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Chapter 2

The Field of Digital Technology Research

Charles Crook

This chapter will explore the landscape of social activity within which digital technology now plays a significant part. The aim is to understand why social scientists have developed so much interest in our relationship with this technology. The particular ways in which that relationship is played out will be more closely scrutinized by other authors in this Handbook. In common with those later chapters, the present overview of the research landscape adopts a social and cultural orientation towards the digital world. This means that, in particular, it will bypass reviewing the emergence of digital technology in engineering and mathematical terms (those matters are addressed in the preceding chapter).

Any such socio-cultural overview must inevitably have a piecemeal quality. Space permits only the sketching of an indicative set of those themes attracting the social scientist towards matters of digital technology. Moreover, no attempt will be made here to offer a unifying theoretical frame for making sense of these themes – that is a challenge for others to address, later in the book. Nevertheless, a scoping exercise such as this one remains useful: it furnishes an organizing birds-eye view of the territory to be interpreted. To get started on this scene-setting, it will help to reflect a little on the terms

'digital' and 'technology'. This will define and contain the boundaries of our concern and specify a structure for the overview that follows.

THE DIGITAL OBJECT

As I write this, I can hear music from the Miles Davis recording, 'Kind of Blue'. Some readers may own this music in its earliest format: as an 'LP' – a 'record', a 'disc'. In my own case, I also own it as a CD and in the format of an MP3 file. Perhaps first thoughts about the digital world gather around something like this example. That is, a familiar and concrete object, that we now see mutating under the influence of digitization. So, there is continuity here, but also discontinuity: similar things but, perhaps, changing engagements with those things. Clearly, there are many examples of fresh engagement around the capture, storing, manipulating and sharing of such digital representations: certainly as music but, also, as all variety (and mix) of image, sound and text. Again: the underlying *practices* of such engagement are surely familiar, yet, at the same time, there is a sense of them being re-configured.

The mundane but pervasive case of a music recording highlights a technical matter right at the heart of our concerns: namely, something distinctive about the manner of *coding* things. Current enthusiasm for discourses about 'this digital world' can be understood in terms of the radical consequences of a shift towards the widespread digital coding of information. In the case of music, that shift has been away from the traditional analogue method. On the vinyl version of 'Kind of Blue', sound has been captured and stored as a continuous waveform. It is visible as the undulating groves on the surface of a disc. There is an agreeable directness typical of pre-digital representation – a matching of

the object and the coding. However, on the CD and MP3 (digital) formats, the waveform of sound has been repeatedly sampled and reconstructed as a long list of successive numerical values: those values being coded as binary numbers. Stark temporal sequences of 1s and 0s are made permanent through the basic electrical states of either being 'on' or 'off'. Such coding is much less easily visible to the naked eye. Yet, compared to the analogue alternative, it offers a highly versatile format. Therefore, a wide variety of input material can be assimilated to the same digital code. In that coded form, material can be readily compressed, manipulated, copied and transmitted. Moreover, given only a small and accessible toolset, it can be *de*-coded and *re*-transmitted. In recent times our appetite for digital representations and our creativity in managing them has flourished.

To exploit the versatility and abundance of items coded digitally, there has evolved an associated infrastructure of access and transport: a public framework for transmission, exchange and participation. Arguably, the *technology* of the digital, in this sense of its mechanisms for access, is one starting point for a deeper consideration of digital artefacts as cultural phenomena. In particular, this might involve considering how the digital infrastructure serves to re-define the time, place and format of our engagements with captured cultural material, thereby altering how it variously enters and interleaves with everyday living. This applies to a wide range of 'information': my newspaper, photo album, city guide, bank statement, unfinished novel, and so on. Moreover, the hosting technologies for these artefacts increasingly invite their owners into an active relationship with the hosted material: interacting, interrogating and manipulating whatever digital objects they can access.

So, digitization shapes how we interact with material artefacts but it also shapes our *social* lives: functioning to offer new points of reference within the interactions we cultivate with others. This may occur at both the interpersonal level ('you and me') and the community level ('us'). For example, I may introduce you to my favourite music by sharing it with you as a copy of some digital file. At the more communal level, a selection from someone's 'Kind of Blue' recording might form the basis of a posting on a website – a space designed to allow a larger (and unknown) audience to share such material. It might, for example, be posted as background to a personal video of a peaceful seascape (see YouTube 2006). Moreover, that same web service also permits construction of an extended text commentary, whereby large numbers of users can reflect and interact around the posted digital artefact. Of course, all such social exchange does not *demand* digitization but it has been greatly elaborated by that technology.

