CHAPTER 3

From Analogue to Digital: Theorising the Transition

> The distinction between digital and analogue representation is philosophical before it is technical.
>
> Chris Chesher (1997), 'The Ontology of Digital Domains', in *Virtual Politics: Identity & Community* in Cyberspace, David Holmes (ed.). London: Sage, p.86.

> The machine seemed to understand time and space, but it didn't, not as we do.
>
> Ellen Ullman, *The Bug* (2003) p.108.

> More and more, we are coming to realize that figures of thought rehearsed and repeated for centuries on end are falling victim to the digital revolution.
>
> Martin Burkhardt, *All or Nothing: A Digital Apocalypse* (2018) p.90.

'This all-or-none machine is called a *digital machine*'[1]

Technological change was very much in the air in the period immediately after World War Two. Computing was no exception. A once-sleepy field was woken by new political and economic imperatives. And so, at the cutting-edge of computer research, a transition was underway. Digital logic was being developed as a potentially more accurate and efficient form of information processing. At this early stage, leading thinkers in the field saw that the essential difference between the new digital machines and their analogue predecessors was something that needed to be discussed and so better understood. Norbert Wiener, for example, in his 1948 work *Cybernetics: Or Control and Communication in the Animal and the Machine*, put it like this:

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> There exist at present two great types of computing machines: those like the Bush differential analyzer, which are known as *analogy machines*, where the data are represented by measurements on some continuous scale, so that the accuracy of the machine is determined by the accuracy of the construction of the scale; and those … adding and multiplying machine[s], which we call *numerical* [digital] *machines*, where the data are represented by a set of choices among a number of contingencies … We see that for highly accurate work … the numerical machines are preferable … those numerical machines constructed on the binary scale, in which the number of alternatives presented at each choice is two.[2]

Wiener combined pioneering work in cybernetics at MIT with the research he did for the US Department of Defense. Cybernetics was a new and potentially game-changing branch of computer science at a time of sharpening Cold War tension. A defence priority for the US was an accurate and safe command and control systems capability that could target and steer its nuclear and conventional payloads.[3] Wiener's research suggested that digital computing was by far the more effective option for the military's needs. Digital cybernetic systems may have been the best for the task, but Wiener realised that a potentially serious ethical issue came freighted with this new technology. In *Cybernetics* he wrote that whilst 'it is advantageous' as far as is possible 'to remove the human element from any elaborate chain of computation', human control must be preserved 'at the very beginning and the very end' of the process.[4] In other words, although human beings are like his analogue computers in respect of their limited capacity for accuracy and speed, they must nevertheless always be in *initial* and *final* control of the command and control process, especially in respect of offensive weapons systems. People had to be involved at these critical junctures, Wiener declared, in order to make ethical assessments that were often context-specific and contingent. Human qualities such as trust and intuition and experience could not be delegated to a highly automated machine. However, in a 1950s Cold War context that increasingly threatened to become hot, the ethical legitimacy or otherwise of potentially war-winning weapon systems did not figure greatly in the generals' calculations, and so Wiener's requests for caution were disregarded.[5]

His feelings of anger at the military's lack of interest in an ethical approach were to be poured into his 1954 book *Human Use of Human Beings.* This was an extended theory on the need for human control over increasingly digital systems whose inner logic was specifically oriented towards removing human participation. In the book's appendix Wiener included a letter he wrote to the US military in response to a request from them for scientific papers concerning his work on cybernetics. In particular, they were seeking advice on how to perfect a 'controlled missile' project. He wrote that he would no longer help them, not even to provide copies of his research that was out of print. He went on in the letter to criticise the ethical vacuity of colleagues who had worked on

the atomic bomb, and who had chosen to become part of a military–industrial system that was creating the post-war computer revolution:

> The experience of the scientists who have worked on the atomic bomb has indicated that in any investigation of this kind the scientist ends by putting powers in the hands of the people whom he is least inclined to trust with their use.[6]

Wiener's experience showed how military expediency routinely overrode any ethical concerns regarding the development and application of computing. Importantly, this same expediency also brushed aside any lingering institutional curiosity regarding the broader philosophical questions surrounding analogue and digital computer systems and the nature of human engagement with these.

Wiener was active on fronts outside of the military, however. For example, the Macy Conferences were a series of intellectual gatherings that took place in New York between 1946 and 1953 to discuss new research in computing, philosophy, psychology and other fields. These had the specific aim of breaking down the specialist boundaries that existed between science and the humanities, to see what insights could emerge from a more interdisciplinary approach. A topic at the March 1950 conference was titled 'Some of the Problems Concerning Digital Notions in the Central Nervous System'. This included discussion on the analogue versus digital question, and was led by Ralph W. Gerard, an eminent neurophysiologist and psychologist. Gerard later wrote up a transcript of these discussions with Gregory Bateson, an anthropologist and linguist, the mathematician and physicist John von Neumann, and Norbert Wiener himself, on the characteristics of analogue and digital in respect of the nervous system and the brain. However, to read Gerard's account is to see how disciplinary boundaries remained firmly in place in their exchanges. Partly this was because simple matters of definition of the words 'analogue' and 'digital' immediately imposed themselves as problems. In one telling passage of Gerard's transcription, Gregory Bateson, the humanities scholar, comes over as someone outgeneralled by a roomful of world authorities on mathematics and computing, and so he confines himself mainly to asking questions:

> Bateson: I am a little disoriented by the opposition between analogical and digital. … It would be a good thing to tidy up our vocabulary. We have the word 'analogical', which is opposed to the word 'digital.' We also have the word 'continuous,' which is opposed to the word 'discontinuous'. And there is the word 'coding,' which is obscure to me.[7]

There follows a short and self-assured back and forth on the subject of definitions between the scientists von Neumann and Wiener. Then Gerard, another scientist, interjects by using a comparison that corresponds with the one Wiener used in his 1948 book and cited above. He does it in rather more redolent

terms than did Wiener—but also in terms that could, without too much imagination, be understood as being patronising towards Bateson, the outnumbered humanities man:

> Gerard: … an analogical system is one in which one of two variables is continuous on the other, while in a digital system the variable is discontinuous and quantized. The prototype of the analogue is the slide rule, where a number is represented as a distance and there is continuity between greater distance and greater number. The digital system varies number by integers, as in moving from three to four, and the change, however small, is discontinuous. The prototype is the abacus, where the bead on one half of the wire is not counted at all, while that on the other half is counted as a full unit. The rheostat that dims or brightens a light continuously is analogical; the wall switch that snaps it on or off, digital. In the analogical system there are continuity relations; in the digital, discontinuity relations.[8]

The discussions never did get much beyond this elementary definitional stage, and the Macy Conferences overall never came close to developing a systematic or even slightly promising comparison between analogue and digital machines. There was some discussion on the analogue and digital qualities of the nervous system and the brain, but it did not amount to much either and never involved Bateson. The transcript shows that Gerard—after flattering von Neumann for his 'expert tutelage' (at the conference)—was of the opinion that although the nervous system and the brain both have analogue and digital functioning—e.g. continuous and discontinuous (electrical signals flow and synapses fire)—research and understanding was still in its infancy. Von Neumann then seemed to close off discussion on the subject altogether, chiming in with the inflexible comment, almost a QED, that: 'It is very difficult to give precise definitions of this, although it has been tried repeatedly. Present use of the words "analogical" and "digital" in science is not completely uniform.'[9] The transcript suggests that the world-renowned physicist puts (almost) the last word in for science, leaving Bateson, the more philosophically-informed anthropologist, isolated and still 'disoriented' on the question.[10]

These faltering discussions did have a wider effect, however. They became representative of a general attitude regarding digital computing that was beginning to harden at the time. It was a tone shaped by a Cold War military-industrial complex attitude that helped ensure that a largely instrumental approach was taken in respect of technological development and application. And it was an instrumentalised and ethics-free approach that would take decades to come to light outside of the tight circles of an exclusive scientific community. For instance, the management theorists François-Xavier de Vaujany and Natalie Mitev have recently reviewed the Macy Conferences from a critical perspective and argue that they functioned as the foundations of the rise

of what they term the 'philosophy of the digital'. This was a 'philosophy' that dovetailed with the 1940s conception of the electronic brain or computer brain then emerging through the work of Alan Turing and others.[11] De Vaujany and Mitev see the Macy legacy as characteristic of a so-called 'representationist philosophy' in which the world and its objects are paralleled by symbols which can be 'manipulated according to logical rules to become "computable" symbols.'[12] Such an approach derives from nineteenth-century positivism, a philosophy that stresses an unshakable 'commitment to empirical facts', as Fredric Jameson puts it, and where the language of mathematics is considered the language of truth.[13] In particular, de Vaujany and Mitev argue that for many of the Macy delegates, fuzzy and 'uncomputable' human characteristics such as 'emotions, perceptions, sense-making and embodiment' are too subjective and therefore were 'not part of the design or description of these information processes.'[14] Their analysis of the conferences indicates that notwithstanding their stated interdisciplinary intentions, other views—such as the phenomenology of the humanities-trained Bateson, for example, where a whole tradition stretching from Henri Bergson through to Maurice Merleau-Ponty sees embodiment and subjective experience as an important factor in understanding the world and its reality—went unheard.[15] The Macy Conferences did not signal a total and unambiguous victory for the scientistic and positivist view of the human as being a digital and computational creature. But without a leading and authoritative science figure such as Wiener around to drive the public debates on the ethical and ontological questions, they simply petered out.[16]

The last Macy Conference on cybernetics was held during April 1953. In July of that year, President Dwight D. Eisenhower forced an armistice in the Korean War after threatening to use nuclear weapons north of the 39th parallel. In 1949 the USSR developed its own bomb and so the Cold War was now a war of technologies of mass destruction—and also a secret war. And so, in keeping with the exigencies of secrecy surrounding military technological development, an instrumental *technocratic discourse* on the respective qualities of analogue and digital machines retreated from public view into what Paul N. Edwards called the 'closed world' of top-secret projects, enormous government contracts, and covert military applications. In the testing labs and strategy seminars of the Pentagon and its numberless branches, Wiener's ethical concerns and metaphysical speculations had no place.[17] As Edwards tells it in his Foucauldian analysis of the power discourses in the US military industrial complex of the Cold War, it was *ad hoc* competition between narrowly disciplinary-trained research teams and government agencies that created the foundations for the computers that we know today.

In the 1940 and 1950s most existing computers were analogue. These were massive stand-alone, electricity-devouring machines built by corporations such as IBM and Remington Rand, and they crunched numbers and processed data on punched card, solid state, or vacuum tube computers for government departments and contractors around the USA. Alongside their great size and

cost, their very existence at the heart of government and big business constituted a powerful source of institutional resistance to the new digital machines. In their early prototypes, the digital machines were experimental and not very dependable. Even by the late 1940s when workable and more reliable and far faster digital machines were developed, they still faced obstacles in the vital command and control function that they were required for. For example, the human as interpreter of data, such as a radar operator, still functioned comparatively well in analogue form.[18] The eventual fate of analogue computers was sealed, however, when the USSR developed the bomb. In theory, Soviet long-range bombers could now strike US cities, and so the generals and politicians pressed its scientists, engineers and computer specialists to come up with a comprehensive air defence system for continental North America. The perceived mortal threat to the homeland was an unprecedented situation in US history. For the first time there was a need to defend the *whole country at the same time* from potentially devastating air attacks—and so this called urgently for new thinking and new technologies.

