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Organs of the human brain, created by the human hand? The social epistemology of information technology.

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Abstract. *Purpose.* Information science has been conceptualized as a partly unreflexive response to developments in information and computer technology, and, most powerfully, as part of the gestalt of the computer. The computer was viewed as an historical accident in the original formulation of the gestalt. An alternative, and timely, approach to understanding, and then dissolving, the gestalt would be to address the motivating technology directly, fully recognizing it as a radical human construction.

Methodology / Approach. The paper adopts a social epistemological perspective and is concerned with collective, rather than primarily individual, ways of knowing.

Findings. Information technology tends to be received as objectively given, autonomously developing, and causing but not itself caused, by the language of discussions in information science. It has also been characterized as artificial, in the sense of unnatural, and sometimes as threatening. Attitudes to technology are implied, rather than explicit, and can appear weak when articulated, corresponding to collective repression.

Research implications. Receiving technology as objectively given has an analogy with the Platonist view of mathematical propositions as discovered, in its exclusion of human activity, opening up the possibility of a comparable critique which insists on human agency.

Originality / value of paper. Apprehensions of information technology have been raised to consciousness, exposing their limitations.

Keywords   Technology   Computer gestalt Social epistemology
Categorisation   Research paper

Introduction

A thesis derived from Marx – 'It is not the consciousness of men that determines their existence, but, on the contrary, their social existence which determines their consciousness' (Marx, 1975, p.425) – can strongly explain the production of information science, as part of collective consciousness. The thesis has diffused and become accepted well beyond explicitly Marxian thought (Hobsbawm, 1998, pp.xi, 195). A partial analogy can be detected with Kuhn's insistence on instrumentation strongly affecting the development of scientific theory (Kuhn, 1970, pp.40-41), with instrumentation

corresponding to an aspect, although not the totality of, material being and scientific theory to the relevant form of consciousness. From a perspective combining themes from Marx and Kuhn, information science has been conceptualized as part of a pattern where '[n]ew tools beget new sciences', specifically, as 'a response to changing economic conditions, and most plausibly as a function of developments in computer technology' (Brown, 1987, p.115).

Such an account of the production of information science admits a strong influence from technology, as instrumentation, on consciousness, but need not be received as technologically determinist. Technology can itself be understood as a human construction [1] and as 'a *part,* a moment, naturally of great importance, of the social productive forces, but … neither simply identical with them, nor … the final or absolute moment of the changes in these forces' (Lukács, 1973, p.53). Technology can also be accorded a crucial role mediating between being, the conditions and activities necessary for the reproduction of human life, and consciousness:

> Technology reveals the active relation of man to nature, the direct process of the production of his life, and thereby it also lays bare the process of the production of the social relations of his life, and of the mental conceptions that flow from these relations.
>
> (Marx, 1976, p.493)

The relation between being, 'the process of the production of the social relations of his life', and consciousness, 'the mental conceptions that flow from these relations', can, on the basis given, be read in a particularly revealing way by studying technology and its effects on consciousness. Mental conceptions can be regarded as underdetermined by being and technology (Childe, 1956, p.103) and by making the implicit effects of being and technology explicit, we may enlarge the freedom enabled by that underdetermination.

The computer has been the defining technology for professional practice and for research in information science. In information science practice, including the central domain of information retrieval, the computer as a universal information machine began to displace the special purpose information machines, which had proliferated from the late 19th century (Ohlman, 1996), from the 1950s. Information science research has tended to receive significant software products from commercial developments. It has also inherited a degree of mystical practice from computer science, with only indirect, and infrequent, access to the more restrained theory of computability (Leith, 1990, p.115).

Information science has, then, tended to receive modern information technologies, particularly in their hardware aspect, as products, with less engagement with their processes of production. The incomplete engagement with the production of technology may have led to a limited understanding of technology. For instance, the significance of the computer for relieving the drudgery experienced in aspects of documentation work has been acknowledged (Meadows, 2002, p.172), but this has only recently been developed into a more systematic distinction of human mental labour from machine

processes (Warner, 2005, pp.554-563). The congealed appearance of technology has been accepted without further investigation and its human origins and historical development (Ohlman, 1996) only occasionally explored. Both the human construction of technology and the specific motivating historical forces for the growth of information science have, then, been disguised. A compensating claim, often orally communicated rather than published, that information science distinctively deals with information processes apart from their technological manifestation, represses, rather than fully confronts, the influence from technology, by excluding technology from consideration.

A more indirect influence from technology on information science has been from telecommunications. The material technology was fully realised and widely diffused in the mid- to late 19th century – 'the whole earth … [was] girded by telegraph cables' (Marx, 1991, p.164). An encompassing theory of telecommunications was not published until 1948, with Claude Shannon's *A mathematical theory of communication* (Shannon, 1993a), partly initiating a field often known as information theory. Concepts and models of communication from information theory were deliberately imported into information science. The process of importation often involved an analogical interpretation of those concepts and models (Tidline, 2004), applying them to the effects of messages on human consciousness or to the semantics of indexing, despite Shannon's deliberate exclusion of issues of meaning from consideration (Shannon, 1993a, 1993b). The diminished influence over time from information theory could be traced to the relative failure of attempts at its analogical application and to the declining number of information scientists from backgrounds in telecommunications (Roberts, 1976). The influence from telecommunications on information science has, then, been from the material technology, through a particular form of consciousness, information theory, adapted to purposes excluded from its original formulation.

The indirect influence from the technology of telecommunications can itself be understood as part of a pattern of adoption, by information science, of methods of thought favoured by disciplines associated with the production of technologies. For instance, in information retrieval informing assumptions have been imported from physical and mechanical engineering, a deeper and more encompassing paradigm than those directly developed in information retrieval:

> the proto-paradigmatic base may then be seen as representing a deeper or more fundamental conceptual base for research following the Cranfield paradigm than could be offered by the procedures or results of the Cranfield tests themselves. So that, rather than referring to it as the Cranfield paradigm it is perhaps more informative to conceive of it as the physical paradigm imported and given coherent form as a paradigm for information retrieval research by the Cranfield tests.

