Special Effects; or, The Tooling Is Here. Where Are the Results?

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Abstract. Technological developments tend to move at a very different speed from their cultural assimilation. Hence it is not surprising that impressive technical wizardry should be used in culturally unimpressive ways. The real problem is one of imaginative maturity. Here I argue that Choueka's old question, "The tools are here; where are the results?", similarly directs humanist scholars to pay attention first to development of theory rather than to the features of software. For those who know where to look, the results we do have are hardly unimpressive, but to argue their importance requires a new understanding of both theory and practice. The problem scholars face is twofold: first to develop a computational discourse adequate to the best artefactual theories we have; second to reconceive their computational practices as a matter of tooling rather than tool-use. For computer science the biggest challenge is to understand and implement dynamical scholarly practices as they metamorphose from one temporary state to the next.

Keywords: digital humanities, metamorphosis, culture, results, tools, modelling, model systems, text-analysis, textual theory.

> iamque opus exegi, quod nec Iovis ira nec ignis nec poterit ferrum nec edax abolere uetustas… ore legar populi, perque omnia saecula fama (siquid habent ueri uatum praesagia) uiuam.
>
> *And now my work is done, which neither the wrath of Jove, nor fire, nor sword, nor the gnawing tooth of time shall ever be able to undo… I shall have mention on men's lips, and if the prophecy of bards have any truth, through all the ages shall I live in fame.*
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> Ovid, *Metamorphoses* 15.871-2, 878-9

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1 Mid-Atlantic, November 2007

The film *Transformers*, based on a children's toy launched about 2 decades ago, has just run its course on a tiny screen in the seat in front of me. Surprisingly, viewing it was not the mistake I had imagined, since it has supplied me with a useful allegory with which to begin. You need not have seen the film to appreciate the allegory. Its essentials are easy enough to imagine from the common experience of Hollywood blockbusters since the advent of "industrial light and magic". Any deficiencies of imagination can be supplied by the Web.[1]

The film's special effects – an astonishing display of technical wizardry, requiring clever algorithms and massive computing power – yield the best explanation for its box-office success. A puerile storyline, painfully vestigial, barely satisfies our primitive desire for a story. I say "vestigial" advisedly, because the ancient narrative archetype of metamorphosis that lies at the root of both toy and movie remains almost completely dormant. All we get are dramatic but repetitive transformations back and forth between apparent automobiles, trucks, airplanes and other mechanical devices and the extraterrestrial robotic life-forms they conceal. (Curiously, the life-forms are rearranged human artefacts, not the other way around.) But if we put aside the techno-paranoia of a fight-to-the-death invasion from outer space, the loud music, massive fire-power, maudlin sentimentality and the teenage hero's lust for his heroine, and if we recall the toy's ability to fascinate children with its crude transformations, the great archetype surfaces, though barely.

As the credits roll, I am left with a dissonant mixture of admiration for the staying-power of the archetype (which has been in the European cultural mainstream since Ovid wrote the words, quoted above, which conclude the *Metamorphoses*) and frustration that such a tool of thought should be so poorly used. This frustration is increased by calling to mind numerous advertisements, at least on British television, for automobiles whose virtues are depicted by playful, even witty illusions of momentary transformation, in one case into an ice-skating robot, in another serially into a spider, a snake, a crocodile and so on. The brief, non-narrative adverts are far more appealing because no story at all is better than a bad one.

I start with movie-as-allegory rather than simply argue for a particular view of computing because the movie helps me to make a much broader point and to introduce my theme, which is the metamorphic quality of digital computing. My point is that the situation we are in is not an isolated case. Rather the filmic allegory exemplifies the different speeds that technical developments and the cultural assimilation of them move, famously in the case of computing at *very* different speeds. This is not, I take it, because whatever we may mean by culture slows the mind with irrelevant considerations. To use a biological analogy, when an invention leaves the laboratory or workshop, enters the mainstream and starts to be regarded as a cultural artefact, it becomes evolutionary. It begins to signify, and so to become, in

[1] For current offerings see `www.transformersmovie.com/`; for Industrial Light and Magic, `www.ilm.com/` and `en.wikipedia.org/wiki/Industrial_Light_and_Magic` (31 October 2013).

the full sense of the term, *complex*. Cultural assimilation appears to move slowly because so much is happening, though mostly out of sight.

