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SOMALETHEIA:
CULTURAL
TECHNIQUES OF
BIOSENSING

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ABSTRACT

Biosensors are sensor technologies designed to produce data about the functions or vital capacity of the body. While biosensing has often been analysed in presentist terms, this thesis attempts to account for the long history of biosensors, the better to frame an understanding of the contemporary ‘sensor society’. This thesis proposes two ‘births’ of the sensor society – the first occurring in the mid-19th century, and the second in the early 21st century. This thesis considers the Quantified Self movement as serving to problematize the conditions of this ‘second’ sensor society, at the same time as critical questioning of the significance of biosensors has exceeded the form of praxis promoted by the movement.

This thesis argues that biosensors figure the body as both the bearer of truth, as well as that which frustrates this truth through the exigencies of biological errancy. I refer to this metrological dynamic of bodily veiling/unveiling as ‘somaletheia’, a portmanteau combining the words ‘soma’ for ‘body’ and ‘(a)letheia’ for ‘(un)concealment’. This thesis draws upon cultural techniques theory to genealogically analyse the way that this dynamic has conditioned biosensors’ place in the clinic, the workplace, and the home, from the mid-19th century to the present day.

Cultural Techniques theory analyses chains of ontic operations which coalesce into what are referred to as ‘operative ontologies’ – the production of ontological distinctions which are in retrospect understood to function as ‘essential’ truths about a given domain of experience. I trace the cultural techniques of biosensing across the fields of the clinic, the workplace, and the home, demonstrating how biosensing produces a mode of measure which is at once troubled as well as propelled by its ‘working through’ of the difficulty of a body which is figured as errant.

I analyse the difficulties surrounding the tools of 19th century biosensors like the sphygmograph and the haemautograph, the techniques of the ‘educated finger’, the tools of the post-Taylorist European Science of Work and Human Relations studies, and early servant-managing home security technologies. I compare these with contemporary digital, networked biosensor technologies like the Apple Watch, the Sociometer, and

Amazon Key, to demonstrate how their associated cultural techniques have been reworked and extended as tools of governmentality.

This thesis contributes to a consideration of media critique which grapples with the difficulty of aporia and error as a material force. While the vital capacity of the human body has often been argued to hold an immanently resistant capacity, this thesis analyses how ‘biological errancy’ is managed as a productive aspect of the biosensing apparatus. This thesis argues that this dynamic be understood neither from the perspective of media as ‘Enframing’, but nor from the perspective of a normatively understood vital body. Instead, this thesis proposes an approach which charts the genealogical production of a form of bodily truth which emerges in the complex interplay between human activity and an evolving and intimate form of measure.

DECLARATION PAGE

I, Christopher Allan O'Neill, do hereby declare that this thesis comprises only my original work towards the degree of Doctor of Philosophy, except where indicated in the preface; that due acknowledgement has been made in the text to all other material used; and that the thesis is fewer than the maximum word limit in length, exclusive of tables, maps, bibliographies and appendices.

SIGNED,

(SIGNATURE REDACTED FOR MINERVA COPY)

CHRISTOPHER ALLAN O'NEILL

PREFACE

Material in chapter three has been adapted from an article published as:

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No other work within this thesis has been previously published. No part of this thesis was written in collaboration with others. No part of this thesis has been submitted for other qualifications. None of the work completed for this thesis was carried out prior to enrolment in the degree. No third party editorial assistance was provided in the preparation of this thesis.

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INTRODUCTION

SOMALETHEIA: CULTURAL TECHNIQUES OF BIOSENSING

The body veiled itself. It was necessary to go beyond symptomatology: “The symptoms given by sounding are suspect: the moving heart prevents our determining the exact origin of the noises.” Marey’s argument is a little surprising, but it shows to what extent he sought less apparent kind of evidence and proof.

– Étienne-Jules Marey: *A Passion for the Trace*, François Dagognet, 1992: 18.

In the contemporary period, and especially across the second decade of the 21st century, sensor technologies have become ubiquitous, banal, and embedded within a diverse range of sociotechnical contexts. The rise and, arguably, fall of the *Quantified Self* movement stands as testament and reaction to the significance of this context. In 2010, Gary Wolf, one of the founders of the ‘movement’, published in the New York Times *The Data Driven Life*, which stands as a sort of manifesto for the potential to reimagine life as framed through the possibilities afforded by sensor technologies and data analytics. The piece begins with a resounding condemnation of the human capacity for ‘error’ and ‘gut feeling’: “Humans make errors”, Wolf writes, “We make errors of fact and errors of judgment... Sometimes we can’t even answer the simplest questions... These weaknesses put us at a disadvantage. We make decisions with partial information. We are forced to steer by guesswork. We go with our gut” (Wolf, 2010: online). As Wolf continues, this state of ignorance is no longer an inevitability; Wolf is full of praise for his friends who have used data variously to moderate their alcohol and caffeine intake, to gauge their aerobic output, to track their intellectual performance over time and in different circumstances, and so on.

This thesis is not about the Quantified Self, in the sense that it does not consider the Quantified Self as its key object of study. However, the Quantified Self movement is

significant as a problematizing catalyst for thinking through the significance that sensor technologies have had in reorganising bodily comportment in a sociotechnical milieu characterised by the proliferation of sensor technologies.

This milieu has been described by Mark Andrejevic and Mark Burdon as ‘the sensor society’, a world in which “the interactive devices and applications that populate the digital information environment come to double as sensors” (2015: 20). Andrejevic and Burdon argue for the significance of this development along several critical axes, most significant of which is the transformation of digital culture from being primarily premised on an *interactive* relationship between users and media technologies towards one in which “forms of pervasive, always-on, passive information collection are coming to characterize the use of digital devices and the business models with which they are associated” (Andrejevic & Burdon, 2015: 20). According to Andrejevic and Burdon, we no longer interact with media technologies so much as we are positioned as data producers for the benefit of the companies providing us with access to digital technologies. There are many different kinds of sensors incorporated within many different kinds of media technologies – movement sensors, occupancy sensors, accelerometers, pedometers, photoplethysmographs, and so on.

My thesis focusses on a particular subclass of sensor technologies, what Dawn Nafus has referred to as ‘biosensors’ – sensors which are aimed at the sensing and production of data about the human body and its biological function (2016: xiv). Although this term has been traditionally limited to discussion of a specific class of ‘wet’ sensor within electrical engineering studies, one which combines “a biological element (like sweat, saliva, or CO₂) with a physiochemical detector” I agree with Nafus that there is a utility in extending our use of the term to describe other sensors directed towards the body (Nafus, 2016: xiv), such as heart rate sensors, or ‘sociometric’ gesture sensors, or home security sensors. The use and interpretation of sensors aimed at the body has such significance for contemporary technopolitical questions, and in ways which I will argue can be understood collectively through the frame of what I term *somaletheia*, that they compel our further critical attention. I will define this term shortly. In the ‘sensor society’ biosensors and sensors more broadly are ubiquitous, constituting the defining technological logic of our times. Andrejevic and Burdon (2015) argue that this has led

to a growing degree of passivity in our interaction with the technological environment, and that this passivity has grave consequences for the way in which we are controlled and governed within the technological landscape. They argue then for a need for greater awareness and even consciousness raising of the place that sensors hold in the mediation of the social order, that we might better understand their dangers or limitations.

This thesis contributes to this general program of research. But it also brings a historical dimension to this analysis by asking the question – ‘When did the sensor society begin?’. Although we tend to think of sensor technologies as contemporary phenomena, my thesis proposes that the sensor society began in the mid-19th century – or, to be more precise, that there have in fact been two ‘births’ of the sensor society. The first took place in the mid-19th century with the development of electromechanical sensor technologies such as Étienne-Jules Marey’s wearable sphygmograph (1859) and Augustus Popes’ Electro-Magnetic Alarm system (1852). In line with the methodological principles of Cultural Techniques theory, this thesis will demonstrate how such technologies served to recursively formalise and destabilise existing practices of measurement and interpretation within the medical clinic, the workplace, and the home. These cultural techniques have in turn been remediated by the second ‘birth’ of the sensor society, which we can situate in the early 21st century, when increasingly unobtrusive and networked digital sensor technologies became prominent as elements of the so-called ‘Internet of Things’. The significance of approaching the question of the sensor society from this position of historical comparison is to defamiliarise the already familiar effects of this second ‘birth’ – the omnipresence of ‘Big Data’ analytics, algorithmic control, invasive and intimate surveillance, and so on, by demonstrating clear historical parallels to contemporary trends. Such parallels can be instructive in offering suggestions for how we might approach the difficulties and aporias of the contemporary sensor society.

MEDIATING THE BODY

It is often argued that something crucial, some *lived* aspect of the body, is obscured or denied by modern forms of technical measure. For example, Nicholas Jewson (2009), in his influential critique of the ‘disappearance of the sick man from medical cosmology’ argues that the rise of ‘hospital medicine’ has seen the particularity of the sick patient lost in the abstraction of modern forms of patient surveillance. Lorraine Daston and Peter Gallison (1992; 2007) meanwhile have argued that the rise of scientific objectivity was predicated upon a Victorian project of ascetic withdrawal from interpretation and diagnosis. Indeed, the question of how the body is mediated by modern technology has been thought from a variety of critical perspectives.

In his 1988 lecture on *Health: Popular Concept and Philosophical Question*, Georges Canguilhem makes a normative vitalist argument for ‘the truth of the body’ as corresponding to what he refers to as its ‘health’, and a particular understanding of health as something beyond measure and beyond representation (Canguilhem, 2012: 52). For Canguilhem, the truth of the body lies in its creative fecundity, its capacity to overcome its own norms – he cites Nietzsche, that “there is more reason in your body than in your best wisdom” (Canguilhem, 2012: 46). He contrasts his understanding of the creative vitality of the body with the schematic abstractions of ‘public health’ experts:

Here we are far from a health measured by apparatuses. Let us call this health free, unconditioned, unaccountable. This free health is not an object for those who believe themselves to be specialists in it... The truth of my body—its very constitution or its authenticity of existence—is not an idea susceptible to representation. (Canguilhem, 2012: 49-50)

For Canguilhem it is the error of modern bioscience to have miscategorised life such that its “existential meaning has been occulted by the demands of accounting” (Canguilhem, 2012: 48) – life understood as a creative and dynamic force must be reintegrated into modern medicine in order for the living body to be accorded its rightful place within contemporary society.

A key work in 21st century theorisations of the relation between body and mediation is Eugene Thacker's 2004 monograph *Biomedica*. What are 'biomedica' for Thacker? Biomedica are a means by which modern technologies and understandings of the body move beyond the anxieties and critiques posited by thinkers like Canguilhem, in an act of double-mediation through which the body becomes both that which mediates and that which is mediated, one in which there is no clear or necessary distinction between the body and its mediation as such, and hence the end of 'body anxiety' – the term Thacker uses to describe the old "will to transcend the base contingencies of 'the meat' in favor of virtual spaces" (Thacker, 2004: 6). Rather than seeking to 'transcend' the body (such as through fantasies of 'uploading' one's consciousness to a computer hard-drive or through the 'capture' of populations through accounting mechanisms), Thacker argues that the contemporary measurement of the body is predicated upon its 'optimisation' (Thacker, 2004: 27). Thacker analyses the development of digital, 'wet' technologies like DNA computing, microarray sensors, and bioinformatics, arguing that contemporary mediations of the body essentially collapse the distinction between the body and its measure, such that "[t]he biological and the digital domains are no longer rendered ontologically distinct, but instead are seen to inhere in each other; the biological 'informs' the digital, just as the digital 'corporealizes' the biological" (Thacker, 2004: 7). Rather than moving 'beyond' the body, biomedica constantly 'return' to the body "in a self-fulfilling, technical optimization of the biological, such that the biological will continue to remain biological (and not 'technological')" (Thacker, 2004: 28).

Thacker's argument, that digital means of measuring the body have served to 'ontologically' synthesise with the body itself, has been contested from a Whiteheadian, 'post-phenomenological' perspective by Mark Hansen in his 2015 work *Feed-Forward: On the Future of Twenty-First-Century Media*. Although Hansen argues that biosensing has indeed altered human sensibility by opening sensing practices to realms beyond the existing remit of human intentional consciousness, he also stresses that there is never any total collapse between measure and its object, due to "the irreducibility of temporality, or, more precisely, the irreducibility of a minimal temporal gap between occasions of experience" (Hansen, 2015: 11). Hansen argues that while contemporary sensor technologies attempt to corporealise data at a pre-conceptual level (that is to say,

through a datafication of physiological processes which occurs at a technological scale below the threshold of phenomenological consciousness as classically understood), there is an inevitable and irreducible gap which serves to propel and ‘processualise’ this relation:

What, in the philosophical tradition, is a radical opposition between two modes of consciousness’s Being...becomes, in and through the operability of twenty-first-century media, a functional, and as we will see, a processual, relationship. With this functionalization, moreover, the relationship between aboutness and being, between data as access to sensibility and data as sensibility, undergoes a certain reconceptualization through its anchoring in temporalization: aboutness is linked to being in an incessant oscillation, where each act of access onto sensibility creates a new unit of sensibility that itself calls forth a new act of access that creates a new unit of sensibility, and so on, as Whitehead would put it, until the “crack of doom.” (Hansen, 2015: 7)

For Hansen, it is this temporal gap which permits the possibility of the critique and rejection of the argument that the body and its measure might ultimately coincide, and that moreover “this temporal gap of subjectivity, insofar as it inheres in the data-fication operated by contemporary techniques and insofar as it forms the materiality of sensibility, holds the promise for a reinscription of human experience within the very objectification that allegedly renders it superfluous” (Hansen, 2015: 11).

We encounter then several related accounts of the relation between the body and its measure understood variously as constituting a *loss* or *withdrawal* from some essential aspect of the lived, vital human experience, as constituting an ontological coincidence aimed at corporeal optimisation, or as revealing an essential ontological gap between the body and its measure which nevertheless offers an opportunity for the rearticulation and refounding of human experience.

The argument presented in this thesis engages and critiques several aspects of these different approaches by pursuing a media genealogical analysis of biosensors predicated upon the Cultural Techniques school of interpretation. My approach avoids the

humanist vitalism of Canguilhem and the normative phenomenological framing of Hansen, but also complicates the biomediatric approach of Thacker. I argue that from the mid-19th century modern researchers have sought methods of measurement which would indeed *coincide* with the body, which would allow for the body itself to become the measure of its own measure, for life to be enabled to ‘speak-itself’. In this way, I demonstrate how rather than *eliding* the body, modern technological measurement has emerged as a means by which power-relations are sensualised and reproduced *as embodied*, rather than as an escape from or mastery of embodiment. Modern technological measure has emerged as a medium by which, in Foucault’s words “the relations of power pass through the interior of the body” (Foucault, 2001a). Yet I demonstrate how this project is also ever failed, ever frustrated by the exigencies of biological errancy – my analyses show that sensor technologies and bodies repeatedly, and with great consequence, misalign. However, rather than arguing for this failure as a means for the critical reevaluation of the human subject, or as demonstrating an immanent ‘resistant’ power of the corporeal or the affective, I demonstrate how the cultural techniques used to ‘correct’ for these failures have functioned as a means by which to further sensualise, reproduce, and extend power relations. To put this most directly, my argument is that sensor technologies work by failing. That is, biosensor technologies ‘work through’ their failures, seeking to correct for error, however this is also ‘how they work’, such that error is not outside their ‘normal’ functioning.

SOMALETHEIA

This state of affairs is what I call *somaletheia*, a portmanteau, derived from the Greek words *soma*, meaning of or pertaining to the body, and *aletheia*, meaning ‘coming to truth’, or literally ‘un-veiling’. The ‘a’ shared by *soma* and *aletheia* does a lot of analytical work here (just like the ‘a’ in Derrida’s *différance* or Lacan’s *objet petit a*). If we read the term as *soma-aletheia*, this would suggest a kind of ‘body-unveiling’, by which we might come to know, through modern investigatory apparatuses, something about the body which has been hidden from us by its appearance, and this is partly the meaning I have in mind. If we read the term as *soma-letheia*, this would indicate a mode of knowledge which would posit the body (*soma*), as that which veils (*letheia*), and this

is also what I believe is true about the way the body has been conceptualised as an object of modern technical measurement. From at least Marey onwards, the body has been conceived as both the site of the truth of the body *as well as* that which most surely stymies our knowledge about the body. The body is both ‘its own truth’, as well as that which through the exigencies of biological errancy most surely denies us the knowledge of this truth. I argue that the dynamic tension between these two understandings of the body’s measure produces sensors as cultural techniques of governance which unfold as emergent and relational forms of control. The body is entangled with its measure, and the form of measure which has become hegemonic in the sensor society is a form whose cultural techniques are imminent, emergent, and (quasi)-vital.

