Rethinking History

ISSN: 1364-2529 (Print) 1470-1154 (Online) Journal homepage: https://www.tandfonline.com/loi/rrhi20

Intervention: Hacking history, from analogue to digital and back again

William J. Turkel

To cite this article: William J. Turkel (2011) Intervention: Hacking history, from analogue to digital and back again, Rethinking History, 15:2, 287-296, DOI: 10.1080/13642529.2011.564840

To link to this article: https://doi.org/10.1080/13642529.2011.564840

Published online: 19 May 2011.

Rethinking History
Vol. 15, No. 2, June 2011, 287–296

Routledge
Taylor & Francis Group

INTERVENTION

Hacking history, from analogue to digital and back again

William J. Turkel*

Department of History, University of Western Ontario, Canada

The process of digitization creates a representation that shares some of the attributes of an original, but not all of them. Which attributes are preserved is not an essential trait of digitization *per se*, only of a particular process. Technologies that are not frequently used by historians, for example, could allow us to capture and recreate the smells of documents, foods, artefacts and environments. Rather than concentrating on the properties of digital representations as such, historians are encouraged to think in terms of transduction, the conversion of energy from one form to another. From this perspective, new possibilities can be found for creative research and expression which integrate affective history with more traditional modes of understanding.

Keywords: digitization; hacking; historical consciousness; materialization; odour; transduction

In *The social life of information*, Seely Brown and Duguid (2002, 173–4) describe the practice of a medical historian working in an archive of eighteenth-century documents:

> He read barely a word. Instead, he picked out bundles of letters and, in a move that sent my sinuses into shock, ran each letter beneath his nose and took a deep breath, at times almost inhaling the letter itself but always getting a good dose of dust. Sometimes, after a particularly profound sniff, he would open the letter, glance at it briefly, make a note and move on.

When Duguid asked him what he was doing, the man replied that the letters had been treated with vinegar to prevent the spread of cholera. By correlating the scent of vinegar with the date and place that a letter was written, he could track the course of an epidemic. Seely Brown and Duguid conclude that 'digitization could have distilled out the text of those letters. It would, though, have left behind that other interesting distillate, vinegar.'

*Email: william.j.turkel@gmail.com

ISSN 1364-2529 print/ISSN 1470-1154 online

DOI: 10.1080/13642529.2011.564840
http://www.informaworld.com

Seely Brown and Duguid's point, of course, is that something is always lost when the textual content of a document is extracted. It may be the details of handwriting, font or layout. It may be an illustration or marginalia. Sometimes, the quality or chemical composition of ink or paper tells a story of its own. The *original*, whether document, artefact or environment, always bears material traces of its past, and the potential inferences that may be made from those traces are unbounded (Turkel 2006, 2007). Historians, archaeologists, archivists, curators all agree that, for some purposes at least, nothing but the original will do. In this, they are not alone. Guilt or innocence hangs on a spent bullet. A mechanic needs to see the carburettor in the car that is not working, not the one in another car just like it. The petroleum geologist studies the sediment in this basin to know if an oil deposit is likely to be found here. One fundamental way in which one understands the world is through indexical signs, the clues, tracks and symptoms that allow one to infer fire from smoke, an animal from its print, and so on (Ginzburg 1989). The well-known benefits of working with originals are matched by an equally well-known set of costs: they may be scarce, fragile, ephemeral, hazardous, inaccessible or fixed in place. We have to make representations of the world to get by, and those representations will always be radically incomplete.

It is safe to say that the world is messier, more complicated and deeper than any representations of it could ever be, but that does not mean that the problem lies with the process of digitization. Everything that can be discriminated or measured can be digitized, often in many different ways. Take the vinegary archival documents. If the historian in question had read one of the documents and typed a transcript into his laptop, he would have created one kind of digital representation. Each handwritten *a, b* or *c*, no matter how variable they appeared on the page, would be represented by the same electronic character each time that they appeared. Things that were obvious to a reader of the original (did the writer have a neat or shaky hand?) would not be discoverable from that digital representation. Alternatively, the historian might have photographed the document with a digital camera or made an optical scan. In that case, the continuously varying brightness at each point would be sampled, and mapped into a much smaller, pre-determined range of possibilities: black or white, 16 or 128 different levels of grey, 256 possible colours. At a high enough resolution, some aspects of the original might be captured in the digital representation, such as the neatness of the writer's hand or the colour or quality of the paper. It is true that minute traces of vinegar probably would not by captured by optical scanning at this scale, as Seely Brown and Duguid suggest. One should not make the further inference that the traces of vinegar could not be digitized at all.