The history of the shift to automated digital systems is unavoidably a technical one. But technological forms and functions were shaped by particular ideological choices that emerged out of the inter-agency closed world discourses within the overall context of US government Cold War strategy. And these were discourses that were themselves shaped by a military-industrial complex rationality.[19] The details need not detain us too much here, save to say that a continent-wide air defence system called for efficient and fast *networked* systems, something that siloed analogue computers could not provide. And so, a networking logic was set in train, beginning with the founding of the Defense Advanced Research Projects Agency (DARPA) in 1958, and then the Advanced Research Projects Administration (ARPANET) in 1969, both of which were precursors to the commercial internet and web. But this closed world of technology development, containing the 'hidden history' of its formation, also concealed a paradox concerning automation and the role and function of the human. As Edwards argues: 'Computers were used first to automate calculation, then to control weapons and guide aircraft, and later to analyze problems of command through simulation. The final step in this logic would be to centralize it and remove responsibilities from lower levels' as the 'ultimate goal'.[20] This was the technocratic dream of the 1940s generals who were dazzled by the possibilities of Wiener's cybernetics. Automated and comprehensive digital systems would act upon a chaotic and dangerous world, a world to be rendered controllable and orderable as a rationalised time and space by 'intelligent' computers under the 'ultimate' control of a military-political elite. The paradox is that the prosecution of war (and the function of the economy) has never been separate from the very human world of individual and collective irrationality, of conceit and paranoia within a socio-cultural and political context of uncertainty—and not least from a technologically-induced hubris.[21]

In such an environment, questions concerning the nature of analogue machines versus their digital counterparts were beside the point. Speculations on the analogue-digital divide as a philosophical–ontological question would have sounded absurd in the planning rooms of the Pentagon or in the laboratories of private contractors. A new language had established itself around technical challenges and it called inevitably for instrumental solutions. These were in the sole purview of a military-industrial complex which, as Eisenhower belatedly warned, was led by 'a scientific and technological elite' that was in danger of capturing public policy.[22] As to the deeper (and logically following) questions of the role and function of humans vis-à-vis analogue and digital technologies, these were no longer even asked. For three decades the closed world discourse reigned. As Edwards put it, the 'confusion of philosophy [was] gradually replaced by the precision and clarity of science.'[23] Only computing could order the world in the required way. And with networked computers the only feasible solution to Cold War exigencies, digital computers began to shape the technological core of the world's foremost military and economic power, first in defence systems, spreading then into business, and then further into culture and society.

By the 1980s (when, incidentally, digital parallel computing finally became superior to analogue processes)[24] the US public, and publics of the developed world more broadly, became gradually aware of a more encompassing computer revolution that went beyond the scare stories of military applications and the more anodyne applications of corporate business and production systems.[25] A revolution was underway, and it was to be a 'personal' one in the form of the 'personal computer'. As the public were being introduced to this new world of individual possibility by ads such as Apple's '1984', behind the high-tech scenery, digital had already triumphed over analogue in the battle for the soul of the computer. In this new entrepreneurial era of Bill Gates and Steve Jobs, the love-children of the union between the military–industrial complex and the 1960s counter culture, philosophical questions regarding technical processes were reduced to epiphenomena; ethics and morality became a separate sphere altogether, one concerned with issues of privacy and how computers should be used and so on—not what these new computers actually *were*. Wiener's 'all-or-none' machine was thus able to emerge from its closed world chrysalis as a fully-fledged techno-logic—and now had the field, indeed the world, all to itself.

Are We Analogue?

The question is one that does not readily suggest itself, although Wiener definitely had a vague presentiment of it.[26] This is because important philosophical concepts developed at the dawn of Western thinking on the nature of the human relationship with technology meant that 'are we analogue?' is difficult

both to conceive and to ask. Beginning in Greek antiquity, there was established a basic ontological *duality* between humans and their tools, and between technology and nature. Two important arguments, attributed to Democritus and Aristotle, illustrate this. First is that 'technology imitates nature'—the idea that humans looked to nature for instruction on how to survive and succeed through technology. In Democritus, the skill of the spider in the action of 'weaving and mending, or the swallow in house-building' are examples of the cues in nature that empowered humans to adapt and control their environments.[27] Second and implicit in the first argument is that according to Aristotle there is an ontological distinction between natural things and artefacts.[28] And so, to say that humans imitate nature in their tool development, and that there exists an ontological division between nature and technological artefacts, is to say that humans exist *apart* from nature, and that their technologies are simply imitations of it.

The branches of this ancient trunk have grown in many directions over the past twenty-five centuries. In the modern period, however, the deep roots of Democritus and Aristotle have acted as a limiting and shaping factor upon how we how nature, technology and ourselves. So much so that in the age of digitality the most influential theories on the relationship with technology now appear as limited and partial accounts for understanding the truly radical nature of digital ontology. We saw that Marx, for instance, thought of technology as a kind of black box that when opened and analysed 'discloses man's mode of dealing with Nature and the processes of production'[29]. The exploitative logic of capitalism is revealed, for him, in the very design of a given production-line machine itself: in the number of workers it replaces, the speed at which it outpaces them in the labour process, and so on. And the factory machine, just like the bullock pulling the plough with the tithed peasant in tow, was conceived in the context of the relation of production at a given time in history. Marx's 'man' stands essentially apart from the technology (or is an accessory to it) and under capitalism is oppressed and exploited by it to a much more efficient degree.

Georg Lukács had developed Marx's account of commodification and the fetish of commodities into his own influential theory of *reification*. Like Marx, Lukács considered that technology and its specific forms have arisen out of the historical relations of production. As he phrased it in his *History and Class Consciousness*: 'economic forces determined the course of society and hence of technology too.'[30] He uses this to argue against the idea inherent in liberal bourgeoise ideology that 'technology functions like a societal "natural force" and is obedient to "natural laws"'. He insists that technology, nature and man are discrete forces, with the particular historical economic model and its relations of production acting as their binding social web. For Lukács, like Marx, capitalism-derived technology *acts* upon the individual in the process of commodity production. In the action of production, the worker's own labour becomes 'something objective and independent of him'. However, for Lukács the worker becomes reified not only from the action itself (from the labour) and from the

product of the labour—but also from the objective social and economic relations that frame the action.[31]

In the Frankfurt School, too, we find the notion that technology forms the individual and class. Theodor Adorno and Max Horkheimer were much influenced by Lukács's idea of reification. They were also troubled by what they saw as the logical consequence of his ideas, ideas drawn originally from Max Weber on the effects of increasing mechanisation, specialisation, and Taylorist calculation within capitalist competition. Adorno and Horkheimer, and later Herbert Marcuse,[32] developed more fully than anyone else the concept of *instrumental rationality*—seeing it as an inevitable outcome where 'reason's old ambition to be purely an instrument of purposes has finally been fulfilled.'[33] For them, the more equable reason of antiquity and the promise of an Enlightenment that reflected upon the means for achieving human potential in a positive way, had regressed into irrationality through capitalism's overheated concern with pursuing rational ends. And it was machine technology that made this possible, if not inevitable. In this particular interpretation Lukács thought that his acolytes had gone too far and that they had checked themselves into the 'Grand Hotel Abyss'[34] with their depictions of an almost total system of control. But for Adorno and Horkheimer, 'Technology', especially in the wake of its instrumental achievements in Auschwitz and in Los Alamos, 'aims to produce neither concepts nor images, nor the joy of understanding, but method, exploitation of the labor of others, and capital.'[35]

Exploitation. Reification. Instrumentalisation. These processes are still with us. They pervade current capitalism as they did capitalism in its early and more mature forms. They constitute the very essence of capitalism. And capitalism has globalised since the 1980s with its logic now seeping into every nook and cranny of life. And every year dozens of books are published on economics, on politics, and on the environment, which argue that the situation is even worse today in terms of capitalism's depredations. Not only that, others say that capitalism *itself* is in a terminal state and speculate how it will 'end' using forms of theorising that no longer necessarily follow the traditional Marxist teleology or dialectic.[36] In other words, there is an *impasse* or poverty of theory in terms of our understanding of the technology-driven trajectory of twenty-first century capitalism. More particularly, there is a serious lack of insight into how and why, as McKenzie Wark has expressed it in the book *General Intellects*, 'information technology seems to [be] something qualitatively different to previous regimes of mechanical … means of production.'[37]

To adequately theorise the transition to digitality means that we need now to look for different lines of cause and effect within what are undoubtedly radically transformed circumstances. The rise of digital means that we need to consider again what capital is and what capital does by way of digital's turbo-charging of capital's own preconditions. Moreover, pervasive and networked digitality gives the processes of exploitation, reification and instrumentalisation a scope that was not possible in earlier (modern) iterations of capitalism, and which as far as machine technology goes, are effects that Marx, Lukács, Weber, Adorno and

Horkheimer, and Marcuse could not have dreamed of. To think more clearly about the nature of digital and our human relationship with it, we need then to consider its relation to its opposite—the *analogue*. And from that comparison we need to ask a question that has never really been properly asked: are we ourselves analogue beings?

Arnold Gehlen implicitly enjoins us to do this in his book *Man in the Age of Technology*, which was published in German in 1949 and translated into English only in 1980.[38] In it Gehlen connects social theory with sociology and human biology with social psychology to fashion a 'philosophical anthropology' perspective on the human relationship with technology that is both novel and highly suggestive. It's an approach that gets us to the roots of how it is that our species evolved as creatures of technology (or 'technique'[39]) and unlike other species in nature are inseparable from it.[40] As he puts it early on:

> Technique is as old as man himself, for when we deal with fossil remains it is only when we come upon traces of the use of fabricated tools that we feel sure we are dealing with men.[41]

But what is the essence of this 'deep-seated bond' between what he terms 'man and technique'?[42] Gehlen argues that although it is tool use that distinguishes us from most other species, unlike most other species, we would not have survived in our evolutionary drift without connecting at some distant point in our pre-history with the means (tools and tool use) with which to overcome the 'weakness and helplessness [our species feels] when confronted with the powers of nature.'[43] Gehlen argues that in our present evolutionary state, in our present physical and cognitive state that stretches back 200,000 years, we are born 'unfinished'—deficient beings who are 'poorly equipped … with sensory apparatus, naturally defenceless, naked, constitutionally embryonic through and through, possessing only inadequate instincts.'[44] The human drift toward technique was necessary for survival and once established acted as the mediating form between 'man and his organic and instinctual deficiencies' and the hostile natural environment.[45] This adaptation, moreover, formed a dependency that has left us in a state of arrested development in terms of nature's evolutionary vigour.[46] As Gehlen puts it, increasing proficiency with technique relieves humanity 'of the necessity to undergo organic adaptations to which animals are subject, and conversely allows him to alter his original circumstances to suit himself'[47]. In other words, we long ago were locked into technique, but this stalled any evolutionary development and left us in a now-congenital unpreparedness for life *without* technique. This in turn set us on a path of human-technological dependency–development that made us what we are—creatures who became so adept at transforming our surroundings through technique, that we are the only species able to live and increase upon every corner of the Earth, reducing our world, in effect, to human dimensions, to the human-scale, and able to subject it to human-technological potential.

