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Chapter 1

The thesis: texts and machines

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Introduction

In order to provide a context in which to think about the dissertation now, this chapter looks both to the past and future. We deal with earlier forms of the dissertation in the nineteenth and twentieth centuries and with the forms that the dissertation might take in the twenty-first. What unites these approaches is the conviction that the dissertation is contingent, changing and changeable. While supervisors may expect their students to produce a dissertation that resembles the one they wrote themselves, changes both in the available technologies and in the kinds of knowledge the dissertation is expected to represent are having a significant effect on its form as well as its content.

This chapter makes no claims to be a general survey of the media technologies relevant to the dissertation; instead it highlights some of the key issues arising from the interaction between media technologies and scholarly practice. We are engaged in a process that Haas (1996, p. 221) called *historicising technology*, that is, looking at the historical development of current technologies. In this case, we consider the knowledge dissemination device of the dissertation, and the material technologies that have and might in the future support it. In her discussion of Ong (1982/2002), Haas describes how writing 'transforms sound into space' (p. 9). The representation of sound by graphic symbols, that is, the spatialisation of language, was for Ong as well as other theorists of literacy such as Goody (1987), and Havelock (1986), a fundamental shift in human history. Haas, however, draws on other scholars (Scribner & Cole, 1981; Lave & Wenger, 1991) to argue that literacy does not represent a "great divide," but that it is a material technology that is value-laden, and "that to treat written language as if it were neutral or transparent has severe political, theoretical, and practical consequences" (p. 21). As dissertations increasingly allow for the possibility of de-spatialising language, as well as inscribing in context still images, sounds and other time-based data, the values and opportunities of the written text become apparent and disputable.

We first consider how the doctorate moved from a largely oral tradition, in which texts played the supporting role of framing public disputations, to the doctorate's own 'great divide' with the emergence of the

doctorate by research from Wilhelm von Humboldt's reform of the German higher education system at the beginning of the nineteenth century. Instead of representing a mastery of all knowledge, the doctorate by research demonstrated the candidate's ability to carry out a research project that generated new knowledge and to disseminate that in a written text. Alongside the development of this form of doctorate, sharing in wider social trends of systematisation and industrialisation, we look back on the role of one particular technology – the typewriter – developed from various attempts to create a machine that would replicate Gutenberg's reproductive technology in text production. The typewriter functioned synergistically in the period from the 1880s to create dissertations that were linear, objective, and often gendered (dictated or handwritten by men, to be typed by women). 'Our writing tools are also working on our thoughts,' as Nietzsche wrote (Kittler, 1999, p. 200).

We then discuss the purposes of the dissertation and the many affordances that the written text offers, possibilities that are enlarged rather than obviated by moving from the typewriter to the computer. Supplemented but not replaced by images, sound, and other time-based data, texts, we argue, allow an important interplay between external representation and internal conceptualisation. With the enhancement of computer technology, texts become easily searchable in ways that other forms of representation, unless provided with metadata in the form of text, are not. Meanwhile, the dissertation on paper retains its simple accessibility and known longevity. We conclude by proposing a seven-fold heuristic which might guide our consideration of competing technologies for the dissertation. Most of these are also relevant to Master's theses and undergraduate final papers.

Although the doctorate is an ancient qualification, the modern doctorate by research is, against this antiquity, quite recent in development. As now, it existed in the past in a complex network of tools and technologies, institutions, and the societies that produced it. We will briefly discuss the development of the doctorate (Doctor of Philosophy; PhD, DPhil) and the tools that have supported it. Tools here refer both to the cognitive tools of language and to the material tools (e.g. pens, paper, typewriters, computers and software) that enable and shape written texts and the doctorate (Haas, 1996). Until recently, the doctorate has been the qualification for teaching in universities, and so the nature of that teaching will be considered. Combining the development of the doctorate with a consideration of these tools, and, in particular, the typewriter as the tool for the production of the modern research-based doctorate helps to historicise the doctorate (Haas, 1996) and suggest the linkages between the doctorate and writing technology.

Origins

The doctorate is as old as the European university; contributors to Powell and Green (2007) write that the doctorate has been awarded for 700 years in Britain and a thousand in France. It entitled the holder to teach at university[1], and demonstrated that the holder had mastered the liberal arts of the *trivium* and *quadrivium* (Simpson, 1983). However, in comparison to modern society, the early doctorate emerged in a society with very limited access to books and other textual material, and the role of the holder of the doctorate was to expound their

interpretations of texts. Teaching and learning in the medieval universities was primarily oral, with written texts playing a supporting role (Kruse, 2006). Lectures in which a teacher would comment on passages from an authoritative text comprised the main form of teaching. These lectures were complemented by formal disputations in which participants would address set questions. Both teachers and students would engage in public disputations, which established the reputation of a university in a way similar to that of today's published research (Kruse, 2006).