> (Ellis, 1992, p.52)

The influence from the methods of thought associated with production of technologies is revealed, *inter alia*, in the experimental isolation of subjects for study and an immediate

resort to quantification. Models for understanding and evaluating information retrieval systems have also been derived directly from information theory. The broader influence from the mathematical and physical sciences has not always been as explicit as the analogical adoption of information theory but has been powerful and pervasive, with methods of thought functioning as grounding assumptions.

Information science can, then, be understood as part of the gestalt of the computer, both through its motivation from modern information technologies and in the adoption and pervasive presence of scientific modes of thought. The explicit formulation of the concept of the gestalt of the computer can be traced to 1974.

> The modern digital computer represents a high point in the development of deterministic electro-mechanical devices. In many ways it also represents the high point, at least to date, of the scientific tradition just described. In information science, as well as other disciplines the computer has become more than a tool or machine, it is a way a way of looking at the world. The computer has emerged as a cultural phenomenon. I call this the 'gestalt of the computer'.
>
> (Rosenberg, 1974, p.264)

Information science participated in the gestalt of the computer through its adoption of behaviourist psychology and a Newtonian view of man as a logically rational individual (Rosenberg, 1974, pp.264-265). The computer itself was regarded as 'perhaps an historical accident' which need not be received as a 'scientific organizing principle'. Deeper understandings of information developments were to be obtained by reaching beyond the technology – 'We must get out from behind the computer.' (Rosenberg, 1974, p.268).

The gestalt of the computer is an extraordinarily powerful, if not fully developed and seldom explicitly adopted [2] concept, comprehending developments well beyond information science. Artificial intelligence was included in the original formulation and regarded as influencing information science (Rosenberg, 1974, p.265). Similarly, cognitive science and aspects of linguistics, with their insistence that theories of the mind (Johnson-Laird, 1988), or, specifically, comprehension of utterances (Sperber and Wilson, 1986, pp.94-95), should be modelled in computational terms, could be assimilated. Other disciplines participate in the gestalt through their anthropomorphic conception of the computer and their inheritance of a 'Newtonian, or deterministic, scientific tradition' (Rosenberg, 1974, p.265). The conception of the gestalt of the computer is amenable to different to different interpretations and transformations. Its richness and power may be connected with the possibility of further transformation, in a manner reminiscent of Kuhn's paradigm (Kuhn, 1970), for which a constellation of meanings was discovered.

The particular nature of the participation of information science in the gestalt of the computer demands careful clarification. A comprehensive bibliometric mapping of

information science noted that it is 'well-known that more than one disciplinary group uses the term 'information science' for its activities' (White and McCain, 1998, p.328) and then delimited the discipline of concern:

> Our choice of journals operationalizes the field as … 'library and information sciences'. … Broadly speaking, this field concerns itself with modeling the world of publications, with a practical goal of being able to deliver their content to inquirers on demand. It is very much implicated with large, content-bearing linguistic structures like indexes, catalogs, and assemblages of full text.
>
> (White and McCain, 1998, p.328)

The operationalization of the field is acceptable as a characterization of its activities and is empirically supported by the congruence between the realistic initial restrictions and the convincing final results of the bibliometric study. The other disciplinary groups using the term information science, which would occupy other journal literatures, are excluded as they 'involve symbol manipulations that are relatively content-neutral; they are infrastructural to information science in our sense' (White and McCain, 1998, p.328).

An influence from technology is not admitted in the characterization of information science as 'library and information sciences'. However, a deliberately excluded broader conception of information science betrays conceptual congruences with the potential of the computer and even verbal analogies with characterizations of that potential.

> The rich word 'information' has seduced some into characterizations of their field that are, to date, overgeneral. … These definitions would have ASIS-style information science dealing with employers' payrolls, a housewife's grocery receipts, *Nightline,* arrival and departure listings in airports, the Grand Ole Opry, and color-coded vial caps used by crack dealers. Need we say that it does not?
>
> (White and McCain, 1998, p.353)

The computer as a universal information machine would be used, and sometimes feature centrally, in all the excluded activities. An early discussion of the computer as a universal machine is verbally reminiscent of the areas excluded:

> If it should turn out that the basic logics of a machine designed for the numerical solution of differential equations coincide with the logics of machine intended to make bills for a department store, I would regard this as the most amazing coincidence that I have ever encountered.
>
> (Howard Aiken quoted in Davis 1988, p.152)

The areas excluded from the characterization and operationalization of information science have adopted the technology of the computer, although this need not imply full participation in its gestalt.

A broader conception of information science has been advocated and partly developed. For instance, broadly concurrent with the formulation of the gestalt of the computer, it was argued that 'prescriptive restrictions of the areas of investigation thought proper to information science' (Roberts, 1976, p.249) should be disputed and that:

> The social implications of communication and information are such that only the widest social base is acceptable as an area of study for information science.
>
> (Roberts, 1976, p.251)

At a later date and from a concern with the influence of technology on consciousness, it was urged that information science should 'broaden its academic remit to include serious consideration of the 'information society' and how it interlocks with the total social situation' (Brown, 1987, p.113). More extensive conceptions of information science, both in social and historical scope, have since begun to develop within the journal and monographic literature of information science (Kari and Hartel, 2007).

The operationalization of the field in terms of its literature by White and McCain (1998) could then be accepted, with an extension to its monographic literature, and, similarly, its characterization of the topics covered, with the qualification that information science is extending beyond these, still centrally included, topics. Crucially, in relation to the gestalt of the computer, information science inherits, and partly sustains, concerns from librarianship and documentation, which then encounter with the growth of modern information and communication technologies and the gestalt of the computer itself, with the inheritance disguised, and sometimes distorted, by that gestalt. The inheritance from librarianship and documentation can usefully be conceived as the diachronic or vertical axis intersecting with the synchronic or horizontal band of the technologies and their associated gestalt, with technologies developing and the gestalt modulating over time.

