Foreword to *Language Technology for Cultural Heritage: Selected Papers from the LaTeCH Workshop Series, ed. Caroline Sporleder, Antal van den Bosch and Kalliopi Zervanou*. v-xiv. Theory and Applications of Natural Language Processing. Berlin: Springer Verlag.

Willard McCarty
January 2011

The task I set myself in this Preface is to sketch out an historical context for the contributions to *Language Technology for Cultural Heritage* so as to illumine their wider intellectual significance. The problems they identify are fascinating in and of themselves, and the work on which they report brings most welcome benefits to the cultural heritage sector. But beyond the technical fascinations and the new affordances is a slower moving, much less immediately visible shift in relations between techno-scientific and humanistic ways of knowing. That's the huge subject at which I take a momentary glance here.

It would be bad historiography to say that the metamorphic device now less and less known as "the computer" is the *cause* of this shift. It is far better, I think, to regard the device as among the most prominent strands in a complex ravelling and unravelling of developments about which we can only speculate – or, as Hugh Kenner did in *The Counterfeiters* (2005/1968), write "an historical comedy". But without doubt the machine which brings us together here is a powerful and influential part of a great change.

To call our device "the computer" (singular noun with definite article) can be seriously misleading, though the convenience this term offers is at times irresistible. I succumb here repeatedly. It is wrong for two reasons. First, Michael S. Mahoney taught us, there's little that is singular about the machinery derived from Alan Turing's scheme, which specifies an indefinitely large number of actual machines; however finite they are, their number is limited only by the human imagination (2005; 1990). Second, Alan Newell and Herbert Simon taught us, what counts is the symbol-manipulation not the calculation (1976). We must return to the etymological sense of "computer" – L. *cum* "with" + *putare* "put, place", paying attention to the implicit kinaesthesis – to make sense of computing more broadly, especially given the growing interest in gestural interfaces, e.g. as depicted in *Minority Report* (2002) and implemented on the iPad. What's happening is not just some game of logic in the head.

Do I digress? Hardly, and not to bring up anything very new. Here is Terry Winograd and Fernando Flores in the Preface to *Understanding Computers and Cognition* (1986):

> All new technologies develop within the background of a tacit understanding of human nature and human work. The use of technology in turn leads to fundamental changes in what we do, and ultimately what it is to be human. We encounter deep questions of design when we recognize that in designing tools we are designing ways of being. (xi)

I want to explore some of these deep questions of design ever so briefly now.

Clearing a space for new

There seem to be moments when an emergent way of thinking or acting must be separated definitively from its origins so that it may be seen not as deviant but in its own terms, as something *new* and so have a chance to survive. Here I can only indicate a temporal sequence suggestive of the historical meaning I want to draw out.

Early in the third century Tertullian of Carthage proclaimed the absolute divorce of Christianity from its pagan forbear, sternly asking, *Quid ergo Athenis et Hierosolymis? quid academiae et ecclesiae?*, "What then have Athens and Jerusalem in common? what have the Academy and the Church?" (*de praescr. haeret.* 7.9). In a similar but opposite act of separation, the Renaissance scholars who were nicknamed "humanists" (*humanistae*) spurned those they caricatured as the "schoolmen" (*scholastici*) so as to establish the *literae humaniores*, the concerns of man, in distinction to the *literae divinae*, the concerns of theology (Burke 2000: 22-4, 35-8). Then, in 1623, Galileo Galilei founded quantitative, scientific epistemology by separating it from the qualitative (which we have come to champion in the humanities), declaring the book of nature to be written not in authoritative words but "in the language of mathematics... without which it is humanly impossible to understand a single word of it" (*The Assayer*). And again, more than three centuries later, in his Rede Lecture at Cambridge, physicist, public servant and novelist Sir Charles Percy Snow defended science (culturally weak in mid-century Great Britain) by declaring it a distinct, more vigorous and progressive culture than that of the privileged humanities (1993/1959). His rhetorical act drew upon a tradition of distinguishing the humanities from the sciences going back at least to Wilhelm Windelband's contrast of law-seeking and particularizing disciplines (1980/1894). The debate Sir Charles kindled with *The Two Cultures* in 1959 has died down and flared up more than once since he spoke, its remarkable persistence worth note. To my mind it has been most persuasively re-articulated by psychologist Jerome Bruner as a matter of divergent but similarly motivated trajectories (1986). Bruner's account, along with several others, make distinctions that clarify relations and so help us in a bridge-building whose time, it seems, has come.