In public disputations, the participants would address a thesis or *dissertatio*. The disputation was rooted in the epistemology of the university; 'knowledge had to be deduced interpretively from the old, authoritative writings. These were the primary sources of knowledge …' (Kruse, 2006, p. 336). According to Kruse (2006), the thesis was initially laid out orally, but later took the form of a written poster. Students would defend or oppose the thesis, and an arbiter would decide the outcome. By the sixteenth and seventeenth centuries, the thesis was disseminated in a pamphlet that participants and audience would read in advance. Russell argues that the tradition that texts were primarily used as the starting point for oral discussion continued into the nineteenth century. This tradition prepared students for 'the pulpit, the senate, the bar,' (Russell, 2002, p. 36). These professions, like teaching at university, involved oratory. The tradition of disputation continues in the oral examination (*viva voce*) for the doctorate; however, the doctorate by research, the modern doctorate, is different in terms of the knowledge it represents and the means by which that knowledge is presented[2].

In the eighteenth century, the nature of the university and its students began to change, a trend that accelerated strongly after the Napoleonic wars. At the beginning of the nineteenth century, a revolution in higher education occurred. 'The stimulus for this development stemmed from Napoleon's military defeat of Prussia in 1806. Smarting over the loss of the university at Halle, which was situated in territory forfeited to Napoleon, a new system of higher education was formulated to assist the rebuilding of the demoralised Prussian state' (Noble, 1994, p. 6). The Prussians founded the Friedrich-Wilhelm University in Berlin, incorporating innovations that had been pioneered in Göttingen and Halle. It was there that the Humboldt model of the university emerged. Wilhelm von Humboldt (1767–1835) reoriented the university away from the analysis and debate of authoritative texts. Instead, the goal of university teaching became that of modelling and instilling the means for the discovery of scientific knowledge (Rüegg, 2004). The university was to become a factory for the creation of new knowledge. In the process, '… the university gradually replaced the church as the central cultural and intellectual institution of the modern nation state …', and '… its indispensable economic power house …' (Nybom, 2003, p. 147).

The shift that established research as the primary goal of the university built on changes that had occurred outside the university, primarily in academies and scholarly societies. The most notable of these was the Royal Society (founded in 1660) in which members, for the most part outside universities and unsupported by them, investigated the natural world through experimentation and observation. Knowledge creation through experimentation broke with the university's tradition of disputation and with alchemy, the secret investigation of

the natural world (Shapin, 1984). Instead of disputation or secret investigation, experiments would be witnessed, and the knowledge would be disseminated through letters to members who could not attend and directly observe the experiments.

Humboldt's reorientation of the university along the line of the scientific societies brought public research into universities on the continent. Quoting Frederich Schleiermacher, Rüegg writes that the goal of the university was to 'demonstrate how this [scientific] knowledge is discovered, "to stimulate the idea of science in the minds of the students, to encourage them to take account of the fundamental laws of science in all their thinking"' (2004, p. 5). Friedrich-Wilhelm University was founded in 1810; by 1815, German universities were attracting ambitious graduate students from Britain and the United States who could not pursue their studies in their own countries (Park, 2005). The Humboldt University continued to prepare students for the learned professions, but its mission focused on training students in science and the scientific approach to fields such as history and linguistics. The Doctor of Philosophy degree reflected the student's embrace of the idea of science. Because of these changes the modern PhD 'had no equivalent in the mediaeval university' (Simpson, 1983, p. 5).

The development of the research university marked a shift in the mode through which knowledge would be disseminated, as well as a shift in epistemology. Knowledge would be explicated through written texts rather than through oral disputation. The form of the written text for the dissemination of knowledge had been in gradual development since the seventeenth century. The research article emerged from the letters of the Royal Society, and was a 'virtual technology' that was 'designed to enable readers of the text to create a mental image of an experimental scene they did not directly witness' (Shapin, 1984, p. 481). The virtual technology of the text complemented the mechanical technology of the instruments used to conduct the experiment. Initially observed by eyewitnesses, an experiment was transformed into an inscription through the medium of the letter; the letter evolved into the journal article. Its tone was to be neutral and straightforward, a mirror of nature. Shapin (1984) argues that the technology of the experiment – both in its material tools, such as the air pump, and its literary tools in the form of the experimental report – were designed to present the knowledge created by the experiment as a matter of fact, a feature of natural reality and not a human artefact. This written text, with its rhetoric of neutral description, became the model for the dissertation. Knowledge would be created by empirical investigation and reported in a form and manner that was honed to obscure its constructed nature.