The pattern of a diachronic inheritance intersecting with a synchronic band can function as a model for the relation of other disciplines to the computer and its gestalt. For instance, computer science itself could be regarded as bringing an inheritance from mathematics and logic, analogous to the areas identified as 'content-neutral' by White and McCain (1998, p.328), to the technology, with the gestalt particularly revealed in associations between the computer and intelligence. Cognitive science, connected to the gestalt by its insistence on the modelling of human thought as computational processes (Johnson-Laird, 1988; Sperber and Wilson, 1986), could be traced to behaviourist psychology. Information systems, regarded as a cognate subject, but disjunct discipline from, information science (Ellis, Allen, and Wilson, 1999), inherits themes from business administration. A concern with the gestalt of the computer, from within information science, then has relevance to other disciplines influenced by the technology and

participating in the gestalt. It may also help further to situate information science in relation to synchronically contiguous disciplines.

The gestalt of the computer is primarily understood as false consciousness, obstructing or preventing understanding, in the original critique. Other disciplines, even those partly participating in the gestalt, have recognized analogous elements of false consciousness. For instance, from computer science, Dijkstra (1989, p.xxxv) observed that, the 'anthropomorphic metaphor – for whose introduction we can blame John von Neumann – is an enormous handicap for every computing community that has adopted it … [t]he analogy that underlies this personification is so shallow that it is not only misleading but also paralyzing.'. In contrast to the original formulation, elements rather than an entirety of false consciousness are recognized and recognition is combined with a continuing engagement with the motivating technology. A general limitation of the view of the gestalt as entirely false consciousness is that it disguises or obscures real changes occurring in the material basis of being, in technologies, and in behaviour and consciousness influenced by being mediated by technology. A related specific, and crucial, weakness of the original critique is the dismissal of the computer as, 'perhaps an historical accident' (Rosenberg, 1974, p.268). The dismissal could be considered analogous to the repression of technology identified in information science, revealing that the critique partly participates in the gestalt it identifies as false consciousness.

The idea of the computer as an historical accident can also be severely questioned empirically. Conceptualization of the computer may have been exogenous to the scholarly and public communities which subsequently received technologies as products, but can be situated in relation to symbolic and mathematical logic, with logic formalized in the mid-19th century, converging with mathematics in the early 20th, and with the theory of computation developed within mathematics in the mid-1930s (Herken, 1995). Invention occurred in possibly three partly non-communicating locations quasi-simultaneously, in the United States, England, and, possibly, Germany, motivated by the need to transform intercepted ciphers into plain text messages (Davis, 2000, pp.177-197). Diffusion by adoption of the computer as an innovation or commercial product can be regarded as partly motivated by lower costs of technological processes compared to direct human mental labour (Webster, 1990; Warner, 2005) [3]. By 1967, it could be observed that, '[t]hough only some of us deal directly with computers, all of us are falling under the shadow of their ever-growing sphere of influence' (Minsky, 1967, p.vii). By 1999, diffusion had proceeded further, with many dealing directly with computers: as *Time* noted, 'everyone who taps at a keyboard, opening a spreadsheet or a word-processing program, is working on an incarnation of a Turing machine' (Time, 1999; Quoted in Davis, 2000, p.193).

A late 20th century revolution in the mechanization of mental labour (Minsky, 1967, p.2), possibly now stabilizing, can be detected, with the special purpose information machines whose diffusion preceded the computer understood as the transitional forms preceding the punctuation of an equilibrium or as the accumulation of contradictions leading to a revolutionary change. Understandings of computability have been experientially acquired by wider publics, from the use of technologies as products, and should be *a*

priori congruent with more esoteric theoretical conceptions of computability, which themselves appeal to what would naturally be regarded as computable (Minsky, 1967, pp.105-111). Current contexts of use, particularly the wider public sphere, are radically different from the original content of conceptualization and invention, and from the continuing mathematical culture of computer science, with limited direct diffusion of central, and crucial, concepts of computability from logic, mathematics, and computer science to the public sphere.

The diffusion and relative stabilization of the computer has eroded its gestalt, in the sense of a mysterious object held within relatively enclosed communities. For instance within information systems, regarded as cognate subject with, but separate discipline from, information science (Ellis, Allen, and Wilson, 1999), information technology has been recognized as an infrastructural resource shared by competitors rather than a differentiating factor, potentially conferring competing advantage (Carr, 2004). Such a recognition of the effects of the wide availability of a technology could have been, and was, anticipated from established economic understandings [4], but the wide diffusion of the insight is indicative of technological stabilization and a reduction of the sense of mystery. Concurrently with Carr (2004), there were pleas within information systems for a return to a more literal and descriptive, rather than potentially mystical, terminology: 'So-called *information* technology … processes data, not information. We should ... revert to the original name used for information systems in the 1960s and 1970s: *data* processing systems' (Galliers, 2004, p.252). The erosion of the gestalt within information systems can be regarded as, in part, a product of the process of naturalization of technologies.

The erosion of the gestalt is different from the articulation of a counter-position, which identifies real changes, and, in particular, naturalization may even inhibit the production of an articulated counter-position. Naturalization can be understood as the transformation of the socially constructed into the natural, disguising its human origins (Berger and Luckmann, 1966). Naturalization of technologies may occur almost consequentially with their diffusion. Naturalization can be distinguished from humanization, a possible counter-position, and may even be in tension with it. Humanization would be understood as recognizing the technology as the product of human mental and productive labour over time, with the technology conceived, invented, and adopted under specific historical circumstances. In contrast to the progressive development of naturalization, a deliberate, partly theoretical and possibly painful, effort is required for humanization. Unless a counter-position, including the humanization of the motivating technology, is fully and deliberately articulated, the gestalt as false consciousness may disappear from the place in which it has been identified and reappear in another – consider , as an example of relocation, the transfer of research attention from artificial intelligence to data-mining.