Computer and human

The computer (allow me this backsliding) sits ambiguously, significantly in the middle, not unlike the nineteenth century technologies of communication that alternately modelled and provided models for human physiology – telegraph and nervous system, for example (Otis 2001; cf Sappol 2006). Thus Alan Turing began his foundational article with the actions of a man doing his sums (1936: 231). In turn Warren McCulloch and Walter Pitts used Turing's scheme to model the brain (1943). Their model then informed John von Neumann's sketch of digital computing architecture (1945)[1], which we follow to this day. Its structure and functions have subsequently permeated the neurological and cognitive sciences. Biological ideas, neurophysiological, evolutionary and genetic, have subsequently influenced developments in computing (Mahoney 2000). Feedback and feed-forward, as the cyberneticists said.

For me at least the iconic image of this telling traffic between human and machine is a microphotograph of brain cells grown in tissue culture on a Motorola 68000 chip, taken by Toronto neurologist Judy Trogadis to illustrate her colleague John K. Stevens' feature article in *Byte Magazine* (Stevens 1985; cf. Reddy 1996: 92). Since that photograph was taken, the juxtaposition Trogadis and Stevens engineered to illustrate their – and our – preoccupation with human-machine relations has been turned into a mass-produced tool for connecting neuronal and nano-electronic circuits.[2] Imagination and implementation in a virtuous circle, or rather, progressive spiral.

A slow and halting progress

The imprinting of machine by human and human by machine would seem to favour computing as an obvious means for bridging the human and non-human sciences. Bridging would seem to be implicit in a tool that gives Galilean epistemology some purchase on human cultural artefacts and returns to students of these artefacts the benefits of the knowledge thus obtained. But realising the potential has not been without its delays, difficulties, mistakes and false directions. This is, in other words, a story of a long struggle that seems now to be paying off.

---

[1] For von Neumann's use of McCulloch and Pitts 1943 see McCulloch 1988/1961: 9. The borrowing is made obvious by the neurophysiological vocabulary of the Draft Report.

[2] See the work of the National Research Council Canada (www.nrc-cnrc.gc.ca/eng/education/innovations/spotlight/brain.html) and the Nanobio Convergence Laboratory, Interuniversity Microelectronics Centre, Belgium (www.imec.be, reported in *Science Daily*, 26 November 2009).

At the outset not so, however. For quite obvious reasons of background, education and disciplinary specialisation, few scholars in the humanities had the training to get engaged with computing in the early years or even to see the possibilities. The technical expertise required first to build and then to use those early machines excluded most if not all non-scientists from direct involvement. But computers were hardly unknown even to the least technically inclined during the incunabular period (the time from the end of World War II to the public release of the Web in 1991).

In fact digital computing was a hugely popular subject, widely if not always accurately reported in the popular media throughout the period. A catalogue of items in the news or otherwise publicised would swamp this Preface, but a few examples will give you an idea.

Notice of the new "electronic brain", as the computer was popularly known (not without reason, we have seen), appeared in the *Times of London* in November 1946. Two years later IBM put its Selective Sequence Automatic Calculator (SSEC) in the front window of its World Headquarters in Madison Avenue, New York, where it remained until 1952. Passers-by nicknamed it "Poppa"; the *New Yorker*'s "Talk of the Town" featured it in 1950. That same year *Time Magazine*, which paid close attention to computers from the beginning, ran a cartoon of the Harvard Mark III on its cover. Kits for children went on the market soon thereafter: by 1955, if not earlier, the GENIAC, a "simple electric brain machine"; by 1963 the Digi-Comp 1, "first real operating digital computer in plastic". The next year the Toronto *Globe and Mail* featured "Computers: The new age of miracles: hundreds of brains in a thimble" (16 November), imagining, in terms astonishingly similar to current dreams of a "semantic web", a world made ever so convenient to family life.