In fact, transcription and optical imaging are only two of a nearly infinite number of possibilities for digitization. In a recent paper in the journal

Analytical Chemistry, Strlič et al. (2009) describe a way of capturing and analysing 'the smell of old books'. When paper degrades, it releases hundreds of volatile organic compounds (VOC). Since these evaporate easily, they can be collected from the 'headspace' – the air around the object – without damaging the original. 'A combination of grassy notes with a tang of acids and a hint of vanilla over an underlying mustiness,' they write, 'this unmistakable smell is as much part of the book as its contents.' As paper ages, various chemical markers accumulate. Given a machine trained to 'sniff' for paper degradation, a machine that digitizes the profile of VOC rather than the text, conservators would have a tool for identifying materials in need of care, and creative historians (such as the man whom Duguid met) would have one more means of selecting a tiny subset of the infinite archive towards which to direct their further attention. For in the age of digital abundance (Rosenzweig 2003), human attention, *care*, is the scarcest resource of all.

Every choice made individually or in larger groups costs something in terms of time, energy, labour, opportunity and other resources, and this is as true of scholarship as any other endeavour. New technologies change the balance of costs, sometimes quite dramatically.[1] When optical scanning became affordable for libraries and archives, collections of documents were digitized and provided with good digital metadata based on their perceived significance in a scholarly context. When optical scanning became affordable for individual genealogists, document digitization became a lot more idiosyncratic and metadata more hit-and-miss. Creating a digital library or archive with the open source Greenstone software is much easier than trying to program one's own system, and uploading scanned page images to Flickr is easier still. Finding digitized documents in an OPAC (an online public access catalogue) imposes different costs on the user and confers different benefits from finding them with an online search engine. Examples can be multiplied at will. Although these cost regimes shape one's experience of what is possible at a given moment, one should not think of the constraints that they impose as immutable, or worse, essential. In the early days of Project Gutenberg, sceptics predicted that the number of electronic books would never surpass that of physical codices. They did not foresee the subsequent rise of the internet, Google Books or Amazon Kindle.

Similarly, although we do not currently live in a world of inexpensive, mobile, on-demand scent analysis or synthesis, it should not be assumed that we never will. Products currently in development or production smell for environmental pollution, spoiled foods, drugs, explosives, diseases such as diabetes or lung cancer, and physiological events such as ovulation (Gilbert 2008). Artists and hackers repurpose these devices as soon as they become available. In Natalie Jeremijenko's Feral Robotic Dogs project (2003–present), students learn to retrofit toy robot dogs so that they have the ability to smell chemicals such as trichloroethylene or chlorofluorocarbons,

using VOC detectors. When a pack of the modified dogs are loosed at a site with a history of pollution, they sniff out and congregate around areas of higher contamination. Although not usually framed as such, this is an excellent example of a novel and mediagenic approach to public environmental history.

While digitization can be laborious and expensive, it costs next to nothing to copy, transmit or store a representation that is already in digital form. This, in part, helps to account for the accelerating proliferation of potential sources. Since any digital representation can serve as the input for a computational process, some scholarly tasks, such as indexing or concordancing, have become the work of seconds rather than of whole careers. So much is familiar to any scholar. Video and still cameras, audio recorders, e-mail programs, computer games and desktop applications all create digital representations, as do satellites, servers, routers, sensors, embedded microcontrollers and industrial control systems. Born digital, these products of computation far outnumber the analogue sources that we explicitly choose to digitize, even taking into account projects such as Google Books. One study estimates that Americans consumed 3.6 zettabytes of information in 2008. 'If we printed 3.6 zettabytes of text in books, and stacked them as tightly as possible across the United States including Alaska, the pile would be 7 feet high' (Bohn and Short 2009). It now takes a continent to express what could be expressed in terms of bricks-and-mortar libraries six years earlier: the estimated accumulation of five new exabytes in 2002 was described as 'equivalent in size to the information contained in 37,000 new libraries the size of the Library of Congress book collections' (Lyman and Varian 2003).