This modest example illustrates a further sense in which the technology of the digital shapes human activity. Not, in this case, through furnishing an infrastructure of sharing objects, but through offering a technology of tools to act upon them: resources that permit the easy exploration and manipulation of digital representations. The owner of the YouTube posting cited above has *mixed* Miles Davis's music with a video, doing so in a way that offers a novel experience for its audience. Moreover, the growth of such creative activity invites us to explore an interpretative dimension of engaging with digital material. The audience must *understand* the constructed artefact. The users of a digital medium must learn how to 'read' (and, perhaps, admire) its objects. Digital media afford new modes of expression that come with their own syntax and semantics. Thus, in addition to mediating new forms of access and new forms of social interaction, digital

technology may demand new strategies of meaning-making: a fresh confidence of interpretation.

To summarize this introduction: the iconic case of a piece of digitally coded music has been worked up as an everyday example of the digital ecology now commonplace within economically developed societies. Implicitly, the example has identified three different senses of 'technology' in the phrase 'digital technology'. First, there is 'technology' as a strategy for digitally *coding* (and compressing) recordable events in the world. Second, there is 'technology' in the form of a digital *infrastructure* designed for transporting those objects and offering engagement with them. Third, there is 'technology' as a set of digital *tools*: resources that permit the creation, representation, manipulation and analysis of the objects so transported.

Now consider the music example in terms of these three senses of digital technology. First, a jazz session may be coded for recording in more than one way. However, the *digital* version imparts an interesting slipperiness to the resulting object: because it is easily replicated, simple to access, and open to be altered with digital tools. Next, an infrastructure of digital transport allows fluent exchange and publication of such objects. Publication creates audience. Audiences create the conditions for acts of interpretation, debate and commentary. Publication also creates issues of ownership and security. While ownership, in turn, creates questions about authenticity and authority. Ownership may also encourage incorporation of such material into public displays of personal or brand identity. It is not that these patterns of activity are anything new; it is more that digitisation has imbued them with a sudden energy – one which is visibly engaging a large sector of society as participants, and one where participation relates to a wide range

of cultural practices. It may also be argued that the forms of relationships with the social and material world that emerge from these changes do indeed confront us with a challenging novelty and discontinuity (Caldwell 2000; Weinberger 2002).

All such manipulation and trafficking in digital objects is of natural interest to social scientists, because most of what is happening in such examples does so within the social microstructure of everyday life. However, there is also a societal *macro*structure to consider. Digitization has been illustrated here through the personal and mundane example of musical recording. But this complex of reproduction, manipulation, sharing, publication, commentary and identity management is active in relation to a very wide range of digital material, and, moreover, such material can implicate a very wide range of actors and organizations. So, even the simple acts of individuals in the digital infrastructure may generate products that are wrapped up in the ambitions of industries, institutions and political interests (Castells 1996). Those ambitions may construct for the citizens of a digital world very different conditions of working and living (Harvey 1989). All of this is further reason why the trajectory of digital technology will be of great interest to social scientists.

The discussion so far has dwelt upon digital technology as expressed in the form of digital objects – that is, files or documents broadly understood. The examples above, while familiar, might be judged to convey too narrow a conception of the contexts in which digital technology is encountered. Accordingly, in the next section the nature of the 'digital environment' will be discussed more broadly.

THE DIGITAL ENVIRONMENT: IMMATERIALITY, VIRTUAL WORLDS AND AUGMENTATION

Certainly, one way to characterize the digital environment is in the terms acknowledged immediately above – as a complex of relationships with digital objects. But a striking feature of the digital 'object' is its immaterial character. Although our access to the digital is usually through the physical means of screens, keys, pointers etc., the representations accessed that way are rendered in the bits and bytes of digital code. Accordingly, one strand of social science research has been to understand the consequence of this apparent loss of materiality in the field of action.

This loss is sometimes expressed as a wider nostalgia for ways of acting that ensure continuity between ourselves and the natural world – nostalgia for everyday practices entailing a greater awareness of human agency and a greater sensitivity to the relationships between processes and their products (Watts 1971). Another way to express unease about immateriality, is in terms of how technology underpins the erosion of craftsmanship (Sennett 2006). Traditionally, this concern would have dwelt upon alienation arising from over-specialized forms of labour that disengage the individual from the creative process. But digital technology is also implicated in potentially pulling us apart within the *interpersonal* structures of work, as well as fragmenting and disconnecting labour in terms of material action. Thus the 'information management' perspective cultivated through digital technologies may encourage the enthusiastic proceduralizing or 'engineering' of workplace *processes*. This, in turn may mean the loss of that informal and lateral communication underpinning the *practice* of work (Zuboff 1984). Relationships with authority move from a consensual form to an 'informated'

form, in which reified categories of analysis replace understanding from traditional forms of social exchange. On the other hand, as Brown and Duguid (2000) illustrate in articulating this concern, digital technology may be recruited to *support* more intimate communication as well as depose it. Clearly, this is a dimension of experience within digital environments that social scientists will want to understand.