Hence by the mid 1960s, at least, humanists – except those without children, neighbours, magazines, newspapers, radio, television or spouses aware of the world – could hardly plead ignorance.

University computer centres were established for scientific research following rapid commercialisation of the computer in the 1950s. But digital computing had already been started in or near the humanities, in two projects first conceived ca. 1949: Fr Roberto Busa's *Index Thomisticus* (Busa 1980) and Machine Translation, proposed in a memo by Warren Weaver (1949) and then funded lavishly by the American government for its Cold War purposes. Within the following ten to fifteen years a relatively small cohort of humanists had taken to computing with great enthusiasm, as is attested for example by literary scholar Jess B. Bessinger, Jr., in his Foreword to *Literary Data Processing Conference Proceedings,* sponsored by IBM in September 1964, and by the articles and reports on activities across the disciplines in *Computers and the Humanities*, founded in 1966 by another literary scholar, Joseph Raben.

Not all embraced the computer so readily, even when it emerged as a general purpose machine programmable in languages such as Fortran and Cobol. Stigma was attached to involvement with it. Indeed, through the 1980s association with computing could delay if not end a young scholar's academic career or stain the reputation of a senior academic. The severely negative reaction can be attributed to a number of causes apart from mere resistance to change: the hype from "early adopters" as well as salesmen; prominent use by the military during the Cold War, which spanned the entire incunabular period and profoundly affected daily life, especially in the United States (Edwards 1996; Whitfield 1996); and perhaps most significant of all, the challenge to human identity of a device that from the beginning was thought one day to be capable of thinking. Even before digital computing moved Herman Goldstine and John von Neumann to define programming as "the technique of providing a dynamic background to the automatic evolution of meaning" (1947: 2), electronic devices had begun to seem disturbingly, autonomously intelligent, for example the Sperry gyropilot, known as "Metal Mike" (Mindell 2002: 72), and Norbert Wiener's Anti-Aircraft Predictor, which spooked engineer George Stibitz when he visited Wiener's laboratory in 1942 (Galison 1994: 242-3).

In the humanities and among public intellectuals expressions of unease, even fear, echoed those in the popular literature. Only some of this had to do with Cold War paranoia and with the threats to jobs from automation and to personal autonomy from mechanisms of surveillance and control. The sense of being made insignificant, even redundant – "a threat less defined than [those others] but even more profound, arising out of the alleged capacity of these machines to develop into *Homo Sapiens* clones" (Pratt 1987: ix) – suggests that the cultural force Sigmund Freud had attributed to his own work a generation earlier could be applied to digital computing as well: a deeply disturbing "and most irritating insult... flung at the human mania of greatness" (Freud 1920: 246f; cf McCorduck 1972: 305). Freud had put psychoanalysis in the lineage of two great predecessors, Copernicus, who displaced humans from an imagined centrality in the physical cosmos, and Darwin, whose "dangerous idea" unseated humankind from uniqueness in the living world (Dennett 1995; Mayr 1997). To that list of great insults we must now add Turing's. It is true that the machines propagated from his scheme have become furniture of ordinary life and are now taken for granted when not entirely undetected. But at the same time they have informed every aspect of how we think and talk about being human. The metaphors computing has provided us seem irresistible. Computers have made possible scientific research that continues eating away at the mania which Freud attacked with his revelations of the profound degree to which we do not know who and what we are.