Knowledge of research practices within the university was transmitted through the intensely human interaction represented by the 'master' and 'apprentice' model of doctoral education. Doctoral candidates would learn the procedures for discovering knowledge under the guidance of an experienced researcher. The doctorate would be evidence not of candidates' mastery of all knowledge, but research procedures and the successful completion of a research project. The model of the university based on Humboldt's concept of graduate training in research rather than undergraduate education (Russell, 2002) spread, with Yale University presenting its first PhD in 1861 and, in 1876, with the founding of Johns Hopkins University, which was a graduate institution

explicitly created along the lines of the German universities. British universities did not follow until the end of the century, when, first, Cambridge approved ScD and LittD (Doctorates of Science and Literature) in 1882, followed by Oxford founding a DPhil programme in 1917. By 1921, all universities in Britain offered PhD programmes (Simpson, 1983). The PhD that these universities offered embodied training in research and the representation of this research in a scholarly text. This is the modern doctorate and barely more than the title links it to its ancient ancestor. The first requirement of a modern doctorate is, in the words of the British Quality Assurance Agency, 'the creation and interpretation of new knowledge, through original research or other advanced scholarship, of a quality to satisfy peer review, extend the forefront of the discipline, and merit publication' (QAA, 2001).

Writing machines

As the doctorate developed over the nineteenth century, and more candidates pursued the qualification, the dissertation became increasingly formalised and bureaucratised. This is consistent with changes in the wider western society, in which both businesses and governments became departmentalised and rationalised (Yates, 1989). As Yates describes, businesses in the nineteenth century adopted communication and management systems that enabled growth and continental expansion, including the filing system, the typewriter and carbon paper. Universities also adopted these tools, which contributed to the expansion of higher education, including the doctorate by research. One of the key innovations in the production of documents in the last quarter of the nineteenth century was the typewriter. It speeded up the production of documents and replaced laborious hand copying with clear machined texts. The new inscription system facilitated the production of an important but not widely read text in a cheaper and more accessible form that was also more similar to the scholar's traditional book. Fundamentally, the typewriter was, as Kittler writes (1999, p. 228) 'nothing but a miniature printing press'.

The typewriter achieved a form sufficiently stable to be incrementally improved with the 'Sholes and Glidden Type Writer' of 1876, which was built by the Remington company. At the time, Remington manufactured guns and sewing machines; the typewriter would facilitate the rapid production of text in a way similar to the advances of the sewing machine. This typewriter included the QWERTY keyboard and the roller that both held and advanced the paper (Adler, 1973; Yates, 1989). Although early dissertations were hand written and could have been published (the QAA text above alludes to research meriting publication), many were not. For example, Karl Marx's dissertation, which was submitted to the University of Jena in 1841, was not published until 1902, long after his death (Kamenka, 1983). Yale University's first dissertation was handwritten in Latin and six pages long (Weeks, 2002, 18 March). However, the typewriter allowed the production of a text that in many ways resembled a book, with machine-formed letters that ran in parallel lines down the page. (In some countries, for example Switzerland, all dissertations were published in typeset form; however, this requirement did not emerge in the US or UK, where theses had to satisfy at least the commercial needs of the academic publishing houses.) It introduced 'Gutenberg's reproductive technology into textual production' (Kittler, p. 187). The typewriter

allowed text to be written at more than three times the speed of handwriting, and, with the introduction of carbon paper, it allowed the production of multiple copies of the text. This allowed the dissemination of research, which was one of the primary aims of the doctorate, a key aspect to which we return below.

Famous early adopters of the typewriter included Mark Twain (Samuel Clemens), who claimed to be the first author to deliver a typed manuscript for a book, and Friedrich Nietzsche, who, suffering from loss of sight, renounced his professorship at the University of Basel. He subsequently learned to write on an early typewriter and reflected in a letter that 'our writing tools are also working on our thoughts' (Kittler, 1999, p. 200). The use of the typewriter impelled him to write in a telegraphic style, which he felt responded to his new writing machine. Later, the most academic of great writers, T. S. Eliot, composed *The Waste Land* on a typewriter. Like Nietzsche, he found that in 'composing on the typewriter' he 'sloughed off all the long sentences [he] used to dote on'; the typewriter 'makes for lucidity', if not for subtlety (Eliot, 1971, p. x).

The use of a typewriter, however, did not always lead to a staccato writing style. Henry James began to dictate his novels to young women who would type them and came to depend on Theodora Bosanquet and her Remington typewriter. She typed for him from 1907 to his death in 1916. She wrote that dictating to the typewriter invariably led to longer texts; he wrote by hand only for shorter works such as short stories. The sound of the Remington typewriter soothed him, and he asked her to take his dictation after suffering the series of strokes that eventually killed him (Kittler, 1999; Werscher-Henry, 2005).