The argument being made here borrows from Martin Heidegger’s discussion of the term *aletheia* as ‘unveiling’ or ‘unconcealment’ (Heidegger, 1998), but my argument is not itself Heideggerian. The point of my analysis is not to argue that sensor technologies have produced a ‘false’ measurement of the body, or that we need to substitute a poetic understanding of the body for the quantitative understanding produced through the measurements of sensor technologies (as the Heidegger of the *Question Concerning Technology* (1977) or the *Zollikon Seminars* (2001) might conceivably argue). Nor am I concerned with making a normative argument about the true capabilities of the body, or indeed as to whether there is an ‘essential’ errancy to the body which might forever escape capture (cf. Canguilhem, 1994). In my analysis, it is not sensor technologies themselves, or some inherent property of sensed bodies which ‘leads’ to somaletheia in any direct sense. Rather, what my analysis uncovers is a set of cultural practices – ‘cultural techniques’ – that have served to reify certain problems of measurement, which have in turn produced a certain understanding of the body as that which both reveals and veils its truth. The aporia of somaletheia is produced by a particular, historically contingent arrangement of biosensing technologies and cultural practices, which produces a dynamic and adaptive mode of governance that seeks to manage a body understood as the source of a truth which it also antagonises.

While many critiques of modernity (for example Jewson (2009), Lefebvre (2004) and Thompson (1967)) have argued that the vital capacities of the body hold the key to an

immanent resistance to the calculative technologies of modernity, I argue by contrast that the resistant capacity of the corporeal has already been recuperated within a technological environment predicated upon the management and distribution of affective relations. I argue that biological errancy is the key representational correlate of somatheia. Although the term ‘errancy’ itself has both Heideggerian and Canguilhemian resonance, (see Canguilhem, 1994: 287-319; Trawny, 2015), I use the term ‘biological errancy’ here in a more deflationary or prosaic manner, to mean simply the capacity for the biosensing relation to produce error, in an essentially positivistic sense, as when bodies step outside or fail to align within a given metrological parameter. I do not argue for this errancy as the grounds for resistance to the biosensing apparatus or as being grounded in any ontological essence. Rather, my analysis demonstrates genealogically that it is through the negotiation of errancy that certain practices of biosensing reproduce and extend power relations as they pertain to the realms of the clinic, the workplace, and the home.

In the first chapter of my thesis I outline my methodology, which draws primarily from the school of German Media Theory referred to as *Cultural Techniques theory*. Cultural Techniques theory involves the study of “the inchoate mixture of techniques, practices, instruments, and institutional procedures that give rise to a technological set-up” (Geoghegan, 2013: 70), analysing how such practices and technologies come to be formalised and to constitute a recognisable domain of media expertise and practice. However as Bernhard Siegert argues, Cultural Techniques analysis also emphasises that “cultural techniques are not only media that sustain, disseminate, internalize and institutionalize sign systems, they also destabilize cultural codes, erase signs and deterritorialize sounds and images” (Siegert, 2013: 62). That is to say that any given cultural technique both formalises as well as destabilises other existing cultural techniques. The study of cultural techniques then conceptualises the significance of media technology as contingent and complex, caught in a territorialising/deterritorialising process with no clear start or end point, which must be understood as in communion with a host of other complex social forces. In this chapter I outline in some detail how Cultural Techniques theory also serves as a critique of the

approach to German media studies pioneered by Friedrich Kittler. The key innovations of the Cultural Techniques approach are in moving from an archaeological approach predicated upon analysing the materialities of communication, towards a genealogical approach, aimed at analysing the way that chains of interpretative and configurative techniques coalesce into the production of certain ontological distinctions, which are in turn undone or refigured by new cultural techniques responding to new sociotechnical problematics.

The significance of this methodology for media studies is that it reframes the relation between media and their use away from an ontological argument predicated upon the enframing effect of media technology, in favour of an analysis of how cultural practices of sense-making respond to and reformulate themselves in the wake of new technological developments, producing what are referred to as ‘operative ontologies’ (Siegert, 2013), ontological distinctions which are only understood in retrospect to have had a determining, causal effect. I put this methodology into practice through the analysis of a variety of archival sources, including popular literature, physicians’ reference guides, smart lock patent applications, and Apple Watch manuals, in order to chart the development of cultural techniques of biosensing from the mid-19th century to the present day.

In my second chapter I chart the way in which the Quantified Self movement served to problematize the body-mediatic relation, and to serve as a catalyst for academic enquiring into biosensing media, even as this enquiry has now progressed beyond the study of Wolf et al as a social movement. I identify four key schools of interpretation of the cultural significance of biosensing to emerge in the wake of the Quantified Self movement. In the first ‘generation’ of responses to the Quantified Self there were broadly two key responses to the movement. On the one hand there were those who interpreted the distribution of biosensors as a means by which ‘ordinary people’ might come to produce new and creative forms of self-measurement which would challenge existing methods of biometric control. This ‘resistant’ school of interpretation was countered by the argument that the Quantified Self movement should be understood as the internalisation of a neoliberal ideology of self-management and self-optimisation, and motivated by a fear of bodily degenerescence. I argue that the interpretation of

biosensing as either a form of ‘resistance’ to norms of measure and calculation, or as the internalisation of such norms, demonstrates how early academic responses to biosensing emerged largely as a response to the theorisations of Gary Wolf et al, and pursued a set of arguments which are prefigured in works like *The Data Driven Life*. I argue however that the academic literature on biosensing has now moved beyond the Quantified Self as its key point of reference, as biosensing becomes increasingly mundane and embedded within daily life. In this second ‘generation’ of theorisation, there has been a flurry of responses drawing upon new materialist and speculative realist interpretations of the potential of biosensors to reveal potentially novel ‘entanglements’ between self and other, going beyond the forms of ‘empowering’ self-knowledge imagined by Wolf et al. However, this analysis, predicated upon an understanding of the biosensing relation as one of hybridity, has been countered by a growing literature examining the ‘aporetic’ apparatus, which foregrounds the difficult place of disuse, misinterpretation, and error in the uptake of biosensor technologies. Bergroth (2019), Kragh-Furbo et al (2016), Lomborg et al (2018), and Nafus (2016) have drawn attention to what Kragh-Furbo et al refers to as the “material force” (2016: 21) of uncertainty, and the way in which biosensors serve to produce and mediate this uncertainty. Taking up this line of interpretation, this thesis examines the historical production of said aporias, and draws upon this perspective as a way of reframing the question of the relation between biosensing and neoliberal governmentality raised in the ‘first’ generation of academic literature.

These preliminary chapters set the scene for the main work of my thesis – a genealogical analysis of the development of sensor technologies in the clinic, the workplace and the home. I focus on these three fields because they constitute significant sites of social and economic life, and demonstrate in a particularly clear way the cultural techniques of sensor society at the level of bodily comportment and daily practice, in which the body enters into relations of health, of labour, and of rest.

In my third chapter I analyse the cultural techniques surrounding medical biosensors. I examine the development of the ‘graphic method’ in the mid-19th century, and analyse the cultural techniques surrounding Étienne-Jules Marey’s sphygmograph, the first wearable and non-invasive pulse writing biosensor. The sphygmograph comprised a pad

which would rest upon the pulse point of the subject's wrist. This pad was in turn attached to a stylus which would 'trace' the movements of the pulse onto a mechanically rotated strip of paper. Marey hoped that his invention would enable the vital phenomena of the body to 'write itself', thus freeing physiological enquiry from the distorting interpretative effect of the physician or biologist. Lorraine Daston and Peter Gallison (1992) have positioned Marey as a significant figure in what they describe as the rise of 'mechanical objectivity' in the 19th century, by which scientific truth came to be understood as produced through the withdrawal of the subjective interpretations of the doctor or scientist, in favour of a view of reality defined in austere, nominalist terms via technological measurement. Other critics, such as Nicholas Jewson (2009) have pursued a certain ethical or moral critique of the rise of technological or quantifiable forms of measurement as an element of medical diagnostics, arguing that these have compromised some essential 'human' element of the intimacy which comprises the doctor-patient relationship.

I re-examine the emergence of medical biosensors and their significance for 'knowing the body' in two parts. I begin by analysing the technical supplements that Marey drew upon to prove the accuracy of his own sphygmograph, which had been contested by Karl Vierordt, a rival whose differently designed sphygmograph produced a noticeably different tracing of the pulse to that of Marey's device (see Vierordt, 1855). In his 1881 study *La Circulation du Sang*, Marey discusses the results produced by several other biosensing technologies as evidence for the accuracy of his own device. I consider the implications of two of these. The first is the ghoulish 'haemautograph', designed by the German inventor-physiologist, Leonard Landois (1876). The haemautograph involved the tying down of either a large dog or a hare to a table; a rotating (and blank, unlined) paper band powered by a clockwork mechanism would then be placed next to the tibial artery of the animal, which would be slit. The arc of the dying animal's exsanguinations appeared to follow the shape of the double-notched pulse tracing produced by Marey's sphygmograph, thus according to Marey 'completely justifying' the results of his own device (Marey, 1881: 281). A second device Marey discussed was the photospphygmograph of Johann Czermak (1864), which "projected the movements of a ray of light reflected from a small mirror, placed upon the artery, [which were then projected] and photographed upon a screen of prepared collodion" (Power, 1865: 227).

I argue that Marey's investment in Landois' haemautograph is confounding, given that according to Marey the utility of the non-invasive biosensors of the graphic method was precisely to avoid the potentially distorting effects upon which haemautographic measurement and its violent intervention was predicated. I argue that these supplements to the sphygmograph position its traces within a kind of dialectic – between the singular, immanent, and troubling physiological singularity of the haemautograph's blood-signifier, and the pristine, weightless trace as projected by Czermak's photospkygmograph. This dialectic reveals a troubling inconsistency within the graphic method; between a desire to produce a truly universalising, light-borne abstraction of the body, and the frustration of this desire through the destabilising and stymieing problematic of physiological difference.

I further examine this tension through a consideration of the clinical application of the sphygmograph. In England, a number of physicians produced guides to the application and interpretation of the sphygmograph. Rather than obviating traditional 'hands on' means of pulse palpation, figures such as W.H. Broadbent (1890) and John Burdon Sanderson (1867) advocated that the sphygmograph be used in combination with such methods to produce an 'educated finger'. Rather than diminishing the embodied authority of the doctor, I argue that the ambiguities and errancies of the sphygmograph, its need to be carefully adjusted to give meaningful measurements of different bodies, reveals that biosensors produced a new sensualisation of the doctor-patient relationship, as both enabled and authorised *through* rather than *in spite of* the technological apparatus. I analyse what I call the cultural techniques of touch which characterised this process – Broadbent et al's production of the educated finger was a means by which physicians ensured that their own touch remained 'proper', authorised to secure the meanings of the traces produced through biosensors.

In the latter section of this chapter I analyse the photoplethysmographic sensors which comprise the pulse writing biosensor of the contemporary Apple Watch. Although promoted as a means by which ordinary people can become empowered to measure, understand, and control their own health, I argue that photoplethysmographic sensors' significant capacity for error again serves to frustrate this project. The failures

especially of commercial grade photoplethysmographs are well documented in the scientific literature – sweat, blanching of the skin through overtight application, and skin colour have, among other factors, been known to compromise the legibility of the sensor’s signal. Users of these sensors then can never be authorised to truly ‘know’ their bodies – rather it is to medical professionals that they must turn in order to have their biodata calibrated and authorised, thus enmeshing biosensor users more deeply within the medical industry, rather than enabling a ‘freedom’ from it.

Biosensors then frame the body such that it is invited to speak its own truth, at the same time that the problem of physiological difference serves to frustrate this project and ensure an endless and endlessly complex process of adjustment and recalibration. This is the *somalectic* problematic that I argue remains with us today. We can detect this dynamic at work at the ‘birth’ of the sensor society in the mid-19th century, as well as in the contemporary era. Today’s digital biosensors do not resolve or overcome this problematic – the Apple Watch rather serves to both individualise and digitally network it, intensifying an interpretative aporia, as well as its concomitant extension of institutional medical authority.

In chapter four of this thesis I analyse the use of biosensors as a form of workplace surveillance. The contemporary development of biosensors in the workplace has often been understood as a form of ‘Neo-Taylorism’. I argue by contrast that a more accurate interpretative framing is to understand them as ‘Neo-Post-Taylorist’. By this admittedly ungainly neologism, I aim to compel a closer consideration of the history of both Taylorism as an ideology and practice of workplace management, as well as the European and American ‘responses’ to Taylorism. In Europe this response would coalesce into a set of practices and theories which Anson Rabinbach has dubbed ‘The European Science of Work’ (1990), while in the USA the most significant response came in the form of the theories of Human Relations developed by Elton Mayo (1933) and his colleagues at Harvard Business School (see Roethlisberger & Dickson, 1939; Whitehead, 1938). Both of these responses drew upon biosensors as a means by which to produce an emergent, iterative, and vital form of measuring the labouring body, capable of responding to the apparent limitations of the Taylorist approach. Where Taylor’s schematic approach to measuring the body sought to dominate the lived body

through the imposition of a normative framework of measurement and evaluation, researchers in the European Science of Work sought to know the body ‘from the bottom up’, drawing upon sophisticated physiological measurements and theories of fatigue in order to more closely mould the rhythms of the working day to the exigencies of the body’s vital capacities. Mayo by contrast and in response sought to understand the worker in her ‘whole environment’, in a context which would include the social and what we might even call the non-representationalist aspects of the workplace – entwined with friendships and other social forces.

F.W. Taylor’s (1911) theory of ‘Scientific Management’ argued that the problem of productivity in American capitalism was one of inefficiency in the workplace, and that this inefficiency was to be overcome by determining the ‘one best way’ to perform tasks in the workplace. However, the time and motion analysis that Taylor used to divine this ‘one best way’ was vague and schematic, and it was unclear as to whether his methods produced data on an average, minimum, or some sort of ‘ideal’ spatiotemporal work process. While Taylor argued that workers could be motivated to the ‘one best way’ of production through incorporation of productivity incentives, workers in both the US and in Europe complained that Taylorism was merely used as an excuse for the endless ‘speed up’ of the work progress, without any concern for the burnout or worse that such methods entailed.

While European workers revolted against the imposition of Taylorist methods through widespread strike action, European physiologists in the research tradition of Marey were appalled by what they saw as the physiologically ignorant theories of Taylor. They argued that the laboratory settings of Taylor’s experiments produced artificially inflated results, because his test subjects were simply overexerting themselves at an unsustainable rate in order to gain the monetary incentives that Taylor was offering (Lahy, 1921: 63). Researchers such as Jules Amar (1917) and Jean-Maurice Lahy (1921) argued that a less destructive and ultimately more sustainable mode of workplace management could be produced through the sensor-enabled measurement of worker’s productive capacity under ‘normal’ workplace conditions. They conducted experiments using biosensors such as the spirometer, which recorded oxygen consumption and so could produce traces which indexed the fatigue levels of the

worker. The recommendations of such ‘work scientists’ were taken as a means by which to productively ‘soften’ the rhythm of workplace production in order to mould it according to the perceived biological capacities of the worker, thus serving to recuperate workplace alienation and discontent to some degree.

In the US the work of Elton Mayo and his colleagues at Harvard Business School came to prominence as a result of their study of workplace productivity at the Hawthorne Works in Cicero, Illinois during the 1920s and early 30s. Mayo rejected Taylor’s argument that productivity could be improved through time and motion analysis and the offering of incentives. Instead, he argued that worker discontent could be understood as a kind of psychological maladjustment or ‘anomie’, and that what workers desired was “a method of living in social relationship with other people and...as part of this an economic function for and value to the group” (Mayo, 1933: 173). While Mayo ostensibly disdained biometric analyses in favour of a form of social psychology, one of the Harvard researchers, Thomas North Whitehead, drew upon sensor data measuring the production rate of the workers being studied in order to produce a vast and complex statistical analysis of the “social sentiment” of the workplace (Whitehead, 1938: 212). While Whitehead’s work was and remains far more obscure than Mayo’s more discursive analysis, I argue that it can nevertheless be understood as a form of measure which reflected an emergent and co-dependent understanding of group dynamics and unity, serving to authorise and calibrate interventions in the workforce and workplace.

I argue that the contemporary use of biosensors in the white collar workplace serves similarly to authorise the endless recalibration and manipulation of the working environment. I analyse workplace biosensing technologies developed by *Volometrix* and *Humanyze*, particularly the sociometer sensor developed by behaviour theorist Alex Pentland. The sociometer is worn around the neck and measures gestures made by workers for what Pentland terms ‘Honest Signals’ (2008), which in lieu of directly measuring production outputs are nonetheless indexical of productive capacity. The analysis of such ‘honest signals’ can in turn be used as a benchmark by which to test and evaluate potentially endless alterations to workflow and the working environment, in order to examine whether such changes produce greater levels of productivity.