The infusion of an immateriality into digitally-mediated interactions is often associated with the term 'virtualization'. This defines a second strand of the digital environment. However 'virtual' is a term that can be used generously – covering all manner of local exchanges with digital artefacts. Yet in the particular phrasing of 'virtual world', it suggests something more integrated than the rather piecemeal environment of 'digital objects' discussed earlier. In fact, it suggests a more profound version of immateriality: in the shape of comprehensive 'worlds' or wholesale simulations of realistic scenarios. These might range from the goggle-and-glove technology of virtual reality systems to the simpler screen-based designs typical of Second Life and online multiplayer games. Evidently the degree of other-world fidelity that is achieved across this range of virtualizing implementations will vary.

These virtual world contexts have been of interest to social scientists for at least three broad reasons: immersion, embodiment and identity. First, states of personal 'immersion' (strong feelings of presence in some simulation) are claimed for virtual world experience. For example, in the context of games, this is sometimes termed 'gameflow' (Sweetser and Wyeth 2005). Although the experience of immersion has not been well theorized – perhaps reflecting the wide range of depths and forms around which it is invoked – immersion is often presented as a subset of the more general experience of 'presence',

whereby the users of some system have a strong feeling of them (or their avatar) being within a digitally constructed scenario. Understanding the depth of these experiences is of importance because they are increasingly implicated in supporting, amongst other things, risk simulation, skills training, clinical therapies and education.

A second and related research theme around virtual worlds is that of embodiment, or the sense of being disconnected from the physical agency of one's body. Evidently such experiences are related to what has been referred to as 'presence' and its phenomenology. However, a focus on the awareness of one's own body resonates with an established theoretical tradition that considers the role of embodiment in shaping cognition and understanding (Dreyfus 1972; Varela et al. 1991). The pursuit of this topic finds its most extreme form in Moravec's (1988) ambition to download human consciousness into a computer. The complex of digital worlds that virtualization promises has encouraged the tradition of 'cyberculture theorists' (Bell, 2007) who have developed for these worlds a distinct form of theorizing the way participants experience and interact.

A third research theme within the tradition of virtual worlds concerns implications for the construction and expression of personal identity. Turkle (e.g. 1995) has been a leading theorist investigating the way in which ideas about ourselves are influenced by sustained engagement with virtual worlds, or 'life on the screen'. Since Turkle's early insights around this topic, research interest in the performance of social identity has spread to embrace not just virtual worlds but the wider space of social networking (boyd, 2010).

The discussion so far has acknowledged 'digital environment' first in terms of pervasive but immaterial objects and the interactions they afford us and, second, in terms of a more all-embracing virtualization of sensory experience. Finally, there is an approach to the construction of 'digital environments' that is less about such wholesale construction of digital worlds and more about a creative interleaving with existing and material worlds. This is often phrased in terms of the 'ubiquity' of digital devices and the 'augmenting' of reality. Such matters can be understood against an established tradition whereby the typical site of engagement with digital goods has been a circumscribed piece of hardware. Traditionally, the iconic site has been a personal computer. More recently, mobile telephony, laptop or tablet computers, and wireless networking have all made the Internet a 'ubiquitous' experience (Weiser 1994). Users can now find connections on the move and can make them with only minimal hardware. As some describe this pervasive access: ' ... losing it can feel like being stranded. Constant connectivity has changed what it means to participate in life' (Grant et al. 2006). Moreover, this intense connectivity is not only a matter of the person-to-person exchange afforded by a digitization of communication through mobile phones. Digital codes are increasingly embedded in the wider world around us, such that our personal devices can read those embedded codes and connect in yet more novel ways with other people, services and events.