A particularly timely approach to understanding, and then dissolving, the gestalt of the computer would be to address the motivating technology directly, humanizing it, and not dismiss it as a historical accident. The elements of false consciousness associated with the gestalt could be dissolved away to expose real transformations in being and more permanent, and legitimately grounded, changes in consciousness. The possibility of

relevant concepts not open to computational modelling and the need to 'get out from behind the computer' (Rosenberg, 1974, p.268) are not denied, but the intention is to absorb the computer, and other modern information and communication technologies, within the perspective developed. The gestalt can then be transcended, rather than partly reproduced by the repression, in effect, of the motivating technology in an otherwise powerful critique, only for the gestalt independently to continue and to transform and re-emerge.

The Janus-like character of information technology, familiarly regarded as facing both the technical world of bits and the social world of human communication, but also requiring understanding from formal and from discursive disciplines, must be fully confronted. Heidegger's remark that, the 'essence of technology is by no means anything technological' and that, accordingly, 'essential reflection upon technology and decisive confrontation with it must happen in a realm that is, on the one hand, akin to the essence of technology and, on the other, fundamentally different from it' (Heidegger, 1993, pp.311 and 340) assumes a specific relevance here. The material substances from which information technologies are constructed have changed over time, without affecting the possibilities and limits of computation, most fully formally understood by automata theory. The divide between the disciplines involved in the conceptualization of the computer, of formal logic and mathematics, from the human and more discursive sciences, themselves more widely publicly intelligible, must be transcended.

The immediate concern here will be with the symptoms of repression of the influence from technology on the development of information science. The language of many discussions tends to treat technology as objectively given and as an autonomous development. Receiving technology as an unmotivated and exogenously given development corresponds to naturalization, the transformation of the humanly created into the natural. There can be traces of technological determinism, most subtly and pervasively in the absence of the recognition of technology as a human construction. Attitudes may be implied, rather than fully articulated, and their diffusion and strength could be related to their lack of formal articulation. Implied attitudes may only be recognized when they are transgressed or identified. While the false consciousness of the reification of technology is sustained, information science's understanding of itself, and its potential for contribution to other disciplines, remains restricted.

Dissolving the gestalt has a triple relevance, to information science's understandings of itself, to enhancing the developing broader conception of information science, and to other disciplines implicated in the gestalt by analogous patterns of disciplinary inheritance and synchronic encounter. The loss of clarity which might follow from the seductions of over generality (White and McCain, 1998, p.353) can be avoided by a rigorous focus on portions of specific texts known to information science.

The focus will be on collective, rather than primarily individual, ways of knowing, in accord with a social epistemological approach (Shera, 1965), which has been more recently partially revived as a proposal for the sociology of texts (McKenzie, 1986, p.7). The choice of texts for study from information science is admittedly eclectic, but remains

sufficient, as counter- rather than further examples would be required to disprove the themes developed. The wider public understanding of information, embodied in reports of information theory (Shannon and Weaver, 1949), itself widely diffused and influential but poorly understood (Tidline, 2004), will also be considered. Individual consciousnesses can be understood to be included in the collective consciousness explored.

Understandings of technology

Objectively given

Technology is often conceived as objectively given, with attitudes revealed by implication rather than explicitly stated, although there can be a continuum from the implicit to the explicit. The following quotation implicitly embodies a view of technology as objectively given:

> We enter the epoch in the natural history of information technology – our epoch, our epic – epitomized and energized by the personal computer and its adjuncts.
>
> (Levinson, 1997, p.114)

A view of technology as having causal effects is congruent with receiving technology as objectively given, although causality is partly explicitly conceived: for instance, within the same work, the position, ascribed to McLuhan, that copyright was a consequence of the printing press, is endorsed without exploring the possibility that both the diffusion of the printing press and the development of copyright were effects of Protestant individualism (Levinson, 1997, p.189). Most explicitly, a 'natural history of information technology' is proposed (Levinson, 1997, p.114), with the reference to *natural* obscuring the human origins of technology. In other studies, a causal connection from technology to society is similarly made: for instance, a democratic tendency is ascribed to modern communication and information technology, and a correlation between measures of democracy and interconnectivity observed, although with some, but not full, distinction between correlation and causality (Kedzie, 1997, pp.107-113).

Even studies which acknowledge the social dimension of technology, by carefully addressing its social impacts, may partly reproduce the implied understanding of technology as objectively given, by failing to enquire into the forces prompting the adoption and diffusion of specific technologies. For instance, contributors to the early study edited by Ithiel de Sola Pool, *The social impact of the telephone* (Sola Pool, 1977), acknowledge that, the 'telephone is a device with subtle and manifold effects which cannot be well guessed a priori', but still tend consistently to regard it as causing, or having impacts, but not itself caused, beyond the science and technology mediated by Bell as an inventor (Pierce, 1977, p.159; Gottman, 1977, p.309). Similarly, H.G. Wells had earlier treated transport technologies as having extensive effects:

> The growth of our great cities, the rapid populating of America, the entry of
> China into the field of European politics are, for example, quite obviously and
> directly consequences of new methods of locomotion.
>
> (Wells, 1902, p.3)

The communication technology of the telephone had secondary effects: it 'will almost
certainly prove a very potent auxiliary indeed to the forces making for diffusion' (Wells,
1902, p.58). A more sophisticated view, which does not deny impacts but which more fully
addresses the production of the technology itself, would be to regard the rapid
transformation of the telephone from invention to diffusion as driven by the need for
business communication over distance.

Premodern computational technologies have been similarly conceived as objectively given,
particularly in their material aspects, with the resistance of physical substance to human
manipulation understood as restraining the development of technologies. A characteristic
view of Babbage's enterprise would be that:

> Babbage never succeeded in constructing his [analytical] engine, in large
> part because of the limitations of nineteenth century technology.
>
> (Davis, 1995, p.152)

A more detailed account, contained in a biography of Babbage, partly reproduces the
received view – 'electrical technology was not sufficiently advanced for Babbage's
requirements … Babbage's methods of the 1860s were technologically premature'
(Hyman, 1982, pp.172, 245-246) – but also gives evidence which can be used to question
it. Babbage's Engines were predominantly individual enterprises with limited funding
(Hyman, 1982, pp.172n, 231). In contrast, the trans-Atlantic telegraph was collectively
funded and developed and the substantial difficulties encountered in its construction were
successfully resolved, by 1866. A more satisfying explanation for the contrast between
the arrest of Babbage's Engines between conceptualisation and invention and the
progress of the telegraph to diffusion would be that the social need for the rapid
transmission of messages over space was greater than for automatic data-processing, in
the mid- to late 19th century [5]. The accordingly greater investment in message
transmission technologies was able to overcome the resistance of material substance. In
the received view, technology tends to be identified with its material aspects and
implicitly conceived as exogenous to logic and mathematics, which may be more readily
recognised as human constructions.