By concentrating on the properties of representation in the digital mode, we have greatly expanded our sense of what the humanities can be. Beyond the sheer mass of information old and new, we have also shown the truth in P.W. Anderson's claim that 'more is different' (1972), that completely new possibilities emerge at different scales (see also Kelly 2008). Search engines and social recommendation engines, such as Amazon's, allow us to harness the patterns implicit in countless individual acts of browsing or purchasing. New research projects can be based on the easy sifting of needles from haystacks, allowing researchers to track, for example, the emotional state of millions of bloggers or tweeters from one day to the next (Baker 2009; Dodds and Danforth 2009).

This is only the beginning, however, because what can be converted from analogue to digital can always be converted back into various analogue forms. These processes of *materialization* complement processes of digitization. An electronic document can be displayed on a computer screen (converting bits to photons), printed out on paper (bits to atoms), read aloud by a text-to-speech converter (bits to sound waves), and so on. To even draw a distinction between bits and atoms becomes more complicated

when one realizes that every bit is always encoded in physical form. Further, 'a digital environment is an abstract projection supported and sustained by its capacity to propagate the illusion (or call it a working model) of *immaterial* behavior: identification without ambiguity, transmission without loss, repetition without originality' (Kirschenbaum 2008, 11). To see some of the full range of creative possibilities available to historians now, it helps to try to get beyond this illusion of immateriality, and to think instead in terms of *transduction*, the conversion of energy from one form to another. Whitelaw writes

> Input and output devices all contain transducers: the keyboard transduces motion into voltage; the screen transforms voltage into light; the hard drive mediates between voltage and electromagnetic fields. A printer takes in patterns of voltage and emits patterns of ink on a page. Strictly transduction only refers to transformations between different energy types; here I want to extend it to talk about all the propagating matter and energy within something like a computer, as well as those between that system and the rest of the world. (Whitelaw 2009)

The problem with emphasizing the digital, as in 'digital history' or 'digital humanities', is that we have generally failed to acknowledge the extent to which we were already living in a digital world, long before the advent of electronics. Writing systems – whether alphabetic, syllabic, pictographic or ideographic – are digital in the sense that symbols are drawn from a pre-determined set and assigned meaning in the context of the other elements. At the level of text, every instance of the English letter A is treated as if it were identical to every other one. This is what allows a handwritten manuscript to be copied by hand. Although it might be illuminated or decorated, no instance of the letter A can be changed to an instance of the letter E without some consequence, large or small. Our long immersion in the world of written text has biased us toward thinking of digitization primarily as a copying process, a way of creating potentially useful but admittedly inferior duplicates of valuable originals. If one reframes digitization and materialization as forms of transduction, one find many new possibilities for creative expression as humanists.

Take the example of smell. In *The foul and the fragrant*, Corbin writes:

> Strong odor, now old-fashioned, became the prerogative of aged coquettes and peasants. Animal scent belonged to the masses. 'The gentleman of fashion no longer exhales ambergris,' noted Louis-Sébastien Mercier. Casanova nearly fainted when an old nymphomaniac duchess made her appearance, smelling of musk from twenty steps away. He himself only used myrrh and storax to concoct the magician's sulfurous apparatus. Corbin (1986, 76)