Digitally augmenting an environment typically assumes that a person engaging with it will have a reading device of some kind (this might be a smart phone for instance). Augmentation may then be simply by location, which might be achieved by GPS estimations. Or it might be by direct reading of structural features of some object (e.g. a posted picture). This is computationally intensive and so a more common method is

through some kind of suitably positioned 'marker' that provides information in standard format, such as a bar code. Such constructions are of research interest because they may enhance people's encounter with specialist environments, such as museums. They are now designed in increasingly dynamic formats: so as to allow more adaptive interaction between individuals and these environments. There has thus evolved a species of augmented reality game – often based in urban settings – and, a developing subset of this species, the augmented reality educational activity.

The digital environment has been characterized here in three broad-brush ways. First, we may consider our environments as variously digitized according to how far interactions with them are shaped by access to and interaction with individual digital objects – music, images, documents, etc. Second an environment may be more dramatically digitized into a self-contained virtual world – offering varying degrees of felt presence and immersion. Finally, environments may be overlayed with digital markers or location 'hotspots' such that space acquires a kind of 'intelligence'. This last case is of special interest where that intelligence is rendered to the actor in a relatively transparent and seamless fashion.

Developments such as those sketched in this section are increasingly familiar to us. What is more intriguing is the challenge of understanding their impact: how they exert an influence on our experience of the world and our cultural practices within it. Later in this chapter some further examples will be explored of how digitalization shapes particular aspects of our experience. However, as a preface to that discussion, it is appropriate to consider how such 'digital effects' are best theorized.

CONCEPTUALIZING THE IMPACT OF THE DIGITAL

The highly digitized world has a technical history that has been summarized in Chapter 1 of this Handbook and elsewhere (e.g. Gleick 2011). From that history it is tempting to seek key turning points that define 'impact': crucial innovations that might be causally linked to changes in social practice. For instance, primary causes of change might be ascribed to the emergence of the transistor as an electrical switching device, or to Shannon's (1948) theorization of information flow using a metric based on binary coding. But such achievements of engineering, logic and mathematics do not simply trigger upheavals that then define 'our new digital world'. Such achievements must resonate with prevailing socio-cultural forces. Those forces will shape and direct how such technical products are actually adopted: what then evolves reflects the human aspirations and appetites of their times.

From the pressure of such forces there has emerged those 'information goods' (Shapiro and Varian 1999) that define a distinct species of economy: one based upon intangible products. Such products include anything that can be rendered in the bits and bytes of digital coding (music, magazines, invoices, etc.) but they also include digital services (such as search engines and sites for user publishing). Considered together, these may be termed 'digital goods' (Loebbecke 2002). Their dematerialized character allows trading around them to flourish within a particular transmission infrastructure – most notably, the Internet. However, the economic viability of digital goods will often depend on achieving a critical mass of consumer access and engagement; in relation to which, many digital goods (particularly those supporting personal communication) benefit dramatically from 'network effects' (Rohlfs 1974). Under these circumstances, increased

levels of adoption act to the advantage of existing users, such that growth in the digital economy thereby will accelerate. That has now happened for many goods. These are developments which have, in turn, stimulated new technologies that further motivate that growth – notably the technologies of faster communications, more intuitive interface designs, and easy-access delivery devices. Caldwell (2000) has argued that within such network effects there can occur 'tipping points' when the pace of adoption and influence manifests a seemingly sudden impact and discontinuity.

The key point is that this growth was not a straightforward or direct response to the technical achievement of digital coding. The growth associated with digitization has been characterized by a generative interplay of technical innovation with cultural practices and preferences. Understanding this interplay has itself been a matter of great interest to economists and researchers of marketing. The digital economy sustains distinctive structures of consumption (Rayna 2008). For instance, on the one hand, the pervasive dynamic of 'network effects' can stimulate innovation and growth. On the other, it can be a source of 'lock in' to particular brands and services.

In sum, the current configuration of a digital world has not been brought about by the technology of digital coding exerting some straightforward pattern of direct causal influence or impact. Where we are now has arisen from a complex interplay between technical designs and cultural appetites. Social scientists have been strongly engaged by the challenge of understanding such a dynamic and from that interest has evolved a tradition of theorizing termed 'the social construction of technology' or SCOT (Bijker et al. 1987). One particular caution that such researchers often urge concerns the assumption that digitization brings about dramatic discontinuities – in how we think, act, engage with

others, or represent the world (e.g. Weinberger 2002). Current new technologies can be seen as continuous with a long history of technology being incorporated into human construction and craftsmanship (Sennett 2008; Sigfried 1948). New media have always been implicated in shifting patterns of how we think and how we re-present our experience (Friedberg 2006; Olson 1994).