Rather than seeing the technology of the typewriter as impelling a writing style, it might be better to think of typewriters supporting and reinforcing social roles. Bosanquet was a famous and articulate model of the typewriter, a word initially synonymous for the machine and its operator. Although men initially took up the new profession of typewriting – moving from clerk in the style of Bob Cratchit to typist – women quickly came to dominate the profession, increasing from 40% of stenographers and typists in the US in 1880 to 95.6% in 1930 (Kittler, 1999, p. 184). The proportion of women in commercial schools that taught typing and shorthand increased from 10% in 1880 to 36% in 1900 (Yates, 1989). Kittler describes how, after his typewriter failed as the ribbon became sticky in the humidity of the Italian seaside to which he had retired, Nietzsche hired young students to replace the machine. Nietzsche's sister wrote that 'professors at the University of Zurich "very much appreciated having emancipated women of the time at universities and libraries as secretaries and assistants"' (Kittler, 1999, p. 208). Bosanquet and Neitzsche's secretaries were followed by countless others who typed their partners' dissertations and theses.

Universities changed as well; Andrew Carnegie gave an address at Pierce College of Business and Shorthand in Philadelphia to graduating class consisting of both men and women in 1891, in which he said:

> I rejoice to know that your time has not been wasted upon dead languages, but has been fully occupied in obtaining a knowledge of shorthand and typewriting … and that you are fully equipped to sail upon the element upon which you must live your lives and earn your living. (Donoghue, 2008, p. 4).

The founding of the land grant universities in the United States and the civic universities of Britain represented social change, a widening of the possibilities of university attendance as well as a shift in the areas studied from "dead languages" to scientific study, whether of linguistics, history, physics or other modern subjects. In the period from roughly the 1870s, when Sholes received his patent for a typewriter and Johns Hopkins University was founded, to the period between the two world wars, textual production became industrialised.

> It became a process with definite steps, a process that could be reproduced on the assembly line. And, for the first time, the representation of work in writing, and all of the attendant filing, sorting, processing, and publishing, became an equally important part of the work itself. (Wershler-Henry, 2005, pp. 137–138)

This was nowhere more true than in the production of dissertations and doctoral students. Although PhD degrees remained relatively less common in the humanities, by 1903 William James could publish 'The PhD Octopus' in *Harvard Monthly* decrying the increasing demand that academics have doctorates (James, 1903).

After an initial period in which typewritten texts were considered inferior or socially unacceptable (Kittler, 1999), typewritten texts came to be seen as superior. Heidegger, quoted in Kittler, wrote that 'mechanical writing provides this "advantage", that it conceals the handwriting and thereby the character. The typewriter makes everyone look the same …' (1999, p. 199). This neutrality, evoking the objective qualities of scientific reporting, may have been behind Margaret Mead's use of still and motion picture cameras and the typewriter, as reported by Blake and Harbord (2008). Tools such as cameras and typewriters conferred authority and methodological precision. In Bali, Mead handwrote her personal correspondence, but had her field notes typed. 'But despite the transformative qualities of the device (for why bother with the labour of typing unless it has an effect), Mead chose to regard the machine as a neutral vehicle, incapable of affecting that which is produced' (Blake & Harbord, 2008, p. 220). However, as Heidegger wrote, 'technology is entrenched in our history' (Kittler, 1999, p. 201)

The typewriter was part of the toolkit – social, institutional, and material – that enabled the expansion of doctoral study during this period. As Haas (1996) indicates, the tools that we use are not neutral. They create possibilities, but also carry their own limitations, which may not be immediately apparent. Compared with handwriting, the typewriter produced texts that were neater and more easily readable and, with carbon paper, more easily multiplied. Typewriting favours written information design and transmission over, for example, graphical information design. Typescripts reproduced well with microfilm, and were much cheaper than typesetting extremely limited distribution books. Typewriting was also consonant with hierarchies of gender and power in this period.

On the other hand, typewriters do not easily support other ways of providing information. Mathematical symbols, graphs and charts, and images such as photographs must be laboriously copied to each text. Colour, and of course sound and moving images are not accommodated at all. These limitations were either invisible or, in the

case of mathematical symbols, graphs, and photographs were considered marginal issues, which could be moved to appendices to the text.

What is the dissertation for?