The use of biosensors in the workplace I argue then displaces the ‘one best way’ of the Taylorist method in favour of the emergent production of norms governing workplace structure and processes. While such norms are presented as more closely aligning with ‘natural’ rhythms of worker capacity, they are pernicious to the extent that they offer no ‘escape’ from measure and management. Because there is no predefined ideal of productivity, biosensors are instead used to justify the literally endless recalibration of the workplace and the workforce. I argue that this analysis is theoretically significant because it troubles the phenomenological critique of work pursued by theorists such as Henri Lefebvre (2004) or E.P. Thompson (1967), who in different ways would argue for a kind of ‘natural’ biological temporality as providing for an immanent resistance to the task-oriented temporality of industrial clock time. Biosensor monitoring has on the one hand been used to recuperate the demand for a more ‘human’ mode of workplace organisation, while the ambiguities of biosensor interpretation at the same time authorise a fluid and intimate mode of worker surveillance. In this I identify another iteration of the somaethic problematic – the demand to take the body as the central object of measurement is coupled with the development of techniques of recalibration and readjustment designed to manage and even ‘productivise’ the perceived instability of the body.

In my fifth and final chapter I analyse the way that sensors have been used as an aspect of home security and as a way of choreographing the movements of domestic servants within the family home. In this section I trace the influence of Augustus R. Pope’s 1852 electro-magnetic alarm and its subsequent development by Edwin Holmes and other American home security entrepreneurs in the second half of the 19th century (see Holmes, 1861; 1867; 1868). Holmes used electromagnetic contact sensors, attached to windows and doors, to operate as the first integrated electrical home security technologies. Home-owners could purchase sensors to attach both to external doors and windows, well as to doors within the house – especially in the densely corridorred neo-Gothic architectural styles of mid to late 19th century American homes, this meant that homeowners could produce an astonishingly complex network of data points tracing movement within their homes.

While the primary stated aim of these systems from their developers was the protection of private property and family from the predations of the “midnight assassin” (Holmes, 1868), an important secondary function of these security systems was in surveilling and choreographing the movements of family members and domestic servants within the family home. I demonstrate in this chapter that it would appear that the primary technological advancements in home security technologies were in fact related to the interior monitoring of homes. Across the second half of the 19th century home security entrepreneurs developed sophisticated technologies for reordering sensor networks within the home – alarm systems could be turned off and on for different parts of the house at different times of the day, and even more sophisticated technologies incorporated time-locks which automatically shunted particular parts of the system on and off at pre-defined intervals. The key benefit for middle and upper class homeowners was that this would allow them to more closely choreograph the movements of their domestic servants. Drawing upon Markus Krajewski’s theorisation of the cultural techniques of service (servomechanisms) (2010; 2012; 2013; 2018; see also Canales & Krajewski, 2012), I argue that burglar alarm systems constituted ‘extraservomechanisms’, technologies designed to manage the service techniques of domestic workers, maintaining order among the circulation of bodies within the home.

In contemporary America domestic service is far from an anachronism. The expansion of digitally networked and casualised service work means that access to domestic service workers is increasingly widespread. Dogwalkers, gardeners, cleaners, and so on, all contribute to the growing field of domestic service work. In the second half of this chapter I analyse the integration of smart lock technologies with the provision of digitally networked domestic service work providers. I address Amazon’s Key service, Walmart’s ‘in-fridge’ delivery service, and Vivint’s smart lock proposals as case studies. I demonstrate how the use of sensor networks within the smart home has enabled homeowners to intricately modulate the boundaries of the home, permitting service workers entry to some parts of the household but not others, at some times of the day but not other times. Like the burglar alarms of the 19th century, contemporary smart security technologies enable homeowners to regulate, surveil and choreograph the movements of domestic service workers. A new iteration of ‘extraservomechanisms’, these technologies are designed to ensure the orderly spatiotemporal coordination of the

household. They have also enabled the fluid integration of the home within a broader service economy, as the limits of the home are redrawn around the body and movements of the visiting service worker. I argue that this has produced the ‘fleeting home’, the home no longer conceived of as primarily a space of security, but as something malleable and in flux, requiring constant monitoring and continual recalibration.

In each of these three fields I describe the ways in which sensor technologies have recursively and reciprocally modified practices pertaining to medicine, labour, and the home. I demonstrate how the use of sensor technologies has been characterised by a desire to remould the practice of measurement and regulation around a body understood in sensualised, vital terms. It is in the interpretative gap which I understand through the term *somaetheia* – between the body as revealed by biosensors, and the body as confounding the interpretative order of biometric data – that the cultural techniques of the sensor society intervene to extend and modulate power-knowledge. The sensor technologies I analyse here have been used to develop a mode of somatic surveillance which is at once fluid, intimate, and yet ultimately frustrated in its ability to totally capture the exigencies of the corporeal. I focus on the three fields here because I argue that they demonstrate in a particularly clear way the cultural techniques of the sensor society at the level of bodily comportment and daily practice.

CHAPTER ONE

CULTURAL TECHNIQUES AS METHODOLOGY: FROM KITTLER TO SIEGERT, AND ONTOLOGY TO THE ONTIC

In this chapter I shall discuss Cultural Techniques theory, which forms the basis of the methodological approach of my thesis. I shall explain several of the key precepts of the theory, particularly as they have been theorised by Bernhard Siegert, and explain the significance of the Cultural Techniques approach as a way of analysing the sensor society. While Cultural Techniques theory has been a vibrant and dynamic mode of media research within so-called ‘German Media Theory’ since at least the 1990s, it is only within roughly the last decade that the approach has made inroads into the ‘Anglophone’ media studies sphere, and it remains a somewhat marginal approach.

I argue that German Media Theory, following in the wake of the pioneering work of Friedrich Kittler, offers us an especially productive way to approach the significance of media technologies as constitutive of discursive formations. I demonstrate the significance of Kittler’s remediation and materialisation of post-structuralist theory, especially that of Michel Foucault, while also noting the limits of his approach – the suffocating totalising tendency of his ontological theorising, as well as his and his followers’ martial reductionism (ie, the tendency to understand warfare as the privileged signifier and ‘motor’ of history – a generally unstated but clear presupposition which limits the productive interpretative potential of German materialism). I argue that the Cultural Techniques school of media theory, especially as theorised by Bernhard Siegert, offers us a productive ‘turn’ which does not refute the Kittlerian approach but rather reorients its emphasis. The two key differences that I consider are firstly the move from a focus upon the materiality of communications media *per se* and towards an emphasis on how media-technological apparatuses produce ‘operative ontologies’, and secondly the shift from a primarily (media-) *archaeological* approach towards a primarily (media-) *genealogical* approach.

I argue that the Cultural Techniques methodology retains the significance of the Kittlerian materialist approach while avoiding the hermetic tendency of some of Kittler's followers – Cultural Techniques' extends its analysis beyond hardware diagrammatics and towards a broader conception of the imbrication of technologies, gestures, habits, and discourses. We are thus able to avoid the somewhat millenarian adumbrations which characterise Kittler and Co's consideration especially of the post-digital. This further enables more meaningful intervention in developing media-technological debates.

In its essence, Cultural Techniques theory refers to the attempt to analyse what Bernhard Siegert calls "operative chains that precede the media concepts they generate" (2013: 58), and to chart the way these operative chains are modified over time in a recursive and reticular fashion. When Siegert refers to 'operative chains', he is talking about particular ways of using and interacting with media technologies, of the particular gestures and habits and drills and processes we follow when using, for example, computers, or abacuses, or musical instruments, or children's toys, or when making maps, or talking to parrots, or opening doors, or any number of such things. These behaviours can be and have been analysed as cultural techniques, and the way these gestures and habits and drills and processes change can tell us important things about how our way of being in the world has changed over time, of how we have defined ourselves as human has changed, and of how techniques of power have served to discipline people and behaviour, particularly at the micro-level.

Cultural Techniques theory represents a particular iteration of the broader school of *soi-disant* 'German Media Theory' – though this is itself a potentially nebulous term, combining as it does disparate scholars working with significantly differing motivations and approaches. A comparison can be made with the term 'French Theory' which was coined in the American academy in the 1980s to describe thinkers as far apart in approach as Jacques Derrida and Gilles Deleuze, united by and large only by a common geographical referent. If German Media Theory can be said to be united around a

particular conceptual referent it is the media theorist Friedrich Kittler, as well as by Kittler's innovative and idiosyncratic reading of the work of Michel Foucault, supplemented by his understanding of the materialist theories of writing put forward by Jacques Lacan and Jacques Derrida. As David Wellsbery argues in the introduction to his translation of Kittler's *Discourse Networks 1800/1900*:

Kittler's work cannot be classified as Derridean, Foucauldian, or Lacanian; rather, it grounds itself on what might be termed the joint achievement of the three. Perhaps this is the major methodological innovation of Kittler's book. By eliciting from the divergent elaborations of post-structuralist thought a collective epistemological apparatus, Kittler establishes a positive research program for a post-hermeneutic criticism. (1990: xi-xii)

Contemporary Cultural Techniques theory must be understood as a reaction to the practice of media theory in the Kittlerian mould – whilst it is a continuation of a particular understanding of discourse as grounded in the materiality of media technology, Cultural Techniques theory also tempers some of the more totalising claims made by Kittler regarding the ontological properties of media forms. In order to demonstrate the significance of this turn, it is necessary firstly to give an overview of Kittler's method and its key strengths and weaknesses, before outlining the key theses of Bernhard Siegert's articulation of Cultural Techniques theory, in order to demonstrate how it has responded to these limitations. As shall be demonstrated, Cultural Techniques theory enacts two significant shifts. The first is a shift from quasi-ontological claims about the essence of mediation towards a more deflationary 'ontic' account of particular processual chains of mediation. The second is a turn away from an archaeological approach with limited capacity for analysing the causal element behind shifts in media regimes (beyond what shall be criticised as a problematic and reductive appeal towards martial metaphors and analytics), and towards a more 'genealogical' approach, which is better equipped to analyse and synthesise both the ruptures and the continuities which constitute the development of media technologies and cultural techniques.

KITTLERIAN POST-HERMENEUTICS

Friedrich Kittler is without question the most significant thinker in the history of German media studies – the influence of his work can be seen as constituting a turning point in establishing the viability and institutional scholarly position of media studies within the German academy and its influence within global media studies (see Graw, Martin & Rottman, 2015). Kittler's two most significant works in this process were his 'habilitation' thesis, published in English as *Discourse Networks 1800/1900* (1990), and *Gramophone, Film, Typewriter* (1999), an (even) more freewheeling and discursive presentation of a similar contention and material to that covered in his thesis. The infamous opening words of *Gramophone* identify the starting point for Kittler's approach – "Media determine our situation, which – in spite or because of it – deserves a description" (Kittler, 1999: xxxix). This statement glosses a similar point, expressed in slightly less confrontational and more precise language, in *Discourse Networks*, that "Technologically possible manipulations determine what in fact can become a discourse" (Kittler, 1990: 232). While Kittler's *habilitation* thesis was undertaken in the field of Modern German Literary History, the text is an excoriating and uncompromising critique of the German hermeneutic tradition of literary interpretation – rather than following the tradition established by Schleiermacher of attempting to divine the true meaning of a given literary text, Kittler pursued a 'post-hermeneutic' approach, which sought to unveil the underlying media apparatus which supported the production of a given text, its *Aufschreibesystem* (literally 'writing down system' or 'inscription system', but translated as 'discourse network'). At the same time Kittler was hugely hostile to the prevailing hegemony of the Marxian Frankfurt and neo-Frankfurt schools of media criticism, as most famously represented in Theodor Adorno and Max Horkheimer's *Dialectic of Enlightenment* (1973) and Jürgen Habermas' *The Structural Transformation of the Public Sphere* (1989) respectively. As Kittler writes in the afterword to *Discourse Networks*:

Meaning as the fundamental concept of hermeneutics and labor as the fundamental concept of the sociology of literature both bypass writing as a channel of information and those institutions, whether schools or universities, that connect books with people. Hermeneutics did not deal with the literal

materiality of the letter, but with works and traditions, because only these were said to be historical and capable of producing history. Contemporary sociology of literature takes the opposite approach and reads texts as reflections of relations of production, whose paradigm is energy or labor rather than information. Steam engines and looms (in Goethe also) became topics, but typewriters did not. (Kittler, 1999: 370)

For Kittler then, both traditional hermeneutics and Marxian media critique were too indebted to an idealised conception of truth as oriented around particular transcendental signifiers (meaning and labour respectively) which obscured the material foundations of discursive production within a given discourse network.

Kittler's critique of these two traditions and his own distancing therefrom were informed by his reading of French post-structuralist theorists. Foremost among these influences was the 'archaeological' methodology established by Michel Foucault in his *Archaeology of Knowledge* (2002) and *The Order of Things* (1989), particularly his theorisation of the *archive*. In *The Archaeology of Knowledge* Foucault defines the archive as that which is "the law of what can be said, the system that governs the appearance of statements as unique events" (2002: 145), or as "that which, at the very root of the statement-event, and in that which embodies it, defines at the outset the system of its enunciability" (2002: 146). That is, the archive defines that which may be considered as coherent and legitimate conditions of thought for particular historical eras, as that which is sayable, as that which constitutes the conditions through which people are able to speak themselves into subjectivity. This notion of the archive is closely linked to what Foucault identified as the *historical a priori*, a term which emphasises the 'givenness' or 'innateness' of the status of the archive within any particular historical period, as that which does not "refer back to an alien development" (2002: 143). The historical a priori then does not draw upon a transcendental historical logic which would be anterior to a given historical situation, but is rather "caught up in the very things that they connect; and if they are not modified with the least of them, they modify them, and are transformed with them into certain decisive thresholds" (2002: 144). Hence, the concept of the archive and the historical a priori in Foucault emphasises a methodological commitment to divining shifts in the way that subjects are

able to constitute themselves and be constituted through changing and historically situated regimes of discourse.

Kittler accepted this anti-transcendental method of analysing the conditions of historical possibility, and the shifts he analyses between the discourse networks of The Republic of Letters, Discourse Network 1800 and Discourse Network 1900 broadly reflect the ruptures in discourse which Foucault himself recognises (Wellberry, 1990: xix). In Kittler's work though the historical *a priori* is transformed into a *technical a priori*, and Foucault's neglect of the technical substrate of the discourses he analyses comes to comprise for Kittler a serious flaw in the archaeological project:

His concept of the archive – synonymous with the library in Foucault's research methods, if not in his theory – designates a historical *a priori* of written sentences. Hence discourse-analytic studies had trouble only with periods whose data-processing methods destroyed the alphabetic storage and transmission monopoly, that old-European basis of power. Foucault's historical research did not progress much beyond 1850. (Kittler, 1990: 369)

Though this is not strictly speaking accurate (consider Foucault's later lectures on the mid-20th century 'birth' of neoliberalism in his *Birth of Biopolitics* lecture series at the Collège de France (Foucault, 2008), or his engagement with the language of information theory and the body's mediation in his 1966 article *Message ou Bruit?* (Message or Noise?) (Foucault, 2001a)), it is true to say that Foucault generally paid little attention to the media technical substrate of the discourses he analysed. While the productive element of Foucault's method was to refuse recourse to the logic of a transcendental motor of history in favour of analysing the precise range of epistemological possibilities which governed the formation of subject positions within a given historical era, the lack of attention to the material substrates of this discourse threatened in Kittler's view to render 'discourse' itself as an unacceptably idealist abstraction. To paraphrase a much used formula employed the Freudo-Marxist philosopher Slavoj Žižek (2006) to describe a critique predicated on 'over-identification', the object here is to 'take Foucault more seriously than Foucault takes

himself', and so to radicalise his historicisation of the conditions by which subjects are formed as objects of knowledge-power.

This critique of Foucault itself can be seen to draw upon both Jacques Derrida's and Jacques Lacan's somewhat disparate theorisations of the materiality of communication. As Wellsbury succinctly explains it:

Writing (or arche-writing) as the condition of possibility of meta-physical conceptuality: this, of course, is a major tenet of Derrida's work. In Lacan, the cognate notion is that our existence is a function of our relation to the signifier. Kittler concretizes this post-structuralist theme by situating his analysis not at the level of writing or the signifier in general, but rather at the level of the historically specific machineries – scriptural and otherwise – that in their various arrangements organize information processing. (1990: xii-xiii)

The appeal and fruitfulness of Kittler's approach to the study of media is situated then in its radical attempt to truly place the materiality of media and mediation at the heart of its analyses. As noted, it is as a theory able to retain, radicalise, and extend the insights of sophisticated post-structuralist critical theory without accepting said theory as an anterior logic guiding the elaboration of the significance of media technology within modernity. Even if Kittler's *Discourse Networks* can be seen to correspond to the shifts between *epistemes* that Foucault discovers, the intent of the Kittlerian method is *not* to merely supplement Foucault's approach by showing how discourse production influenced the production and interpretation of media technologies, but to show how said media technologies themselves condition and produce the possibility of discourse.