It is a particularly vivid passage, even if the vast majority of people who read it are unable to conjure an impression of the scent of raw ambergris, or of

a mixture of myrrh and storax. But what if it were possible to produce scents to order, to 'illustrate' text with a different sensory modality than the visual? The technology to do so certainly exists, albeit in unwieldy form. Chandler Burr (2007, 235–6) describes the sample compounding robot at the Technical Applications Lab at International Flavors and Fragrances as 'a giant metal machine with dozens of tubes rotating around its middle', able to mix 'milk shakes of allyl amyl glycolate and undecalactone and ethyl vanillin'. Although access to such a device will probably remain out of the question for most humanists, at least for the time being, hackers are already working on computer-controlled scent devices at the other end of the price spectrum. In an article in *MAKE* magazine, Wayne Holder (2008) describes a way to repurpose the commercial Glade Wisp air freshener so that it will dispense custom aromas under the control of the open-source Arduino microcontroller. Since each Arduino can control up to six Wisps, Holder suggests that one might create their own 'version of John Waters' notorious Odorama, triggering a ''smelltrack'' that's synchronized with pictures or scenes of different aromatic subjects appearing onscreen'. In fact, a subsequent project at the art and technology centre Eyebeam did create an immersive digital cinema project complete with scent, although the creators chose to hack the inexpensive AromaUSB fragrance dispenser instead (Tandefelt et al. 2009). There is no reason why this type of technology could not be put to work recreating historical smells, a different way to evoke particular states of historical consciousness. To do so would be to participate in history's affective turn, creating a 'historical representation that both takes affect as its object and attempts to elicit affect' (Agnew 2007, 301). This does not mean abandoning traditional historical understandings of events or processes or structures, but rather supplementing them.

Under exceptional circumstances, we are occasionally able to smell things from the distant past.[2] Moore, Krotoszynski, and O'Neill (1984) described a method of using gas chromatography to extract the odours from coprolites, the fossilized faeces of humans and other animals. They started by collecting stool samples from a volunteer who was fed a variety of different foods. The samples were freeze dried and rehydrated, and then passed through an instrument which allowed a trained human sniffer to smell the VOC from the sample as they were being recorded. Once the research team could reliably detect food odours from contemporary stool samples, they used the same method to test coprolites from a Utah cave, *circa* 6400 BP, detecting 'odors of grass, green leaves, licorice, meat, and corn'. (Two native plants eaten by Aboriginal peoples of the area, American licorice and sweet cicely, both smell of liquorice.) Fragrance and flavour companies routinely use gas chromatography and mass spectrometry to analyse and then duplicate the scents of their competitors (Burr 2007). The only barriers to bottling the smell of an eight-thousand-year-old meal and then re-presenting it are cost and interest.

Could a scent compounding device let us know what the past actually smelled like? Of course not. Here one runs into well-known concerns with re-enactment (e.g. Agnew 2007; de Groot 2009). In most situations, we do not have access to the smelly stuff of the past, and even when we do, we can only know what it smells like to us, and not what it smelled like to historical actors. This conclusion follows from Thomas Nagel's classic argument about consciousness in 'What is it like to be a bat?' (1974). Although it might be possible 'to imagine that one has webbing on one's arms, which enables one to fly around at dusk and dawn catching insects in one's mouth; that one has very poor vision, and perceives the surrounding world by a system of reflected high-frequency sound signals; and that one spends the day hanging upside down by one's feet in an attic', one can only really imagine what it would be like for oneself under those circumstances. The thought of eating insects, for example, plays out differently among Japanese and Jains. Nagel's conclusion was that we could never know what it is like for a bat to be a bat. And so, although we can try to bracket our own experiences and cultural expectations, we will each perceive different scents a bit differently. The smell of chlorine may evoke nostalgia in children of the 1960s and 1970s, but disgust in those born a generation earlier (Hirsch 2006).

Given the idiosyncrasies of smelling and the inaccessible experiences of the past or of others, the utility of reconstructing scents may seem beside the point. But that argument could as easily be applied to the writings of Casanova or Corbin. Casanova smelled things and smelled like something. Thanks to the vividness of Casanova's prose, Corbin could imaginatively reconstruct his olfactory world and, thanks to Corbin, the reader has a better understanding of odour in the history of French society. When we read Corbin or Casanova and imagine the smells that they describe, we are not really getting any closer to the originals than if we were provided with some kind of a suggestive sample to smell. Words, like reconstructed scents, provide a mediated experience. But smell's close relationship to memory, *à la* Proust's madeleine, makes it a potent and as yet almost entirely untapped way of communicating interpretations of the past.