Raising the implied view of technology as objectively given to consciousness and
critiquing is not to deny that material substance may offer different, and, possibly, greater
resistance to humanly imposed patterns than semiotic phenomena. Rather it is to insist
that such implicit conceptions of technology receive technology as a given and tend to
deny that it is a product of human mental and physical labour, humanly made by working

on the accumulated knowledge embodied in existing technologies as well as on material substances.

Autonomous development

Technology is also received as an autonomous development, growing independently of human activity, but having causal effects on human behaviour. For instance, in the view that, successive generations of online systems have led to changes in the relations between intermediaries and end-users (Hancock-Beaulieu, 1993, p.1), information technologies are implicitly conceived as independently developing and as having causal effects. More explicitly, James Beniger's influential study of the control revolution (Weller and Bawden, 2005) concludes, 'technology appears autonomously to beget technology' (Beniger, 1986, p.434). *Appears* implies a reservation on receiving technology as an autonomous development, and the idea of the rapid development of technologies has real historical correspondences, but Beniger does not fully move beyond implying a possibly misleading appearance. *Beget* is associated with biblical genealogies and implies the significance of technological development, but as a mysterious process, with evidently not self-reproducing objects characterised in terms of human reproduction. The idea of descent and transformation can be preserved, while distinguishing human activity from that of natural and inert materials. Norbert Wiener observed:

> In all engineering, there is a certain family history, a certain genealogy. The smith's hammers were forged by the hammers of an earlier smith.
>
> (Wiener, 1993, pp.46-47).

In contrast to Beniger, Wiener acknowledges that technology is humanly constructed, using existing instruments of labour, exposing the real empirical basis for its cumulative development.

The idea of technology as an autonomous and causal force is present in wider scholarly discourse, beyond information science. It can be detected, for instance, in the assertion that, '[t]here is surely no question about the impact of the printing press as a force for change' (Jardine, 2004), without enquiring into the forces which made for the diffusion of printing. Other texts can slide between implied elements of causality from technology to an explicit assertion that technology is not autonomous and out of control, but can be deliberately humanly modified (Levinson, 1997, pp.189, 204). The idea of technology as out of control has been detected as a recurrent motif in understandings of productive technologies in political thought (Winner, 1997).

A more sophisticated position is required, which recognizes the social changes associated with technologies and their appearance of autonomous development, but which attends to the causes as well as the impact of technology and which moves beyond implying that an appearance of self-reproduction is misleading.

Threatening and artificial

A widely diffused and strongly influential image of industrial technology is as something threatening and artificial, with artificial implicitly primarily understood as unnatural rather than as made by human artifice. Marvin Minsky alludes to the threat to the human body from industrial machine, in one of the few explicit discussions of the image of the machine within computer science, after differentiating information and control from industrial machines:

> It [the term *machine*] brings to mind a big, heavy, complicated object which is noisy, greasy, and metallic; performs jerky, repetitive, and monotonous motions; and has sharp edges that may hurt one if he does not maintain sufficient distance.

> (Minsky, 1967, p.1)

The description of the machine is thematically and even verbally reminiscent of Dickens' characterization of industrial machinery in Coketown in *Hard Times*, where 'the piston of the steam-engine worked monotonously up and down, like the head of an elephant in a state of melancholy madness' (Dickens, 1989, p.28). The reference to 'melancholy madness' in the analogous passage brings out the implication by Minsky that monotonous, repetitive, and jerky movements would be regarded as signs of mental disturbance in human or animals, confirming the alien character of the machine to normal human being.

Further associated effects on human consciousness can be connected with the hard materiality of the machine. The substantively real danger to the body from the machine may account for the reluctance to embrace it as a human product.

> Even today, most of the machinery we see is concerned with the use of brute power to distort and transform crude materials. Most present-day machines *are* dangerous. Unlike our bodies, production machines are made of large, sturdy parts that need no soft sheathing for their protection.

> (Minsky, 1967, p.1)

These effects may be reduced, although not entirely eroded, for machinery approaching or constituting information technology:

> There are occasional exceptions to this feeling. We may admire in the works of a small watch that craftsmanship required to create miniatures; we may admire the quiet competence of a high-speed computer. Neither of these are involved in the distortion of materials; they are still machines, however, and not too far to be trusted.

> (Minsky, 1967, p.2)

The surface appearance of a clear boundary between the machine and its environment and from other machines, plausibly derived from its hard materiality of the machine, is liable to be betrayed when systematic attempts at delimitation are made.

> the question of where a particular machine ends and its environment begins can only be settled by a convention or definition. The body can be regarded as the environment for the brain or for the liver. The distinction between the essential part of a machine and the inessential trim depends on one's choice of values.
>
> (Minsky, 1967, p.19)

The difficulty of demarcation is reminiscent of Saussure's remark that, in linguistics, 'it is the viewpoint adopted which creates the object' (Saussure, 1983, p.8)

The distinction implied in the contrast between machinery which distorts materials and those quietly working without distorting their environment can be developed into a theoretically articulated understanding of information technology:

> [information technologies] do not do 'work' as did machines of the Industrial Revolution. Instead of dealing with material or energy, we are told they handle 'control' and 'information' and even 'intellectual processes'
>
> (Minsky, 1967, p.vii)

Concepts developed for machines for the transmission of force do not fully comprehend information technology or information mechanisms within such technologies:

> the classical idea of 'simple machine' – lever, wheel, inclined plane, etc. – does not capture the spirit of what is involved in today's machines because it doesn't help understand anything except the transmission of force. We cannot explain in those terms even some parts of clockwork, such as the ratchet (an information-storage device)
>
> (Minsky, 1967, p.7n)

The idea that information technology is concerned with information and control would be a grounding assumption for computer science. An analogue has developed in ordinary discourse, where it would be informally understood that information technologies act on information or data and are not directly concerned with the transmission of force or the distortion of materials [6]. The substances from which computers are made have reduced their machine character since Minsky's observations. It may now require a deliberate effort to recall that the computer is only a machine, of a specific type, with the effort needed to sustain this position testifying to the distorting power and wide diffusion of the gestalt.