Given that these new technologies are so pervasive in everyday life, it might seem unexceptional to note that social scientists attend to digital matters – but are these digital matters any more than a fine tuning to the ease of how we live? In practice, some adoptions of digital technology are much more than this and some invite the attention of social science more urgently than others. These may be understood in terms of the manner in which they re-*mediate* human activity in significant ways. In fact, the term 'mediation' deserves careful marking as a valuable one in this context.

Cole and Griffin (1980) contrast the term with a traditional understanding of technological innovations that employs various discourses of efficiency, economy or amplification. They argue that such terminology constrains our vision of change and influence. 'Amplification' (in engineering) implies increasing the strength of some signal – with no change to the basic structure of what is being amplified. In the case of human activity, it may sometimes seem harmless to invoke the amplification metaphor in this 'strengthening' sense. For instance, relative to a bicycle, a motor car amplifies the speed of getting from A to B. But it also radically changes our experience of transport; it re-shapes our engagements with the world in all sorts of ways. So, we can say that the internal combustion engine '*re-mediates*' the cultural practice of travel: motor cars do not simply speed up travelling, they re-structure our world – doing so around how they solve

the basic need for travel. Similarly, appropriating a digital technology into some cultural practice (say, education, shopping or banking) is not simply 'strengthening' that practice, say in terms of its pace, efficiency or economy, it causes that practice to be executed differently. It re-mediates the structure of how we act. Social scientists must have a natural interest in these transformations. That scope of that interest – expressed as re-mediations – will be sketched in the following sections.

Accordingly, in the remainder of this essay, a simple three-part structure will be deployed to organize an overview of some central issues pertaining to digital technology research. Under each heading attention will be given to how this technology re-mediates forms of human experience and varieties of cultural practice. First, issues concerning how individuals integrate digital technologies with their everyday activity will be considered under the heading of *prosthesis*. Second, a section on digital *representation* will discuss how these media afford new opportunities for expressive activity, and new challenges for the reading or interpretation of such constructions. Finally, a section on *coordination* will address digital media within social interactions: considering the various ways in which this technology supports communication, collaboration and participation with other people.

DIGITAL PROSTHESIS

The term prosthesis implies circumstances in which technologies are incorporated into human action in a manner that creates more elaborate systems of action. Of particular interest here is what may be termed 'cognitive prosthesis' (Clark 2003), meaning the possibility of these technologies extending the way in which we think and reason. Such

possibilities are a natural concern of Psychology, although that discipline adopted the idea of prosthesis only after having explored other motives for engaging with digital technologies as a resource for understanding mental life.

Arguably, Psychology has been the only social science discipline that embraced digitization through appropriating the mathematical and engineering concepts that lie behind it. It was Shannon's (1948) seminal work on information theory that argued the possibility of measuring information and, thus, systematizing the scientific study of communication. His paper opened with the following observation:

> The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have meaning; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem. (1948: 379)

As Gleick comments 'A psychologist could hardly fail to consider the case where the source of the message is the outside world and the receiver is in the mind' (2011: 259). Accordingly, researchers started to conceptualize mental life in computational terms: thinking of the mind as an information processing and transmitting system (e.g. Attneave 1959; Broadbent 1958). Behaviourism's oppressive language of 'stimulus' and 'response' gave way to a vocabulary that framed human cognition in terms of the transmission and reception of information, with decision making being a matter of reducing (measurable) levels of information uncertainty. Much was made of the limited 'channel capacity' of this human cognitive system, with Miller (1958) stressing our ability to overcome this by strategically re-coding incoming information. Indeed the ingenuity with which the

cognitive system undertakes this organization of input became the basis of a richer form of cognitive psychology: one richer than that based slavishly on the computational models of information theory. However, an understanding of the neurone as a binary signal device continues to invite theorizing based upon information processing: but, now, more the *pattern*-forming activity of digital systems (e.g. connectionist theories of learning).

Yet this computational metaphor of mind has recently been reconsidered. Since the early 1990s, the work of Vygotsky (1978) and other cultural-historical theorists has stressed the significance of tools as a theoretical resource for understanding human thinking. For example, much has been made of the emergence of writing and, subsequently, printing as technologies that alter human cognition, consciousness and social relations (e.g. Olson 1994). At the same time, empirical studies of human thinking in natural situations of problem solving (e.g. Hutchins 1995) have encouraged a conception of cognition as 'distributed' (Salomon 1993) – meaning that mental activity naturally incorporates the resources of the material and social world into its computations. Subsequently, Clark and others further articulated this idea through the notion of an 'extended mind', radically questioning the idea of the human mind as something bounded by the human skull (Clark 2003; Clark and Chalmers 1998).