The telephone is particularly good for illustrating the uncertainty that may be involved. When Alexander Graham Bell invented the device in 1876, telephony had already been under discussion for many decades, but consensus as to its social function was not at all clear until the 1920s. As Ithiel de Sola Pool explains, the telephone supplied a technology for transmitting articulate sound, but there were "two conceptions of what society needed it for": switched point-to-point communication on the one hand or broadcasting on the other. [1: 14] The sociology of its use during those four decades of uncertainty, until the development of radio settled the matter, is both complex within each country that adopted it and significantly variable across national cultures. [2] Societies of the late 19th and early 20th centuries thus found themselves with technological abilities but no clear idea of what to do with them.

A tool, Dr Johnson wrote, is "Any instrument of manual operation" (*OED* 1.a) – including, we may add, programmable computers. But note that tool and operation are in principle co-dependent. Thus a rock becomes a tool when used to hammer something; binding that rock to a handle, thus adapting it more closely to human purposes, makes it a tool in a stronger sense. Contrariwise, the rock once tossed away becomes again only a rock; even the rock-stick reverts to the status of a mere object when in the hands of someone who has no idea of its use. Hence the co-dependency relation: the tool-ness of the object and the imaginative use of it create each other.

In his keynote address to the 1994 Digital Libraries conference, the late Paul Evan Peters optimistically declared that we seem to have emerged from the digital palaeolithic to find ourselves "*on the threshold of what can be productively thought of as human-kind's meso-electronic period*". In some respects, yes, but the emergence is demonstrably incomplete. To quote from an earlier and much more interesting American film, *Forbidden Planet* (1956) for commentary on *Transformers* and its ilk, the popular culture of the 21st Century would seem to be populated at least in part by creatures from a pre-human, dinosaur-like past of "monsters from the Id". We need to look to our imaginations more urgently than to our technologies.

2 ALLC, Jerusalem, June 1988

I have put the cart of commentary before the event-horse that powers it in order to emphasize the strength and usefulness of the horse. But now is time to stop speaking in riddles and get to the nub of this essay in honour of Yaacov Choueka.

At the conference of the Association for Literary and Linguistic Computing that he organized in Jerusalem in 1988, Choueka put me in charge of a panel asked to address the question, "The tools are here. Where are the results?" I do not recall any good answers. Certainly none came from me. Knowing the man, I strongly suspect he was being mischievous, but his demanding question was at the same time a badly needed reminder that the humanists among us had work to do: tools *were* there, but in many areas of inquiry results sparse. Now, twenty years later, much has changed. Promising, even impressive results are not difficult to find, at least in disciplines

where attention to data is primary. But abundance of results does not silence the questioning in the question Choueka asked. It survives and has survived these twenty years (a strong horse!) first to help pry open the very idea of having results in the humanities, then, and especially, to see beyond the tools we do have, or between conceptual neighbours, to imagine what we cannot even begin to talk about.

Powerful computing tools are here for scholars, just as they are for filmmakers. In both cases results are not hard to find. But in respect of what we as cultural beings have reason to think possible, those results are rudimentary. This is to be expected alongside our celebrations of work such as Choueka's, to which I was introduced through his demonstrations of the *Global Jewish Database* in the mid 1980s. But here, to honour the man, I want to focus on the road ahead, first to assess where we are with computing in the humanities, then to make some guesses as to what sort of a journey we might be on.

3 Results?

By questioning the very idea of *result* I do not mean to disparage achievements so far in computing, notably by collaborative research projects that have provided scholars with new means of examining old problems. These are achievements of which we can be justly proud, and for which developments in computer science have been crucial. Rather I wish to pick apart the connotations of the word *result*, as I might have done (but didn't) all those years ago, to figure out what work this word might do for a computing humanist.

