analysing the intersection of technology and historical research is not just another case study in the history of epistemic virtues. More than that, by using these virtues as a point of departure to analyse that intersection, we can clarify what was at stake in the technology-inflected pursuit of history.

Gerben Zaagsma is an assistant professor at the Centre for Contemporary and Digital History (C²DH) at the University of Luxembourg. His current research focuses on the history and politics of digital history and heritage, and more broadly on the history of historiography and the history of knowledge. Recent publications include "Facing the History Machine: Toward Histories of Digital History", History of Humanities 9, no. 2 (2024): 451–491 and "Digital History and the Politics of Digitization", Digital Scholarship in the Humanities 38, no. 2 (2023): 830–851. His new book project explores the history and genealogies of the field today known as "digital history". For more information, see: https://gerbenzaagsma.org.