The Analogue 'Circle of Action'

Gehlen is not concerned so much with *what* characterises the essential connection in the human–technology–nature relationship, so much as he wants to establish that there *is* an essence. However, he does hint at the analogue nature of technology's 'ultimate determinants':

> If by technique we understand the capacities and means whereby man puts nature to his own service, by *identifying nature's properties* and laws in order to exploit them and to control their interaction, clearly technique, in this highly general sense, is part and parcel of man's very essence. It *truly mirrors man*… (emphasis added).[48]

Gehlen's insights provide a basis upon which to discuss and contextualise what I mean by the term analogue, and where humans fit within its operational compass. Unlike the impatient von Neumann who seemed irritated by a lack of definitional precision in the 1950 Macy Conference, and so offered no way forward, it is more fruitful if we begin with the etymology of the word and look for clues within it that can help us to move on. The term analogue—notwithstanding a slight renaissance in hipster music circles—is rapidly fading from our collective vocabulary. In everyday use it often referred to pre-digital consumer goods such as radios, or TVs, or record-players, and was understood mainly as a technology descriptor. But it's much more interesting than that. One OED definition of analogue is as 'a person or thing seen as comparable to another'. This is derived from the Greek word *analogon*, which means 'equivalent' or 'proportionate'. This is rather different from dying memories of a 1970s Sony PS-6750 Stereo Turntable or the David Bowie vinyl disc that would spin on it. The OED offers a *completely* different realm of understanding from the everyday definition. It's human-centred for a start. It tells us that 'equivalent' or 'proportionate' are about the relationship between people and things—in the context of their environment. I wanted to preface 'environment' just then with the word 'immediate'—but I'll come to that shortly.

From the OED definition we can see that the hammer, for example, is analogue in that it is 'equivalent' to the human hand. Not only that, and to pick up Gehlen once again, the hammer is an analogue 'strengthening technique that extends the performance of our bodily equipment.'[49] Gehlen makes the distinction between three types of technique: first is the *strengthening technique*, such as the hammer, or more recent technologies such as a microscope or bullhorn, which augment or amplify natural human capacities; second are *techniques of 'facilitation'*, such as to be found in, say, a wheel or a bridge or an automobile, and which act to relieve the burden upon organs and eliminate effort; and third are *replacement techniques* such as airplanes or ships, which act in place of organs or capacities not possessed by humans. This human multifacility with technique is hugely impressive if separated out in this way. It also makes even

more remarkable our evolutionary drift toward tools and tool development. At its most elementary (and idealised) level in pre-modern days, this relationship with technique finds expression in what Gehlen terms the 'circle of action'[50], an ancient—*the* most ancient—dialectical process which 'goes through object, eye, and hand and which in returning to the object concluded itself and begins anew.' Explaining further, Gehlen lyricises on the concept:

> The fascination exercised by the analogous process of the external world bespeaks a 'resonance' which conveys to man an intimate feeling for his very nature, by focusing on what echoes his nature in the external world. And if we today still speak of the 'course' of the stars and of the 'running of machines', the similarities thus evoked are not in the least superficial; they convey to men certain distinctive conceptions of their own essential traits based on 'resonance'. Through these similarities man interprets the world after his own image, and vice-versa, himself after his image of the world.[51]

Gehlen intimates at various points (such as in the above quotation) that this is a feedback loop of action that over thousands of years of trial and error has made it possible for us to create *ourselves* and re-create our *environment*. Moreover, the circle of action is profoundly analogue in that by imitating nature though techniques that correspond to nature or are in some way proportionate with nature—we 'resonate' with nature, become as one with nature and find our own image reflected in nature.

Except that Gehlen says also that some technologies are more abstract than others, meaning that some were created 'without reference to nature.'[52] He claims that the wheel, or the flint blade and other fundamental inventions are simple testimony to human inventiveness and intellect, and so constitute technologies that are '*nature artificielle*'. Indeed, man, too, for Gehlen, is an artificial creature, so profound is the relationship with technology.[53] Well, yes and no. Humans *are* constituted *as technique* and so have always been posthuman. But this does not mean that they are abstracted from nature at this most basic level, and it does not mean that the wheel, or the knife or even the airplane or the automobile are not in themselves analogue.[54] This is an important point in my comparison of analogue with digital. It allows me to bring in a rare and insightful perspective from more recent times that explicitly makes the case that humans are essentially analogue creatures in a digital world. In an underappreciated essay on nostalgia and digital communication among the Ecuadorian diaspora, Silvia Estévez takes up the issue directly. She begins with a revealing observation from Charles Petzold, one of the authors of the Microsoft Windows program: 'people and computers are very different animals, and unfortunately it's easier to persuade people to make adjustments to accommodate the peculiarities of computers than the other way around.'[55] However, for Estévez, computers are more than simply machines determining our behaviors: they

are *antithetical* because we are analogue and computers are digital. Estévez describes the analogue-human connection: 'Steam powered trains or ships were analog machines, whose operation simulated processes that people had seen before in nature and in the functioning of their own bodies.'[56] This is partly the mimicking proposal that we see in Democritus, Aristotle, Gehlen and elsewhere. But note again that line 'processes that people had seen before in nature'. Estévez follows up this point by remarking: 'Moreover, their [analogue technologies] activity crosses time and space in a *visible way* that allows us to *grasp the link* between a movement and its effect, the process, the continuity.'[57]

The observation is both simple and remarkable. Estévez tells us what we already know, but at a deeper level of consciousness, and so with more profound consequences. When we see a technology in operation, be it a train hurtling past or a jet plane zooming high overhead, we *recognise* what is happening; we can see and understand cause and effect in action. The train or plane doesn't materialise from nothing and then de-materialise back into nothing; they move through time and space in a motion that has continuity—and to remind ourselves what R. W. Gerard said at the Macy Conference: 'In the analogical system there are continuity relations'[58]. Of course there are. Because humans created techniques based upon what they found around them, what was immediately to hand in nature, and in their application, their tools followed nature's lead in that they functioned in time and space in ways familiar to their own experience. The airplane does what the eagle does, and the train does what a human does when, say, carrying weight—it moves through time and space in ways that are recognisable. They may be far more impressive in that they are faster and stronger, but what they do is to follow the rules of what analogue is and does. And Gehlen's example of the wheel, a technique 'so abstract'[59] that certain cultures never attained it, is nonetheless analogue because although it is a pivotal technology, it does not appear as from another world. It is the creation of humans who are part of nature and it fits with analogue criteria in that we are able to '*grasp the link* between a movement and its effect, the process, the continuity' from the relatively fixed human perspective in time and space. In this process of technology recognition, the early important tools that humans created were created as part of the circle of action. This means that 'analogue' only really makes sense if it acknowledges human participation in the ways just described.

Postscript on the 'Circle of Action'

I will discuss shortly what being analogue in a digital-governed world means for us as individuals and for Harvey's post-post-modern vision for Marxism as a project of freedom in the future. However, I will conclude the discussion on Gehlen's insights with some more thoughts on his circle of action and what its logic meant for the historical relationship between 'man and technique'—and what it meant for the future as he saw it.

Firstly, Gehlen was an old-school conservative, harbouring a worldview that coloured his philosophical anthropology to a degree that needs to be acknowledged.[60] For Gehlen, modernity and the rise of industrialisation were unfortunate.[61] His circle of action is for me a compelling accounting for the deep bond between humans and technology. However, for Gehlen, in its fullest and most unadulterated expression, it constituted a simpler and more preferable time. This was the vast majority of the historical time; the tens of thousands of years where 'organic' technologies of stone and flint and wood and basic metals of iron and bronze were the materiality of technique. Such technologies derived from nature did not disturb the rhythms of nature, and so the innate 'need for stability' in the environment, over the long primal stage of the relationship, in a world 'not yet influenced by science', could be sustained.[62] This was Gehlen's vision of a pre-industrial semi-harmonious semi-idyll. Being able to control and impose a protective stability upon nature meant that humans could begin to use their intellect to consider and exploit the *potential* in the relationship with technology. And it is our predisposition to adapt and develop tools in more complex and open ways which defines our species. As Gehlen puts it, it is the cognitive capacity to react to a tool by thinking 'I'll take this along, I might be able to use it' that is the capacity to see in the thing its 'potential usefulness'.[63] This aptitude gave developmental momentum to the circle of action, which at the primal level enabled humans not only to survive, but to settle, to begin to lay down forms of civilisation, of culture, of institutions and of community—and to construct forms of *Gesellschaft*. It needs to be remembered that over this long pre-modern phase, Europe at least was a world of disease, of short life span, of violence and oppression, of irrationality and all kinds of belief-systems—and was framed by the social relations of slavery, feudalism and absolutism. But from the late-Middle Ages at least, the nature of potential was beginning to be transformed.[64]

By its nature 'potential' is an open-ended process with trial and error, diversity of contexts, diversity of needs and diversity of demands always providing the necessary drive for further, *ad hoc* and contextually-arising innovation and discovery. This momentum of continual tinkering and invention, however, was to meet with a mental (and later economic) revolution that would transform the human relationship with technique forever and infuse a new quality into Gehlen's naturalistic and pre-modern circle of action. The scientific revolution of the early seventeenth century was the catalyst. Francis Bacon's *Novum Organum* of 1620 outlined the scientific method, which constituted the intellectual breakthrough that would lead to the Enlightenment, industrialisation and capitalism. Bacon declared that what is needed is that:

> … the entire work of the mind be started over again; and from the very start the mind should not be left to itself but be constantly controlled; and the business done … by machines … [And] in any major work that the

> human hand undertakes, the strength of individuals cannot be increased nor the forces of all united without the aid of tools and machines.[65]

Bacon's method was more than a philosophical handbook for uncovering facts about the world. It was a proposal for a new relationship with technology, through science and method, to remake the world, to sweep it clean of the 'Idols' or 'Illusions' that stood in the way of human reasoning. Thousands of years of relative harmony with nature by adapting it through the circle of action were to be ineluctably transformed by a new guiding principle: science and technology were to be reoriented toward a new idea of *progress* characterised by efficiency and power and by the development of new machines envisioned by a new mind—an industrialised mind.[66] Focussed and systematic patterns of innovation and discovery began to replace the organically directed improvisation and contextual diversity that had characterised the human relationship with technology since pre-historic time. The open potential that existed in this relationship was now to be scrutinised by the method-trained, reasoning and universalising mind of the natural philosopher, who would soon be known as the scientist. As the industrial revolution got underway, the potential of technology became separated from the potential of the human. Or, rather, our potential was subsumed under that of technology's. Technique was no longer shaped by naturalistic technique,[67] but was 'set free' by reason to become fully-fledged and nonorganic 'instruments of purpose.'[68]

If we accept that we are not separate from either nature or the technologies we derived from imitating nature, and that to be considered analogue we must be able to comprehend the link between a technology's movement and its effect, then with the arrival and rise to domination of digital logic we are *bound* to ask where we stand in relation to the analogue and digital. And so I will turn to a consideration of the analogue human in our present circumstances—a world 'turned into a gigantic word processor, orbited by satellites and shrouded by an ether of information.'[69]

Digitality

The last quote is from Martin Burkhardt's book *All or Nothing: A Digital Apocalypse*. It is a useful little book, and one of the few that make reference, albeit briefly, to analogue in a critical comparison with digital in the human context. This gives more of the flavour:

> Although analogue reality will survive digitalisation, we can already sense that it is deteriorating into an atrophied likeness—a facade or ashen shadow—of itself. In its digital mode of presentation, reality's effects are far more potent: seemingly infinite, lasting forever, everywhere.[70]

Burkhardt's slim volume continues in a style reminiscent of Paul Virilio: a heightened prose that is pitched at a sky-high level of abstraction. This kind of theory is necessary, but we need also to see it for what it is—a logic that is sound but pushed to the brink. In this, Burkhart, like Virilio, sits at one end of a spectrum, espousing ideas that we can *work back from* toward more grounded and tangible reality. Burkhardt's vision is apocalyptic, but there is no sense in his book why this is so, and why the logic of the digital is 'far more potent' than analogue, or what analogue's own 'mode of presentation' might be.