One might think that getting a *result* – "the effect, consequence, issue, or outcome of some action, process, design, etc" (*OED* 3b) – would be entirely unproblematic, and certainly always better than not getting any. The problem I wish to finger arises when we stop there, with "the effect, consequence, issue, or outcome" and do not ask about the outcome of the outcome, or better yet, about the out*coming*. In failing to ask that question, we at least allow the "action, process, design, etc" to take on a sense of closure or finality – which suits only some circumstances of life. The one of interest here it suits quite poorly. When, for example, the police get a *result*, they have done their job and are rightly satisfied, but the problem has only begun for the offender and for society as a whole.

For research the desirability of closure depends on the kind with which one is engaged. The old distinction between "pure" and "applied" kinds makes the gross cut, but these terms also bring with them the deleterious suggestion that the applied kind is both polluted and derivative. [3: 35f] In the present context of making and using tools such connotations are especially damaging because they lead us to confuse the old, formerly aristocratic prejudice against work with the cry for freedom from the restricted mental horizons of "deliverables". Historically this prejudice is easy to spot, e.g. in Shakespeare's late 16th-century depiction of common labourers in *A Midsummer Night's Dream* as "rude mechanicals" or, earlier in that century, Spanish humanist Luis Vives' "relatively unusual… admission that 'peasants and artisans know nature better than so many philosophers' (*melius agricolae et fabri norunt quam ipsi tanti philosophi*)".

[4: 13] For us this prejudice survives in the idea of the mechanical as robotic, powerfully life-like but crucially deficient, e.g. in such contemporary phrases as "uncaring machine" or "merely engineering".[2] The latter attests to a widespread ignorance of epistemic practices that engage with the world directly rather than reason about it abstractly. I note that much recent work in the history and philosophy of the sciences and technology concentrates on arguing the case for artisanal "thing knowledge". [5] At the same time, from the other direction, the boundary between ourselves and things is rapidly becoming less distinct. [6]

Let us, however, put that set of problems aside by adopting the social scientists' language and so distinguish "wicked" from "benign" research, or "curiosity-motivated" from "mission-orientated", or simply contrast research conducted for its disturbing rather than its comforting effects. Bryan Norton points out in usefully computational terms that problems of the former kind – the wicked, curiosity-motivated, disturbing sort – have no "stopping rule". [7: 195]. In fact, when successfully addressed they not only fail to halt but multiply profusely, rhizomatically.

But what then? Whether this profusion of problems is taken as provocation to better questioning, to devise a more robust and comprehensive account or to add a new model or exemplar to the epistemic repetoire depends on the research. Like so many disciplinary terms what counts as a "result" varies widely across the disciplines. [8: 137-55]. In philosophy and among some other fields of the humanities, a result is whatever reveals a problem where none was suspected, or shows one to be much worse than anyone had realised. In engineering a result is something that works reliably, perhaps with the elegance of great economy or mechanical intricacy, or simply with joyous exhibition of doing something that seems impossible. In experimental science (to follow Ian Hacking's argument) it is to make a theoretical entity real by learning how to manipulate it. [9: 263] In mathematics it is a proof (which can be a negative one, such as Gödel's conclusive demonstration that we *cannot* rest). In each case, I am suggesting, a different balance is struck between vision and accomplishment: between, on the one hand, the recognition of critical finitude, incapacity or failure that illumines transcendent possibilities – a secular *via negativa*, if you will – and, on the other, a craftsman-like pride in one's work.