Kittler's approach offers a thrilling rebuke to what media philosopher Gilbert Simondon criticised as the tendency within western metaphysics to understand technology in terms of *hylomorphism*, the consideration of objects, and especially technical objects, as merely the result of an imposition of form upon matter. Simondon proposes the term 'ontogenesis', by which being and becoming are understood to happen within the same reality, as a way countering this fallacy (see Simondon, 2009). Although Kittler does not take Simondon as a reference point, their approaches are at least to some degree

commensurate here, and it is for this reason that to label Kittler's approach as 'technologically determinist' (as many critics have done (cf. Winthrop-Young, 2011: 5)) is reductive and liable to mislead if not considered carefully. When Kittler writes that media "determine what can become a discourse", we can understand this in terms close to the also often misunderstood Derridean dictum, that 'there is no outside the text' – this should itself not be understood as some sort of textual determinism, but rather as arguing that we can never find a privileged point beyond a given text from which to objectively and absolutely fix the meaning of said text. Similarly for Kittler, because discourse is constituted within technological media, it is not possible for discourse to exceed the conditions of said media, and this compels us to understand and to describe the limits of media's "technologically possible manipulations". While this is a 'determinism', it does not determine as a kind of *deus ex machina*, as something which might emerge from outside of discourse in order to provide the key to unravelling said discourse, because there never is any such outside. Discourse and technology are bound together, imbricated the one within the other, and in such a manner as to frustrate the possibility of establishing hermeneutic truth in the traditional sense.

Nevertheless, this method is not without its issues. Perhaps most significant is that of causality. Kittler elaborates a complex model of the way that media 'determine', as well as a compelling portrait of the significance in shifts between given discourse networks. But as with his key inspiration Foucault and his archaeological method, the question of why a given discourse network shifts is typically occluded or bracketed or otherwise left unexplained. As Geoffrey Winthrop-Young comments upon the dictum that "media determine our situation":

...this is not much of an explanation; it merely serves to defer the question from one a priori to the next. So media shifts are said to cause epistemic shifts – but what causes the former? Why are there more or less sudden ruptures in media ecologies? What fuels media evolution? (Winthrop-Young, 2002: 843)

Even if we are positioned within a post-hermeneutic frame, sublimating the question of causality runs the risk of letting us fall into a *mise-en-abyme* by which scholarly enquiry devolves into the merely scholastic and fetishistic adumbration of aesthetic values and

technical histories, a pitfall which Kittler's writing comes perilously close to committing at points. As Winthrop-Young goes on, there is however a sort of clandestine causal principle at work within Kittler's account of media, which is a particular reverence for the stressors of warfare as the essential testing ground of a given discourse network's efficacy:

The very terminology employed by Kittler – “the history of communication technologies [is] a series of strategic escalations” – already contains the answer: war. Media evolve because war is both the context and the catalyst that will allow for the launching, perfection, and clashes of storage, communication, and computation technologies. (Winthrop-Young, 2002: 843-844)

As Winthrop-Young subsequently notes, this reliance upon war as the most essential a priori of analysis casts an oddly reductive trans- or ahistorical sheen upon a method supposedly predicated upon the scrupulously historicist, empirical, and positivist approach which characterises the vitality of Kittlerian media studies. Even if there are of course many circumstances where key media technologies have been developed during and for the purposes of war, the case studies examined in this thesis have only a tangential relation to warfare at best (unless one understands all social interactions from a Hobbesian perspective as rooted in an all-consuming and primal war of all against all – an approach which in addition to being ahistorical, moves from a provocative anti-humanism to a reductive misanthropy).

This martial disposition is related to another key criticism of the Kittlerian approach to media studies, which is that its provocative value became tied to a chauvinistic academic culture which, in its quest to exorcise the *Geist* (spirit) from the humanities (*Geistliche Wissenschaften*) (Kittler, 1990), had also thrown out a good deal of the progressive insights gathered through post-structuralist accounts of culture and society. Kittler's followers became known ironically but notoriously as the *Kittlerjugend* (McCarthy, 2011) or the ‘Kittler Boys’, and were noted for their aggressive masculinist posturing and “unpleasantly sectarian vibes” (Graw in Graw, Martin & Rottberg, 2015) (although it is important to note that the *Kittlerjugend* still counted several women among its ranks, and figures such as Cornelia Vismann, Sybille Krämer, and Wendy

Hui Kyong Chung have pursued an approach to media studies heavily influenced by Kittler's approach). Whether or not such an approach is inherently chauvinistic or not, several critiques have raised the point that Kittlerian media studies draws little from and has had little to contribute to questions of the political 'more broadly conceived' – that is to say, with relation to questions of gender, class, or race. Of course for Kittler such an understanding of the political would not in fact be more broadly conceived, but simply more badly abstracted, but this is for our purposes indeed precisely the problem (see Parikka, 2013).

A further issue is the somewhat apocalyptic or even millenarian aspect of Kittler's historiography. For Kittler, all media essentially culminated and realised themselves in the universal machine of Turing and the subsequent obsolescence of analogue media channels in the process of their digitalisation, such that "The general digitization of channels and information erases the differences among individual media. Sound and image, voice and text are reduced to surface effects, known to consumers as interface. Sense and the senses turn into eyewash. Their media-produced glamour will survive for an interim as a by-product of strategic programs" (Kittler, 1999: 1). As Bernard Dionysius Geoghegan comments, such an account of media technologies leaves little to describe or analyse after the digital turn of the 1980s:

The problem with end of history arguments is they don't leave you with much to talk about once history has come and gone. For all their apocalyptic poetry about Alan Turing's universal machine and Claude Shannon's schematic account of communication, Kittler and his most fervent disciples never had much to say about media after the mid-1980s, when personal computers became a common presence in the domestic home. This seems decidedly unfitting for a theorist eulogized as 'the Derrida of the digital age' (Jeffries, 2011). (Geoghegan, 2013: 68)

Kittler's critique of Foucault, that he never had much to say after the transition to electrical storage media in the 19th century, comes to be redeployed against himself – he was never able to comment innovatively upon our media situation after the fact of its digitalisation. If we are to understand the technical capacity of the archive as

constituting a given culture's 'situation', and if this capacity has now reached a certain universalising level beyond which technical *différance* itself becomes essentially obsolete, then it is unclear what there is left to say about said situation, or even how it is possible to say anything about it. Kittler's provocative methodology seems to at once excavate fascinating new possibilities for media analysis at the same time as it produces a solipsistic and hermetic framing by which said analysis would be henceforth redundant. And yet, it seems quite evident, from our contemporary vantage point, that history did not end in the mid 80s, or with the end of the Cold War for that matter. The question of how to do media theory after digitalisation and after the non-end of history thus presents itself.

THE 'OPERATIVE ONTOLOGIES' OF CULTURAL TECHNIQUES

Cultural Techniques theory (*Kulturtechniken*) has emerged as a means by which to extend the Kittlerian materialist approach to the study of media history while also addressing the defects noted above, particularly its tendency towards a hermetic formalism which would impair the ability of media studies to engage with questions of the political and the question of causality. Key theorists in the Cultural Techniques school have included Bernhard Siegert (2007; 2011; 2012; 2013; 2015; 2017; 2018, see also Siegert, 1999), Thomas Macho (2013), Sybille Krämer (2006; 2017), Horst Bredekamp (Krämer & Bredekamp, 2013), Markus Krajewski (2010; 2012; 2013; 2018), and Cornelia Vismann (2013) in the German academic context, while important contributions from outside the German academy have been provided by scholars such as Jussi Parikka (2013; 2014), Geoffrey Winthrop-Young (2013; 2014; 2017; Winthrop-Young & Siegert, 2015), Bernard Dionysius Geoghegan (2013; 2014, see also Geoghegan, 2015), and Liam Cole Young (2015; 2018).

The foremost theoreticians of Cultural Techniques theory have been students of Kittler, and the theory does not reject his approach in any substantive sense. Rather, Cultural Techniques theory can be seen to retain the influence of Kittler's materialist approach (and his own discussion of cultural techniques) while shifting the emphasis in its methodological orientation in several key respects. Of these the most significant for the

purposes of this thesis can be summarised as a move from the question of the *ontological* import of media-technological shifts towards an examination of the *ontic* processes by which ontological distinctions are produced, sustained, and transformed, and a concomitant shift from the *archaeological* approach of the early Foucault towards one premised upon his later *genealogical* method.

Almost all discussions of cultural techniques include mention of Thomas Macho's now classic definition of the term, and this chapter will be no exception:

Cultural techniques cannot be practiced without media, but they cannot simply be reduced to media technologies either. Even if it is unclear which cultural technique should be considered the first, it is safe to argue that cultural techniques are always already older than their media and that they are certainly older than the terms which emerged from them. People wrote long before any notions of writing or the alphabet were conceived; pictures and statues did not inspire the idea of a picture until thousands of years later; to date, some people still sing and make music without any conception of tone or a system of notes. Counting, too, is older than numbers. Most known cultures did, no doubt, count or perform certain mathematical operations, but they did not necessarily derive the notion of a number from such operations. (Macho, 2013: 44-45)

Macho's definition highlights several key aspects pertaining to the definition of cultural techniques as object of study and as a methodology. Cultural techniques pertain to the manipulation, configuration, and extension of media technological objects, but are not themselves reducible to or contained within said objects. Cultural techniques are characterised by something similar to the Freudian notion of 'afterwardsness' (see Caruth & Laplanche, 2001) – that is to say, they are developed and performed before they are conceptualised as a coherent 'technology' as such, and their significance as media are only recognised after the fact. For Macho, it is this recursive quality which distinguishes cultural techniques from other kinds of techniques and technologies – their capacity to symbolise themselves is the key factor contingent upon our recognition of them as such:

Cultural techniques differ from all other techniques through their potential self-referentiality, a pragmatics of recursion. From their very beginnings, speaking can be spoken about and communication be communicated. We can produce paintings that depict paintings or painters; films often feature other films. One can only calculate and measure with reference to calculation and measurement. And one can of course write about writing, sing about singing, and read about reading. On the other hand, it is impossible to thematize fire while making a fire, just as it is impossible to thematize field tilling while tilling a field, cooking while cooking, and hunting while hunting. We may talk about recipes or hunting practices, represent a fire in pictorial or dramatic form, or sketch a new building, but in order to do so we need to avail ourselves of the techniques of symbolic work, which is to say, we are not making a fire, hunting, cooking, or building at that very moment. Using a phrase coming out of systems theory, we could say that cultural techniques are *second-order techniques*. (Macho, 2013: 31)

The significance of the distinction between first and second order techniques has however been disputed by fellow Cultural Techniques theorist Bernhard Siegert. Siegert argues that any such distinction is ultimately untenable:

It is no doubt very tempting to follow a proposal of such alluring simplicity, but unfortunately it suffers from an overly reductive notion of the symbolic in combination with a too static distinction between first- and second-order techniques. Granted, you cannot thematize the making of fire while making fire, but this certainly does not apply to cooking, at least not if you pay heed to Claude Lévi-Strauss's structuralist analysis. (Siegert, 2013: 59)

As Siegert goes on then, cultural techniques need to be understood as constituting ontic chains of practices which reflexively and recursively combine with each other to produce the means by which technological assemblages are produced. To cook is always to cook about cooking, in the sense that all cooking techniques are adapted *from* and result in the adaption *of* prior cooking techniques, and the same can be said about essentially any practice related to (media) technological processes. It is the study of these practices, of the way they are constituted and reconstituted, which is essentially the object of Cultural Techniques analysis.

This is a somewhat broad definition of the term and the project, and indeed Cultural Techniques as an approach and an object of study is to some degree defined and invigorated by its openness, or as Geoghegan puts it, “the absence of a rigorous consensus about the scope and purview of *Kulturtechnik* speaks, in a sense, to its conceptual fertility” (2013: 67). Cultural Techniques theory can be understood more readily as a certain tendency or disposition towards analysing the practices which surround and produce media technologies, rather than as a ‘method’ defined in strictly prescriptivist terms. The disagreement between Macho and Siegert underscores the degree to which serious conceptual distinctions can still be to some degree subsumed within the Cultural Techniques approach to media theory. Having noted this, my own interpretation of the Cultural Techniques approach is most strongly influenced by the work of Siegert, who is the theoretician whose work has been most translated and influential in the English-language academy. His most ‘programmatic’ definition of cultural techniques, at least in English translation, can be found in his 2013 article *Cultural Techniques: Or the End of the Intellectual Postwar Era in German Media Theory*, where he outlines several key theses for the field.

The most significant is the aforementioned argument drawn from Macho, that “cultural techniques are conceived as operative chains that precede the media concepts they generate” (Siegert, 2013: 58), hence that counting precedes number, singing precedes music, and so on. The significance of this argument is not merely that it helps us to clarify the diachronic development of a given set of cultural practices. Rather the significance lies in that this is an inversion of how causal relationships between people and technology are generally understood. As Geoffrey Winthrop-Young notes, citing Siegert (in a commentary subsequently quoted approvingly by Siegert (see Siegert, 2017)):

the term [cultural techniques] refers to operations that coalesce into entities that are subsequently viewed as the agents or sources running these operations...[P]rocedural chains and connecting techniques give rise to notions and objects that are then endowed with essentialized identities. Underneath our ontological distinctions are constitutive, media-dependent ontic operations that

need to be teased out by means of a deconstructive maneuver able to disentangle acts, series, techniques, and technologies. As Siegert writes: “The concept of cultural techniques clearly and unequivocally repudiates the ontology of philosophical concepts. Humans as such do not exist independently of cultural techniques of hominization, time as such does not exist independently of cultural techniques of time measurement, and space as such does not exist independently of cultural techniques of spatial control” (Siegert 2013: 56-57; emphasis in original). To rephrase it in a more philosophical vein (and at the risk of conjuring up a name that frequently induces flight behavior): the study of cultural techniques continues, in a technologically more informed fashion, a philosophical line of ontic-ontological questioning opened up by Martin Heidegger. If German media theory in the Kittlerian vein focused on the materialities of communication, the study of cultural techniques takes aim at the materialities of ontologization. (Winthrop-Young, 2014: 387)

The reading of Heidegger here is crucial. The later Heidegger’s work, as far as it relates to media technology, is often regarded as being ‘technophobic’ (see for example Latour, 1993: 65; Fuchs, 2015). Heidegger’s most famous consideration of the significance of technology in modernity is his essay on *The Question Concerning Technology* (1977), in which he argues that modern technology has served to ‘enframe’ being as ‘standing reserve’ - that is, to reduce the potentialities of being to that which is merely required of technology. The famous example given by Heidegger is the enframing effect of a hydroelectric power plant attached to the river Rhine – where we might have once been able, as Hölderlin was, to consider the Rhine in terms of its surging poetic force, as a letting forth of that which is beyond the conditions of our everyday lives, now it is merely framed as a water power supplier, ‘at our command’, dammed up and deprived of its mystical power. For Heidegger this is indeed a lamentable state of affairs, “For man becomes truly free only insofar as he belongs to the realm of destining and so becomes one who listens and hears [*Horender*], and not one who is simply constrained to obey [*Horiger*]” (Heidegger, 1977: 25). For Heidegger then, modern technology is a danger because it has served to limit our freedom to explore an authentic unveiling of the nature of Being, and instead compels us towards mere ‘obedience’ to the enframing dictates compelled by technology.

The Question has been a foundational text for the pessimistic critique of modern technology. It is intriguing to note then that Kittler, whose work is if not precisely *technophilic* then certainly dedicated to undermining a technophobic reading of culture, positioned his own work as fundamentally in agreement with Heidegger's approach. In his own commentary on *The Question*, Kittler notes the catastrophic elements of Heidegger's argument, but notes too that:

[Heidegger points] out that technology is not a mere means 'but a mode of revealing' That means in practical terms that 'the energy concealed in nature is unlocked, what is unlocked is transformed, what is transformed is stored up, what is stored up is distributed, and what is distributed is switched about ever anew' At which point, Heidegger, as if he had just invented the closed circuit, concludes that 'unlocking, transforming, storing, distributing, and switching are ways of revealing' What Wiener called Shannon's madness must have been precisely this discovery. (Kittler, 2006: 49)

Characteristically, Kittler assimilates the shift Heidegger identifies to a particular media-technological apparatus, the mathematical model of communication conceptualised by Claude Shannon (1948), by which communication is understood not according to any intelligibly human principle, but instead in cybernetic terms as stochastic patterns of information and noise to be coded and decoded in any number of configurations by the communicative apparatus. For Kittler this is not the catastrophe that it is for Heidegger – it is simply further evidence of the need to conceive of a humanities which has had its 'human' element exorcised. Indeed, Kittler would go on to argue that it is only with Heidegger's analysis that the possibility of conceptualising the relation between media and ontology becomes philosophically possible (2015). However, we can point to this reading of Heidegger by Kittler as an element of the ossifying tendency of his method. For Heidegger, the significance of recognising that technology is itself a 'mode of revealing' was that it might compel us to recognise the danger of technology itself, and to recover a more authentic mode of Being. For Kittler there is no evident possibility of or desire for 'liberation' from the media-technological apparatus – his reading of Heidegger is simply another (very brilliant and

counterintuitive) way of describing the death of man, and is sufficient in itself as methodological principle. But as is already noted, this leaves us with nothing very much to say once this shift has been recognised, except to endlessly adumbrate the poetics of our information apocalypse.