To get to a more concrete comparison, we need to go back to Silvia Estévez and her insight into the recognition quality of analogue technology. But first to return to Arnold Gehlen's philosophical anthropology once more: in *Man in the Age of Technology*, Gehlen makes the interesting connection between technology and *magic*. Citing the work of the philosopher and psychologist Maurice Pradines,[71] a follower of Henri Bergson, Gehlen makes the point that in respect of magic there are 'remarkable similarities found in the magical practices of all races and civilisations [and so they must] involve something anthropologically fundamental.'[72] Gehlen asserts that the ancient aura of magic is something that still lies deep within our psychological relationship with technology. This is especially so with respect to those moving (animated) technologies he terms 'automatisms' and 'mechanisms'. Gehlen writes:

> The fascination with automatisms is a prerational, transpractical impulse, which previously, for millennia, found expression in magic—the technique of things and processes beyond our senses—and has more recently found its full realisation in clocks, engines and all manner of rotating mechanisms.[73]

Science fiction writer and futurist Arthur C. Clarke made the same point in the early 1970s when he wrote that 'Any sufficiently advanced technology is indistinguishable from magic'.[74] Adorno and Horkheimer, too, theorised the nature of magic in *Dialectic of Enlightenment*, observing that 'Magic like science is concerned with ends, but it pursues them through mimesis, not through an increasing distance from the object.'[75] What is 'magical' about digital? We might begin by considering that magic, by its nature, is never apparent, and its workings are permanently shrouded in mystery. This is where Estévez's idea that analogue technologies have the quality of recognition becomes useful once more. Recall that she writes that a quality of analogue is that we can '*grasp the link* between a movement and its effect, the process, the continuity.' The stage magician uses sleight-of-hand to pull the dove from the top hat. Watching, unless we know the trick, we cannot grasp or recognise the continuity or link between the non-existent dove at one moment, and its fluttering and all too real existence the next. To recognise something is to render it non-mysterious, and apparent. Not to recognise is to give scope to our ancient pre-rational impulse. Of course sophisticated late-modern analogue technologies such as the

telegraph, the telephone and television stretched the limit of the criteria of recognition and apparency. But they were never mysterious or beyond our understanding in terms of their time and space shrinking capacities. If you look at the early television experiments of John Logie Baird in the 1930s, for example, you see that there is no mystery involved in its lights, its whirring rotors and its flickering projections. You can see and grasp the entire movement and effect of the clunky-analogue image-transmitter-image apparatus all set up in a glass case in the Science Museum in London.[76]

Digital machines, however, do not function like even the most sophisticated analogue machines. There is no continuity to be stretched and no movement or link that we can even begin to grasp, because there is no comparison. In networked computing the diffusion of the signal and speed of operation are beyond our comprehension, beyond anything we can recognise in nature. As Burkhardt describes it:

> Electricity enables any [digital] sign to travel the world at the speed of light; likewise, it permits a vast number of signs to be copied in an instant. Needless to say, the laws of physics still apply, but since the transformation happens so fast, we cannot follow the logic of distribution.[77]

Most of us do not even try to grasp the logic of digital. We did not ask for it, but it was offered as a choice that we could not refuse. And so, the smartphone or the laptop, at some level of consciousness, are objects of fascination, of magic, possessed of qualities we cannot fathom but yet quickly become dependent upon. And as users we enter a virtual world of make-believe, literally so, in that we willingly suspend rational states of belief in a way that did not apply to any analogue technology in history. In the early twentieth century people thrilled at the novelty of the telephone, but also thought it to be 'phoney'. By describing it as somehow unreal, we were rejecting its magical qualities even if what it permitted was difficult to fully comprehend or recognise. The digital network, by contrast, is magical because we accept its virtuality, its non-materiality, as evidence of its presence as a non-presence. Moreover, mostly we do it unsceptically, unthinkingly, because somewhere deep down in us we feel that it is not really of this analogue-derived world. And so its very alienness, coupled with our dependency upon it, makes the suspension of belief, and the implicit or unconscious attribution of a magical quality to it, the path of least cognitive resistance. Burkhardt again:

> [With the] click of the mouse … the user is teleported at the speed of light from one server to another—from Singapore to Palo Alto. Indeed, how the website appears often does not correspond to a unified space; instead it represents a simultaneity of different spatial points. And with that the browser cashes a check that no physical body could ever pay: being at different locations on the globe at one and the same time.[78]

With analogue technologies our species began to adapt the world to suit our needs; to make it proportionate and equivalent to us; to make it human-sized, apparent and graspable. Within the logic of digital space, however, a digital magic underpins the relationship as an ironic creation of science. Computer science created a technology that its early philosophers did not try too hard to distinguish from its analogue predecessor. And they did not think at all about what this technology's rise to dominance would mean for the ancient relationship with technique. Now networked and ubiquitous, this digital magic makes the physical world disappear, and we disappear with it, and into it. In the magical aura of connectivity, we are not isolated individuals in front of a glass screen but part of a there/not-there world where (so we are told) almost anything, good or bad, is possible. But this form of magic, to paraphrase Adorno and Horkheimer from the quote above, is *science-magic* that is intimately and ultimately concerned with specific ends—a purpose with no apparent means—and the pursuance of those ends of speed and efficiency and exactitude through the ungraspable means of diffusion and discontinuity. In historically short order, however, this logic has served mainly to increase the cognitive distance of the human from both the physical world and the instrumentally-charged virtual world that it has erected everywhere but which exists nowhere.

The Allure of the Magical-Digital

To end this section, I will look at the principal logic of digitality, which is *automation*. In the postmodern evolution of technique, the Lukácsian concept of reification, building on Marx's theory of alienation, reaches a new point of negative refinement in digitality. Before that, however, I will say a final few words about the relative lack of attention given to the analogue-digital ontology and offer a rationale for this.

The inability of the Macy Conferences to get beyond even the beginnings of a discussion on the analogue-digital ontology might be put down to bad luck, or a lack of assertiveness by the humanities man Gregory Bateson, or a want of persistence by Norbert Wiener, or a failing in both of them to follow and promote their ethical and philosophical instincts come what may. None of it would have mattered. Ultimately, it was the supreme political imperatives of the Cold War that choked off any possibility for free-thinking between philosophy and science regarding the position of the human in the context of cybernetics. The closed world discourses around the needs of national defence in the nuclear-capable countries, especially in the US, meant that non-instrumental speculations were superfluous in those places where actual thinking and research were being done. An obvious effect of this was that both the academy and public were intellectually and perceptually unprepared for the computer revolution of the 1980s. Consequently, the critiques that did emerge to meet the new technological age, either from traditional critical theory and neo-Marxism, or by

thinkers influenced by the new 'postmodern turn', were not really equipped to develop an understanding of what digitality signified in the context of a diminishing analogue world.

Economic globalisation was the main vector for the computer revolution. Emanating primarily from the US, it spread its logic and productive capacities towards 'flexible accumulation' with great success.[79] The spectacle of change was such that neoliberal globalisation's economic and political dimensions tended to obscure digitality's ontological consequences. Many on the left, such as David Harvey, did not see much beyond the 'job destroying' power that digital technology possessed for the working classes. There were some salient exceptions, however.[80] Neil Postman's 1992 work *Technopoly*, for example, saw the rise of computing as imperilling democracy, politics and culture through rule by instrumentalised logic.[81] Notwithstanding the value of Postman's book, it was as nothing compared to the general enthusiasm that neoliberal ideology bestowed upon computer technology. Postman's approach was standard critical theory/political economy. It was well-received in the academy and even made it to some popular talk shows in the US. However, and unlike other thinkers who also gained some prominence at the time, such as Francis Fukuyama, for instance, Postman's critique was up against a force and complexity of technological change that was not always clearly understood by ordinary people. Neoliberalism generated such transformation that, as Postman himself put it, 'the world in which we live is very nearly incomprehensible to most of us'.[82] It was a world, in other words, where most of us were eagerly attracted to the solutions promised by the magic of computers and so were primed to lay prostrate before what Theodore Roszak had earlier seen as 'the cult of information'.[83]

Critics such as Postman came from the broadly new left traditions of the 1960s. Many were influenced by strands of Marxism and critical theory that had some focus on technology. However, they tended to see computing as principally a super-efficient variant of existing capitalist forms of exploitation, and not as something qualitatively new and requiring new ways of thinking about it. Others, such as Mark Poster, in his 1995 book *The Second Media Age*, chose instead to engage with computing through a cultural theory of postmodernity.[84] In his book Poster viewed the new digital technologies as heralding the potential for new 'subject positions' through web interactivity and VR, both then at nascent stages of development. His critique, though quite influential at the time, reads as quaint today, fascinated as it is by the almost magical possibilities embodied in such innovations as email and Multi User Domains (MUDs), from where a much 'richer' communicative world than that afforded by face-to-face life could be within our grasp.[85]

Away from the more refined grain of cultural theory and postmodernity, others drew inspiration from the realms of cyberpunk; from novels such as William Gibson's *Neuromancer* (1984) and Neal Stephenson's *Snow Crash* (1992), in particular.[86] In this sub-genre we can find some considered and often positive perspectives on digitality such as in Mark Dery's *Escape Velocity.* In the

1990s, cyberpunk's dystopic tropes mixed with critical theory, and with some Paul Virilio, to generate yet more perspectives. We find examples in Arthur Kroker and Michael Weinstein's *Data Trash* (1994), or in Arthur and Marilouise Kroker's *Digital Delirium* (1997), where a William Burroughs-type prose, containing lines (many of them) such as 'It might be a slow ride to suicide and it's a fast trip to digital delirium' give a sense of its utility as concrete political insight into the condition. More interesting from a philosophy and science perspective is Margaret Wertheim's *The Pearly Gates of Cyberspace* (1999), where she argues that digital technology places us at a crossroads.[87] With patience and insight and an adequate appreciation of what cyberspace actually means, she argues that we might get lucky and be 'privileged to witness the dawning of a new kind of space (and time).'[88] She equates our own time with the age of Copernicus, when time and space were being thought anew. She argues that we need to draw on the lessons of history in order to rethink our world, seeing cyberspace as the child of science but also the servant of humanity. Unfortunately, it was a subject and an idea that Wertheim never really followed up on.