As a complex amalgam of disciplinary agendas, computer science is positioned close to the mathematical sciences in its study of computation, close to engineering in its software practices, close to experimental science in its encounter with physical constraints, close to sociology in its design of interactive tools and environments and ever closer to the humanities in its engagement with complex cultural phenomena [8: 158-98] So when a computer scientist asks, "Where are the *results*?", one has to wonder which disciplinary *persona* is speaking. If, as I have strong reason to believe, the computer scientist in question is a robustly integrated man of great wisdom and insight, then one must assume that all *personae* are speaking simultaneously. Hence the complexity of my response so far.

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[2] Reflect on how oddly unconvincing the friendly, caring Autobot Transformers are in comparison to the ruthless Decepticons.

4 The Humanist's Question

But I must simplify or fear never to finish this tribute to him. So henceforth, I respond by speaking solely from the humanist's vantage point, reversing and amplifying Choueka's question, thus: "The results of human cultural production we have. Where are the tools we need to do them justice?" Again, this may seem surprising, since tools abound throughout the humanities, as I admitted at the outset. Indeed, I am using several of them now, at the time of writing, and more will be put to use before you read these words. Still others await my return to my current research project. More are the subject of the courses I teach, and I am morally certain that still more are emergent in laboratories around the world. On closer inspection, however, precisely the same problem vexes us as did that panel in 1988. There may be many more tools now, and the ones we have may be far more sophisticated, but when brought up against the research problems of the humanities they prove to be as much "a stone adze in the hands of a cabinetmaker" as did searching tools to Vannevar Bush when he considered their capabilities in 1945 [10], and yet again "in spite of great progress", in 1965. [11][3] Despite much greater progress since then, were he alive today, being a very intelligent fellow, he'd quickly learn to be just as dissatisfied. But why?

Bush's metaphor vividly captures the scholar's frustration with crude tools, but it fails us because it posits a static and familiar object, namely the artefact which our cabinetmaker is trying to fashion. As I've argued elsewhere at length, the situation computers put us in is very different.

5 Types of Modelling

Actually computing creates for scholars three logically rather different modes of operation, depending on whether one is studying an existing cultural artefact, developing an idea into something that may be used for study or exploring the constraints of an environment with no clear idea of the outcome. Clifford Geertz called the first two "modelling *of*" and "modelling *for*", [13] [8: 20-72] Perhaps the third should not even be called a form of modelling, but the relationship between the second and third situations is so close that to exclude it would seem perverse. Here I will call it "emergent modelling", deliberately without a prepositional coda because there is no target in sight – certainly nothing to be *of* and not even something in mind to be *for*, at least not in the beginning, not consciously.[4] But however logically distinct, in practice these modes of operation merge into each other according to the demands of the situation, as when one plays with a text in a concordancer, notices an emergent pattern, then formulates that pattern provisionally, searches for it, modifies

[3] As Bush notes at the beginning of the 1967 article, "Memex Revisited", it was written in 1965 but not published until 1967.

[4] I am particularly indebted here to David Gooding for pointing out to me that what often happens in experimental work is a modelling toward something so (consciously) unknown that using the pronominal *it* is misleading.

the formulation as results suggest and uses it to provide evidence for an argument that reveals the basis for a prevalent impression about the text's meaning.

The first kind, modelling-of, is analytic. Its objective, for "wicked" research, is to iterate a computational representation of a scholarly object until the former converges as closely as possible on the latter. This convergence is asymptotic because cultural artefacts are essentially inexhaustible and certainly cannot be fully described even for a moment in computational terms (hence computing's *via negativa*). What matters is the gap, however small, between the model and the investigator's understanding. The point is to use that gap to raise the epistemological question, of *how we know what we somehow know*. The better the modelling tools and the better the modelling, the sharper that question becomes.

The second, modelling-for, is synthetic. It may be illustrated by numerous examples from industrial research and development, e.g. of aircraft, but in the interpretative disciplines it most often takes the form of complex databases specifically designed to facilitate exploration of multidimensional data. Tools such as the *Global Jewish Database* and *The Prosopography of the Byzantine World* provide excellent examples of an approach that has put primary source material into the hands of those who previously would have had to rest content with the conclusions of others. The point is not that the conclusions of the few are of dubious reliability – our disciplines discipline us otherwise – rather that they are fixed pronouncements and so disallow any modelling for other possibilities.