For Cultural Techniques theory, it is not the *ontological* status of our relation to the media-technological apparatus which is of interest *per se*, but rather the question of how certain *ontic* practices coalesce into what has been termed ‘operative ontologies’. This is a reinterpretation of the significance of Heidegger’s argument and a refocussing of terminologies. Where ontology concerns questions of the nature of Being in and of itself, Heidegger uses the term *ontic* to refer to the ‘mere’ factual qualities of our existence, those everyday physical elements which we might in common sense or positivist terms regard as ‘real’. There is a remarkable passage in *The Question* wherein Heidegger notes the distinction between the historical/ontic and the essential/ontological development of modern technology and technoscience:

Chronologically speaking, modern physical science begins in the seventeenth century. In contrast, machine-power technology develops only in the second half of the eighteenth century. But modern technology, which for chronological reckoning is the later, is, from the point of view of the essence holding sway within it, the historically earlier... Because the essence of modern technology lies in Enframing, modern technology must employ exact physical science. Through its so doing, the deceptive illusion arises that modern technology is applied physical science. This illusion can maintain itself only so long as neither the essential origin of modern science nor indeed the essence of modern technology is adequately found out through questioning. (1977: 22-23)

That is, where Heidegger argues that modern technology would appear in chronological, common sense, ontic terms as “applied physical science”, it is in fact the case that it is Enframing as an essence which “holds sway” at all stages of this development, and which is the key factor in determining our ontological relation to modern technology.

Kittler does not discuss this passage in his essay, but we can understand it as foregrounding a key distinction for our purposes in terms of distinguishing the

Kittlerian from the ‘Siegerian’ Cultural Techniques approach. For Cultural Techniques theory, the mission to banish ‘Spirit’ from the humanities must remain paramount. However, the methodological question here is not merely to demonstrate the materialities of our ‘Enframing’, but to analyse how it is that something like ‘Enframing’ can emerge as something which appears to have such a determining, essential, effect. To be absolutely clear, there can be no question of endorsing a phenomenological essence as ‘holding sway’ prior to its instantiation in a given apparatus – Cultural Techniques as a methodology, or at the very least my own understanding and deployment of such, is not oriented according to such a mode of belief. As Winthrop-Young has it, “the term [cultural techniques] refers to operations that coalesce into entities that are subsequently viewed as the agents or sources running these operations... procedural chains and connecting techniques give rise to notions and objects that are then endowed with essentialized identities” (2014: 387). The question is to analyse, to deconstruct, to understand these chains of ontic operations, and how it is that they give rise to a notion of ontological essence. Heidegger’s formulation is illuminating for our purposes, not because it corrects a common misinterpretation of the ‘meaning’ of technology, but in fact constitutes a very brilliant exposition of a common error. ‘Enframing’ is only one example of an essence which is often understood to ‘hold sway’ – for the purposes of this thesis, other key ‘essences’ to be deconstructed include the notion of health, of production and productivity, and of home. There is no essence to health, to production, to home, which precedes their technical instantiation. There are only chains of operations which become understood *only in retrospect* to have been predetermined. Cultural Techniques demonstrates how this is not so, it troubles such distinctions, and hence suggests how things might be otherwise.

The other crucial shift characteristic of Cultural Techniques theory is a move from emphasising the *archaeological* element of Foucault’s methodology to that of the *genealogical*. It is in this respect especially that the Cultural Techniques school of German Media Theory is distinguished from the arguably more prominent (at least in the Anglo-Australo-American academy) school of ‘Media Archaeology’, typified by the research of Wolfgang Ernst (2013), but also including under its aegis such academics as Erkki Huhtamo (2011; 2013), Jussi Parikka (2007; 2011; 2012; see also Huhtamo & Parikka, 2011) (though Parikka has as noted also engaged significantly with the

Cultural Techniques approach), and Siegfried Zielinski (2006). Ernst's 'media archaeology' has furthered Kittler's radicalisation of the Foucauldian archive, however with a particular phenomenological emphasis upon what he terms the 'time-criticality' of digital media, which transform the archive from a site in which memory is fixed spatially to one which requires constant reiteration within the computational processes of digital machines (Parikka, 2011: 59) entailing a different "rhythm of historical memory" (Ernst & Lovink, 2003: web). There is not space here to discuss Media Archaeology at length – suffice to say that its emphasis upon understanding the nature of phenomenological mediatic presence is anterior to our own methodological concerns.

Instead, I draw attention to the productive contribution of genealogy. Where archaeology as a method served to identify the enunciative conditions of a given historical epistme, Foucault defines the significance of genealogy as a methodology which seeks to uncover historical shifts and ruptures without seeking to trace these changes back to any unifying historical source or essentialising logic. In his *Nietzsche, Genealogy, History*, Foucault defines the approach thus:

The purpose of history, guided by genealogy, is not to discover the roots of our identity, but to commit itself to its dissipation. It does not seek to define our unique threshold of emergence, the homeland to which metaphysicians promise a return; it seeks to make visible all of those discontinuities that cross us. (1984: 95)

Alexander Monea and Jeremy Packer (2016) have argued for the importance of a genealogical approach to materialist media theory as a way of extending the purchase of media theory upon contemporary issues of media power. They follow Colin Koopman (2013) in arguing that the thread connecting Foucault's archaeological and genealogical approaches is the technique of 'problematization' – problems in this context being understood as "[emerging] when a field of action, behavior, or practice becomes uncertain and unfamiliar or is set upon by difficulties imposed by (often non-discursive) elements surrounding it (e.g., social, economic, or political processes)" (Monea & Packer, 2016: 3145). Monea and Packer go on to specify how this problematization has different effects and significances, when conceived as subject to a genealogical rather than an archaeological imperative:

In the realm of media studies and media history, the problematization approach has the capacity to not only (archaeologically) articulate the specific affordances and constraints of a technical media apparatus' functions of capture, processing, storage, and transmission but (genealogically) articulate the clashes of power that resulted as multiple technologies were (counter)posed as potential solutions within a problematic field, and thus trace the emergence of a stabilized (socio)technical apparatus. (2016: 3145-3146)

By supplementing Kittler's radicalisation of Foucault's archaeological method through this articulation of a 'media genealogical' approach, it would be possible to open our analysis to the difficulties of articulating the movement of power relations as they coalesce and disperse within a given media apparatus. Though Siegert himself does not explicitly position Cultural Techniques in this way, it is easy to see already how the understanding of Cultural Techniques embraces this 'problematizing' approach to studying the history of the present. Cultural Techniques takes as its starting assumption an understanding of history as a kind of 'problematized becoming' – ideas, technologies, ways of being in the world, do not ever arrive fully, come to present or presence themselves for our benefit and appreciation. Instead, what we understand as media emerge as a kind of deviation from a given set of prior cultural techniques which subsequently 'harden into truth' (see Foucault, 1978: 79) before being challenged and dispersed by the emergence of new circumstances, new pressures, new problematizations. In this way then, the student of cultural techniques, just like Foucault's genealogist "refuses to extend his faith in metaphysics, if he listens to history, he finds that there is 'something altogether different' behind things: not a timeless and essential secret, but the secret that they have no essence or that their essence was fabricated in a piecemeal fashion from alien forms" (Foucault, 1984: 78).

A further important aspect of the genealogical approach emphasised by Foucault is an insistence on considering the body as a key vector for understanding the descent and transformation of knowledge practices across time. According to Foucault:

...descent attaches itself to the body...The body manifests the stigmata of past experience and also gives rise to desires, failings, and errors. These elements may join in a body where they achieve a sudden expression, but as often, their

encounter is an engagement in which they efface each other, where the body becomes the pretext of their insurmountable conflict. (Foucault, 1984: 82-83)

The body for Foucault then takes on a significant interpretative position not because it provides a stable referent by which to contextualise otherwise confounding historical events, but rather because it is in the attempt to write upon the body that practices of knowledge formation are often revealed as contingent and mutable, rather than essential or transhistorical. This perspective provides a useful corrective to the Kittlerian or Media Archaeological approach to studying media, which has tended towards the ‘somatophobic’ (see Flaig, 2018: 107) in its elision of the difficult question of thinking through the place of embodied difference as it relates to the media technological apparatus. As noted above, for Kittler the digitalisation of media especially would appear to render the question of the body entirely moot, mere ‘eyewash’ which persists for the time being as an artefact of the interface, but without any meaningful epistemological or (post-) hermeneutic significance (Kittler, 1999: 1). In line with the genealogical approach, the point here is not to ‘return’ to the body in order to find within it some sort of ‘unifying’ interpretative key, nor to celebrate the place of the body as a humanist riposte to the challenge of thinking mediation as the predicate of discursive production. Rather, the question is how best to understand the body as a correlate of the media technological apparatus – a challenge which is of course especially urgent in the analysis of biosensors, which take the body as the ‘object’ of their analysis (even if the relation between subject and object is itself problematized within the Cultural Techniques framework).

The key term of my thesis, ‘somaletheia’, refers to an idea that the ‘truth’ of the vital body might be brought to our understanding, our analysis, and our control, through the use of biosensor-technologies. However, somaletheia does not *precede* the cultural technologies of the sensor technologies which I will analyse in the following chapters however – it is the cultural techniques of the sensor society which produce somaletheia, and not the other way round. The many claims made for the efficacy and veracity of sensor technologies have been produced *through* the complex and intertwined histories of technical development and interpretation of sensor technologies and sensor data. There has been a significant amount of recent research on the relation between data, the measurement of bodies, and sensor technologies – this will be reviewed in the following

chapter of my thesis. However much of this has lacked a (historical) materialist foundation, and has emerged from what is more properly a sociological or medical humanities approach, rather than a media-theoretical one. The drawbacks of such approaches are that they tend to take certain essential (ontological) understandings of the human, of home, etc., as being *given* prior to the introduction of sensor technologies, positioned as a sort of benchmark from which to evaluate the ‘impact’ of such technologies.

To take one example which I discuss in my chapter on health, a common critique of modern medicine is that the ‘embodied’ affective element of clinical practice has been lost in the wake of the introduction of modern technologies and quantitative understandings of the body into the clinic. A Cultural Techniques approach draws attention to the fact that it is not the case that such an element is lost, but rather *produced* through this technical relation. It is incoherent to speak of an affective, human relation to the sick body as opposed to a technical, inhuman one, in the absence of said technical mediation. A close reading of early clinicians’ response to the introduction of the sphygmograph demonstrates not an overturning or sublimation of ‘hands on’ techniques of pulse measurement in favour of the new and purportedly more ‘objective’ measurements of the device, but instead a complex and ambivalent *sensualisation* of the technology. Established cultural techniques of pulse palpation became reconstituted and recalibrated through the media-technological relation, in a way which alters but does not abolish the status of the clinician as an embodied and tactile ‘knower’ of the sick body. We can in turn trace how in the contemporary sensor society this embodied knowledge remains pertinent, as the clinician is called upon to verify and/or correct the networked errors endemic to sensor technology measurement and data analysis.

The importance of this analysis is again *not* to formulate an argument regarding the death of man or the incoherence of the ‘human’ as an ontological category. It is not to argue for the need to adopt a ‘post-human’ approach to these matters – this would be simply another ontological category which may or may not prove more felicitous than prior conceptions. The methodological importance of this investigation is simply to demonstrate that if we begin our analysis through these “procedural chains and connecting techniques” we can avoid the error of essentialising and ontologising categories which such investigation demonstrates to be historically and theoretically

contingent, as opposed to providing a stable evaluative matrix. This in turn offers us new possibilities for understanding the complex processes of mediation that have produced the dominant categories which are used to order and organise the world in the age of the sensor-society. To quote Peter Krapp in his neat summation of Kittler's legacy, "Simply put, media studies is the introduction of the question of technology into the humanities" (2011: 24). This thesis takes up the challenge of attempting to begin *not* from the ontological distinctions which are characteristic of the sensor society, but from the complex and irreducible mediatic relations which give rise to them. The limitations of Kittler's method in this respect are confronted by the Cultural Techniques approach, which can further extend media theoretical investigation towards those realms of the political and the cultural against which Kittler may have expressed suspicion, as the province of 'so called man'.

To 'operationalise' this approach, I draw upon the genealogical principle of writing a "history of the present", an orientation by which, in Foucault's words, "I set out from a problem expressed in the terms current today and I try to work out its genealogy. Genealogy means that I begin my analysis from a question posed in the present" (Foucault & Kritzman, 1988: 262). I identify several points of 'problematization' in the present sensor society – in the troubled and troubling use of biosensors in the fields of health, work, and the home. I then proceed to uncover the genealogy by which today's operative ontologies have coalesced. In each chapter of my thesis I demonstrate how the contemporary cultural techniques which have emerged as a way of configuring and interpreting the use of biosensors can be understood genealogically as shifts or mutations in the cultural techniques which emerged around biosensors in the wake of their entrance into the technological field during the mid-19th century. I consult a variety of archival sources, including physicians' reference guides, home security advertising brochures, popular fiction, human relations treatises, and product manuals, in order to divine shifts in the means by which biosensors have been used and understood. In the following chapter I set out my interpretative framing by considering how scholarship on biosensors can itself be understood as emerging through the 'problematizing' impetus of the Quantified Self movement.

CHAPTER TWO

THE QUANTIFIED SELF AS *PROBLEM OF* AND AS *PROBLEMATIZING* THE CULTURAL TECHNIQUES OF THE SENSOR SOCIETY

This chapter shall consider current critical paradigms for examining and evaluating what I am calling the cultural techniques of the sensor society. This critical evaluation has been, I will argue, prompted and shaped by the emergence of the Quantified Self movement. This movement, which had its origins in the late 2000s, and rose to prominence in the early years of the 2010s, constituted a semi-formalised ideology promoting the benefits of a kind of hermeneutics of the self which would incorporate the use of biosensing technologies. The movement gave rise to a wide international network of Quantified Self meet-up groups and annual international conferences. The Quantified Self movement constituted a form of praxis – the most prominent proponents of the aims and ideas of the Quantified Self movement being the technology journalists Larry Smarr and Gary Wolf, whose 2010 *New York Times* article *The Data Driven Life* may be considered as a kind of manifesto for the movement.

This thesis is not a critique of the Quantified Self movement *per se*. Practices of biosensing have moved beyond the orbit of the Quantified Self – although the movement still exists, recent studies have indicated that many users of self-tracking technologies or apps often tire quickly of the kind of self-study which is promoted by the Quantified Self movement (see Lomborg et al, 2018). Although the movement continues to organise international conferences and workshops, it does not appear to have become widely taken up beyond a relatively small circle of followers. The Quantified Self then is not of interest as representative of a general shift in practices pertaining to biosensing and body measurement. Rather, the Quantified Self movement is of interest insofar as it can be seen as prompting the kind of *problematization* described in the previous chapter. That it is to say, it is indicative of a general difficulty or uncertainty in the meaning of biosensing, of what it means to measure the body through sensor technologies, of what significance we might give to such measurements

and their interpretation, which had become acute enough in the late 2000s to become articulable in the form of a kind of iterative and semi-vernacular critical analysis, one which threw into question the very meaning of the body and of measurement itself. While this analysis and practice cannot be considered wholly successful in its own right, the questions the Quantified Self movement has prompted have served to encourage media scholars to reassess and ascertain the meaning and significance of practices of biosensing and technological measurement in the era of the sensor society.

The Quantified Self movement itself would publish their speculations and findings in popular outlets, such as the *New York Times* or *Wired Magazine*, with which both Smarr and Wolf were closely associated, as well as on blogs and the official website of the movement <quantifiedself.com>. The discourse of what I shall call here the ‘Practitioner Ideologists’ can be characterised as broadly positivistic, techno-optimistic, and nominalist in its ontology, and yet at the same time interested in a self-reflexive account of the means by which the tools of technical measurement constitute the meaning of the measured object. The Quantified Self movement in turn was subject to a popular backlash, typified in Evgeny Morozov’s polemic against ‘Solutionism’ (2013), which pursued a sort of vulgar-Nietzschean critique of the movement as a ‘data fetishist’ account of reality, one which served to enshrine a reductionist logic to the enfolding and management of all aspects of life.