As the nineties became the noughties, more hopeful Marxist philosophers such as Michael Hardt, often with little familiarity with theories of technology or media, would nevertheless note that the 'network of the multitude' could be the critical factor in the anti-capitalist and anti-globalisation upsurges of the period, an historical-dialectical use of the tools of globalisation to undermine or destroy it.[89] Hardt is a good example of the narrow Marxist thinking of the time which still saw technology and media as Marx himself did in the Victorian age, as an aspect of the class struggle, and not as social-revolutionary in itself. And those others—often ex-Marxist critical theorists—who were swayed to a greater or lesser degree by the integrated postmodern turn would devote much of their semi-hypnotised and fascinated energies to the effects of early digitality upon culture, or literature, and tended to discern opportunities or problems with digitality according to their research interests, and not as an ontological or political problem. Critique of digital continued in its various forms from Manuel Castells, Kevin Robins and Frank Webster in the 1990s, to Lev Manovich and Cass Sunstein in the 2000s. And it continues today with books from a new generation of thinkers such as Adam Greenfield and Alexander Galloway, who offer insights into both the depredations and promise of digital.[90] None, however, critiques digital in the context of it being an analogue antithesis. This has never been the case, even when the book's subject cries out for it. For instance, in 1995 Nicholas Negroponte, founder of MIT Media Lab, could write *Being Digital*, a book about the wonderful possibilities of mixing 'bits with atoms'. He could state at the beginning of the book that 'the world as we experience it is a very analog place'[91] but here he speaks only of the world around us, a world apart from us, as did Aristotle in reference to the natural world and artefacts, and not as a world that we experience as part of ourselves. Negroponte's book offers the vision of our being digital but it does not consider at all the possibility of our 'being analogue'.[92] Like the others I have mentioned from these crucial

decades, and on until today, the nature of the analogue was hardly in anyone's frame of reference.[93]

Automation-Digital Redux

In a section of *Capital* titled 'Machinery and Modern Industry', Marx wrote that:

> The automaton, as capital, and because it is capital, is endowed, in the person of the capitalist, with intelligence and will; it is therefore animated by the longing to reduce to a minimum the resistance offered by that repellent yet elastic natural barrier, man.[94]

Here Marx makes it clear that the automation process, the *excising* of the human from the process of production altogether, is the Holy Grail of capitalism itself. Machine innovation, almost always geared toward more automaticity, obtains its momentum from this inner logic. I will build upon this argument and expand it back to Leibniz, which will then take us forward to digitality which, in its turn and through its effects, will pull us back again to the dawn of the relationship described in Gehlen's reflection on technique and the circle of action it generated. Digital automation, or digitality, *breaks with* this primary relationship with technology and nature. I will propose that digitality *extends further* the negative relationship with technology that capitalism historically imposed and which resulted in human alienation and reification. Digitality goes beyond even these. It cuts into the circle of action to undermine not only the human relationship with the technological artefact, the tool, but the connection with nature itself. Most problematic of all from the perspective of the project of socialist renewal that David Harvey ended his *Postmodernity* with, is that digitality constitutes an assault upon the constructed sense of the social self that historically has been motivated and equipped—through analogue relations and forces of production—to resist and oppose alienation and reification.[95]

In the late 1670s when Gottfried von Leibniz was developing his binary numbering system, he had an overriding humanist objective in mind. He wanted to create a universal system of human communication that would be flawless. His idea was that miscommunication through differences in language could be overcome through a symbolic language or script based upon mathematics. Not only that, faulty and illogical reasoning would be 'reduced to calculus'.[96] Like his contemporary and rival, Isaac Newton, Leibniz imagined he was working in the service of God, bringing light to the world through a deciphering of God's universe. What he achieved, however, was the setting of humanity upon the road to modern capitalism by impregnating technique with the logic of instrumental rationality. Another breakthrough came in 1804 with the invention of the Jacquard Loom by Joseph-Marie Jacquard. Basing his machine's logic on Leibniz's binary numbering system, Jacquard created what was in effect an

analogue machine that ran on digital software—software being the chain of cards with holes punched in them to a certain configuration that automated the processes of weaving and patterning the fibres to be woven. Designs could be thus exactly replicated time after time, thereby eliminating human error from the quality-control process. Productivity was massively increased through the speed of the process, which was no longer limited to the speed of the weaver, but to that of the machine, which was open-ended.

Charles Babbage, who conceived and built the first modern computer, the Analytical Engine, was captivated by Jacquard's invention when he saw it in the 1840s. He was particularly taken by the quality of the patterns in the fabric woven on the loom, which far surpassed the skill and quality of the manual weaver. He used to impress guests at his house with a remarkably fine 'portrait' of Jacquard that he owned, and which everyone assumed to be a high-quality engraving, but was in fact a woven piece of fabric.[97] The potential for computerised machines, and their application in factories especially, preoccupied Babbage greatly. And it was through the practical efforts of people like Babbage and his colleague John Herschel[98] that automation and capitalism would be combined and made generalisable as a default logic.[99] Once proof of concept was established as a working principle, as in the Jacquard Loom, the 'value' of automation needed no explaining to industrialists of the Victorian age of invention. The implementation of automation was held back only by lack of commercial opportunity, by provisional lack of technical feasibility in this or that context, and by worker resistance. However, as the capitalist ideal, automaticity had become the preferred design solution for machines of production wherever possible.

Automatic computing was more than just a technical solution. It was seen as a philosophical triumph, too. In the reasoning of Babbage and his contemporaries, inevitable error by human computers only compounds itself within a system. Error builds upon error to create a chaotic and ultimately unworkable process. However, to have a correct schedule of calculations to begin with, and to program these into a mechanical computer, meant that more and more complex problems could be solved. Accuracy and precision in calculation would build upon accuracy and precision, with each iteration of calculation revealing a higher (or deeper) level of 'truth' not just about mathematics, but about the science that was built upon mathematics—and in turn about the 'truth' of the world made apparent by science. Ada Lovelace, a foundational thinker in computing, and who worked with Babbage on the Analytical Engine, noted the power that computing would give to knowledge:

> The Analytical Engine has no pretensions whatever to originate anything. It can do whatever we know how to order it to perform. It can follow analysis; but it has no power of anticipating any analytical relations or truths. [However], in distributing and combining the truths and the formulas of analysis … the relations and the nature of many subjects

> in that science are necessarily thrown into new lights, and more profoundly investigated.[100]

These modern developers of computer science were uncovering not just 'truths' about the nature of the world in the abstract. They were in the business of creating actual machines—'engines of perfection' to set loose to work upon the world, engines that were error-free and automated to the highest degree possible.[101] The more automated, the more perfect. What this meant was that computing and capitalism could combine efficiency with truth and profit to promote a logic that would implicitly and often explicitly view humans (workers) as something residual to industrial processes; a regrettable obstacle, a problem that capitalism's practical needs and Victorian-age science's quest for uncovering God's truth would one day crack.

When Marx and Lukács theorised alienation and reification they had in mind *analogue machines*, which could only ever be partly automated. These were machines at which men and women stood or sat in factories or in offices in their daily work. From the perspective of capitalism, humans were a necessary but problematic component of the processes of production. For Marx, alienation was the subjective effect of estrangement emanating from the process. Writing over half a century later, Lukács saw that a complex capitalism demanded a reappraisal of Marx's basic concept. His reification is alienation across a wider sphere, across the orbit of effect that is the capitalist *economy* itself, and not simply production. In the 1920s, when Lukács wrote, capitalism and the actions that framed it had expanded greatly. A more complex and nuanced system had generated new forms of *mass culture* driven by modern patterns of production and consumption that grew through innovations such as mass communication and advertising. Reification reflected this more encompassing frame of social life. Moreover, it was a condition that permeated *consciousness* as commodification, as this core element of culture spread deeper and wider. For Lukács there was no objective limit to this unconstrained instrumentalisation of social life, and without a revolutionary transformation of consciousness to halt it, a 'reification of all human relations … without regard to human potentialities and abilities' would be the result.[102]

In this pre-digital relationship there was still a connection to Gehlen's circle of action, and through it to technique and to nature. This would accord with traditional Marxist analysis. Partially automated machines still needed direct human involvement and agency, to a greater or lesser degree. But this was a necessary ideological point as well. The human connection to technique and to nature meant human potential still existed in the relationship. This left open the possibility of *dereification* and thus potential *liberation* from the machines of capitalism. Andrew Feenberg, a contemporary interpreter of Marx and Lukács, reiterates this essential ideological component for Marxist theory:

> The circular relation between economic law and the technical manipulations which unconsciously generate the laws is fundamentally different

> from the case of nature in which laws are not effects of human action. Individuals can break out of the circle of reification through cooperative action to change the system. This dereifying practice is synonymous with proletarian revolution. It is not a technical manipulation of the economy in accordance with its laws but the overthrow of those laws through the transformation of their practical basis in human action.[103]

What is expressed here is a kind of negative circle of reification, one that could be put into reverse through proletarian revolution. For Feenberg, the cycle of economic law and technical manipulation just needs to be turned the other way, somehow, through control by workers. But note how nature and its laws are left to themselves and are accorded no inherent relationship in the constitution of technique. In view of a lack of a solid Marxist philosophy of nature, Feenberg therefore falls back upon the Aristotelian concept of a duality between humans and nature. In the age of digitality, such an analysis looks outdated; simplistic, even. Feenberg's book is titled *Technosystem* yet, despite its name, it takes hardly any cognisance of the dominant category of 'technical manipulation' today, which is digital; and he says nothing at all about automation. Technological change has been so profound that opinions such as these must be critically examined. Dispiriting also from such a consistent flame-keeper for a Marxist understanding of technology, is that any revolutionary potential within *digital* networks is subordinated in his book to ideological sniping at more detailed and engaged theorisations by, for example, Jodi Dean and Christian Fuchs.[104]

Considerations of the logic and effects of automation need upgrading. But we need to do this from the perspective of the human relation to technique and the transformed context that digital technology has created. Otherwise thoughts of liberation and revolution will be confined to an old analogue context whose time has already passed in terms of capitalism's twenty-first century imperatives. Digitality has taken automation and its logic of excommunication to waters that have yet to be properly explored and charted. Seen in this sense, 'automation' and 'capitalism' are no longer adequate theoretical or practical descriptors for this new ontological state. Digitality is generating new social relations. Automated digitality, moreover, constitutes what Gehlen termed a 'replacement technique' in that it not only gives capacity to humans where they had none (such as the creation of virtual time and space) but it replaces us too through an automation logic that is compelled by capitalism to infiltrate as much of life as possible. And so it is necessary to begin, almost *avant la lettre*, to understand these transformations in order to understand the new social, economic and political forms they reproduce.