In the 1790s, Gauss investigated the concept of imaginary numbers, opening up new territory in mathematics. In doing so he made extensive use of diagrams – but only in his private notebooks, not in his 1799 doctoral dissertation. At that time and place, any format other than numbers and words was frowned on (du Sautoy 2003, p. 70). Yet it is far easier to grasp the concept of imaginary numbers using diagrams than text, as Gauss must have been aware. The conventions of the doctoral dissertation at that historical moment militated against the use of the very form which would have most effectively communicated the idea.

As this example suggests, technologies have particular affordances: they facilitate particular kinds of knowledge production. If each modality has its own special properties, how well do these match the objectives of the dissertation? In order to think about this we must first decide what the dissertation, in whatever form, is for.

For obvious reasons, advisory texts for students on dissertation-writing – of which there are an ever-increasing number – tend to concentrate on the document as a form of transaction between the student and the examiners. This is after all the immediately pressing need from the student's point of view. But there is another requirement, especially but not exclusively at doctoral level. The dissertation is a contribution to knowledge – to a body of knowledge shared with a potentially worldwide community. The dissertation must enable the research to be known about, acting as a public document that allows the research to be understood by others. This has an important bearing on the technologies adopted, as we shall show.

The dissertation is part of the means by which the candidate claims an academic award, validating its author's claim to be a researcher at the appropriate level. A doctoral dissertation provides a basis for an in-depth verbal examination, the viva. Indeed, in many countries the viva is a public occasion, uniting in a single event the transaction between the student and examiners on the one hand and the beginnings of the process of dissemination to the wider community on the other.

We assume here that whether it is considered primarily in terms of examination or dissemination, the dissertation is intended to *communicate*. We note in passing that this has implications for practice-based research – discussed elsewhere in this volume – since many forms of practice are not intended as communication but have quite other motivations. The dissertation is expected to communicate in rather distinctive ways. It needs to make explicit things which would simply be implied or skated over in a more casual document. Vagueness, implicitness, allusiveness, ambiguity, multiple meanings are not benefits in the dissertation. Hence the need to do those things that some dissertation-authors find repellent, such as defining terms, making clear the original contribution to knowledge or clarifying the domain to which the dissertation is relevant. Most uncomfortably perhaps, the dissertation should reveal its own weaknesses. A medium that enables significant failings to be glossed over or concealed cannot serve the needs of a publicly validated examination process.

A dissertation is called upon to convey both the ideas of the author and of others. This is important, since in choosing media according to their appropriateness to the task, we need to distinguish between those which are most appropriate for re-presenting artefacts already existent in a range of media, and those most appropriate to the presentation of the dissertation as such. Let us take the case of a dissertation in field geology. It is very likely that photographic images will be helpful – perhaps essential – in representing geological features. If the dissertation is at least in part about visual evidence, the author must be free to bring that evidence to the eyes of the reader. It is normal in dissertation regulations for such pictorial and diagrammatic material to be admitted into the document. Whereas at one time the regulations might have stipulated that such graphics be placed separately at the end of the dissertation text, now, quite rightly, it is normal for the opposite to be stipulated: that the illustrations should appear at the point in the text where they are most pertinent.

Take now the slightly more complex case of a dissertation about the oral dialects of geographical regions. It can be convincingly argued that the author should be allowed to make use of non-text, time-based media. Audio recordings of the regional speech in question are almost certain to be a good means to capture and communicate as directly as possible nuances that would be lost in another representational form. However, formal, textual means of representing dialectal variation will probably have their own advantages for some purposes. For maximum effectiveness it is likely that we would want to use more than one form of representation for different purposes within a single dissertation, always attempting to select the one that is most appropriate to the needs of the moment. The decision needs to be based on a pragmatic concern for purpose, not on an assumption that one medium is somehow inherently better than another.

The photographs in the geological dissertation and the auditory material in that on dialects serve similar purposes. In both cases, these media seem likely to be the most appropriate for presenting particular kinds of evidence. If in these cases the dissertation were limited to text alone it would almost certainly be less effective in conveying important information to the reader. However, the main argument of the dissertation is still developed through words. What would it be like if the dissertation consisted only of photographs taken in the field, or only of primary oral recordings? Then these other media would be doing two kinds of work: they would be both acting as evidence, and carrying the burden of the argument. If the material being studied comprises films, there is a strong argument (leaving aside issues of intellectual property) for presenting pertinent examples of those films within the dissertation so that what is discussed and what the dissertation author says about it are in the closest possible proximity. This is a different issue from the question of whether the dissertation itself should be a film.