Apart from Busa and a few other early figures (such as computational linguist Margaret Masterman[3] and literary critic Louis Milic), the potential of computing to enable radically new work was clear to a number of collaborating artists, engineers and artist-engineers of the early period, especially in Great Britain. They were not frightened away. Their enthusiastic and insightful projects, pronouncements and writings leave us in no doubt of this (Brown et al. 2008). But for reasons yet adequately to be identified and explored, the time was not right. Just as computing entered the humanities, for example, those most involved were marooned professionally by the shift of the disciplines that computing could most readily serve, away from a concern with scholarly data (in literary studies, "close reading") to that which Jonathan Culler has called "just plain 'theory'" (1997).[4] Most of those who persisted with computing, Milic complained at the time, were only mechanising what they conceived to be drudgery rather than using scholarly data to probe the unknown or to puzzle out what the new machine might be, and what it might be capable of (Milic 1966; Busa 1976). On the one hand the computer was widely assumed or thought to be a servant or slave, on the other to be imminently capable of enslaving humankind.[5] In other words, computing got caught in a master/slave dialectic. In an anonymous *TLS* review (probably written by Sir Charles Geoffrey Vickers, lawyer and pioneering systems scientist), the reader was warned that to regard computing in this way would be to bury its intellectual potential. This potential, the author wrote, could help resolve "the major epistemological problem of our time": "[w]hether and, if so, how the playing of a role differs from the application of rules which could and should be made explicit and compatible" (Anon. 1971).

Literary critic Jerome McGann has argued persuasively that for those disciplines focused chiefly on interpreting cultural artefacts, the major emphasis of the digital humanities for the last many years does little itself to liberate this potential (2004), though it clearly benefits conventional research by supplying resources in

[3] See her uncollected contributions to the *Times Literary Supplement* and especially Masterman 1962. She was a vigorous proponent of the kinds of experimental, imaginative work advocated by Milic 1966 and widely spurned by the academic establishment, e.g. F. R. Leavis (1970).

[4] Anthony Kenny has made the fascinating suggestion that the turn from a focus on texts to a preoccupation with theory in mainstream humanities research just as computing entered the scene might have been a negative reaction to all that computing represented – precisely to its power for symbol-manipulation (1992: 9-10). I remain suspicious of such simple, cause-effect formulations, however.

[5] The drudgery of computation could be very real and was certainly thought intolerable by the likes of Leibniz and Babbage, hence their common solution: the mechanical servant (Pratt 1987: 20-44; Goldstine 1972: 8ff). The anti-aircraft problem of World War II likewise made computation by hand unsupportable, hence stimulated development of machines for the task. The error I am describing occurs, however, when we identify the calculational power of computing machines as their essential nature, and having equated that power with intelligence then anthropomorphize our relationship to the machine as that between slave and master.

convenient form. Exactly how best to engage computing *directly* in turning the hermeneutic circle remains an open question and the most difficult of challenges for the digital humanities to consider. Those other disciplines primarily devoted to reporting on, cataloguing and providing access to cultural heritage, such as epigraphy, are at present much better served.

The same year as that stern warning against enslavement, W. G. Runciman wrote consolingly in the *TLS* series *Thinking by Numbers* about the disappointing results from computational studies in sociology, recommending greater patience than a single generation or lifetime could measure (1971: 943). His recommendation remains a good antidote against the all the talk of great paradigm shifts and the hype that goes with it.[6] Steady progress of hardware and software together with online resources have in the intervening years slowly rendered some of the *very* hard computational problems of our cultural artefacts somewhat easier. At a similar pace, alarmingly less in anyone's spotlight, computing has changed how we *and our students* study, use and think about those artefacts. The chief cause of this change, I would argue, is not great analytic breakthroughs, not directly anyhow, but the theoretically simple and unsophisticated fact of access to great quantities of material. The "distant reading" Franco Moretti has described and which Mark Olsen pointed to several years earlier is one such new "condition of knowledge" brought about by quantitative access (Moretti 2000: 56-8; Olsen 1991). Another, anecdotal evidence suggests, is the rude juxtaposition of disciplines by keyword searches for articles e.g. in JSTOR, which implicitly brings the possibility of interdisciplinary interconnections into view and so encourages their exploration. Given constraints of time this in turn pushes research to go wide rather than deep, with implications Richard Rorty has opened up (2000). This is a largely unexplored question, it would seem: how actually to do genuine interdisciplinary research on one's own, or to put the matter pedagogically, how to train our students responsibly to handle what is already being thrust at them.

Humanities and sciences

New analytical tools for the humanities, though slower to develop and still at a highly primitive stage, are advancing apace, as several of the contributions here suggest. My concluding question is, given the long, cultural view, what status do these tools have within the humanities? What are they doing to research?