The challenge of the present moment is not to find residues or auras that cannot be digitized. It is rather to see opportunities for doing new kinds of history and for practising new forms of humanism at sites where energy and information are transduced from one very material form to another. Following Mark Weiser, one might think of these points of transduction as 'seams' (Chalmers and MacColl 2003). By stopping to reflect on what is happening at such seams, we can imagine new sources of evidence for studies that have yet to be written, or for tools that we may wish to build.

For example, Whitelaw noted that, while a person types on a keyboard, physical motion is converted into varying voltages. The digital text that results is only the most obvious source of information that can be captured

here. The interval between keystrokes tells a story of its own: moments of fluidity, hesitation, amendment (cf. Zalewski 2005). In general, we do not care about this level of detail, but the light that it could shed on the composition of particular works might be invaluable. In the aggregate, one might also ask how the typing of millions of people is affected by the time of day, day of the week, season or even the relative prices of coffee and beer. We do not have access to that kind of data for people of the past, but future historians will have it for us.

As another example, Dodds and Danforth showed that blogs and tweets track national mood in real time, surging for some events (President Obama's inauguration) and slumping for others (Michael Jackson's death). The traditional way to present results such as these is to publish an article, which they did. A less traditional way would be to build a publicly accessible, online tool which tracks social phenomena in real time. Both Google Zeitgeist and Yahoo! Buzz provide information about search trends in this fashion. To get a handle on the possibilities, we might think of the different affordances of a published population estimate versus an online population clock. What if we combined these two kinds of representations at the seams? Rather than static graphs and tables, Dodds and Danforth's paper might include live ones instead. Of course, the risk with this kind of 'publication' would be that the live data would sooner or later invalidate the claims or conclusions of the more static textual passages. Given the exponential growth of networked digital representations, it is a safe bet that it would probably be very much sooner rather than later. We are less likely to face this problem if we broaden our notion of publication to include online tools or sensors built to tap live data and to instantiate a certain interpretation. In other words, one should think of transducers as a potential genre of 'publication', one that can incorporate new information rather than immediately being made obsolete by it (cf. Gelernter 1991).

Although the primary focus here has been the analysis, digitization and materialization of scents, there are many other possibilities for forms of transduction that cross the seams between analogue and digital, in either direction. The universal 'replicator' of science fiction is still science fiction, but inexpensive open source software and hardware projects make it possible to digitize a three-dimensional object, scale and edit the digital representation, and materialize it with a desktop 3D printer. If the new object is unsatisfactory for some reason, it can be scanned again to digital form, edited and re-materialized. Sites such as Thingiverse and Instructables make it easy to share digital representations that can be readily modified and materialized. In a graduate course on interactive exhibit design, the author routinely teaches graduate public history students how to use laser and touch-probe scanners, analogue sensors and microcontrollers, programming languages, computer-controlled mills and lathes, RepRaps and other tools. As they learn how to cycle back and forth rapidly between the digital and

material, they continually imagine new sites where the past may be presented to new audiences, and new means to do so.

Notes

1. For a discussion of the economics of digitization that complements the one presented here, see de Groot (2009, esp. 240–7).
2. I owe this example to Gilbert (2008, 210–11).

Notes on contributor

William J. Turkel is an Associate Professor of History at the University of Western Ontario, where he teaches courses on digital history and the history of science, technology and environment. He is the author of *The archive of place: Unearthing the pasts of the Chilcotin Plateau* (Vancouver: UBC Press, 2007) and co-editor of *Method and meaning in Canadian environmental history* (Toronto: Nelson Education, 2009). His first monograph focused on the ways in which people reconstruct the past from its material traces. He is currently working on the histories of measurement, materials science and machine tools. In addition to traditional historical research methods, he uses hacking as a form of critical technical practice, working with microcontrollers, sensors and desktop fabrication devices.

References

Agnew, Vanessa. 2007. History's affective turn: Historical reenactment and its work in the present. *Rethinking History* 11: 299–312.

Anderson, P.W. 1972. More is different. *Science* 177, no. 4047: 393–6.

Baker, Stephen. 2009. *The numerati*. New York: Mariner Books.