The third, emergent modelling, is considerably harder to discuss (therefore requiring more words) because, as I suggested earlier, it is not *of* or *for* something known, in reality or in consciously accessible imagination, and so cannot be systematically distinguished from unstructured play. When successful we often reach in retrospect for the word *serendipity*, Horace Walpole's coinage for "The faculty of making happy and unexpected discoveries by accident" (*OED*). Worried that the success has been due to blind luck, Lorraine Daston points out [14], we often quote Pasteur's dictum that "In the fields of observation, chance favours only the prepared mind", [15: 204] This, however, "does not really capture the essence of serendipity", she notes. "The mind of the discoverer must be not just prepared: it must be broadly enough prepared to register a clue to the solution of a completely different problem. Serendipity calls for a paradoxical combination of focused attention and peripheral intellectual vision. There is no serendipity without a flash of insight from left field, an oblique eureka effect." Thus, in Margaret Boden's sense, when it is successful, emergent modelling is a creative activity of the transformative kind. [16: 3-7] It results not in a new ordering of familiar ideas (combinatorial creativity) or a discovery of an unexplored path within the known conceptual space (exploratory), which are roughly comparable to the first two kinds of modelling and are both, as it were, central-vision activities. Rather its result is a redrawing of the conceptual map that comes from noticing something peripheral to it. Transformational creativity often begins, she points out, in playing around and pushing the limits of a given way of thinking. But again, we know emergent modelling as such, and not as simply a messing about, only in hindsight.

Emergent modelling lies at the core of experiment, which as David Gooding has written, "engages the inchoate, the practical, and the particular". [17: 122f] He notes that in the analytical philosophical tradition, experiment (like emergent modelling more generally) has suffered from a widespread disdain for mundane practice. We are reminded again of the prejudice implicit in the distinction between "pure" and "applied" research, which here takes the form of experiment's relegation to the subservient role of applying theory to the world in order to test its predictions. Since the 1980s, however, the discovery that "experiment has a life of its own" [9: 150] has changed our picture of scientific research profoundly. This is important not only for the experimental side of computer science but also for developing our understanding of how computing creates an experimental practice within the humanities. This in turn bears on convergences of the humanities and the sciences. [18]

6 Modelling with What?

So far I have been speaking more or less of modelling with algorithms or with algorithmic procedures, including situations in which judgements are made about data on the basis of what such procedures can do. Let us say, for example, that you want to work with both computationally tractable and intractable entities in a text. For the former you use software directly, for the latter metatextual tags, which declare e.g. that conceptual entity X occurs in textual locations Y_1, Y_2, Y_3 and so forth. This is algorithmic modelling, which is very close to both the text and the computer processing it. My *Analytical Onomasticon* project worked essentially at this level. [19]

Let us say that you decide to encode text using a systematic metalanguage, such as XML conformant to the standards established by the Text Encoding Initiative (TEI). In doing so you are still engaged in algorithmic modelling as above, but something else is happening. To work within the framework of the TEI you must adopt that framework, or what we might call a "model system"[5], which commits you to certain ways of thinking about text.[6] That is, it involves not just a modelling *of* your text in TEI markup but to greater or lesser degree a modelling *for* TEI-conformant structures in your text. We now know the TEI model system to be highly useful within the theoretical constraints it imposes – but that these constraints are severe. [24] I will return to this point shortly.

Alternatively, let us say that you employ a keyword-in-context (KWIC) concordancer, such as Michael Barlow's *Monoconc,* for the research. Because this sort of tool embodies a certain view of text and textual meaning, it is, once again, a model system. In this case, the system is strongly informed by ideas transmitted and

[5] I am adapting the term "model system" from [20]; see esp. the editors' Introduction and Mary S. Morgan's Afterword.