Finally, the dissertation is not simply presentation: its development should clarify and perhaps transform the author's thinking. The dissertation is thus not just a report, but a construction. Creating the dissertation is (or should be) an iterative, reflective process giving its maker insights that were not otherwise achievable. Scaife and Rogers (1996) coined the term *external cognition* for representations (they were interested primarily in diagrams) that we use to assist our own thinking, building on the concept of a *cognitive artefact* discussed by Norman

(1991). Crucial to this concept is the idea that there is a reflexive relationship between knowledge-in-the-head and knowledge expressed in some external form. On this model, rather than an external representation being the end-point of a process, it becomes a point on an arc of interaction, from author to representation and back again (Figure 1.1). Maglio, Matlock, Raphaely, Chernicky, and Kirsh (1999) showed how in playing Scrabble the player performs better if allowed to physically rearrange the letters: while trying to generate as many words as possible from the available seven-letter set, more words are generated when players are allowed to manipulate the tiles than when they were not. The player manipulates the representation, and this in return helps generate new ideas which might otherwise have been missed – a nice demonstration of ongoing interaction between an external representation and processes in the mind.

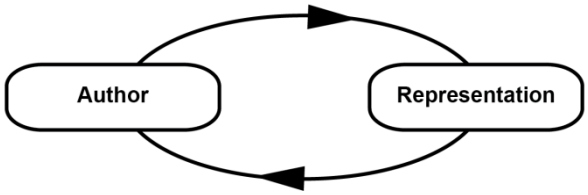

Figure 1.1. An external representation as a point on an arc of interaction, from author to representation and back again.

Affordances of different media

We noted above how diagrams seemed to be more productive than letters and numbers as a way to understand a particular aspect of number theory. Each medium has its own affordances, making available certain kinds of knowledge in distinctive ways. Diderot in the mid-eighteenth century was one of the first to make the case, based on his conversations with a single blind man, that the channels of communication we use influence in a fundamental way the concepts we are able to form (Diderot, 1749). Much twentieth century thinking on media has amplified this notion, summarised in McLuhan's quip that the medium is the message. At a more technical level, Larkin and Simon (1987) influentially distinguished between information equivalence and computational equivalence. Two representations are informationally equivalent when in theory the same information can be extracted from them both; they are only computationally equivalent when in reality the human viewer, reader or listener can and does – with equal facility – indeed extract the same information. For all practical purposes connected with a document as complex as the dissertation, we suggest, such equivalence cannot exist. The choice of media will be crucial to what can be conveyed.

It may be tempting to hope that there is some perfect representation. Students may sometimes suggest that a recording of a piece of music is more faithful to its original than a score, that a photograph is more faithful than a drawing, or that almost any medium is more faithful than verbal text. This touches on a debate which there is no space to investigate here: suffice to say that the argument here does not concern the faithfulness of a particular

representation, but its utility. Our discussion prioritises the *effectiveness* of a medium or mode of communication in the context of the purposes that the dissertation serves.

Reclaiming the value of text

Perhaps the commonest objection to verbal text is that it is too abstract, too remote from lived reality. If the world being studied is visual, aural, tactile, multimodal, multidimensional, polysemic, is it not unreasonable to squeeze this richness into a single channel of communication? Given the growing range of other options such as sound recording, film-making and the construction of websites or other interactive media, it might seem that the textual dissertation is increasingly irrelevant. However, if we consider its properties, text turns out still to have some remarkable strengths. In the remainder of this chapter, we shall concentrate on just two: the visual properties of text, and its usefulness as part of a worldwide information resource.

Text as a visual medium

Text offers powerful generic structures such as the sentence and paragraph as well as more specialised forms associated with the conventional dissertation such as the table of contents, footnote, index, bibliography, and so forth. The familiarity of these structures means that we tend to take these visual forms for granted. However it is only necessary to glance at a dissertation or any similar structured document to see that it conveys much of its meaning through visual form. Because the forms of conventional writing are just that – conventional – a delicate balance within its characteristic structures is easily overlooked. If we look for a moment at a misguided attempt to introduce a new visual form for text, the merits of the conventional forms stand out more clearly. Tonfoni and Richardson (2000) proposed that the components of texts should be boxed up within differently shaped outlines representing the function of each paragraph, so that, for example a concept would appear in a semi-circle, a comment in a triangle. Such devices would fatally restrict the role of each component in all but the simplest documents. By contrast, the visual structure of conventional writing, typing or printing strikes a balance between allowing the words themselves to speak and enabling the reader to see at a glance the purpose they serve within the larger text and how to read them. Every such device of the conventional dissertation is an invention which should of course be questioned – but it may prove worth retaining, at least for the time being.

Even within the apparently conventional domain of text, variables now used to affect meaning may previously have been used quite differently. For example in the title pages of books from the sixteenth and seventeenth centuries, the choice of type size was made with ‘singular disregard for the content of the message’ (Twyman, 1986, p. 201) in a way that we now find strange. This has important implications for digital technology: if the meanings of such spatial variables have been different in the past, it is safe to assume that they will change again.