To begin, then, is to state that the ancient circle of action is being broken by digitality. The connection to technology and nature that the analogue relationship preserved, however slight and tenuous in the high modern age, finds no primal bond or even trace wherever digitality imposes itself between human and machine. And so the effects are more serious than Marx or Lukács, or even

Adorno, Horkheimer and Marcuse could have envisaged in their pre-digital worlds. To break the circle of action is to be disconnected from both the facility with tools—that is to say, the analogue relation with technique and its liberatory potential—and from nature itself. Digital technique finds no analogue in nature nor in the simulated processes that we recognise in nature and in the functioning of our own bodies. Digitality has transformed the character of the estrangement that capitalism is able to impress upon the human relationship with technique. We saw that alienation, for Marx, was a localised phenomenon; and for Lukács the more generalised effect of commodification was expressed in his idea of reification. Digitality, however, affects the estrangement process in ways that would have been impossible under the analogue relationship. To expand on the point just made about the broken circle of action, we can see two main forms emerging: first is that humans are estranged from their ancient *relationship with tools* in that the computer-automation process in which we increasingly work finds no analogue in the natural world. With digital tools, it is impossible to grasp the link between the cause and effect actions that take place when producing and consuming. Second is that a disconnect from the *relationship with nature* is similarly affected by digitality in that the virtual space in which we increasingly produce and consume is a digitally-constructed one, an almost 'magical' space-time where our digital world is no longer human-sized, physical and graspable, but planet-sized, virtual and ungraspable. Moreover, the actual physical world of sky and soil and air now acts as backdrop for sedentary bodies engaged by screens; or else digitally-connected bodies impassively moving through smart homes or offices or cities; or bodies immersed in the Internet of Things, or in similarly distractive and absorbing digital environments that render the physical environment as at best a secondary aspect—or more often as just scenery.

The coming together of automation and capitalism has created a logic that is oriented toward a perfect world emptied of 'that repellent yet elastic natural barrier, man'[105]. In digitality the elastic has snapped, and the repellent creature is distanced as never before. But perfect automation (a kind of perpetual motion machine) as the font of unending surplus value, was always a chimera. Digital capitalism will always create new work for hands and minds. And commodities will always require a growing market of consumers. Digitality has not solved capitalism's human problem. The system continues to innovate and grow, but it has taken other directions in search of the self-same goal of profit. We will consider some of the main directions below. However, to finish off this theorisation of the transition from modernity to digitality, I will speak briefly about how philosophical anthropology, combined with a reflection on what I see to be a more illuminating perspective on the alienation from nature deriving from digitality, will allow us to move on to the later discussions better equipped to understand the ontological, political and economic challenges stemming from digitality.

Jacques Ellul was one of the few post-World War Two thinkers who, like Gehlen, perceived that 'technique'—employing the same German meaning—was

an anthropological question as much as a technical one. In his 1964 book, *The Technological Society*, originally published in French as *La Technique* a decade before, Ellul develops a startling thesis in what was then still very much an analogue world. A 'characterology' of emerging technique, he observes, is 'automation and its attendant exclusion of man.'[106] He gives descriptions of the 'astounding' growth in automation in the ten years since the end of the war—in factories, offices, airplanes, anti-aircraft defence and so on. Such growth is only logical, he notes, because from the perspective of technique, humans are an unwanted 'source of error and unpredictability'.[107] He saw that the logic of automation had inserted itself, and that this new relationship with technique would breed a 'mutation' in capitalism.[108] The cause of this mutation was automation itself. For Ellul, the digital logic of cybernetics (Ellul had read Wiener's *Cybernetics* and *The Human Use of Human Beings*) was to enable capitalism to break with the human world of analogue messiness and to begin to forge a new world of defined ends, the rationalisation of means, and the 'extensive application of mathematics' into every register of life.[109] His main point is made early in the book: 'Technique has become autonomous; it has fashioned an omnivorous world which obeys its own laws and which has renounced all tradition. Technique no longer rests on tradition…'.[110] This takes Wiener's concerns to the next logical step, to a world where capitalism is transformed, driven by different means towards its own unchanged ends. For Ellul, this is the 'monolithic world that is coming to be', where 'the buffer between man and nature' has been removed and where man is no longer able 'to find again the ancient [technological] milieu to which he was adapted for hundreds of thousands of years.'[111]

How do we stand, as analogue creatures, in relation to what John Johnston called this 'new *type* of machine, defined by a logical and functional rather than a material structure'?[112] The first step towards knowing is to know ourselves. However, Marx and Lukács' theories of alienation and reification have created a legacy problem for this. The concept of selfhood is the sticking point. Alienation and reification are predicated upon the distancing of the authentic self from the world through capitalism's logic of exploitation. In Marx and Lukács this inner self is something whole and essential. To be alienated is to have this inner self detached by capitalism and to be unable to identify with what one does within its orbit. Neither develop this ontological aspect very much, but it is implied in their respective and broadly complementary teleologies of revolution and liberation which posit, for a communist future, a *reunified* individual, where work and life are no longer broken down into component parts by capitalism. Contrastingly, for Adorno and Horkheimer, instrumentalisation brought only devastation to what they anyway saw as the 'synthetic unity' of selfhood:

> Even the ego, the synthetic unity of apperception, the agency which Kant calls the highest point, from which the whole of logic must be suspended, is really both the product and the condition of material existence. Individuals, in having to fend for themselves, develop the ego as

> the agency of reflective foresight and overview; over successive generations it expands and contracts with the individual's prospects of economic autonomy and productive ownership. Finally, it passes from the expropriated citizens to the totalitarian trust-masters, whose science has become the quintessence of the methods by which the subjugated mass society reproduces itself.[113]

A perspective that departs from these idealistic and pessimistic views on alienation and reification we find in Rahel Jaeggi's *Alienation*. The book is an essential adjunct to the intellectual armoury against digitality—even though it makes no reference to computers or technology. It is concerned only with a phenomenological rethinking of the nature of selfhood, and with the creation of a framework that interpreters can build upon. First of all, Jaeggi makes the necessary corrective to the worn-out modernist conception of the self as a 'thing' alienated from the world. Jaeggi calls this the 'container model' where 'the self exists somewhere inside, waiting to be expressed.'[114] She sees that in critical theory alienation has unfortunately become a superannuated issue, much like the concept of class, notwithstanding the fact that the condition of alienation (like class) is real.[115] If the problem of alienation is still alive under capitalism, then it is one that is particularly urgent in the age of digitality. Jaeggi articulates alienation's central features, manifesto-like, in the first (and last) sentences of page one of her book. She writes: '*Alienation is a relation of relationlessness*' and '*Alienation is a failure to apprehend, and a halting of, the movement of appropriation*'.[116]

Jaeggi wants to explore the *content* of alienation through a combination of everyday subjective experience and social philosophy concepts. Her central point, as just noted, is that we need to reject the idea of an essence that has been fragmented and which must be reunified. For Jaeggi, there is no self to be alienated, only a self to be formed in an unalienated context. She argues that there is no truth of the self beyond its manifestations. In other words, 'What we *are* must be expressed and *externalised* in order to acquire reality. There is no self apart from its realisation; it becomes determinate only as something realised'.[117] I will combine this open and flexible approach to the nature and possibilities of self and selfhood in the world of the everyday and in philosophy, with my more focused view of the self in relation to the circle of action and digitality. The ideas behind her use of the terms 'relation' and 'appropriation' are important to opening up the theory. A positive *relation* links the individual to the world to form a context wherein the self can begin to be created, to be expressed, externalised and realised. This is an ideal position of true freedom and of autonomy to the highest degree, where one 'can *appropriate* the life one is leading' and where one 'has oneself in one's command in what one does'.[118] Such a life is impossible under capitalism, in any of its manifestations. However, as a workable conceptual frame it allows us to see the damage that digitality does and see what, individually and collectively, is needed for the self to find

a position where human expression, externalisation and realisation are freed up sufficiently to begin to acquire an unalienated reality.

I interpret and adapt Jaeggi's theory of alienation in the following way: the 'relation of relationlessness' and the alienation that stems from it, corresponds to the broken relation with technique and nature that digitality has imposed. In other words, digitality, with automation as its major expression, has severed the circle of action. Digital-automation destroys the analogue relation to leave us in a new relationship with technology—a relation of relationlessness—that shuts us out from its logic, its operation, and the virtual and material worlds that it creates. A central point is that if digitality severs the analogue link and this relation, then automation *appropriates* the actions of working upon the world for itself. It abstracts the context of the relation into its own automaticity. Moreover, through the disconnect we are denied the means (through an even partial control over technique) that would halt or arrest the movement of appropriation by automation. Physical and mental labour is subsumed by the movement of appropriation and is articulated in the action of the speed-of-light digital pulses that connect and network the computer systems that permeate life as digitality. Disconnected from a logic that is programmed to discard us wherever possible, and from a magical logic we cannot fully comprehend, we become powerless to take back possession of what is in effect the appropriation of what *could be* another possible life, another possible world. Yet we are dependent upon digitality and its networks of appropriation—and are thereby compelled to live through the 'relation of relationlessness' dialectic that is digital alienation.

Jaeggi devotes much time to thinking about how such a life is bearable. We bear it, she theorises, by adopting roles: by taking on the parts which are largely allotted to us by an administering system and where, as Jaeggi writes, we act as the mere 'bearer of a function' in a process of encultured acquiescence.[119] This is what she terms self-alienation, where social roles—female, male, professional, vegan, labourer, writer, daughter, programmer, son etc.—are ones that either actively form us as persons in social life, or we adopt unconsciously. Either way, we act them out through a constricted existence where we never get the chance to express and externalise the self in any meaningful way. As Jaeggi puts it: 'What is alienating is not the roles per se but the impossibility of adequately articulating oneself *in them*.'[120] The 'impossibility' Jaeggi speaks of is the difficulty in appropriating roles for oneself when trapped within adopted or assigned social roles that serve to self-alienate. Jaeggi goes on to discuss a way out of this dilemma through what she calls 'living one's own life' through a form of 'self-determination'.[121] This element of her work need not detain us here. However, her idea of the 'relation of relationlessness' as the dynamic font of alienation, helps us to better understand the human relationship with digital-automation and networking as one of relationlessness, one that cuts us adrift from the logic and the actions of the new machines that give rise to our world.

We brought this on ourselves. And it has a name: neoliberalism. Neoliberalism was the ideological–political decision to leave research and development of

a 'new *type* of machine'—a new *category* of machine whose logic and powers we are only dimly aware of—to market forces and private companies. In doing this we effectively concede social power to the magic of computing. And in our general obeisance to the hidden hand of the market and the post-modern (mostly) men in Silicon Valley,[122] we adopt new (or different) roles as producers and consumers in the network society. This has changed us. Jaeggi quotes the 1960s sociologist, Helmuth Plessner, who pioneered role theory, and asserted that the bearer of a role appears to us as a 'pale, incomplete, strange, artificial man'.[123] Perhaps it was this general demeanour of alienated weakness that caused us—individually and collectively—to acquiesce so readily to the promises of the followers of Milton Friedman and Bill Gates and Steve Jobs in the late-modern phase of the 1970s. Their market-driven digitality now encompasses much of social life and creates and distributes digital-dependent roles and jobs for digital-dependent people. David Graeber terms these 'bullshit jobs'—the jobs that automation generates in services, administration, education, finance, marketing, distribution and so on.[124] These are the categories wherein millions upon millions of *recognisably* alienating jobs are created as a direct by-product of automation. And most of them await their own automation or obsolescence in some near-future time when the next digital productivity-enhancing solution comes along.