This direction of theorizing is often illustrated through a popular quote from the writing of the anthropologist Gregory Bateson. He reflects:

Suppose I am a blind man, and I use a stick. I go tap, tap, tap. Where do *I* start? Is my mental system bounded at the hand of the stick? Is it bounded by my

skin? Does it start halfway up the stick? Does it start at the top of the stick?

(Bateson 1972: 459)

The man's stick is a prosthesis. It could be said to be a 'cognitive prosthesis' in that it doubtless incorporates its data (tap, tap, tap) into the man's thinking and reasoning. Evidently the rich information management that is afforded by digital tools will make them a significant component of this 'extended mind'. However, as stressed earlier, this would not be a simple matter of 'amplifying' the mind's capabilities. A recent study by Sparrow, Liu and Wegner (2011) demonstrates how digital extensions for remembering work by changing the structure of that cognitive practice. They show how being aware of the Internet as a memory resource re-mediates the manner in which we learn new information. So, expecting to have Internet access actually attenuates remembering for the information itself, while enhancing memory for where to find it (online).

This cognitive prosthetic conception of digital technology evidently attracts the research activity of psychologists but it also has implications for pedagogy and the design of schooling. It is, therefore, not surprising to find many manifestos for educational innovation placing digital technology in the foreground of their vision. Yet a recurring concern within the social sciences is the apparent reluctance of educational practitioners to embrace the demands of adapting practice towards a more cognitive prosthetic conception of learning and inquiry (Collins and Halverson 2009).

REPRESENTATION

Central to the cultural evolution of the modern mind has been our ingenuity in capturing experience and then re-presenting it, both for the self and for others (cf. Donald 1991).

We naturally think of language as a key representational vehicle for such purposes: first through the voice patterns of oral tradition and then, most powerfully, by means of writing things down. Indeed, much educational practice relates to this: it concentrates on the effort of establishing print literacy in young people (Olson and Torrance 2009).

Written text can, of course, be encountered in a digital format. This observation may seem unexceptional – merely a matter of migrating text from one physical medium (page) to another (screen). But there is plenty of research that illustrates the demands of engaging comfortably with this re-mediated version of writing (Haas 1996), because these 'migrations' entail formats that may sometimes disorient the inexperienced user – particularly if they impose new designs on objects known by names inherited from older traditions. For example, a digital newspaper might need to be read differently from the print version and yet it is still presented to the user as 'a newspaper'. Similarly, a student's (digital) essay may exploit presentational possibilities not easily recruited in traditional academic formats and so demand a reading different to a purely textual composition.

Certainly, the impact of digital technologies on the representation of human knowledge goes further than shifting the medium of writing from page to screen. So much so that the phrase 'digital literacy' has become fashionable. Its cultivation is often presented as a modern challenge for educational practice (Cervetti et al. 2006). The term 'literacy' has thereby expanded to embrace much more than its original association with the printed word: extending from 'the ability to read and write' to 'the ability to understand information however presented' (Lanham 1995: 198). Kress (2003) in particular has argued for the increased importance of 'multimodality or the ability to

express ideas across a wide range of representational systems'. On this analysis, each medium of communication has its own constraints and affordances. Digital literacy is about acquiring confidence in 'reading' these systems (Buckingham 1993). Social science research explores both the nature of these new expressive forms as well as the practical challenge of preparing us for the interpretative reading that they demand (Bateman 2011).

However, the above sketch of changing literacy demands needs to be expanded. It needs to acknowledge the wider and institutional reach of these innovations: in particular, the ways in which traditional and public genres of expression or communication are being re-mediated by digital technology. In the arts, this often reflects the potential of digital media to enhance the interactivity of performance or the participation of audiences (e.g. Ryan 1997), and there is growing interest in 'electronic literature' (Hayles 2008) with its multimodal possibilities. In the context of scholarship, an influence of digital media has been felt less at the level of multimodality and more in terms of a greater inclusion of authorship and new methods of knowledge organization and access. Remarks on each of these topics below should indicate how they would interest social science research.