Two theorists who have given extensive consideration to the effects of making words spatial and visual in

the transition from speaking to writing are Goody and Ong, cited earlier. Their work predates most digital texts. Ong claims that, 'more than any other single invention, writing has transformed human consciousness' (Ong 1982/2002, p. 77). The word 'invention' captures an important idea: that writing is a technology, artificial by contrast with the naturalness of oral speech. Goody (1987) identifies two main functions of writing. One is the familiar storage function, allowing communication over time and space. The second, shifting from the aural to the visual, makes possible a different kind of inspection at all levels down to that of individual words. The spatial relationships between words take on new meanings for the very reason that they are abstracted from the linear oral flow. Twyman (1986) remarked that 'graphic language is very different from spoken language. The one is not an interpretation of the other', while Ong (1982/2002, p. 152) argued that text 'styles what we know in ways which make it quite inaccessible and indeed unthinkable in an oral culture'. Goody (1987, p. 187) suggested, 'writing permits not only the recording but the reorganisation of information. One can operate on these representations'. Just as in Scaife and Rogers' example of diagrams as tools for external cognition, the emerging dissertation acts as a stimulus to the mind, even when it is wholly textual. We may be used to thinking this way of diagrams, less so of text.

Text as part of a worldwide information resource

Thanks to digital technologies, the dissertation has progressed from the often unread volume on a dusty shelf to internationally accessible resource. Previously, the bound paper dissertation would be filed in the examining institution's library as the primary record of the candidate's achievement. In most cases from then on it was rarely if ever consulted. It was not easy to find, nor were its contents easily explored. Though the title and abstract might be recorded and made available in some public form, the majority of the text could only be used by someone having physical access to the volume and turning the pages. The case is altered now, thanks to the Web. Institutions increasingly put theses, especially doctoral theses, into institutional repositories, or post them to some other location accessible to Web users. Once the document is present on the Web, it takes only a matter of days before the indexing engines of the major browsers discover its existence. When they do, they crawl through the entire text. As a result, every part of the document can be discovered. In addition, someone using the Web – whether in an adjoining room or on the other side of the world – can get access to the document at the particular point that interests them. There are two interrelated but distinct issues here: whether the contents of a document are discoverable, and whether they are addressable. After assessing how text performs in this respect we shall need to compare the current performance of other media.

Discoverable and addressable

In an article in 1945, Vannevar Bush, science advisor to the Roosevelt government, complained that 'our methods of transmitting and reviewing the results of research are generations old and by now are totally inadequate for

their purposes' (Bush 1945, p. 101). He proposed the Memex, a microfilm-based system that would allow not only the compact storage of large quantities of documents, but the meaningful interlinking of each text to many others. Though the system was never built, Bush's article influenced the pioneers of the Web. With the aid of the Internet, what we can now do with text is better than Bush envisaged, since his system relied on photographs of pages: there was no access at the level of individual words except where these had been explicitly identified and marked up with codes by a human reader. Now every word is seen by search engines, however deep within the document. Users can discover a dissertation that is useful to them, even if neither the title nor the abstract gives sufficient clue to the contents.

Not only is text discoverable down to the level of individual words, the user can normally navigate easily to any part of a text document, whether it is a web page, a PDF, or a word-processing file. The text is addressable with a high degree of granularity.

It should be noted that computer software currently does not generally determine what a text is *about* – this is the subject of work in semantic search and lies at the heart of proposals for the 'semantic web' (Shadbolt, Hall, & Berners-Lee, 2006) – but the words in a text are usually a very good clue to the concepts it discusses.

What we have said about the discoverability and addressability of text may appear unremarkable until we contrast text with other media. In considering the strengths and weaknesses of particular media technologies as a means to share research knowledge, the current weaknesses of other media in this respect need to be acknowledged. If our means of dealing with images were similar to those available for text, we would be able to discover at a distance everything depicted in an image – and would be able to navigate to the exact place in the image where the object of interest appears. If images were as discoverable and addressable as words, we would be able to rapidly identify all the images on the web containing, for example, a particular species of tree. We would be able to do this whether the tree appeared in botanical drawings, religious allegorical paintings, holiday photographs or any other kind of image. In addition, having retrieved one of these images we would be able to navigate rapidly and assuredly to the place or places in the image where this particular tree appears. Currently, none of this is a practical proposition. In recent years when searching the web for images, users have been obliged to use text as the means of finding images. The user types in a word or phrase and the search engine seems to find images of what was named. What in fact the search engine does is to search the text of the web pages that contain those images and infer – correctly or not – the subject of the images from the surrounding words. Unfortunately, using this method, many of the results returned are irrelevant to the user's needs. Clearly, this is still far from the scenario described above where individual elements of pictures would be easily discovered and accessed. Currently, search engines do not look at what is contained within an image in the way that a human viewer does. Some early steps have been taken towards visual comparison between images, so that the form of the image is used in addition to the surrounding text. Such approaches are based on the idea that related images typically look similar while unrelated images typically look different (Fergus, Perona, & Zisserman 2004). However, this is still