[6] The unthinking importation of Thomas S. Kuhn's idea of a "paradigm shift", from *The Structure of Scientific Revolutions*, brings with it the assumption of a complete break from one way of thinking to another incommensurable with it. However well that works for physics, it seems a highly dubious notion for the humanities.

Elsewhere I have argued that these tools create a conjectural space within the humanities in which cultural artefacts can be operated on *as if* they were natural objects (McCarty 2008). This argument proceeds from the fact that to make a cultural artefact computationally tractable it must be rendered as data. Since data are qualitatively indifferent as to source, scientific methods of analysis apply. That which is lost in the rendering, and so does not affect the analysis, can then be brought into consideration by comparing the results with the researcher's pre-existing ideas, changes made and the hermeneutic cycle repeated. Thus *modelling* in the humanities (McCarty 2005: 20-72). Meanwhile – and here is my overriding point – such analytic practices in the digitised humanities have implicitly established what Geoffrey Lloyd has called a "beachhead of intelligibility" joining the humanities with the sciences (2010). Borrowing liberally from Ian Hacking's work on "styles of scientific reasoning", I have argued that in effect computing has given us *humanistae* a way of tapping into centuries of scientific work and wisdom in our employment of these styles (cf. Hacking 2002).

Again: the important matter here is that beachhead of intelligibility, or what I have called the bridge-building that the computer has greatly strengthened if not made possible. Earlier I devoted space to the incunabular fears of the machine in the humanities. I did so not simply to help explain our rather halting progress toward this time of bridge-building but to shine a light on the bridge under construction. Even if we no longer write articles entitled "Fear and Trembling: The Humanist Approaches the Computer" (Nold 1975) or feel compelled to reassure ourselves that in the face of computing the scholar can still find "work which only he can accomplish" (Pegues 1965), we still, indeed especially, need to be most acutely aware – not to that fear (which continues)[7] but to that to which fear is a less than helpful reaction: the defamiliarizing perception of changed epistemic conditions.

These which follow are not just scientific papers. They are components of the bridge now visible to any who care to look.

[7] The fact that the American Association of Artificial Intelligence felt moved two years ago to convene a meeting to worry over "potential long-term societal influences of AI research and development" is perhaps evidence enough that familiarity has not superseded fear but only blanketed it (Horvitz and Selman 2009; see Markoff 2009, which however intemperate makes the point).

Works cited

Anon. 1971. "Keepers of rules versus players of roles". Rev. of Thomas L. Whisler, *The Impact of Computers on Organizations*, and James Martin and Adrian R. D. Norman, *The Computerized Society*. *Times Literary Supplement*, 21 May: 585.

Bessinger, Jess B., Jr. 1964. "Foreword". In *Literary Data Processing Conference Proceedings September 9, 10, 11 -- 1964*. Ed. Jess B. Bessinger, Jr., Stephen M. Parrish and Harry F. Arader. 1-2. Armonk NY: IBM Corporation.

Brown, Paul, Charlie Gere, Nicholas Lambert and Catherine Mason, eds. 2008. *White Heat Cold Logic: British Computer Art 1960-1980*. Cambridge MA: MIT Press.

Bruner, Jerome. 1986. "Possible Castles". In *Actual Minds, Possible Worlds*. 44-64. Cambridge MA: Harvard University Press.

Burke, Peter. 2000. *A Social History of Knowledge*. London: Polity.

Busa, R. 1976. "Guest Editorial: Why can a computer do so little?" *Bulletin of the Association for Literary and Linguistic Computing* 4: 1-3.

---. 1980. "The Annals of Humanities Computing: The Index Thomisticus". *Computers and the Humanities* 14: 83-90.

Culler, Jonathan. 1997. *Literary Theory: A Very Short Introduction*. Very Short Introductions. Oxford: Oxford University Press.

Dennett, Daniel C. 1995. *Darwin's Dangerous Idea: Evolution and the Meanings of Life*. New York: Simon & Schuster.

Edwards, Paul N. 1996. *The Closed World: Computers and the Politics of Discourse in Cold War America*. Cambridge MA: MIT Press.