In relation to the first issue – authorship of knowledge – both (internet) digitization of publication and the flat structuring of access to the global networks has allowed wider participation in the public conversations of knowledge construction. Anderson's (2006) thesis of the 'long tail' draws attention to how the Internet supports access to more obscure items (i.e. those that would normally be lost on the 'long tail' of a retail demand curve). Today, items that would not survive in the real-world marketplace may more

easily find an Internet niche where they might then be discovered. Our ability to find low-popularity books and music is often cited as the reward of protecting (and celebrating) the long tail. However, information of any kind can be long-tail protected in this way, including scholarship. The ubiquitous Web provides powerful tools for a wider constituency of authors (those defining the flat extent of this tail) to publish their ideas. This in turn raises issues of authority: a concern that has been highlighted by the sceptic Keen (2007), who diagnoses a dangerous 'cult of the amateur', as processes that protect the authority and credibility of scholarship (or news or commentary) are rendered more permeable. One sense in which these become core social science concerns is in relation to the new imperatives that are created for inducting students into thoughtful enquiry in this arena. In a sense this is a further extension of the need to prepare digital literacy – but a form of literacy that includes more than usual attention to the social and political construction of public knowledge.

The same imperative applies to digital influence in the structural organization of knowledge, particularly in relation to designing architectures that permit comfortable inquiry and search. It is inevitable that the growth of digitally-coded information increasingly challenges our ability to conduct rational search. Of course, it is also true that the tools of digital search become more sophisticated in parallel with this abundance of information. But the authority and strategies of those tools needs to be interrogated and understood. It may be for the information sciences to articulate those properties (e.g. Morville 2005) but it is for social sciences to design and implement the pedagogic processes that ensure such digital literacy is effectively cultivated.

COORDINATION

This final section considers the mediation of digital technology within the social exchanges in which we take part. It is interesting that this technology – at least in the form of the personal computer – was originally characterized in terms of its potential for socially isolating its users. Early research observers in both work and play settings were fond of documenting a rather compulsive pattern of engagement (Kidder 1984; Turkle 1984). Typical concerns voiced at the time cautioned against technology cultivating within learners 'thought in isolation' (Kreuger et al. 1989: 113), predicting that 'What is learned, then, is passivity and alienation from oneself and others, and that the most fruitful relationships with people will be as passive and impersonal as the solitary interaction with the computer (Kreuger et al. 1989: 114). While such marginalized absorption can still be documented, it is striking how the technology is now seen in terms of its potency for social networking, not social isolation.

The range of issues that could be discussed under this heading is very large. The intention here is merely to summarize them and give a flavour of the challenges currently available to social science research. This summary will be organized through brief consideration of three themes: the digital mediation of personal communication, collaborative relationships, and structures for participation.

Mediating Coordination – Relationships and Interactions

For describing patterns of personal communication that are digitally mediated, the phrase 'social networking' is very familiar. It conveys a positive tone. Perhaps a human concern to be in harmony with others. Yet the designs of social networking are not universally

applauded. Benninger (1989) ventures a parallel between the mechanization of labour in the nineteenth century and the current spread of a proceduralizing bureaucracy that now mechanizes personal relations. Social software may contribute by formalizing the informal. As boyd (2007a) observes, networked conventions, such as dichotomizing relationships into friends and non-friends, violate ways of perceiving relationships that have matured over a long period of personal development. A more immediately troubling aspect of the digital social world is the prevalence of online bullying – sometimes termed 'cyberbullying'. Many young people have reported this kind of persecution as an unwanted consequence of Internet participation (Li 2007; Stomfay-Stitz and Wheeler 2007).

However, there is risk of demonizing digital communication. The opportunity for research to understand the way in which it allows young people to explore their social identity is identified by boyd (2007b), and it is certainly implicated in fostering digital romance (Doring, 2002). Clearly those aspects of social science that address matters of personal communication and relationships have much to explore within digital technology.

Mediating Coordination – Collaborating

A form of social relationship of special interest to social scientists is that in which interacting partners work towards the creation of some shared knowledge. Semantics around this topic can be difficult. So, it is not always clear when a simple 'conversation' should be termed a 'collaboration'. This move is usually made when the conversation has a strong focus: when it is oriented towards constructing a particular product or outcome.

In which case it acquires a more organized and directed flavour. It is in respect of managing that organization and direction that digital tools play an interesting role.

A task at the heart of collaborating is creating and updating an external (and therefore shared) representation of what the collaborators know. Crook (1994) has argued that digital media provide a powerful resource for creating and managing joint understandings. The personal computer furnishes an environment characterized by powerful opportunities for joint activity: versatile modes of problem representation, tools for interacting on such representations, and a sustained narrative of what the collaborators have done. The working of such collaborative mediation has become a core concern in the area of 'computer supported collaborative learning' (CSCL).