not much like the processes that humans use for grouping and choosing images. Humans segment an image into identifiable components. Asked to find images of figures in a landscape, a human looks in every image for figures and for landscape backgrounds, selecting only images with both. A machine search on the other hand is likely to produce images of landscape with no figures and vice versa, together with many other even less relevant images. As often with computers, within limited domains things work better. For example, the FABRIC system (Jia, McKenna, & Ward, 2009) can find shapes within textile patterns; but for general image searching we are still heavily dependent on words.

In recognition of the power of words as a means to access images, an important approach widely used for the large image databases held by picture libraries and other large media collections, is for a team of humans to 'tag' every image: to enter a set of terms that denote the things the image depicts, together perhaps with qualitative descriptions. Whereas the image itself is *data*, such information about the images is *metadata*. This approach has its own problems. One is that images tend to contain a very large number of components, so an exhaustive list of all the things in an image is not possible. In addition, tagging is biased to the needs and preconceptions of the organisation: thus, images owned by a particular organisation, such as for example a transport museum, will tend to be tagged in relation to the dominant subject matter, whereas the researcher may have completely different interests, such as the clothing of the travellers or the typography of the posters in railway stations. It is less likely that these aspects will have been captured by the tagging process. The other very significant problem for tagging is the cost. Since it requires skilled human intervention, and the number of images is typically very large, the costs can be prohibitive. A way round this problem is to incentivise either the makers or the users of images to create tags, a form of crowdsourcing (Howe 2006), but this has had limited success. We are not aware of any university that currently asks its students to tag the images in their dissertations.

Time-based data such as moving images and sounds present problems analogous to those relating to images. Large media-owners such as film libraries and broadcasters invest significantly in the creation of metadata. Nevertheless it will be readily understood that the occurrence of a particular, apparently insignificant, sound in an audio file, or a detail in a moving image – either of them perhaps of great significance to the researcher – is not likely to be captured by such a process. Again, when such media are submitted as part of, or appendices to, dissertations, there is no requirement that significant metadata be provided.

We cannot leave the subject of media technologies and the dissertation without mentioning the problem of longevity: in a scholarly library one can rather easily access every part of an early seventeenth book, but it is hard to imagine that a digital multimedia dissertation will be accessible four hundred years from now. The dissertation regulations of MIT (presumably more optimistic about new technologies than some universities) permit the use, at least as a supplement to the dissertation, of 'digital or magnetic materials' but warn that 'students should recognise […] that rapid changes in technology make these formats obsolete quickly' (MIT 2010). Once again, words tend to fare better than other media: the text of digitised books is often recoverable to a

far higher standard than the graphics.

Reassessing the technologies of the dissertation

It should be clear that there are few easy answers when choosing technologies for the dissertation (or, for that matter, other scholarly documents such as the master's thesis) today. Any simple notion that non-text is somehow more truthful or faithful than words should be discarded. What matters is how different media technologies measure up to the criteria we have discussed. This requires asking:

1. To what extent do the chosen technologies support an iterative, reflexive form of development as cognitive artefacts?
2. How well are they suited to the particular domains and communication tasks to which they are applied: what conceptual operations do they afford?
3. Can they be used effectively in the transaction between the student and the examiners: can they convey information explicitly and unambiguously, including making any weaknesses apparent?
4. How well can disparate technologies be integrated, so that – once each technology has been chosen for its fitness for purpose – the dissertation functions as a whole?
5. What are the requirements arising from, on the one hand, presenting evidence and, on the other, making the dissertation argument: how are these different demands served?
6. Do the technologies adopted enable the new knowledge created by the researcher to become known, and made easily accessible, to the world wide community?
7. What are the implications for longevity: will the dissertation still be accessible in five, fifty, or 500 years?

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Notes

1. According to Simpson (Simpson, 1983, p. 5), the doctorate developed in the universities

influenced by the University of Bologna, while the Master's degree developed in those influenced by the University of Paris (Thomas Aquinas at Paris and Roger Bacon at Oxford held Master's). Both qualifications indicated that the holder was entitled to teach in universities. The undergraduate degree evolved much later.

2. In Australia, oral defences are rarely part of the examination process; candidates are generally assessed solely on their texts (Evans, 2007, p. 117).