[6] For an overview of textual encoding, see [21: 24-48]; for "position statements" sketching out the essential lines of debate [22]; for a thorough discussion, chapters 14, 16 and 17 of [23]. The TEI maintains a large bibliography of writings at `www.tei-c.org/Activities/SIG/Education/tei_bibliography.xml` (31 October 2013).

developed by corpus linguistics from earlier work in textual computing, e.g. collocation and span, and by the visual design of the KWIC format. [25] Its widely acknowledged success establishes concordancing as a disciplinary model to think with. Once again, however, we know the model system to be useful but severely limited in what it can show. Obviously it cannot deal well with computationally intractable entities (for which markup provides), nor does it offer much to help the scholar triangulate on such entities by more sophisticated manipulation of the character-strings it can handle. The frequency lists *Monoconc* and similar programs can generate constitute a short step in that direction, but a very short step indeed.

Two possibilities open out from here – two quite different model systems. One of these is based on an important observation made separately by Stefán Sinclair [26] and Julia Flanders [27: 54], that concordancing and other text-analysis tools strand the scholar at a considerable distance from the locus of reading and thus create an impediment to criticism at the same time as they assist it. Two quite different responses are Sinclair's own *Voyeur* and John Bradley's *Pliny*, both of which identify annotation as an (or the) essential interpretative gesture.[7] Loosely, we might say, both participate in the same model system, or perhaps more helpfully we might say that both are working toward a common model system based on the ancient practice of glossing and commenting that continues to this day, perhaps most influentially in our informal practice of writing marginal notes.

The other possibility I mentioned opens out from the simple frequency-generation in concordancing software to embrace a loose assembly of tools and techniques for computational stylistics, most notably in the work of John Burrows.[29] [30] Again a particular view of text and textual meaning is implied, and again something like a model system or exemplary way of thinking with tools is involved. "We have mounting evidence", Burrows writes in a summary essay, "that work by different authors, work in different genres, work of different eras, work in different national forms of English can all comprise statistically distinguishable groups". [31: 28] This is possible, as he and others show, because what a reader perceives as an authorial voice, national style or the like is generated sub-consciously (but not automatically) from subtle patterns analytically visible only with the help of statistical software.

The last model system in my survey is relational database design, which I mentioned earlier as yielding the primary examples of modelling *for* in the humanities. Like the other model systems it assumes an idea of text (that it consists of relatively short discontinuous chunks susceptible to a high degree of structuring) and a theory of textual meaning (that it is plural and generated by ordering and reordering these chunks according to pre-defined relationships among them). The tendency in its application is at least partially to substitute categories for raw text and to specify textual structures, so it has some relation to textual encoding, but it differs radically in the fragmenting of original syntax. Because of this fragmenting it is particularly vulnerable to Sinclair's and Flander's criticism when applied to discursive text.

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[7] For Voyeur see `http://hermeneuti.ca/voyeur/background`, esp. with ref. to HyperPo [26]; for Pliny (`pliny.cch.kcl.ac.uk/`), see [28].

7 Textual Theory

In 1962, in "The Intellect's New Eye" (part of a series on the digital computer in the *Times Literary Supplement*), Margaret Masterman countered the argument for computing as a mere handmaiden to conventional work by suggesting "another, quite different, use for the digital computer… namely, its potential use not as a tool but as a telescope". [32] Borrowing from the history of 17th-century science, she argued for a device-model that unlike a spade (her idea of "just a tool") enlarges "the whole range of what its possessors [can] see and do… changing their whole picture of the world". She concluded that "[t]he potential capacity of the digital computer to process non-numerical data in novel ways – that capacity the surface of which has hardly been scratched as yet – is so great as to make of it the telescope of the mind".[8]

Such statements of promise are familiar to us all from a period of great optimism based on early results, most famously, perhaps, in artificial intelligence. [34] [35] [36] [37] [38] [39] [40] For textual studies, critical assessment came early, for example from Susan Wittig, in 1978. [41] Quoting Masterman's visionary words she argued that although "the computer *has* added immeasurably to the ability of literary analysts to perform better and more efficiently the same tasks that they have performed for many years", the machine had not by then, 16 years on, "enlarged our range of vision or radically changed for us the shape of the universe of esthetic discourse" (211). Wittig did not rule out the possibility of a paradigmatic shift, but meanwhile she laid the fault at the threshold not of computing or technical practice but of literary theory, specifically the school prevalent at the time, New Criticism. She directed attention to the question of "how we might put the computer to work within a more powerfully explanatory theory of literary experience", focusing precisely on the concept of *text*.