Issues analogous to those arising for industrial machinery can be detected for information technologies and may have arisen as transformed inheritances or independently developed commonalities. The appearance of a clear boundary around an information machine, which might be given by its character as a physical object, is similarly continually betrayed for information technologies, including the computer. Information and communication technologies, such as the radio, camera, telephone, and satellite, need to be embedded in an elaborate infrastructure to make them useful and to preserve their usefulness (Ohlman, 1996, p.694). The difficulty of demarcating a computer from linked storage devices then complicates the correlation with models of the computational process. The original models did not differentiate volatile from persistent media (the distinction was also not present in early magnetic core based machines) (Cockshott and Michaelson, 2007, p.239). The distinction of program from data, discernible clearly from the models, can also become arbitrary in working practice. The difficulty of determining where a particular machine begins and ends, present for industrial machinery, applies, then, to information technologies as well.

Information technology is also similarly perceived as threatening and artificial, with the strength of the feeling and the depth of the analogy suggesting that it is both a transformed inheritance and independently sustained commonality.   The danger to the human body associated with industrial machinery is replaced by supplanting or destroying of the human mind. Poincaré, in advance of the construction of working computers, but critiquing the reduction of mathematics to purely formal procedures, which preceded and enabled the isolation of mathematical operations for automata theory, suggested:

> Thus it will be readily understood that, in order to demonstrate a theorem, it is not necessary or even useful to know what it means. We might replace geometry by the *reasoning piano* imagined by Stanley Jevons; or, if we prefer, we might imagine a machine where we should put in axioms at one end and take out theorems at the other, like that legendary machine in Chicago where pigs go in alive and come out transformed into hams and sausages. It is no more necessary for the mathematician than it is for these machines to know what he is doing.

> (Poincaré, 1952, p.147)

The analogy between mechanical computational processes and the destruction and transformation of the animal body embodies the link between the threat from industrial machinery and from information technology and is extraordinarily intensely expressed. The formal character of then new mathematics, critiqued by Poincaré but inherited by computer science, has tended to remain dominant. The substantive could be isolated from the mythic components of the threat, by acknowledging technology as a human construction, which may reconfront its producers in the appearance of objective reality (a chess playing computer which defeats a human grandmaster remains a product of human activity, in both its hardware and software aspects). In the case of information technology, the further possibility of human intelligence exceeding the computational

procedures it can produce can also be indicated (consider the human construction of this sentence).

Mythic accounts of technology similarly regard it as both humanly made and non-human and as threatening its creator, with some confusion between maker and monster. In the modern myth of Frankenstein, creating the monster technology is analogous to conception, parturition, and birth:

> With an anxiety that almost amounted to agony, I collected the instruments of life around me that I might infuse a spark of being into the lifeless thing that lay at my feet. It was already one in the morning; the rain pattered dismally against the panes, and my candle was nearly burnt out, when, by the glimmer of the half-extinguished light, I saw the dull yellow eye of the creature open; it breathed hard, and a convulsive motion agitated its limbs.
>
> (Shelley, 1998, pp.38-39)

The monster is made from dead human parts, brought to life by intervention from a living human, but rejected by the people it encounters, with pathos attaching to it as a victim of human conduct, both in the original narrative and filmic representations. The popular confusion of maker and monster corresponds to the absence of a clear boundary between machine and environment. The human maker exists towards his monster, which has some analogies with the golem, formed from clay, of Jewish mythology (Wiener, 1966, p.95), as God to man. Frankenstein's monster, like Satan, is exiled. There is a reluctance to embrace what man has made. The Frankenstein myth embodies the humanist perspective on technology, now eroding in relation to information technology, in which technology is received as unnatural and not human, rather than, more fully, humanly made but not human in itself, with both the restricted and encompassing perspective captured by the myth.

Information theory and information technology

The wider public understanding of information, as a nexus of associations between information and modern technologies, may have been influenced by the diffusion of information theory, possibly to the extent of the adoption of the term, *information* technology. Public discussions of information theory tend to share the characteristics of other discourse about information technology.

Obituaries of Claude Shannon revealed a view of technology as an autonomous development, in its material aspect.

> Many of Shannon's pioneering insights were developed before they could be applied in practical form. Along with Alec Reeves's concept of telephone conversations transmitted as pulses and Alan Turing's dream of

all-purpose computing devices, Shannon's ideas had to wait for solid-state electronics to mature before they could be achieved practically.

(Emerson, 2001).

The references to *to wait* and to *to mature* imply growth independent of human activity. The continuation from the obituary, 'it was only the arrival of integrated circuits in the 1970s that made possible the commercial exploitation of technology based on Shannon's theories' (Emerson, 2001), treats technology as objectively given in its reference to *arrival*.   It also indicates the concurrent, although not necessarily simply causally connected, development of integrated circuits and of the practical application of Shannon's theories, regarded by Shannon as sharing the non-constructive nature of existence proofs, in certain respects (Shannon, 1993, p.39) [7]. Theories are treated as specific human constructions, associated with, and sometimes called after, the names of their inventors, while the material aspects of technology are conceived as natural and external to human activity

The full historical precedence of theory to practice is questionable, from a more inclusive understanding of practice: the 19th century telegraph embodied the components of the model of communication formulated by Shannon, with human and technological entities corresponding to the information source, message, transmitter, signal, communication channel, receiver, and destination; the telegraphic codes Shannon played with as an adolescent were subsequently found to be highly efficient in their reduction of redundancy from alphabetic written messages for telegraphic signals, when assessed from information theory. Turing's universal machine was also constructed before solid state electronics. A fuller understanding of the dynamics of development of technology is needed, which acknowledges a dialectic interchange between practice and theory, with contrasting constraints on theoretical development and practical implementation.