The 'relation of relationlessness' is perhaps a too Critical Theory-sounding descriptor for the successor to alienation or reification. It does, however, give some sense of a looming and all-encompassing void between the individual and the world; one where digitality gives no opportunity to form a basis upon which we can create a sense of self that is connected to the two most important elements of our social being: labour and nature. Being cut off from these through digital-automation means being cut off from the promise of emancipation that modernity offered through the potential that existed within the analogue relationship. What this new power of alienation suggests is that capitalism was vulnerable then, in predigital times, to processes it is no longer vulnerable to today: anti-alienatory processes such as organised labour and political parties that would genuinely represent them. This realisation brings us back to the question that the many on the left, such as Wolfgang Streeck, now ask in this historically unprecedented phase: 'how will capitalism end?'[125] He's not sure. No-one is. What many *do* feel sure about is that it won't come about the way we thought it might, or would, in the pre-digital age.[126] So how, then? In his book *How Will Capitalism End?* Streeck notes that information technology has 'destroyed the manual working class [and] is now attacking and about to destroy the middle class as well….'[127] This comes at the beginning of his book. But he never again mentions information technology, or automation, or the internet. Which is strange, given that he realises that computing has done so much damage to capitalism's central social structures. Social media gets a single paragraph on page 103. The term 'digital' appears nowhere at all. Notwithstanding the evisceration of capitalism's traditional component of class, Streeck still looks to

more traditional solutions. Having said that, Streeck's book is important. It is important because it constitutes an example of failure in Marxist analysis, one that follows in the path of David Harvey in its inability to look more deeply into the effects of information technology.

The logic of digitality can be looked at with too little focus—or with too much. And so at the other end of the continuum of critique there is Byung-Chul Han, a rising theorist of the neoliberalism-digitality connection. We have seen how, in the style of Paul Virilio, theorists such as Martin Burkhardt[128] prefer to work with a wide theoretical licence. The value of this is that their extravagances allow us to plot the whole field of a concept to its limits of tenability—and then work back from this to a position that can have more theoretical and practical purchase. However, in Han's theorisation of digitality, *In the Swarm*, he pushes digital theory too far towards the erasure of what it meant to be human in pre-digital times. Digitality, for Han, has not banished us from the circle of action and the possibilities that existed within analogue-generated technique. The logic has instead colonised us, taken us over, to make us into what he calls *homo digitalis*.[129] We are not alienated or experiencing 'relationlessness' in this telling, but instead we are incorporated into the swarm (the network) by the awesome power of computing. The technology relation for Han is like a singularity, where we are *as one* with the logic of digital and exist as part of it. The only freedom of movement we have is to oscillate between the swarm and what he terms an isolated 'private identity', which turns out to be little more than an IP address.[130] Digitality in this reading has not only destroyed the relationship to labour and nature, but also caused *homo faber* (the analogue human) to give way to *homo digitalis*, a 'man' we can recognise in Jaeggi's 'pale, incomplete, strange, artificial man',[131] one 'who is no longer a man of action'[132] and is therefore doomed to a kind of digital slavehood.

Han gives us nowhere to go. But, then, neither does Streeck. Each resides at the extreme end of a continuum regarding digital capitalism. In his unreconstructed new left Marxism, Streeck identifies the cause of the problem, but cannot see the cause as being in any way connected to the solution. Han, for his part, sees the cause, but instead of disregarding it as strangely epiphenomenal, like Streeck, he takes it to its nihilistic fringe, to what at the end of his short book he sees as a future of 'digital psychopolitics' where the possibilities afforded by biopolitics are also doomed as a new era of surveillance, programming and control unfolds.[133]

In this quite long section I have theorised the transition from an analogue to a digital world. I undertook to show that through the course of that transition we have missed something important—the world-transforming effects of digital logic upon our most ancient of relationships. Of primary importance in the age of digitality is not class, nor even capitalism, but digitality itself. Digitality has transformed our understanding of class and has transformed capitalism into something else, something that we find elusive and not fitting readily into the traditional moulds. I will look at what I see as some of

digitality's primary effects before going on to consider once more the politics of liberation, and whether socialism in any form is still available to us as a theoretical and practical means of resistance to digitality—and so as a means towards some form of freedom.

Notes

[1] Norbert Wiener (1948) *Cybernetics: Or Control and Communication in the Animal and the Machine*. New York: The Technology Press, p.11.
[2] Ibid., pp.138–139.
[3] James Ciment (2015) *Postwar America: An Encyclopedia of Social, Political, Cultural, and Economic History*. New York: Routledge, p.370.
[4] Wiener, *Cybernetics*, p.139.
[5] See Thomas Rid (2016) *Rise of the Machines: The Lost History of Cybernetics*. London: Scribe Publications, pp.8–43, 'Control and Communication at War'.
[6] Norbert Wiener (1954) *The Human Use of Human Beings*. New York: Houghton Mifflin, p.xxvii.
[7] R. W. Gerard (1953) 'Some of the Problems Concerning Digital Notions in the Central Nervous System', *Eighth Macy Conference* http://pcp.vub.ac.be/books/gerard.pdf, 171–202, pp.172 & 181.
[8] Ibid., p.172.
[9] Ibid., p.181.
[10] On the next page of transcript, however, von Neumann was clear about the analogue and digital dualism in respect of the science of physics: 'one must say that in almost all parts of physics the underlying reality is analogical … The digital procedure is usually a human artifact for the sake of description.'
[11] See Alan Turing (1950), 'Computing Machinery and Intelligence', *Mind*, 50, 433–460; see also Andrew Hodges (1983) *Alan Turing: The Enigma*. New York: Simon and Schuster, p.106.
[12] François-Xavier de Vaujany, and Nathalie Mitev (2017). 'The Post-Macy Paradox, Information Management and Organizing: Good Intentions and a Road to Hell?', *Culture & Organization*, 23(5), 379–407
[13] Fredric Jameson (1992) *Late Marxism*. London: Verso, p.102.
[14] François-Xavier de Vaujany, and Nathalie Mitev (2017a) 'The Electronic Brain that would Change the World: Back to the Historical Roots of Digital Transformation.', *The Conversation*. 17 October https://theconversation.com/the-electronic-brain-that-would-change-the-world-back-to-the-historical-roots-of-digital-transformation-85265
[15] Ibid.
[16] Wiener's attitude meant that, effectively, he cut himself out from the Defense Department research bonanza, and so was marginalised from the ongoing debates. He died in 1964. See *Dark Hero of the Information Age: In Search of*

Norbert Wiener, The Father of Cybernetics. Flo Conway and Jim Siegelman (2005) New York: Basic Books.

[17] Paul N. Edwards (1996) *The Closed World: Computers and the Politics of Discourse in Cold War America*. Cambridge, Mass.: The MIT Press. As Edwards puts it, the fact that Wiener was also interested in 'other types' of cybernetic machines, such as prosthetics, meant that military industrial work was never going to be his home. See p.67, n. 67.

[18] Ibid., p.69.

[19] Rid, *Rise of the Machines*. See especially Chapter Two 'Automation'.

[20] Edwards, *The Closed World*, pp.71–73.

[21] Mikael Hård and Andrew Jamison (2005) *Hubris and Hybridity: A Cultural History of Technology and Science*. London: Routledge.

[22] Dwight D. Eisenhower (1961) Military-Industrial Complex Speech: http://avalon.law.yale.edu/20th_century/eisenhower001.asp

[23] Edwards, *The Closed World*, p.xi.

[24] Ibid., p.70.

[25] As early as the 1960s, debates raged on the merits or otherwise of computerised production-line systems in automobile production. For a good summary, see Lars Westerlund (2000) *The Extended Arm of Man – A History of the Industrial Robot*. Stockholm: Informationsförlaget.

[26] In *The Human Use of Human Beings,* and elsewhere, Wiener continually discusses the 'analogies' between humans and computers, and their growing synthesis through computers and feedback loops. For example: 'While it is impossible to make any universal statements concerning life-imitating automata in a field which is growing as rapidly as that of automatisation, there are some general features of these machines as they actually exist that I should like to emphasize. One is that they are machines to perform some definite task or tasks, and therefore must possess effector organs (analogous to arms and legs in human beings) with which such tasks can be performed.' Wiener (1954), pp. 33–34. In other words, through interaction with computing the 'analogue' disappears to become a single entity; the human and machine become one, a combined analogue of each other—a human and machine analogue.

[27] The quote comes from Stephen Menn's 'Democritus, Aristotle and the Problemata' in Robert Mayhew (ed.) (2015) *The Aristotelian Problemata Physica.* Leiden: Brill, p.18. See also Joachim Schummer's 'Aristotle on Technology and Nature' in *Philosophia Naturalis*, 38 (2001), pp.105–120.

[28] Joachim Schummer, p.105.

[29] Marx, Karl (1976) *Capital*, Volume 1. New York: Penguin., p. 352.

[30] Georg Lukács (1990) *History and Class Consciousness*, p.xxiii.

[31] Ibid., p.87.

[32] Herbert Marcuse (1991) *One-Dimensional Man*. Boston: Beacon Press.

[33] Theodor Adorno and Max Horkheimer (2002). *The Dialectic of Enlightenment*. Stanford: Stanford University Press, p.23

[34] See Lukács's (1974) *The Theory of the Novel*. Cambridge, Mass.: The MIT Press, p.23.

[35] Adorno and Horkheimer, *The Dialectic of Enlightenment*, p.2

[36] A recent example, which gives no answer to its questioning title *How Will Capitalism End*?, is by Wolfgang Streeck (2016) London: Verso. In order to understand its crisis more deeply, others begin to shift away from older notions of capitalism and argue that to retain them is to suffer from 'poverty of nomenclature'. We need now, they say, to speak of and think of a 'capitalocene', suggesting that its demise is locked into the future of the environment. And it is here, in a victory in the battle against the depletion of nature, that capitalism will finally have run its destructive course. See Jason W. Moore (ed.) (2016). *Anthropocene or Capitalocene?: Nature, History, and the Crisis of Capitalism*. Oakland, CA.: Kairos Books

[37] McKenzie Wark (2017) *General Intellects: Twenty-One Thinkers for the Twenty-First Century*. London: Verso, p.3.

[38] Arnold Gehlen (1980) *Man in the Age of Technology*. New York: Columbia University Press.

[39] It's interesting to note that in German, 'technik' implies a process or action that involves or incorporates the actor, the tool, and the physical world that is to be acted upon; whereas the English term 'technology' implies, as it does in Aristotle, a discrete artefact, something objective and distinct from the actor and nature.

[40] As Friedrich Rapp puts it, 'the strength of his [Gehlen's] investigation lies in the explanation of what mankind took to technology *in the first place*' (emphasis in original). See his (1981) *Analytical Philosophy of Technology*. London: D. Reidel Publishing Company, p.113.

[41] Gehlen *Man in the Age of Technology,* p.2

[42] Ibid., p.16.

[43] Ibid., p.18.

[44] Ibid., pp. xi & 2.

[45] Ibid., p.4.

[46] Species of Galapagos finches, for example, can change beak size and shape within a couple of generations, in response to naturally occurring changes in the environment that force adaptation in the birds. See, for example, B. Rosemary Grant and Peter R. Grant (1989) *Evolutionary Dynamics of a Natural Population: the Large Cactus Finch of the Galápagos.* Chicago: University of Chicago Press.

[47] Gehlen, *Man in the Age of Technology,* p.4.

[48] Ibid., p.ix.