In the academic literature we can identify, I argue, four more or less distinct modes of ‘response’ to this initial discursive moment: I will describe these here as the ‘Resistant’, ‘Foucaultian’, ‘Assemblages’ and ‘Aporetic’ modes. The first two can be considered as ‘early’ responses, and approached the question of biosensing largely in terms defined through the problematization of sensor measurement by the Quantified Self. On the one hand, several scholars interpreted the Quantified Self as a form of immanent resistance and critical praxis within a technological milieu increasingly defined by big data analytics and proliferating surveillance technologies. Meanwhile, the ‘early’ critique of the Quantified Self tended to consider the movement from a particular Foucauldian perspective, as exemplary of neoliberal discourses of self-management. Later, as scholarship developed, elements of biosensing which had not been explicitly considered by the Quantified Self movement came to be considered. One strand of this thinking,

informed especially by New Materialist and Actor Network Theory, came to emphasise the complexity, hybridity, and vitality of the assemblages produced through the use of sensing technologies. Such analyses suggested that the use of sensor technologies might go beyond the hermeneutics of the self envisaged by the Quantified Self movement, and instead serve to trouble the boundaries of the self and give a richer sense of the interaction between human and non-human actors and agents. A further strand, perhaps more marginal, contested this account by pointing to the difficulties posed in sensor measurement – the incompleteness and capacity for error that had become apparent in the widespread use of sensor enabled technologies. This approach suggested that this element of indeterminacy served to trouble the status of the trace produced through sensing technology, complicating biosensors’ status either as tools for pursuing a project of self-discovery, or indeed of the more complex analytics and connections proposed by some scholars.

The purpose of this chapter is to situate this thesis’ interventions within the broader study of biosensing and the sensor society. This literature has (with some exceptions) been relatively ‘presentist’ in its approach – that is, it has understood the Quantified Self and sensor epistemologies or heuristics or hermeneutics as an essentially novel development. This can to a large degree, I believe, be attributed to the way that the Academy has approached the field as a reaction to the advent of the Quantified Self, which has typically sought to portray itself within just this understanding of historical time. That is, the Quantified Self has sought to represent itself as a radical break with older traditions of (self) knowledge (such as the ‘literary’ model of psychoanalysis), as well as with older models of technical measurement (such as the ‘too rigid’ Taylorist model of human biological capacity). To the extent that biosensing is understood as developing from a broader historical context, this is typically understood as being usefully limited to the post-war turn towards the ‘biomedicalisation’ of everyday life, and the digital computing revolution of the 1980s onwards. Reference is often made to isolated ‘pre-digital’ historical figures such as Benjamin Franklin and his famous ‘book of virtues’, as an example of a general tendency towards self-evaluation and measurement which have in turn been ‘remediated’ through recent technological innovations (see for example Nafus, 2016).

By contrast, this thesis draws on the Cultural Techniques methodology outlined in the previous chapter in order to deepen and extend existing scholarship in two key ways. The first is to counter the presentist discourse of the Quantified Self movement by pointing to the deeper historical residues and continuities of the sensor society. While acknowledging the significance of digitalisation and biomedicalisation, I argue that biosensing can be understood as a coherent set of cultural techniques from at least the mid-19th century, with such key innovations as the sphygmograph and its associated interpretative techniques emerging in this period. It was also during roughly this period that statistics and quantification emerged as key tools of governmentality and social control. Secondly, I seek to build upon existing interpretations of the cultural significance of sensor measurement techniques by in effect synthesising what I have identified as the ‘Foucauldian’ and ‘Aporetic’ schools of interpretation. I argue that the cultural techniques of biosensing can be understood to constitute an important means by which subjects are tracked and controlled under broader regimes of governmentality. At the same time, the status of the trace produced through biosensing technologies is often contested, ambiguous, and error-stricken. These two modes of understanding biosensing practices are mutually reinforcing. The fluidity and ambiguity of biosensing technologies afford an emergent and dynamic mode of measurement and evaluation, while also necessitating complex modes of knowledge to authorise and validate the status of the data thus produced. The unveiling/displacement of the measured body which I describe using the term ‘somaetheia’ is the key cultural technique which sustains this irresolvable tension and the productive nature of this technical arrangement as a means for managing the body. While the digital revolution is sometimes described as having ‘intensified’ existing means for disciplining and managing bodies, I argue that this intensification must also be understood as an intensification of this aporetic or interpretative gap. It is for this reason that the hermeneutic proposed by the Quantified Self and its supporters is insufficient as a means for understanding the ‘meaning’ of the lived body within the current technological milieu.

THE QUANTIFIED SELF AND ITS CRITICS

The Quantified Self movement was founded in 2007 by Gary Wolf and Kevin Kelly, two initiates of *Wired* magazine (Kelly's official biography lists his occupation as 'Senior Maverick' at the publication (Kelly, undated)). According to Wolf, the movement started as series of conversations between the two regarding what they observed as their fellow Bay Area Californians' increasing enthusiasm for self-tracking using mobile sensors and smartphone applications. These conversations in turn led to the development of the 'Quantified Self Show and Tell' sessions, in which participants would present a short lecture showcasing their self-experiments in quantification (Wolf, undated). It was not until 2010 however that Wolf published in the *New York Times* 'The Data Driven Life', a key text outlining the aims and epistemological assumptions of the movement.

The piece constitutes a key text within the movement, defining the breadth of its ideological and intellectual ambition as well as highlighting the limits of its approach. Perhaps the piece's most striking attribute is the ambiguity of Wolf's consideration of the Quantified Self's relation to what he terms 'efficiency', an ambiguity quite lost in, for example, critic Evgeny Morozov's reading of the movement and Wolf as ideologist, to be discussed below (Morozov, 2013). True, the piece begins with a resounding condemnation of the human capacity for 'error' and 'gut feeling': "Humans make errors. We make errors of fact and errors of judgment... Sometimes we can't even answer the simplest questions... These weaknesses put us at a disadvantage. We make decisions with partial information. We are forced to steer by guesswork. We go with our gut" (Wolf, 2010: online). As Wolf continues, this apparently benighted state of ignorance is no longer an inevitability; while "some of us" correspond to the above description, "[o]thers use data" (Wolf, 2010: online). Wolf is certainly full of praise for those of his associates who have used data variously to moderate their alcohol and caffeine intake, to gauge their aerobic output, to track their intellectual performance over time and in different circumstances, and so on. But he is also at pains to reject a Neo-Taylorist reading of the Quantified Self, noting that "[p]eople are not assembly lines. We cannot be tuned to a known standard, because a universal standard for human experience does not exist" (Wolf, 2010: online). What Wolf wishes to argue then, is not that we ought to be using self-tracking technologies to reach some ideal state of physiological and mental efficiency, but rather that we use data as a means to greater

self-knowledge and self-reflection; “Behind the allure of the quantified self”, Wolf argues, “is a guess that many of our problems come from simply lacking the instruments to understand who we are” (2010: online). Wolf offers the striking insight that whereas previous attempts to better understand the self, in particular Freud’s positing of “new psychoanalytic concepts of repression and the unconscious” grew out of his and his followers’ “love of language” and were animated by a spirit of “literary humanism”, new technologies provide new means with which to question the meaning of being: “Trackers are exploring an alternate route. Instead of interrogating their inner worlds through talking and writing, they are using numbers. They are constructing a quantified self” (Wolf, 2010: online).

For Wolf and the Quantified Self, the individual as constituted within ‘n=1’ experiments is paramount, it is this figure which is arrayed *against* broader societal institutions, particularly medical institutions. Wolf cites the example of Bo Adler, who became alarmed at the prospect of medical intervention after being diagnosed with sleep apnoea:

“Here’s what they told me was the normal surgical course of treatment,” Adler explained. “First they were going to cut out my tonsils, and if that didn’t work, they would break my jaw and reset it to reposition my tongue, and finally they would cut out the roof of my mouth. I had one question: What if my case is different? They said, ‘Let’s try the standard course of treatment first, and if that doesn’t work, then we’ll know your case is different.’” (Wolf, 2010: online)

The appalling fact, Adler grasped, was that “doctors had no cure for different” (Wolf, 2010: online). Rather than accede to what appeared a horrible Procrustean fate, Adler proceeded to self-quantify using a “blood pressure cuff, oximeter and accelerometer”, in order to determine if he really did fit the ‘standard’ case; perhaps it would turn out that his difficulty sleeping was due instead to too many caffeinated beverages before bedtime. Wolf does not mention it, but ‘unfortunately’ for Adler it turned out that he did in fact constitute just such a standard; his condition improved considerably after surgery to correct a deviated septum (Adler, 2010: 2). A more ‘successful’ and celebrated challenge to medical convention is that of Larry Smarr (cf. Smarr, 2011; Smarr, 2012;

Bowden, 2012), who through an intense regimen of self-quantification, including fortnightly chemical analyses of his own stool samples, was able to diagnose himself with the inflammatory bowel disease Crohn's disease, long before it started manifesting typical physiological symptoms. Smarr has advocated for a "digital revolution in health care", by which we would "become personally responsible for monitoring our bodies, noticing deviations from trends, and making appropriate changes. Use of this paradigm will allow us to avoid many of today's chronic disease states. In coming decades, the new model will be 'maintenance of wellness' rather than 'treatment of chronic illness'" (Smarr, 2011: 25). Smarr and Wolf are not alone in advocating for a revolution in the health industry predicated upon encouraging the take up of Quantified Self techniques of self-diagnosis. Walter de Brouwer in 2013 launched the *Scanadu Scout*, a portable electronic device designed to be a "DIY doctor's office, minus the frustration, endless waiting, and lack of empowerment that's often associated with the health care system" (Hernandez, 2013: online).

Although there is a certain sophistication and acknowledgement of ambivalence in Wolf's formulation of the problematic of self-tracking, it is perhaps unsurprising that there has been something of a backlash to the movement in the popular press. Intriguingly, these popular critics would seem to share with the practitioner ideologists a fear of standardisation and control by bureaucratic structures. As Whitney Erin Boesel has noted, the "Quantified Self often stands as proxy for everything we fear about living in a world full of 'data'" (Boesel, 2013). These fears are writ large in perhaps the most well-known of the movement's critics, Evgeny Morozov, whose devotes a chapter of his polemic against the ills of 'Solutionism' to the movement (2013). For Morozov, Quantified Selfers are by and large paranoid, lazy and gullible cryptofascists. If at times he seems to suggest that they should be more pitied than despised, he ultimately seems to conclude that they should be both pitied *and* despised in equal measure. Morozov casts himself as a Nietzschean, following the Nietzsche of the *Gay Science* who complained of the progenitors of modern technologies of quantification like Charles Babbage and Adolphe Quetelet, "do we really want to permit existence to be degraded for us like this—reduced to a mere exercise for a calculator and an indoor diversion for mathematicians? Above all, one should not wish to divest existence of its rich ambiguity..." (Nietzsche, 1974: 335 in Morozov, 2013: 243). Hence, Morozov casts

pity on the Quantified Selfers; he takes it as axiomatic that anyone who tracks the nutritional value of their diet is in imminent danger of losing (or has already lost) the capacity to “derive great sensual pleasure” (Morozov, 2013: 255) from one’s meals, leading to the looming threat of a future in which we “all end up eating liquid paste that meets all the demands of nutritionism but lacks the texture, beauty and aroma of a well-prepared meal” (Morozov, 2013: 256). What the Quantified Selfers gain in terms of maintaining a healthy diet they lose in their capacity for ‘flourishing’. The possibility that one may both be conscious of one’s intake of saturated fats and yet still enjoy one’s meals, or that one may ‘derive great sensual pleasure’ from a healthy lifestyle, is a possibility which Morozov chooses not to broach (cf. Nansen, 2011: 152).

Morozov’s tone of disdain and suspicion are echoed in much of the popular criticism of the movement, though often without the corresponding political engagement. Self-quantification has been described by the *New Republic* in explicitly pathological terms; according to author Alice Gregory, Quantified Selfers are “the kind of people who proudly declare themselves to be ‘on the spectrum’” and a clinical psychologist is quoted to the effect that “[i]t doesn’t really take research for me as an organization or for me as a clinician” to see that dieting apps are exacerbating anorexia, by promoting a sense of guilt and shame when daily calorie targets are not met (Gregory, 2013: online). Similarly, Jonathan Blum has described ‘The Quantified Self delusion’ which self-trackers are indulging in, criticising the scientific credentials of Quantified Self apps and their ‘one size fits all’ specifications and recommendations, which in the words of an interviewee creates “nothing more than the ‘qualified self’” (Blum, 2013: online). Intriguingly, there is a distinction made between a ‘bad’ and a ‘good’ self-quantification which is likely to be shared by the practitioner-ideologists of the Quantified Self. For example, while Gregory’s article decries the ‘bad’ quantification of the calorie counting which dieting apps promote, her clinical psychologists also promote the ‘good’ quantification of ‘mood tracking’; recovering anorexia sufferers are encouraged to log whether they are feeling “joy, guilt, disgust, anxiety” as “part of the recovery process” (Gregory, 2013: online).¹ Similarly, Blum’s article cites a worried physical therapist,

¹ This speaks to the complicated place which quantification holds within anorexia nervosa; while it may very well be a ‘disease of numbers’, its diagnosis and treatment has also become profoundly quantic. As Christopher Till notes, following the discrediting of Freudian

who argues that “[t]he truly dangerous devices are the ones that say no matter what shape, size or fitness level you are, if you use our one-size-fits-all device we’ll tell you how many calories you are burning...and therefore what your next choice of action should be” (Blum, 2013: online). And yet it is precisely this ‘one-size-fits-all’ approach which the Quantified Self’s practitioner ideologists rail against; a slavish obedience to the dictates of number is entirely antithetical to Wolf’s dictate, that “people are not assembly lines” (Wolf, 2010: online). The point here is not to suggest that those who use these apps necessarily do so in a critical and introspective manner. The point rather is to contest and complicate the portrait of the ‘average Quantified Selfer’ which Morozov and other popular critics have sketched out; imagining the movement as populated entirely by stunted, ‘autistic’ (sic) men, *Untermenschen* who cannot deal with the complexity of life ‘as it is lived’, who would prefer to yield interpassively to the authority of number so as to avoid the terrible burden of critical thought. This caricature is in itself wildly reductive and does little to allow for greater critical purchase on the movement. Indeed, as has been noted, the Quantified Self is itself ideologically committed to a nominalist view of reality which eschews precisely the abstractions with which it is charged.

EARLY RESPONSES – RESISTANCE OR NEOLIBERAL SELF-MANAGEMENT?

While Morozov’s critique is reductive and moralistic, it is clear that the Quantified Self movement is of significance as a means of ‘problematizing’ the relation between sensor technologies and (self-) knowledge. Although the work of authors like Wolf and Smarr is not aimed at a ‘rigorous’ theorisation of the social relations conditioned through sensor technologies, the relative success of their organisation speaks to a meaningful

explanations for anorexia in terms of “phantasies of oral impregnation” (Till, 2011: 438), psychologists adopted a theory that anorexia nervosa was constituted through a surfeit of the ‘typically feminine characteristic’ of ‘lack of autonomy’ regarding societal norms around appearance. Accordingly they developed gender scales which quantified the levels of one’s masculinity or femininity, with a too-strong degree of ‘femininity’ considered a risk-factor for the development of anorexia nervosa (Till, 2011: 440).

framing of certain difficulties in the definition of the values and kinds of knowledge produced through biosensors and (self-) tracking practices. In particular, the relative value of the individual within the statistical production of the 'population', and the related question of how the individual is to be figured within the clinical relationship between patient and physician, is made explicit, challenged, and reconstituted through the praxis of the Quantified Self.

It is, I argue, as a response to the Quantified Self's theorisations, that much of the initial academic discourse on biosensors, tracking and quantification was framed.

On the one hand, there were those critics who saw within the movement a form of immanent resistance and creative practice which held the potential for questioning and imagining alternate ways of living with and complicating the place of sensor measurement and big data in our everyday lives. The concern for this school, perhaps most prominently represented initially by Whitney Erin Boesel's frequent reporting at *cybergology.org*, was to document the great plurality and novelty of Quantified Selfers' exercises in self-quantification, as well as the commendably 'self-reflexive' manner in which these exercises were undertaken. While Jonathan Blum's above-cited physical therapist can decry the Quantified Self as really nothing but a 'Qualified Self', it is the 'qualitative' aspect of the movement which the critics celebrate. According to Jenny Davis, "This qualitative component is key in mediating between raw numbers and identity meanings...Self-quantifiers don't just use data to learn about themselves, but rather, use data to construct the stories that they tell themselves about themselves" (2013: online). It is this 'humanist' quality which is seen as to be celebrated, holding out "the possibility that the Quantified Self might preserve the personal context in a world leaning toward Big Data" (Watson, 2013: 32). Thus, the emphasis within this mode of reception may be seen to follow more so Gary Wolf's emphasis upon the use of the Quantified Self to investigate how technologies of quantification are used to constitute ourselves as subjects (without any suggestion that such technologies threaten the notion of the liberal human subject *tout court*), rather than the techno-optimism of Larry Smarr and Walter de Brouwer's brand of positivism and valorisation of the neo-liberal entrepreneurial spirit.