Languages of discussion

Languages of discussion have been regarded as significant in the discussion here, implicitly understanding consciousness as constituted in language (Vološinov, 1986, pp.85-93). The idea of technology in its material aspect as objectively given, autonomous, simultaneously human and non-human, and threatening may reflect an inheritance from the development of language itself. Languages developed at an early stage of social development where there was little distinction made between inanimate things and persons: things have gender in two-gendered languages, 'a knife *cuts* and a flint *flakes*' (Childe, 1956, pp.84, 86-89, 117), and brooks have *mouths* (Fisch and Bergin, 1990, pp.91-92). In the myths inherited from the society of the Old Stone Age, things were composed of substances, with the idea of substance generated from the manual fabrication of tools and profoundly affecting man's reproduction of reality (Childe, 1956, p.89). Similarly, the Italian philosopher Giambattista Vico, noted that language embodies a view of nature as animated and human.

Thus *head* for top or beginning; the *brow* and *shoulders* of a hill; the *eyes* of needles and of potatoes; *mouth* for any opening; the *lip* of a cup or pitcher; the *teeth* of a rake, a saw, a comb; the *beard* of wheat; the *tongue* of a shoe; the *gorge* of a river; a *neck* of land; an *arm* of the sea; the *hands* of a clock; *heart* for center (the Latins used *umbilicus*, navel, in this sense); the *belly* of a sail; *foot* for end or bottom; the *flesh* of fruits; a *vein* of rock or mineral; the *blood* of grapes for wine; the *bowels* of the earth. Heaven or the sea *smiles*; the wind *whistles*; the waves *murmur*; a body *groans* under a great weight. The farmers of Latium used to say the fields were *thirsty*, *bore fruit*, were *swollen* with grain; and our rustics speak of plants *making love*, vines *going mad*, resinous trees *weeping*. Innumerable other examples could be collected from all languages.

(Vico, 1976, p.129 (§405))

The threat to the human body from the material aspects of technologies particularly incorporates the primitive conception of substance as both human and non-human and as resistant to humanly imposed patterns. The attitudes to technology discovered are, then constituted in language, with language itself permeated by primitive animist assumptions, but are not solely linguistic and have analogues in disciplinary and conceptual divides, particularly between the humanist resistance to technology as non-human and the scientific and technological fascination with the artificial.

Analogy with Platonism

The idea of technology as objectively given also has an analogy with the Platonist view of mathematical propositions as discovered rather than created, particularly in its elision of human activity. Further analogies can be found between the idea of technology as objectively given and other, less specific and more widely culturally diffused, elements of Platonism, particularly the view of ideas or ideal forms existing independently of human activity and apart from particular instantiation in an expression. The analogy between receiving technology as objectively given and Platonist perspectives on mathematical propositions and on ideas and their expression may be largely implicit, but can still be highly influential, with its power partly deriving from the lack of explicit articulation.

Platonism may have been a partly unconscious inheritance from the mathematically influenced contexts from which information science developed (Roberts, 1976) and there is also the possibility of explicit derivation. Influential, although not necessarily well understood, mathematical logicians, connected to information science through the gestalt of the computer, such as Gödel, were strongly and explicitly Platonist. A further analogy with Platonism in information science could be found in bibliometrics, where products of intersubjective human activity, such as citations and publications, are treated as objective existents, capable of yielding measures of research impact necessarily more valid than those obtainable directly from the people who generated them. Similarly, ideas in documents for indexing have been assumed to exist, and to be discoverable for labelling, apart from their, or any, language of expression. Human activity in the making and

renewal of semiotic products is then obscured. A counter movement can be discovered in the reference to artefacts of language, such as documents, by the name of their authors, even for later editions of books, affirming their human origins, with similar treatment of some scientific theories, although material technologies are still called by their generic name, removing evidence of humanity and human labour in their making.

The recognition of analogies with Platonism does, crucially, open up the possibility of a related, although still differentiated, critique: that information technology, like mathematical axioms and theorems, is a radical human construction, but with patterns imposed on recalcitrant material substance as well as on semiotic phenomena.

Summary

In summary, then, information technology has been implicitly understood as objectively given, with an associated, but more explicit, conception of causality from technology to society. Both modern and pre-modern information technologies are conceived as exogenous to logic and mathematics, particularly in their hardware or material aspects. Technology has also been conceptualized as an autonomous development, reproducing itself without human intervention, with a similar sense of causality from technology to society but a stronger connection with technological determinism, which could be ascribed to the idea of technology as acting and not just existing independently. In both scholarly and public understandings, theories have been divided from their materialization, with a limited understanding of the dynamic of interaction between them. Mythically, technology was conceived as threatening and unnatural, with the threat to the human body replaced by a danger of supplanting the human mind. A deep analogy with Platonism could be found in the view of technology and of mathematical axioms as objectively given rather than humanly created. Understanding has, then, tended to remain arrested at the level of appearance, receiving technology as a 'natural fruit of social labour' rather than as a 'historic product' (Marx, 1993, p.700).

Conclusion

The implied attitudes to technology which have been revealed are pervasive, may not reach the level of formal articulation, and can appear weak when articulated. The combination of pervasiveness with lack of formal articulation embodies classic features of repression:

> The mark of something repressed is precisely that in spite of its intensity it is unable to enter consciousness.
>
> (Freud, 1990, p.73)

Repression occurs in collective rather than primarily individual minds, in an extension of concepts beyond the individual, legitimated by elements in Freud's work, particularly through the idea of the community as also having a super-ego (Freud, 2002, p.77) and of surviving 'myths [as the] … distorted vestiges of the wishful phantasises of whole

nations, the *secular dreams* of youthful humanity' (Freud, 1990, p.140). Revelation of attitudes through language, particularly through the animist elements inherited from the early stages of social development, strengthens the sense of repression, through the analogy between the savage and modern neurotic (Freud, 2001, pp.1-2).