[49] Ibid. In his ideas on technologies as 'extensions' Gehlen foreshadows Marshal McLuhan's much more influential theory of this in his 1964 book *Understanding Media*.

[50] As he describes it: '… technique, from its beginnings, operates from motives that possess the force of unconscious, vital drives. The constitutional

human features of the circle of action and of facilitation are the ultimate determinants of all technical development.' Gehlen, *Man in the Age of Technology,* p.19

[51] Ibid., p.14.

[52] Ibid., p.4

[53] Ibid., p.5

[54] Gehlen does not develop the point on the technologies that do (or do not) reference nature in a way that affects the issue of analogue and digital that I am developing. Instead, he concentrates on the materiality of the technology, whether organic nature (such as wood and leather) or inorganic nature as in plastics, or metals. This is ultimately a problem for Gehlen, as he argues that 'nonorganic nature is more knowable than organic nature' (p.6) and develops this into a bleakly dystopian scenario, where a superpositivism drives science toward hyper-rationalised futures (beginning with the development of machines)—and implies that there is not much we, armed with stunted philosophy and dwindling powers of reflection, and our still essential deficient survival instincts, can do about it. See Chapter 8 'Automatisms' in particular. This element of Gehlen's work has been much criticised, not least by the Frankfurt School, who were themselves pessimistic about technological development. Notwithstanding that there is some merit in Gehlen's argument, this particular direction does not fall within the scope of my arguments here.

[55] Silvia Estévez (2009) 'Is Nostalgia Becoming Digital?' *Social Identities*, 15(3), 393–410, p.401.

[56] Ibid., p.402.

[57] Ibid., pp.402–403. (emphasis mine)

[58] R. W. Gerard (1953) 'Some of the Problems Concerning Digital Notions in the Central Nervous System', *Eighth Macy Conference* http://pcp.vub.ac.be/books/gerard.pdf, 171–202, pp.172

[59] Gehlen, *Man in the Age of Technology,* p.4.

[60] See Jerry Muller (1997) *Conservatism*. Princeton, NJ: Princeton University Press, pp.401–404. For a discussion on the intellectual lineage of Gehlen's conservatism, see Thomas Molnar's 'A Posthumous Conversation with Arnold Gehlen', *The World and I*, November, 1989. Online at: http://www.amerika.org/texts/a-posthumous-conversation-with-arnold-gehlen-thomas-molnar/

[61] See Peter Bergen's 'Introduction' in Gehlen, *Man in the Age of Technology,* p.xvi.

[62] Ibid., p.13.

[63] Arnold Gehlen (1988) *Man, his Nature and Place in the World*. New York: Columbia University Press, p.165.

[64] For an introduction see Jean Gimpel (1992) *The Medieval Machine: The Industrial Revolution of the Middle Ages.* London: Pimlico.

[65] Francis Bacon (2000) *The New Organon*, Lisa Jardine & Michael Silverthorne (eds). Cambridge: Cambridge University Press , pp.28–29.
[66] See John Ashworth's highly insightful 'Memory, Efficiency and Symbolic Analysis: Charles Babbage, John Herschel, and the Industrial Mind'. *Isis*, 87(4), 629–53
[67] See my note 39.
[68] Adorno and Horkheimer, *The Dialectic of Enlightenment*, p.23. See note 54 on Gehlen's ideas on 'organic' and 'nonorganic' technology.
[69] Martin Burkhardt (2018) *All or Nothing: A Digital Apocalypse*. Cambridge, Mass.: The MIT Press, p.3.
[70] Ibid., p.3.
[71] Gehlen, *Man in the Age of Technology,* p.12.
[72] Ibid, p.12.
[73] Ibid., p.14.
[74] Arthur C. Clarke (1973) *Profiles of the Future*. New York: Harper and Row, p.21.
[75] Adorno and Horkheimer, *The Dialectic of Enlightenment*, p.7.
[76] See: https://www.youtube.com/watch?v=O5ZSXPMlumc
[77] Burkhardt, *All or Nothing: A Digital Apocalypse*, p.12.
[78] Ibid., p.48.
[79] During the early part of the 1980s, the tide turned in terms of the developmental arc of computer development and spread. By that time, more of the investment dollar in the US went into computer and related high-technology equipment than went into traditional labour-intensive machinery. See Joyce Kolko's (1988) *Restructuring the World Economy*. New York: Pantheon, p.66.
[80] There is no space for me to list and describe the relatively small number of books and authors who were engaged in a critical appreciation of the rise of computing that made possible the rise of globalisation. For an in-depth look, see my book (2012) *Age of Distraction*. New York: Transaction Publications.
[81] Neil Postman (1992) *Technopoly: The Surrender of Culture to Technology*. New York: Vintage.
[82] Ibid., p.58
[83] Theodore Roszak (1986) *The Cult of Information*. New York: Pantheon.
[84] Mark Poster (1995) *The Second Media Age*. Cambridge: Polity.
[85] Ibid., p.195.
[86] William Gibson (1984) *Neuromancer*. London: Gollancz; Neal Stephenson (1992) *Snow Crash*. New York: Bantam Books.
[87] Margaret Wertheim (1999) *The Pearly Gates of Cyberspace*: *A History of Space from Dante to the Internet*. New York: Doubleday
[88] Ibid., p.308.
[89] Michael Hardt (2002) 'From Porto Alegre: Today's Bandung?' *New Left Review*, 14, 112–118, p112.

[90] Manuel Castells (1997) *The Information Society*. Oxford: Blackwell; Kevin Robins and Frank Webster (1999) *Times of the Technoculture: From the Information Society to the Virtual Life*. London: Routledge; Lev Manovich (2001) *The Language of New Media*. Cambridge, Mass.: MIT Press; Cass Sunstein (2001) *Republic.com*. Princeton: Princeton University Press; Adam Greenfield (2016) *Radical Technologies: The Design of Everyday Life*. New York: Verso; Alexander Galloway (2012) *The Interface Effect*. Polity Books.

[91] Nicholas Negroponte (1995) *Being Digital*. Cambridge, Mass.: MIT Press, p.15.

[92] In 1998 Carol Wilder wrote a wonderful chapter titled 'Being Analog'. I am indebted to her for introducing me to the Analog-Digital discussions at the Macy Conferences. It is a beautifully subjective piece in which, like Silvia Estevez's essay, and the novel by Ellen Ullman that she quotes from, Wilder takes almost for granted that we are analogue, the surprise being that it is necessary to make the argument. Thinking about what has been lost in the rise to domination of digitality, Wilder considers our relationship to nature and the ecology as being of primary importance. She uses the work of ecologist Bill McKibben to argue why it is that 'lost information' is a strange paradox in our digital world of info-glut. For her the 'lost information' is the human, the fuzzy, the grey areas, the tacit, and that which is the preserve of the workings of the analogue world. She ends the chapter by stating: 'Being analog is only a start, and only a part of the story, but taken seriously, it may provide one more aperture to "missing information" in an age that so clearly calls for the collective wisdom an ecological vision may hold.' See Carol Wilder (1998) 'Being Analog' in *The Postmodern Presence*, Arthur Berger (ed). London: Sage.

[93] In the previous chapter I used Ngram to chart the decline of the term postmodernism from 1990 to 2008. I used it again to see the fate of the words 'analog' and 'digital' over the same period ('analogue' also included). Notwithstanding the program's limitations, the results were in line with my expectations. The term 'digital' has been on an upward curve since 1990, reaching a peak in 2004, dipping slightly after that to remain constant. 'Analog' has been on a downward path since the beginning, with only a brief period of gain, plateauing in 2000, and then continuing down again.

[94] Karl Marx (1976) *Capital Volume 1*. Harmondsworth: Penguin, p.527.

[95] *The Condition of Postmodernity,* p.359.

[96] See E. T. Bell (1953) *Men of Mathematics*. Harmondsworth: Penguin, p.123.

[97] See James Essinger's (2007) *Jacquard's Web: How a Hand-Loom Led to the Birth of the Information Age*. Oxford: Oxford University Press, p.4.

[98] John Herschel (1792–1871) polymath, supporter and friend of Charles Babbage. See Doron Swade (2001) *The Cogwheel Brain: Charles Babbage and the Quest to Build the First Computer*. London: Abacus.

[99] See John Ashworth, (1996) 'Memory, Efficiency and Symbolic Analysis: Charles Babbage, John Herschel, and the Industrial Mind', *Isis*, 87(4).

[100] Cited in Bruce Collier and James MacLachlan (1998) *Charles Babbage and the Engines of Perfection*. Oxford: Oxford University Press, p.70.
[101] Ibid.
[102] Lukács, *History and Class Consciousness,* p.6.
[103] Andrew Feenberg (2017) *Technosystem: The Social Life of Reason*. Cambridge, MA.: Harvard University Press, pp.149–150.
[104] Ibid., see pp.89–95.
[105] Marx, Karl (1972) *Capital*, Vol. 1, in *The Marx-Engels Reader*, ed. Robert C. Tucker. New York: Norton., p.405.
[106] Jacques Ellul (1964*) The Technological Society*. New York: Vintage, p.135.
[107] Ibid., p.136.
[108] Ibid., p.153.
[109] Ibid., p.342.
[110] Ibid., p.14.
[111] Ibid., p.429.
[112] John Johnston (2010) *The Allure of Machinic Life*. Cambridge, Mass.: MIT Press, p.70. (emphasis in original)
[113] Adorno and Horkheimer, *The Dialectic of Enlightenment*, p.68.
[114] Rahel Jaeggi (2014) *Alienation*. New York: Columbia University Press, p.46
[115] Ibid., p.46. Axel Honneth, in his 'Foreword' to the book, laments the disappearance of the concept of alienation, and warns that 'Nothing signals more clearly the danger that Critical Theory might become obsolete that the death of what was once its fundamental concept'., p. vii.
[116] Ibid., p.1. (my italics)
[117] Ibid., p.46.
[118] Ibid., p.48. See also, pp.36–37.
[119] Ibid., p.68.
[120] Ibid., p. 68. (emphasis in original)
[121] See Chapter 10: 'Living one's own life: self-determination, self-realisation, and authenticity'
[122] See Nathan Cohen's (2018) *The Know-it-Alls: The Rise of Silicon Valley as a Political Powerhouse and Social Wrecking Ball*. New York: The New Press.
[123] Jaeggi, *Alienation,* p.70.
[124] David Graeber (2018) *Bullshit Jobs: A Theory*. New York: Simon and Schuster.
[125] Streeck, *How Will Capitalism End*?, n.34
[126] The cultural theorist Mark Fisher sees capitalism, neoliberal capitalism, as 'zombie capitalism', an 'undead system which people can't see beyond'. See his 'We need a post-capitalist vision' in (2018) *K-Punk*. New York: Repeater Books., p.672.
[127] Ibid., p.9
[128] Martin Burkhardt, (2018) *All or Nothing: A Digital Apocalypse*, Cambridge, MA.: The MIT Press. See page p.3.
[129] Byung-Chul Han (2017) *In the Swarm: Digital Prospects*. Cambridge, Mass.: The MIT Press.

[130] Ibid., p.11.
[131] Jaeggi, *Alienation*, pp.68–98.
[132] Han, *In the Swarm*, p.32.
[133] Ibid., p.80.