This is not to suggest however, that this mode did not believe that the movement had political valence, even if their claims differed slightly from those of the practitioner ideologists. Boesel has, in an essay otherwise devoted to tempering the more bombastic claims Morozov et al have made about the movement, declared that the Quantified Self constitutes nothing less than “basically the Occupy of science and medicine” (Boesel, 2013: online). For Boesel, while admitting that unlike the Occupy movement, Quantified Selfers were unlikely to ever find themselves “the target of state suppression and police brutality” (Boesel, 2013: online), they were similar in that, like Occupy Wall Street, the Quantified Self “represents a decentralized challenge to traditional authority that is trying to be everything to everyone while still speaking for no one” (Boesel, 2013: online). In a similar vein, Dawn Nafus and Jamie Sherman seized upon the critical, self-reflexive capacities of the movement to argue that it represents the possibility for ‘soft resistance’ to ‘soft-biopower’ (2014). For Nafus and Sherman, the nominalism of the movement was of value insofar as it constituted an attempt to define a new, ‘resistant’ metrology which “does not cohere” with established methods of monitoring and control: “The difference cannot be thought of as a standard deviation from a norm; rather, they are not on the same curve. Their differences are embodied in diverging practices that cannot be meaningfully assembled together using the categories in current circulation” (Nafus & Sherman, 2014: 1791).

Nafus and Sherman’s valorisation was close to that of Smarr, but couched in a critique of medical power which drew heavily upon the early Foucault. Interestingly, at the same time, Nafus and Sherman denied that Foucault’s model could ever account for the challenge to power which the Quantified Self represents:

people like Michael [a member of the Quantified Self] collapse measurer and measured in an analytical hermeneutics not captured in Foucauldian understandings of the disciplined body, where internalized normative standards are determined top down. Here, the self is made subject in the double sense of the word (as both subject of-, and as subject to-), through self-objectification, but this self-objectification lays claim to more far reaching sovereignty than Foucault’s model allows. (Nafus & Sherman, 2014: 1792)

That is, for Nafus and Sherman, the Quantified Self represents a challenge to the imposition of top-down ‘normative standards’, especially regarding the definition of health. In similar terms, Pantzar and Ruckenstein argued that the Quantified Self represented a phenomenon by which “various kinds of practices [were] trickling down the knowledge hierarchy from experts to ordinary people” (2015: 93). Where authoritative and actionable medical advice was previously the forbidding preserve of experts and institutions, Mika Pantzar and Minna Ruckenstein argued that Quantified Self technologies were enabling a more accessible interpretative relation to biodata, presented in a form which empowered ordinary users to take control over the definition and management of their own health. This form of vernacular control may “in turn generate unconventional and transformative ideas of health and well-being” (Pantzar & Ruckenstein, 2015: 106), as the creative fecundity of everyday practice generates a more personalised and idiosyncratic approach to the maintenance of health and wellbeing than would be possible in an institutionalised and generalised setting, such as the medical clinic or hospital.

While Nafus and Sherman argued that the Quantified Self exceeds the disciplinary subject position defined by Foucault, for other thinkers, especially Deborah Lupton, the Quantified Self could be best understood as a new iteration of the injunction towards individualised ‘self-management’ endemic to neoliberal subjectivity (see Lupton, 2013a; 2013b). Lupton’s argument turns on a Foucauldian analysis of the movement which sees it as an example of Foucault’s ‘techniques of the self’ (1988), designed to promote a comforting feeling of self-mastery in an era in which it has become necessary for individuals to accept the burden of high levels of personal autonomy and concomitant risk, as well as providing a salve against the fear of bodily degeneration. For Lupton, the critical attention which Boesl lionises is largely a smokescreen obscuring what the Quantified Selfers are truly interested in, a project pursuing the perfectibility of the human body, or at least the perception that the self can be perfected. Lupton uses the term ‘qualified self’ as a pseudo-epithet to describe the group, in an attempt to draw attention to the way in which it is necessary to consider the movement as a project of self-creation; “Self-tracking is a practice that presents a version of the self and the body that one most wants to achieve. This is the qualitative or interpretive aspect of self-quantification: the ways in which the numbers are interpreted and given

meaning. Here ‘the quantified self’ in effect is ‘the qualified self’” (Lupton, 2013b: 29, see also Whitson, 2013).

Gina Neff (2013) was similarly cautious in her analysis of the budding movement, arguing that the growth in the use of self-tracking technologies had not led and likely would not lead to a ‘power shift’ from health care providers to patients, but would potentially tie patients ever more tightly to the medical establishment, insofar as the masses of data produced by methods of self-quantification must still be interpreted, or at the very least ‘verified’, by medical professionals. As such, rather than constituting anything like a ‘liberation’ from apparatuses of medical authority, one may see this emphasis on self-quantification as constituting part of the trend towards what Robert Aronowitz defines as the ‘convergence of risk and disease’, by which “early diagnosis and aggressive treatment have led to symptom-less and sign-less disease...in which treatments have largely been aimed at altering the disease’s future course” (2009: 417). The development of such a model of medical practice may be seen to emphasise individual responsibility for detecting whether or not one's biological state deviates from particular norms, norms which themselves may be constantly revised by the appropriate medical bodies, and themselves require constant monitoring (Rose, 2001: 40). Hence, rather than ‘liberating’ patients from the grasps of the medical establishment, the emphasis on self-monitoring and ultra-early detection of disease imbricates patients ever more deeply within it, insofar as new methods for managing medical risk mean that one is able to begin undergoing treatment many years earlier than would have otherwise been the case. In addition, once this data is in the hands of the medical establishment, it is potentially subject to the ‘calculation of probabilities’ of medical insurance providers who have the power to decide whether it is cost effective to deal with the illnesses which patients are tasked with discovering within themselves.

What is of interest here is that both of these prominent initial critical reactions to the Quantified Self movement framed its significance in Foucauldian terms informed by the question of the discipline of the subject.² Nafus and Sherman especially acknowledge

² My own analysis is also informed by a Foucauldian perspective, however as I shall discuss below, I argue biosensors are more productively understood through the frame of Foucault’s

the significance of the ‘disciplinary’, following from Foucault’s seminal theorisations in *Discipline and Punish* (1977) on how the subject is formed and controlled through the embodied interiorisation of discursive commands. For Nafus and Sherman, the Quantified Self’s ‘proliferating’ sets of self-measurement practices represent a kind of diversity which cannot be recuperated or controlled according to existing techniques for the normalisation or normation of subjects. Lupton, by contrast, makes a kind of a dialectical counterargument – that the Quantified Self’s creativity is a freedom limited to that of the neoliberal injunction to ‘manage the self’ in an era where the welfare state’s provisions for health care are increasingly stripped away (see Rose, 2007). In each conceptualisation, the Quantified Self is understood in terms either mirroring or inverting their own self-explanations, as a transformation of the self through metrics, or as the avant-garde of a new mutation of the disciplinary project. These early responses were both predicated upon an essentially discursive analysis – the understanding of the movement as either ‘empowering’ or as a new mode of internalised control derived from a close, critical reading of the movement’s self-description and legitimisation.

BEYOND THE QUANTIFIED SELF – HYBRIDITY OR APORIA?

These initial responses were deepened and redeveloped through scholars’ engagement with biosensor tracking in the following years. A key feature of this further study was a move to study biosensors and biodata tracking outside of or beyond the orbit of the Quantified Self community. Lupton herself for example would come to argue that it is necessary to conceptualise tracking as being comprised of variegated modalities – not merely the “private self-tracking” practices developed and espoused by the Quantified Self, but including other modes such as:

Pushed self-tracking [which] represents a mode that departs from the private self-tracking mode in that the initial incentive for engaging in self-tracking comes from another actor or agency... **Communal self-tracking** [which] involves the voluntary sharing of a tracker’s personal data with other people....

later theories of governmentality or security, rather than in terms of the disciplinary subject *per se*.

Imposed self-tracking involves the imposition of self-tracking practices upon individuals by others primarily for these others' benefit. These include the use of tracking devices as part of worker productivity monitoring and efficiency programs...[and] **Exploited self-tracking** refers to the ways in which individuals' personal data are repurposed for the (often commercial) benefit of others. (Lupton, 2014a: online, see also Lupton, 2014b)

The significance of this observation was to move analysis of biosensors and sensor tracking away from the ends defined by the Quantified Self community itself and towards a more developed understanding of their place with contemporary technoculture. (Self-) tracking was no longer understood according to the purely volunteerist model of the Quantified Self, but as operating according to variable levels of user agency and towards various ends. This led to several new strands of interpretation.

One of these was to further emphasise the hybridity and complexity of the assemblages produced through biosensor analysis. Tamar Sharon and Dorien Zandbergen (2017) developed the response to Morozov's critique further, arguing that understanding the Quantified Self as 'data fetishists' was reductive. Rather than a Quantified Self, they argue that their ethnographic research on biosensing practices identified a '*quantifying self*' who "ascribes meaning to self-tracking and the data generated by it through a process of continuous negotiation with self-tracking methods and tools (literally dismantling them at times), of constant interaction with the daily environment, and of involvement with others who share similar interests" (Sharon & Zandbergen, 2017: 1706). Farzana Dudwhala (2018) extended this understanding of 'negotiation' – drawing upon Karen Barad's understanding of ontology in terms of the 'entanglement' (2007) of the social and the natural, to argue that biotracking entails the complication of biological boundaries which traditionally define the human subject. Dudwhala (2018) argues that when the data produced by biosensing technologies differ from the expected outcomes (for example when a diabetic finds a different blood sugar reading than expected after having lunch), users are obliged to renegotiate the meaning of their activity in light of this data, either choosing to reject the discrepancy, or instead to reevaluate the 'meaning' of said activity such that it more securely coheres with their

sense of lived experience. Consequently, Dudwhala argues, it is necessary to understand biosensors not as representative technologies, revealing a given state of mind or of embodied being, but as *coproductive* of such, meaning that rather than “[continuing] to talk about knowledge of the ‘self’ as a singular and fixed entity [such technologies encourage us to consider] the ways in which interaction/intra-action with these self-quantifying technologies fosters a constant enactment of fluid and multiple ‘selves’” (2018: 98). Such a critique points to the productive, agential capacity of such technologies, of their role as a kind of ‘companion species’ (Rettberg, 2014: 61-78) which extends and challenges the boundaries of the self, rather than merely offering us a means towards its perfectibility.

This line of interpretation has also been taken up by Lupton in a recent ‘turn’ in her research, informed by New Materialist and feminist theories of technology and embodiment (see Lupton, 2019a; 2019b). In an interesting revision or complication of her initial critique of Quantified Self technologies, Lupton has argued that:

The resonances of these people’s accounts of the agential capacities generated by self-tracking practices with neoliberal ideals of citizenship are obvious. Crucially, however, these self-trackers had found personal benefits that, while aligning with the interests of the state or commercial enterprises, also aligned with their own interests. They were not passively manipulated by digital technoutopian solutionism, as critics such as Morozov (2013) have characterised them...The very process of collection was itself meaningful in the comfort and sense of control it offered people. The participants referred to the benefits bestowed by becoming ‘more aware’ of their bodies and mental states. Their enactments of these practices bestowed agential capacities in and through bodies that were viewed as recalcitrant, but then were disciplined to be manageable and less chaotic. (Lupton, 2019a: 76)

Lupton’s earlier position, that biosensor technologies represented a new iteration of neoliberal technologies of the self, is subtly repositioned here, indeed coming closer to Nafus and Sherman’s earlier argument that the self-tracker is to be understood as producing a more far-reaching sovereignty over the self than it is possible to

conceptualise under the Foucauldian schema. The emphasis of this more recent mode of interpretation however is to move scholarship of biotracking away from the politics of the subject *per se*, and to point to how tracking technologies serve to trouble the definition of the subject as a coherent category of meaning altogether. Rather than simply ‘empowerment’, this line of interpretation argues that biotracking also enables a greater awareness and appreciation of the agential capacities of the non-human or of ‘chaotic’ bodies. The political valence of such critique seems less Foucauldian, and more in the line of a certain tendency within Science and Technology Studies, typified by New Materialists such as Barad (2007) but also including the work of Donna Haraway (1987) and the Actor Network Theorist Bruno Latour (1993). These thinkers are united in their aim of seeking to decentre the modern subject from its preeminent hermeneutic position, and to enable a more expansive description of the networks of the human and the non-human which it would be argued constitute our contemporary situation. The critical examination of the production of the neoliberal subject through biotracking technologies is bracketed, whether in its empowerment or its critique, in favour of a broader ontological argument about the undoing or decentering of the subject, which such technologies are able to reveal.

However, a related but divergent interpretation of this complexity in biosensor measuring which has also emerged. This strand of interpretation emphasises not the production of complex or hybrid arrangements through biosensing practices, but instead the difficult place of error, disuse, and aporia as elements of the technical arrangement.

One rather prosaic aspect of this analysis has been the acknowledgement of the strong tendency towards disuse amongst many would-be self-trackers. Stine Lomborg et al’s study (2018) found that while users were encouraged by biosensor manufacturers towards a ‘flow’ state by which self-measurement and self-analysis operated as mutually reinforcing modes of use, many users reported feelings of “annoyance and discouragement” when self-tracking technologies either failed to register activity correctly, or sent out irritating notifications and reminders in the effort to ‘nudge’ users towards undertaking greater amounts of exercise. Lomborg et al note that such ‘nudging’ can “serve as a source of frustration and discouragement that turns playful activities into tedious labor” (2018: 4599, see also Etkin, 2016; Lupton et al, 2018; Patel

& O’Kane, 2015, Till, 2014). Self-tracking fails to signify in the way that practitioners were hoping it would, it becomes boring, and once enthusiastic users drop out. In a similar vein, Harley Bergroth (2019: 196) found in his recent study that the many difficulties presented to users prompted not merely boredom or irritation, but also an understanding of lived experience as something “you can’t really control”, in the words of one of his research subjects. Bergroth argues that the capacity or tendency for tracking technologies to not work or to work in unexpected ways, prompted users to reflect upon the impossibility of the desire to know fully the truth of their own bodies as they were undergoing tracking regimes. As Bergroth writes:

This is to say that *the functionality of self-tracking systems as systems of self-related knowledge production seem to, in part, stem from the production of the self as a temporal object that can never be known well enough, or that can never be ‘completed’ as an object of knowledge*. Self-tracking systems then easily lure the individual into a logic of constant monitoring and temporal extension (emphasis in original). (2019: 204)

The point to be made here is related to but distinct from the argument pertaining to the ‘complexity’ produced through tracking ‘assemblages’. Biosensors’ capacity for error, misuse, or difficulty challenges the integrity of the measuring subject. But this challenge is conceptualised less as a positive ‘extension’ of the boundaries of the subject than as an aporetic gap, which throws into question the coherence and meaning of the subject as measurer. The point to be made here is not simply that this aporia should be understood as an ‘essential’ gap, in the way that New Materialist analyses understand the subject to be essentially ‘entangled’, but that such gaps are themselves technologically and politically conditioned. As Nafus notes, such gaps should be understood in the context of discursive fantasies of the ‘flow’ of data:

The trope of data “flowing” reflects our ability to imagine the connective qualities of data. It is easy to imagine how a piece of location data combined with heart rate data combined with yet more data can paint a detailed picture (and the truly frightening things that can happen when this picture is painted without our consent). However, the material realities do not come together as

easily...The data cannot just “flow” between those services, even if the connecting pipes are there. There is friction (Edwards et al. 2011) between the datasets themselves, and nontrivial resources are required to remove that friction if someone is going to successfully paint a picture with it. With NSA sized budgets, such friction is easily overcome, but not so for smaller firms and research projects. (2016: 26)

Nafus’ point regarding the efficacy of ‘NSA sized budgets’ brings into frame the political and political-economic questions which bear upon how such gaps are overcome or not, corrected or not, and with what resources and epistemic authority. This issue is also raised in an interesting way through Mette Kragh-Furbo et al’s consideration of the question “Do Biosensors Biomedicalize?” (2016). ‘To biomedicalise’ in this context means to participate in what is broadly considered by health scholars as the dominant contemporary discourse in which health services are conceptualised as “commercial, service-oriented, risk-focused, technoscientizing, knowledge-transforming, body- and identity-morphing processes” (Kragh-Furbo et al, 2016: 5). Kragh-Furbo et al argue that biosensor technologies do in a general sense contribute to this project, but with an important caveat, which is that the contested nature of the trace produced through biosensors brings to the fore a fundamental ambiguity which is not well conceptualised in most academic understandings of the production of modern medical knowledge or the provision of health services. Kragh-Furbo et al specifically discuss DNA microarrays in their work, but the general point may be more broadly relevant. Their core argument is that the data produced by biosensors is widely mediated and highly contested:

...the microarray data, no matter how concretely *indexical* (in the Peircean sense of contiguously signifying something in its measurements) it may be, it is indelibly *derivative*. That is, like financial derivatives, its apparent referentiality to a state of affairs in the world—an inherited propensity, a bodily trait, an environmental event, a disease state—relies on the highly statistically and biologically leveraged value materialized in the DNA data ecologies. This opens up biosensing to forms of negotiation, contestation, and diversity that may not be fully biomedicalizable. (Kragh-Furbo et al, 2016: 9 emphasis in original)

That is to say, for Kragh-Furbo et al, biosensor data have no “simple, direct indexical connection to living bodies” (2016: 11) – rather, the data they produce traverses and is traversed by multiple sites of mediation and derivation, each of which opens up opportunities for contestation, reversal, error and so on. Kragh-Furbo et al describe how this process also produces new forms of sociality, as the chronically ill who seek to better understand their condition, discuss the difficulties of measurement, interpretation, and care in biosocial online networks where “ambivalence and the incompleteness of biomedical knowledge are therefore not only what brings this group of people together, but also what takes them forward”, and by which “Uncertainty has a kind of material force” (Kragh-Furbo et al, 2016: 21).