Since then practitioners have repeatedly wrung their hands in varying degrees of dispair over computing's lack of impact on the world of literary criticism, for example in special issues of both *Computers and the Humanities* (27.5-6, 1993) and *Literary and Linguistic Computing* (18.2, 2003). Meetings convened on the subject have inconclusively recommended either design of new tools (Princeton, May 1996) or better use of the ones we have (Virginia, September 2005). [42] [43] In the literature, critical focus has tended to be on theoretical and philosophical misconceptions, on the one hand of what computing does and can do, on the other (renewing Wittig's point) of text itself. In a comprehensive survey of the theoretical conditions for productive work, David Hoover has recently identified two concomitant sources of difficulty for text-analysis, Chomskyan linguistics, whose emphasis on linguistic competence diverts attention from literary performance, and "high theory" [44], which as Leonard Forster argued in the same year as Wittig's article, tends to turn quickly into a "flight from literature". [45] In several 21st-century contributions to the debate, the literary critic Jerome McGann has again asked Wittig's question but proposed a Bakhtinian conception of a "textual field" in which reader and text exist in co-dependent relation. [24] What is notable here is McGann's solid grasp both of what the codex book has

[8] Masterman's words were approvingly quoted in [33], from which Wittig, cited below, took them.

enabled us to do as critics and of how it has failed our best theoretical gropings toward what we might now do. He argues that digital technology must be, as it now is not, at least as good as codex technology, in parallel with but different from it.

My own research moved from the algorithmic level, in the *Analytical Onomasticon*, to a relational model for recording and systematizing literary judgements. The failures of both approaches to deal adequately with the dynamics of reading brought me to the same theoretical doorstep as McGann describes. Focusing most recently on the problem of literary context, I have come to argue with theoretical biologist Robert Rosen that the fundamental problem is the "mindset of reductionism, of looking only downward toward subsystems, and never upward and outward" that has crippled our computational efforts in criticism as much as the biologists' in understanding life. [46] [47] McGann's *Ivanhoe Game*, in which players experimentally rewrite a fixed text in order to understand its potentialities, and so gain an authorial "inner standing point" [48], is at least a step in the right direction. But beyond that baby-step lies *terra incognita*, which to explore requires model systems of a very different sort than we have made so far. It requires a vocabulary that we, culturally incunabular in the digital age, are just beginning to form.

8 Tooling Rather Than Tools

In drawing this essay to a close, I want to leave the reader with the conviction that in the digital medium tools matter far, far less than tooling, not just at the moment but in principle. That styles of tooling may change I am in no doubt, nor that, in some sense absolute to our frame of reference, we will get better at tooling. But what is new, what specific to digitality? It is perhaps always difficult to say at any time what is truly new, but we can, I think, identify a profound shift of emphasis in intellectual life, from propositional knowledge about the world, written down in and for a highly stable medium, toward epistemological processes of world-building urged on by computing. To echo Hacking again, in the bookish humanities, it is a shift from propositional *representation* of its worlds to processural *intervening* in them.