Freud, Sigmund. 1920. "Eighteenth Lecture. General Theory of the Neuroses: Traumatic Fixation – the Unconscious". In *A General Introduction to Psychoanalysis*. Trans. G. Stanley Hall. 236-47. New York: Boni and Liveright.

Galison, Peter. 1994. "The Ontology of the Enemy: Norbert Wiener and Cybernetics". *Critical Inquiry* 21.1: 228-66.

Goldstine, Herman H. 1972. *The Computer from Pascal to von Neumann*. Princeton NJ: Princeton University Press.

--- and John von Neumann. 1947. *Planning and Coding of Problems for an Electronic Digital Computer*. Report on the Mathematical and Logical aspects of an Electronic Computing Instrument, Part II, Vol. I-3. IAS ECP list of reports, 1946-57, nos. 4, 8, 11. Princeton NJ: Institute for Advanced Study.

Hacking, Ian. 2002. "'Style' for Historians and Philosophers". *Historical Ontology*. 178-99. Cambridge MA: Harvard University Press.

Horvitz, Eric and Bart Selman. 2009. "Interim Report from the Panel Chairs, AAAI Presidential Panel on Long-Term AI Futures". www.aaai.org/Organization/Panel/panel-note.pdf (30 January 2011).

Kenner, Hugh. 2005/1968. *The Counterfeiters: An Historical Comedy*. Dalkey Archive, Scholarly Series. Normal IL: Dalkey Archive Press.

Kenny, Anthony. 1992. *Computers and the humanities*. The Ninth British Library Research Lecture. London: The British Library.

Leavis, F. R. 1970. "'Literarism' versus 'Scientism': The misconception and the menace". *Times Literary Supplement* 3556 (23 April): 441-5. Repub. 1972 in *Nor Shall My Sword: Discourses on Pluralism, Compassion and Social Hope*. 137-60. London: Chatto & Windus.

Lloyd, G.E.R. 2010. "History and Human Nature: Cross-Cultural Universals and Cultural Relativities". *Interdisciplinary Science Reviews* 35.3-4: 201-14.

Mahoney, Michael S. 1990. "The Roots of Software Engineering". *CWI Quarterly* 3.4: 325-34.