CSCL is not exclusively about the intimate forms of exchange associated with small group problem solving. Digital tools also have empowered individuals to collaborate while separated by distance, and even in arrangements that do not require their activity to be synchronous. This has largely been made possible by the infrastructure of digital networks. These environments create a structure in which participants can converse but, also, representational tools that express and preserve the evolution of their shared understanding. Researching the ways in which such tools mediate a more distributed form of collaboration is a priority in one particular domain of these designs: namely, 'networked learning' (Goodyear 2002).

Mediating Coordination – Participations

Through the Internet, digital technology offers a striking platform for the individual voice. Moreover, the means available for individual expression are generous. That 'voice'

may be encountered in various forms: writing, sound, image, video, or as mixtures of these modalities. Accordingly, users of this platform may see it, amongst other things, as an opportunity to be creative, to agitate, or to make knowledge claims. However, the Internet furnishes a platform for multiple voices and, therefore, the possibilities for them to interact. What the individual does may then be termed 'participative' in so far as the expression of individual voice becomes recognized and coordinated with others and in so far as this coordination creates some sense of shared engagement.

However, there are different ways in which such coordination can occur. At its simplest, it may take the form of relatively contained dialogue or conversation. Such exchanges might occur as commentary on the postings of bloggers. Or they might be less intimate, such as might occur within the focused concerns of a text-based discussion forum. Or they might be extremely fragmented, as those that occur in the Twitter stream.

Richer forms of conversation can be achieved when the interactions involved acquire continuity and coherence, and when they are sustained over significant periods of time. It then becomes natural to speak of online 'communities' having been formed – either through deliberate shaping by participants or as the result of a more improvised or spontaneous consolidation. Arguably, the growth of digital communication has encouraged a lazy use of the term 'community'. For instance, Nunberg (2001) notes how it tends to have a status that is inherently positive (it would be a little odd to speak of the 'terrorist community' or the 'paedophile community'). Consequently, any invoking of the term to characterize successful digital coordination might mean the communication is judged rather uncritically: perhaps with limited consideration as to whether 'community'-based argument, decision making or problem solving has actually been optimized. Such

uncertainties relating to understanding the workings of digitally-empowered communities makes them a natural topic of attention for social science research. This applies whether such communities are exclusively online or whether they blend online communication with more tradition methods of convening face to face.

The bonding that can occur for online communities illustrates the socially richer end of a continuum of digitally-mediated and participative coordination. Meanwhile, at the other extreme is the loosely-knit structures often associated with networked communication: that is, structures involving very large numbers of individuals, perhaps exchanging infrequently and perhaps unknown to each other at the personal level. Such groups are sometimes termed 'crowds', particularly when their constituent individuals are polled for evaluations or opinions: the outcome of such polling being valued as the 'wisdom of crowds' (Surowiecki 2004). Some authors advocate efforts to mobilize and structure such networks of loose participation: thereby orchestrating more formal but large-scale collaborative thinking in pursuit of 'mass creativity' (Leadbetter 2008). This notion is not without its critics (e.g. Lanier 2010), and social science research must help the understanding of where it works satisfactorily.

The reality of a crowd wisdom is just one area of participative coordination where there is doubt and criticism. There is a rhetoric in this area that stresses inclusion. Yet unmanaged inclusion must challenge the ease with which confidence about voice and message can be achieved (Keen 2007). Moreover, it may seen churlish to question the success of digital communication in opening up an arena of political participation and agitation. However, some commentators have noted the difference between the fragmented political engagement of digital communications and an earlier form of

participation based on the bonding achieved by well-structured and sustainable social groups (Caldwell 2010). Once more it is for social science to make more visible the forces of re-mediation that shape a new digital experience of participation.

CONCLUSION

When significant changes in identity, society and culture are too firmly ascribed to a particular technology we are right to feel uneasy. Adopting a deterministic attitude to digital impact will only serve to conceal from us a more complex and interesting dynamic of influence and causality. However, articulating that dynamic is a far bigger task than can be embraced in one book chapter. Fortunately, later chapters in this volume will go further in both exploring complexity and arousing interest. From the present chapter it is hoped that a rough map has emerged: one that describes the landscape of relevant socio-cultural forces operating around digital technology. So, emphasis has been given to how digital coding has created novel species of artefact and representation and how new cultural practices of creating, sharing and interpretation have evolved around them. Such novel cultural practices are an inevitable interest for social scientists. That interest becomes amplified as engagement with digital artefacts generates quite new structures of experience – such as those encountered in the virtual worlds that may be constructed from digital raw materials. Finally, we have also identified how a growing awareness of digital coding has stimulated new forms of theory building within the social sciences. In short, this is a rich territory of concern for theorist, designer and practitioner.

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