For individual neurosis, 'analysis … brings simultaneous cure' for the sufferer (Freud, 1990, p.112), but cure may not follow recognition for collectively held attitudes. A similar opening can be, and here has been, made by identifying the symptoms of repression and raising the repressed to consciousness, exposing its limitations and recognizing that the implied position is unsatisfying. Articulating a more developed and intellectually satisfying counter-position may involve the difficult and painful effort at theory. Relevant disciplinary perspectives on information technology, which both inherit, and, particularly in the social construction of technology (Stewart and Williams, 1998; Kling, Rosenbaum, and Hert, 1998; Bowker and Star, 2000; Bowker, 2005), begin to transform and depart from the elements of repression identified here, will need to be considered, with a full counter-position developed from critiques of Platonism which insist on logical and mathematical axioms as human constructions and from Marx's conception of technology as '*created by the human hand*'.

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Notes

[1] The title of this paper itself alludes to a classic, although neglected, locus for understanding technology as a human construction, a passage from Marx's *Grundrissse*, concerned primarily and immediately with productive rather than information technology:

> Nature builds no machines, no locomotives, railways, electric telegraphs, self-acting mules etc. These are products of human industry; natural material transformed into organs of the human will over nature, or of human participation in nature. They are *organs of the human brain, created by the human hand*; the power of knowledge, objectified. The development of fixed capital indicates to what degree general social knowledge has become a *direct force of production*, and to what degree, hence, the conditions of the process of social life itself have come under control of the general intellect and been transformed in accordance with it. To what degree the powers of social production have been produced, not only in the form of knowledge, but also as immediate organs of social practice, of the real life process.
>
> (Marx, 1993, p.706)

The conception of technology as a radical human construction, given in the *Grundrisse*, underlies the more empirical treatment of industrial technology in the later *Capital*, but is not made as explicit there (Marx, 1976, pp.492-639).

[2] Searches in August 2007 revealed 19 references to Rosenberg, 1974 in the ISI citation indexes with c.10 substantive references to the 'gestalt of the computer' recalled by a *Google* search, with some commonality between the citing and the recalled documents (Thomson ISI, 2007; Google, 2007). Patterns of citations over time indicate a slight recent revival.

Citations to Rosenberg 1974
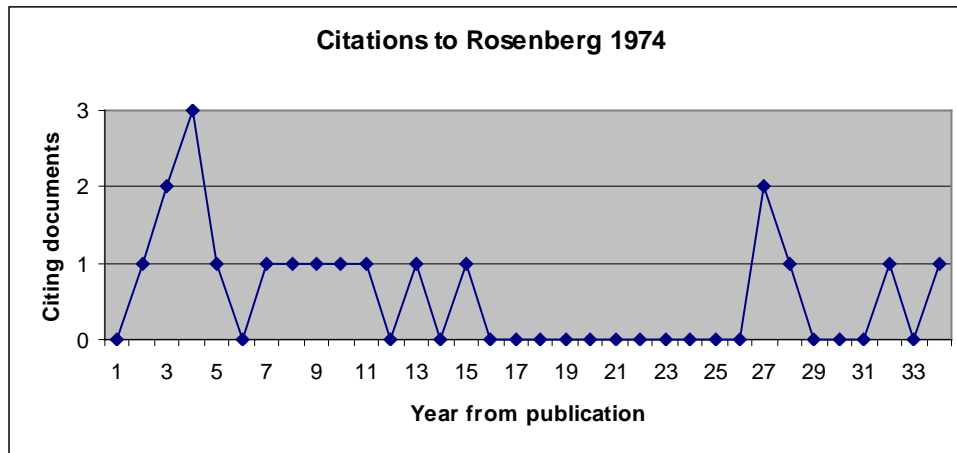
[3] The distinction of conceptualization, invention, innovation, and diffusion is derived from economics (Rosenberg, N., 1976, pp.192-93).

[4] Consider, for instance, Marx's view of the effects of the diffusion of productive technologies on the relative advantage obtainable by adopters.

> As machinery comes into general use in a particular branch of production, the social value of the machine's product sinks down to its individual value, and the following law

asserts itself: surplus-value does not arise from the labour-power that has been replaced
by the machinery, but from the labour-power actually employed in working with the
machinery.

(Marx, 1976, p.530)

[5] Interestingly, Hyman (1982, p.242) warns that, great caution is needed in relating Babbage's Engines to modern computers.

[6] Ordinary discourse may itself be elusive and difficult to produce as evidence, particularly in its spoken form, but judgments and legislative considerations in connection with copyright can be regarded as socially shared and endorsed texts and used as a surrogate. A pattern of emphasizing the mechanical aspects of new information technologies, followed by assimilation to categories for existing semiotic products, can be discerned. For instance, it was considered 'strained and artificial' to state that 'a mechanical instrument which reproduces a tune copies it' in an early 20th century United States Supreme Court judgment, under the existing legislation (White-Smith v. Apollo, 1908, pp.2984-2985), but closely subsequent legislation treated 'the parts of musical instruments serving to reproduce mechanically the musical work' as constituting copies (Copyright Act, 1909, §25(e)). By the later 20th century, only one member of a commission convened to review copyright in new technological uses of copyrighted works argued that copyright protection should not 'extend to a computer program in the form in which its is capable of being used to control computer operations', as, in this form, a program was 'a machine-control element, a mechanical device' (Contu, 1978, pp.1 and 27). The progressive assimilation can be regarded as an aspect of naturalisation, specifically of relatively novel technological processes to products already partly conceived as natural, and to semiotic rather than mechanical products.

[7] 'The demonstration of theorem 11, while not a pure existence proof, has some of the deficiencies of such proofs. An attempt to obtain good approximation to ideal coding by following the method of the proof is generally impractical. In face, apart from some rather trivial cases and certain limiting situations, no explicit description of a serious approximation to the ideal has been found.' (Shannon, 1993a, p.39)