---. 2000. “Historical Perspectives on Models and Modeling”. XIIIth DHS-DLMPS Joint Conference on “Scientific Models: Their Historical and Philosophical Relevance”, Zürich, 19-22 October 2000. www.princeton.edu/~hos/Mahoney/articles/models/models.html (30 January 2011).
---. 2005. "The Histories of Computing(s)". *Interdisciplinary Science Reviews* 30.2: 119-35.
Markoff, John. 2009. “Scientists Worry Machines May Outsmart Man”. *New York Times* 25 July. www.nytimes.com/2009/07/26/science/26robot.html (30 January 2011).
Masterman, Margaret. 1962. “The Intellect’s New Eye”. Freeing the Mind. *Times Literary Supplement* 284: 27 April. Repub. in *Freeing the Mind: Articles and Letters from The Times Literary Supplement during March-June 1962*. 38-44. London: Times Publishing Company Ltd.
Mayr, Ernst. 1997. *This is Biology: The Science of the Living World*. Cambridge MA: Belknap Press, Harvard University Press.
McCarty, Willard. 2005. *Humanities Computing*. Houndmills, Basingstoke: Palgrave.
---. 2008. “Being Reborn: The Humanities, Computing and Styles of Scientific Reasoning”. In *New Technologies and Renaissance Studies 1*, ed. William R. Bowen and Raymond G. Siemens. Medieval and Renaissance Studies and Texts, Vol. 324. 1-22. Tempe AZ: Iter Inc. in collaboration with the Arizona Center For Medieval and Renaissance Studies.
McCorduck, Pamela. 1972. *Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence*. San Francisco CA: W. H. Freeman and Company.
McCulloch, Warren S. 1988/1961. “What is a Number, that a Man May Know It, and a Man, that He May Know a Number?” The Ninth Alfrew Korzybski Memorial Lecture. In *Embodiments of Mind*, Intro. Seymour Papert, Pref. Jerome Y. Lettvin. Cambridge MA: MIT Press.
--- and Walter H. Pitts. 1943. “A Logical Calculus of the Ideas Immanent in Nervous Activity”. *Bulletin of Mathematical Biophysics* 5: 115-33.
McGann, Jerome. 2004. “Marking Texts of Many Dimensions”. In *A Companion to Digital Humanities*, ed. Susan Schreibman, Ray Siemens and John Unsworth. 198-217. Blackwell Companions to Literature and Culture. Oxford: Blackwell Publishing. www.digitalhumanities.org/companion/ (30 January 2011).
Milic, Louis T. 1966. “The Next Step”. *Computers and the Humanities* 1.1: 3-6.
Mindell, David A. 2002. *Between Human and Machine: Feedback, Control, and Computing before Cybernetics*. Johns Hopkins Studies in the History of Technology. Baltimore MD: Johns Hopkins University Press.
Moretti, Franco. 2000. “Conjectures on World Literature”. *New Left Review* 1: 54-68.
Mumford, Lewis. 1970. “The Megamachine – III”. Reflections. *The New Yorker* 24 October:
Newell, Alan and Herbert A. Simon. 1976. “Computer Science as Empirical Inquiry: Symbols and Search”. 1975 Turing Award Lecture. *Communications of the ACM* 19.3: 113-26.
Nold, Ellen W. 1975. “Fear and Trembling: The Humanist Approaches the Computer”. *College Composition and Communication* 26.3: 269-73.
Olsen, Mark. 1993. “Signs, Symbols and Discourses: A New Direction for Computer-Aided Literature Studies”. *Computers and the Humanities* 27: 309-14.
Otis, Laura. 2001. *Networking: Communicating with Bodies and Machines in the Nineteenth Century*. Ann Arbor MI: University of Michigan Press.
Pegues, Franklin J. 1965. “Editorial: Computer Research in the Humanities”. *The Journal of Higher Education* 36.2: 105-8.
Pratt, Vernon. 1987. *Thinking Machines: The Evolution of Artificial Intelligence*. Oxford: Basil Blackwell.
Reddy, Raj. 1996. “The Challenge of Artificial Intelligence”. *IEEE Computer* 29.10: 86-98.
Rorty, Richard. 2000. “Being that can be understood is language”. *London Review of Books* 16 March: 23-5.
Runciman, W. G. 1971. “Thinking by numbers: 1”. *Times Literary Supplement* 6 August: 943-4.
Sappol, Michael. 2006. *Dream Anatomy*. Washington DC: National Institutes of Health, National Library of Medicine. www.nlm.nih.gov/dreamanatomy/ (30 January 2011).

Snow, C. P. 1993/1959. *The Two Cultures*. Intro. Stefan Collini. Cambridge: Cambridge University Press.

Stevens, John K. 1985. "Reverse Engineering the Brain". Artificial Intelligence. *Byte Magazine* (April): 286-99.

Turing, A. M. 1936. "On computable numbers, with an application to the Entscheidungsproblem". *Proceedings of the London Mathematical Society*, ser. 2, 42:230-65.

von Neumann, John. 1945. "First Draft of a Report on the EDVAC". Philadelphia PA: Moore School of Electrical Engineering, University of Pennsylvania. Rpt. 1993, *IEEE Annals of the History of Computing* 15.4: 27-75.

Weaver, Warren. 1949. "Translation". In *Machine translation of languages: fourteen essays*, ed. William N. Locke and A. Donald Booth. 15-23. Cambridge MA: Technology Press, Massachusetts Institute of Technology, 1955.

Whitfield, Stephen J. 1996. *The Culture of the Cold War*. 2nd edn. Baltimore MD: Johns Hopkins University Press.

Windelband, Wilhelm. 1980/1894. "History and Natural Science". Classics in the Philosophy of History. Transl. with intro. Guy Oakes. *History and Theory* 19.2: 165-85.

Winograd, Terry and Fernando Flores. 1986. *Understanding Computers and Cognition: A New Foundation for Design*. Boston MA: Addison-Wesley.