Bohn, Roger E., and James E. Short. 2009. *How much information? Report on American consumers*. San Diego: Global Information Industry Center, University of California. http://hmi.ucsd.edu/pdf/HMI_2009_ConsumerReport_Dec9_2009.pdf

Burr, Chandler. 2007. *The perfect scent: A year inside the perfume industry in Paris and New York*. New York: Henry Holt.

Chalmers, Matthew, and Ian MacColl. 2003. *Seamful and seamless design in ubiquitous computing*. http://www.equator.ac.uk/var/uploads/ChalmersTech2003.pdf

Corbin, Alain. 1986. *The foul and the fragrant: Odor and the French social imagination*. Cambridge, MA: Harvard University Press.

De Groot, Jerome. 2009. *Consuming history: Historians and heritage in contemporary popular culture*. London: Routledge.

Dodds, Peter Sheridan, and Christopher M. Danforth. 2009. Measuring the happiness of large-scale written expression: Songs, blogs, and presidents. *Journal of Happiness Studies*. http://www.springerlink.com/content/757723154j4w726k/fulltext.html

Gelernter, David. 1991. *Mirror worlds, or, the day software puts the universe in a shoebox – how it will happen and what it will mean*. New York: Oxford University Press.

Gilbert, Avery. 2008. *What the nose knows: the science of scent in everyday life*. New York: Crown Publishers.

Ginzburg, Carlo. 1989. Clues: the roots of an evidential paradigm. In *Clues, myths, and historical method*, 96–125. Baltimore, MD: Johns Hopkins University Press.

Hirsch, Alan R. 2006. Nostalgia, the odors of childhood and society. In *The smell culture reader*, ed. Jim Drobnick, 187–9. New York: Berg.

Holder, Wayne. 2008. Hacking the Glade Wisp: make your own scent output peripheral from a piezo air freshener. *MAKE Magazine*, 16: 161–4.

Jeremijenko, Natalie. n.d. *Feral robotic dogs*. http://www.nyu.edu/projects/xdesign/feralrobots/.

Kelly, Kevin. 2008. Everything, too cheaply metered. *The Technium*. http://www.kk.org/thetechnium/archives/2008/09/everything_too.php

Kirschenbaum, Matthew G. 2008. *Mechanisms: New media and the forensic imagination*. Cambridge, MA: MIT Press.

Lyman, Peter, and Hal R. Varian. 2003. *How much information*. Berkeley: School of Information Management and Systems. University of California. http://www2.sims.berkeley.edu/research/projects/how-much-info-2003/

Moore, J.G., B.K. Krotoszynski, and H.J. O'Neill. 1984. Fecal odorgrams: a method for partial reconstruction of ancient and modern diets. *Digestive Diseases and Science* 29: 907–11.

Nagel, Thomas. 1974. What is it like to be a bat? *Philosophical Review* 83: 435–50.

Rosenzweig, Roy. 2003. Scarcity or abundance? Preserving the past in a digital era. *Journal of American History* 108: 735–62.

Seely Brown, John, and Paul Duguid. 2002. *The social life of information*. Boston: Harvard Business School Press.

Strlič, M., J. Thomas, T. Trafela, L. Cséfalvayová, I. Kralj Cigić, J. Kolar, and M. Cassar. 2009. Material degradomics: On the smell of old books. *Analytical Chemistry*, 81, no. 20: 8617–22.

Tandefelt, Marko, Donnie Bugden, Esa Vesmanen, Hilda Kozari, and Antti Louhivaara. 2009. Interactive digital cinema project. http://eyebeam.org/projects/interactive-digital-cinema-project–0

Turkel, William J. 2006. Every place is an archive: Environmental history and the interpretation of physical evidence. *Rethinking History* 10: 259–76.

Turkel, William J. 2007. *The archive of place: Unearthing the pasts of the Chilcotin plateau*. Vancouver: University of British Columbia Press.

Whitelaw, Mitchell. 2009. *Transduction, transmateriality, and expanded computing*. http://teemingvoid.blogspot.com/2009/01/transduction-transmateriality-and. html

Zalewski, Michal. 2005. *Silence on the wire: a field guide to passive reconnaissance and indirect attacks*. San Francisco: No Starch Press.