At the beginning of this essay I referred briefly to the telephone as an example of a technology that, somewhat like computing has often done, left its users in some perplexity as to its proper use. But the telephone does us much better service in its more recent history. For many years after it disappeared into the fabric of ordinary life, incremental changes were certainly made behind the scenes, but the device itself remained highly stable, with its brilliantly simple interface design, until the advent of the mobile (cell) phone. The history of the mobile is complicated by its overlap with wireless telephony and gradual invention of the several components involved in the technology as we know it today. Roughly, however, the revolutionary social phenomenon of mobile telephony began in the early 1990s with the first handsets small enough to be carried on the person. Minaturization followed developments in digital computing, but the surprising, perhaps even unpredictable effect of digitality was not to minaturize. Minaturization, as William Wulf has remarked about the

digital computer generally, could easily have been foreseen by a competent engineer.[9] In the case of the mobile phone, the striking effect was its technologically destabilizing force. Digital computing allowed function to be separated from form, and the function of telephony as it had been understood to be combined with others, not only housing them together but also blurring the distinctions among them. A new, still fluid genre of device had emerged.[10]

Because historical contingency plays such a large role in the outcome, it would be folly to guess when or even if telephony will re-stabilize. But to return to the subject of tools, my point in any case is the larger one of digitality's effect on the very notion of tool, both reversing and temporalizing it. Dr Johnson's definition, "an instrument of manual operation", no longer seems quite apt. Perhaps we should rather say, *a manual operation manifested temporarily in a particular way in one or more particular instruments*. The uncertain status of any given digital assortment of functions is not due to our ignorance of what will be or to our inability to grasp the logic of the situation. For either to be true, we'd have to assume a teleology of mundane things. Rather it results from the mutability, hence manipulability of the digital medium, its utter plasticity and its availability to us, acculturated as we are now to restless innovation. Digitality invites metamorphosis.

This is, of course, happening on the relatively stable basis of systems software whose layered design allows for relatively long-term stability. But the digital research tools of concern to scholars directly are relatively unstable, and – here is my point – they are so precisely because *they are tools for research*, which is always in motion. It would be quite convenient from a tool-builder's perspective if a set of low-level tools (analogous to those in Unix) could be implemented from a common set of scholarly "primitives", but the existence of such primitives remains an open question – if indeed the notion of such primitives is even a coherent one.[11] Some argue that scholars should become programmers; others observe that a few are, despite the professional risk this still involves. Since programming languages and orientations are more like trends than bedrock, themselves giving no sign of long-term stability, advocating a scholar's programming language is unlikely to prove persuasive or further attempts at one successful.

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[9] Remark made at the Roundtable Meeting, Computer Science and Telecommunications Board, National Research Council (U.S.), 28 March 1997; see [49].

[10] For purposes of my argument I am ignoring the additional role of the change from line-switching to packet-switching, which makes a range of more fluid options available, as shown e.g. by Skype, with its ability to converge and diverge a range of digital services. I am indebted on this point to Dr Carsten Sorensen, London School of Economics (private e-mail, 4 December 2007).

[11] For computational primitives in the humanities, see [50]. The coherence of the notion in its strong form (as denoting a finite set of actual components rather than a commonly observed set of actions) is questionable because it assumes a reductive process that can take no account of co-dependent relations between what scholars in any given instance do and how they do it.

Finally, in answer to an old friend, in looking around I find that the tools I need for my own wicked research are *not* here – nor, as far as I know, anywhere else.[12] But even if they were, I'd hope quickly to grow dissatisfied. In plain but broader terms my argument is that they never will be simply *here*. The tools we do have, like the results we generate, serve chiefly to identify areas for further research. In other words, we do not simply apply tools to objects of study, even if we call it "modelling". What we are actually engaged in is a model-building, tool-making activity that shows no sign of perfection or even closure. Hence my recommendation is that, forever cautious about resting on our achievements, we ask with gratitude to Yaacov Choueka, "The tooling is here. Where are the results?"

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[12] My qualification isn't simply a rhetorical flourish: tools in someone's lab are not *here*, and quite often, it seems, never will be. To cite but one famous example, *NoteCards,* developed at Xerox PARC, would have made a great difference in the humanities had it ever successfully emerged from the lab, but it never did, except in a minor way through *HyperCard* on the Macintosh.

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