GOVERNMENTALITY AND UNCERTAINTY

As Ian Hacking argues in *The Taming of Chance* (1990), the political valence of uncertainty is not a new problem, but itself a legacy of the rise of statistical technologies of governance in the 19th century, which contributed to a displacement of ‘determinism’ as the chief underlying logic of social thinking, in favour of the valorisation of statistical phenomena which seemed to obey their own ‘laws’. The ‘inexplicable’ obstinacy of statistical regularities across large populations came to the fore as a means by which to ‘tame chance’, to evoke a sense of order out of the caprice and danger of the Industrial Revolution (Hacking, 1990: 5-6). There emerged a belief, which persists to this day, in “the autonomy of statistical law” (Hacking, 1990: 80), and as such questions of social control became fundamentally *actuarial* questions; theories of the *causal* determinants of social conditions became subordinated to the cataloguing and cross-referencing of their occurrence. This view of statistics as a new technology of government control is congruent with Foucault’s analysis of statistical analysis as an apparatus of governmentality predicated upon ‘security’, as opposed to the previous emphasis upon ‘discipline’ (Foucault, 2007).

The term ‘governmentality’ has several meanings relating to what Foucault terms the ‘art of government’, but for the purposes of this thesis it shall be understood as referring

to the emergence of a new deployment of power emerging primarily from the 16th century on, which took as its privileged points of composition “the population as its target, political economy as its major form of knowledge, and apparatuses of security as its essential technical instrument” (Foucault, 2007: 108). These apparatuses of ‘security’ can be contrasted to the earlier apparatuses of ‘discipline’. For Foucault, the apparatuses of disciplinary society, such as the prison, or the asylum, sought to mould groups of individuals within the walls of particular institutions, to control all aspects of particular groups’ behaviour, to institute a process of ‘normation’, by which people are expected to conform to certain pre-defined ‘norms’ of behaviour (2007: 57). The apparatuses of ‘security’ by contrast are far more supple and dynamic; rather than instituting ‘bans’ on certain types of behaviour within certain prescribed areas, apparatuses of security “let things happen” (Foucault, 2007: 45). As with the tools of Deleuze’s ‘Control Society’ (1992), they seek to intervene in behaviour at the level of the population, rather than particular small groups, through abstract ‘technologies of government’, such as the calculation of risk through statistical investigation (O’Malley, 2008: 57). Foucault himself described ‘risk’ as one of the technologies of government called upon in order to make the future knowable and calculable, as a way of ‘letting things happen’, while also modulating reality in such a way as to “nullify, limit, check or regulate” its effects (Foucault, 2007: 47).

Louise Amoore, in her consideration of *The Politics of Possibility* (2013), argues that contemporary algorithmically-automated means of border security govern mobility, ‘letting things happen’ through the statistical calculation of potential movements, allowing a dynamic mode of governmentality to emerge in a post 9/11, “low probability, high consequence” world (Amoore, 2013: 1). Amoore describes the complex ways in which the danger of the unknown becomes subject to a form of algorithmic processing which transforms an array of diverse data points into an ‘actionable’ means of processing supposedly high-risk subjects. In similar terms in her *Governing through Biometrics*, Btihaj Ajana argues that the proliferation of biometric technologies can be seen as genealogically tied to prior means of measuring ‘risky’ bodies, such as the use of fingerprinting (Ajana, 2013: 4). Ajana notes that biometric technologies serve to enrol the body within regimes of governmentality through the twin mediation of the body as “at once...a ‘medium’ and the ‘mediated’ through its

interface with biometric technology, while the latter represents something that exceeds its status as a mere instrument or extension” (2013: 4). Drawing upon the biomediatric thesis of Eugene Thacker (2004), Ajana argues that contemporary regimes of body measurement have served to ‘intensify’ the control of populations, by “[refashioning]’ their predecessors, not only in the technical sense (by performing, extending, reworking and enhancing similar sets of functions and measurements), but also in terms of the socio-political context of their introduction”, that is, they also remediate prior “anxieties, motives, rationalities, functionalities, discourses, responses and so on” (2013: 34). For Ajana, these regimes take “the body itself as the site of remediation whereby the biological and the technological are brought even closer” (Ajana, 2013: 34). Ajana’s analysis is situated more securely within questions of state sovereignty than this thesis; I argue that the ‘aporetic’ interpretation of the function of biosensing highlights how the ‘intensification’ of bio-measurement produces not just a new intimacy or closeness with the measured body, but also an intensification of the interpretative gap between the measuring apparatus and the body which it would seek to encompass.

The key point here is that the aporias, gaps, and uncertainties which characterise contemporary biosensing techniques should be understood not as outside the realm of the technopolitical, but indeed as a product of particular technological apparatuses, which may be understood as predicated upon such uncertainties, rather than as necessarily being undermined by them. The question of risk, of knowledge gaps, is produced as the correlate of a certain distribution of power-knowledge, as a productive force, as something which shapes conduct and behaviour. I argue that the ‘aporetic’ interpretations of biosensing technologies may be further informed through considering such uncertainty as having political resonance under governmentality.

CULTURAL TECHNIQUES AND MEDIA GENEALOGY

In this overview of the development of the literature on biosensing practices, we see how academic analysis has moved beyond discussing biosensing technologies and practices according to the discursive framing established by the Quantified Self

movement itself. In the first ‘period’ of such discussion, a certain Foucauldian framing was common, by which self-tracking could be understood as either compromising a new ‘technology of the self’, or as representing a challenge to the imposition of disciplinary power. In the second ‘period’, the volunteerist figure of the biotracking subject yielded to a more contested framing which on the one hand emphasised the capacity for biotracking to reveal the complex relations between human and non-human, and on the other hand examined the ambiguity of the practice of tracking or being tracked, underlining that rather than revealing unknown connections, such technologies introduce a degree of ambiguity into these relations which must be considered in terms of both its practical as well as epistemological implications.

How to further develop and intervene in this analysis? The essential aim of this thesis is to develop and synthesise certain of these approaches by examining how it is that biosensing aporia is produced and maintained precisely as an element of biopower. The ‘Assemblages’ interpretation is left bracketed in this analysis. Cultural Techniques theory is essentially predicated upon an understanding of being as perpetually in flux – in Bernard Dionysius Geoghegan’s reading of Bernhard Siegert, he notes that “Siegert’s case studies suggest that human being (*Dasein*) articulates itself through a strife inherent in the play of ontological difference. This strife demands the construction of distinctions that produce human identity and cultural differences. Siegert assigns the name ‘cultural techniques’ to this production and maintenance of difference” (2014: 423). From a Cultural Techniques perspective, the important thing is not to insist upon the need to recognise this strife or flux or entanglement as an interpretative end in itself, but to examine the means by which it is brought to order through the production of contingent cultural distinctions, and with what consequence. There is nothing ‘essential’ within a particular arrangement of cultural techniques which needs to be described as such, only the ontic production of differences which appear in retrospect to take on a sense of ontological stability. It is the ‘Aporetic’ strand of investigation that thus appears to offer the most compelling and fertile possibilities for considering the implications of uncertainly as a techno-political force.

Beyond this, I argue that further historical analysis is necessary in order to determine the conditions by which contemporary cultural techniques of sensor technologies have

arisen. There has been relatively little historical analysis of the development of biosensors in the literature on contemporary sensor culture (cf. Crawford et al, 2015; Hong, 2016, Pantzar & Ruckenstein, 2015). As this review of the existing literature has demonstrated, recent scholarship has moved beyond the narrower focus of the self-description and limited discourse surrounding the Quantified Self movement more immediately. Nevertheless, an unfortunate hangover of the field's early focus on the Quantified Self movement and its insistence that it represented a radical break with the past may be an insistent element of presentism.

In the following chapters of this thesis I will argue that the indeterminacy of the trace produced through sensor technologies is not a new phenomenon, but can be traced genealogically to the 'birth' of the sensor society in the mid-19th century. I will furthermore demonstrate that these historical insights are not contained to the sphere of biomedicine, but can be examined within the development of workplace surveillance and home security. In these spheres, the 'body' has come to simultaneously denote and stymie an essential truth about human behaviour, a phenomenon I refer to as *somaletheia*.

CHAPTER THREE

BIOSENSOR TECHNOLOGIES AND THE CULTURAL TECHNIQUES OF HEALTH

This chapter shall examine the development of wearable sensor technologies and their associated techniques of use in the clinical and extraclinical sphere. The aim of this chapter is to contribute towards a genealogy of medical biosensors, the better to understand the way in which the use of sensor technologies has been imbricated within new representations of the body and of physiological processes, and how these developments have transformed the status of medical knowledge and the relationship between patient and physician.

This chapter will draw especially upon Michel Foucault's definition of the anatomico-clinical gaze in his *Birth of the Clinic* (1973) and Lorraine Daston and Peter Gallison's account of the 'birth' of 19th century mechanical objectivity (1992; 2007) as both a representational and an ethical project. The first part of this chapter will constitute an account of the early development of pulse sensors, focussing particularly on the competing sphygmographs (pulse-writers) of Karl Vierordt and Étienne-Jules Marey, and the implications of the competition between Vierordt and Marey for Marey's concept of the 'graphical method' (*la méthode graphique*). For Marey, the development of mechanical sensor technologies had profound implications for the status of scientific knowledge; from now on scientists would be able to provide representations of natural processes in a manner which would constitute a universal language, allowing accurate observations and comparisons in a way which had been impossible when scientific practice relied on qualitative descriptions (cf. Marey, 1885). However, despite Marey's aspirations towards transcending the idiosyncrasies of personal judgement, an analysis of the technical supplements used to adjudicate between the claims of Marey's and Vierordt's sphygmographs reveals the productive inconsistencies at work within this representational philosophy. A close reading shall be undertaken of the gruesome 'haemautograph' of Leonard Landois, which recorded the trace of actual jets of blood of dying animals, in comparison with the light-borne tracings produced by Johann

Czermak's photosphygmograph. In the clinical setting, the 'affect' of these new apparatuses, and the way in which the felt experience of wearable sensor technologies was combined with existing techniques of 'hands on' diagnostics, rather than producing the objective ideal of knowledge for which Marey had hoped, in fact served to produce doctorly intuition as possessing a new kind of authority and consequence. This contention shall be supported through the analysis of W.H. Broadbent's popular handbook on the use of the sphygmograph (1890), in which he describes the way that physicians could incorporate sphygmographic traces with ancient Galenic techniques of the *Ars Sphymgica*. Rather than transcending the embodied intuition of the doctor, it shall be demonstrated that wearable sensor technologies enrolled the patient into a sensorial dialectic, between the 'universalism' of light and of mechanical reproduction, and the violent particularism of the blood-signifier, which remains impervious to abstraction, literally 'inextricable' from the vital capacity of the patient. While acolytes of the graphic method held utopian hopes for the capacity of abstraction to free diagnostics from the personal equation of the doctor, the apparatuses of the graphic method in fact served to bind the patient more intimately to the touch of the doctor. The need for a deft touch in calibrating the sphygmograph to the needs of differentiated pulse points, requiring the assessment of physiological difference as a form of embodied knowledge, served to produce the 'educated finger' of the doctor as a necessary correlate of these new medical technologies. In the production of the sphygmographic trace we witness then the simultaneous production of the somaethic problematic – the attempt to produce an abstract record of the body is troubled by 'biological errancy', by a figuration of the body which both confirms and troubles its own measure. This errancy is in turn 'worked through' by the attendant cultural techniques of touch, in a process which brings this errancy to order, at the same time as it transforms the techniques and position of the toucher.

By drawing attention to the particular haptic reconfiguration afforded by pulse measuring technologies, this chapter will critique biosensors in their function as tools for the sensibilisation of authority. The touch of the physician is often considered metonymic of the intimacy which characterises the ideal relationship between doctor and patient. Much criticism of modern medicine decries this loss of intimacy, of the hands-on relationship between doctor and patient which becomes irrelevant when it is

machines rather than hands doing the probing of sickly bodies, or when taking a patient's pulse (Jewson, 2009). However, as an analysis of 19th century sphygmographic and contemporary photoplethysmographic devices reveals, the hand of the doctor has remained an impassable element of the technological apparatus, fundamental in the correct application and interpretation of the device. While many accounts of technological media have emphasised the excision of the haptic and the promotion of a violent scopic drive as constitutive of modernity's sensorium (see Crary, 1990), this chapter will argue that the 'proper' touch of the doctor remains integral in the authorisation and calibration of physiological data. 'Proper' touch is defined as touch which has been 'tamed' of its 'improper' capacity for unstructured physiological heterogeneity, and which would affirm proximity, intimacy, connection. The sphygmograph can be seen to have produced doctorly touch as newly 'proper' within the context of a clinical practice transformed in the wake of Étienne-Jules Marey's graphic method.

This chapter will go on to compare the cultural techniques surrounding the 19th century pulse writing technology the *sphygmograph*, and the contemporary blood pressure measuring medium of *photoplethysmography*, a clinical technology which has been remediated as a component of numerous wearable digital biosensors, including the Apple Watch and the Fitbit. The proliferation of wearable sensors and the rise of the Quantified Self movement has been promoted as remediating 'proper' touch, empowering ordinary people with the capacity to pursue a project of bodily self-knowledge. However, an analysis of how error is produced within the photoplethysmograph as a component of the Apple Watch demonstrates how this project is thwarted; the ordinary user is unable to independently correct for this error and to produce their own touch as 'proper' in the way that 19th century clinicians were able to. This observation in turn serves to complicate arguments that the contemporary proliferation of wearable sensor devices and the emergence of the Quantified Self community signals the obsolescence of the doctor-patient relationship, demonstrating instead that trained medical practitioners remain necessary in order to bridge gaps in wearable sensors' recording mechanisms, thus binding users of wearable sensors in an intimate embrace with the medical industry. Put simply, while wearable sensors have been interpreted as allowing anyone to become their own doctor, the inextricable error-

ness of the apparatus means that this cannot happen; wearables may simply produce further anxiety, rather than ‘true’ self-care, in this sense.

MEASURING THE BODY: THE WITHDRAWAL OF THE INTERPRETER?

Probably the first man in history to weigh himself every day (Kuriyama, 2008: 416), and to attempt to quantify the relation between human waste and the vital functions of the body, was a contemporary of Galileo’s named Santorio Santorio. Santorio devised a weighbridge, which he had erected in his home, by which he was able to monitor the fluctuations in his weight before and after meals, sex, and defecation. Santorio’s investigations produced the remarkable constant detailed in his *Medicina Statica* (1712), that for every eight pounds of food he ingested, he excreted only three pounds of waste, prompting the question of where the remaining five pounds went. To answer this question, Santorio made recourse to the ancient Galenic theory of *insensible perspiration*. Absent a theory of metabolism, the 2nd century Roman physician Galen proposed that food ingested which did not exit the body as urine or fecal matter did so as “massive clouds of effluvia, wafting out of the pores, unseen by the eye” (Kuriyama, 2008: 417). While Santorio was not the first to propose the theory of insensible perspiration, he was the first to attempt to produce a ‘rigorous’ quantification of it, and also proposed a proto-theory of homeostasis, by which he argued that “If a Body returns to the same Standard every Day, without any change in the Quantity of Perspiration, there will be constantly preserved a perfect Health, and no need of Critical Evacuations” (1712: 7). Santorio’s method was much celebrated and had many imitators. However, it did not fundamentally alter the received wisdom of Galenic methodology, which had little place for precise measurements and rested instead upon an anxiety over imbalance between the four classical humours of yellow bile, black bile, blood and phlegm. It was not until the emergence of the anatomo-clinical method following the French Revolution that the precise measurement of localised pathologies came to assume importance.

As Foucault (1973) describes, the birth of the clinic marked an epistemological break with the previously dominant form of medical thought, the ‘classificatory method’,

following what one might call an arborescent logic by which symptoms of diseases had no interpretative value in and of themselves, but which only pointed to a deeper ‘essence’ of the disease, which held a hierarchical precedence in terms of defining the nature of an illness. Doctors following the classificatory method aimed at an ideal abstraction of the patient; “To the pure nosological essence, which fixes and exhausts its place in the order of the species without residue, the patient adds...a whole series of events that, in relation to the essential nucleus, appear as accidents. In order to know the truth of the pathological fact, the doctor must abstract the patient” (Foucault, 1973: 7). The classificatory method followed a rigorously realist epistemology; manifestations of illness existed only as imperfect iterations of a higher order of disease essences. Within this epistemology, illness was never fixed within any particular tissue or organ, but could travel around the body, manifesting itself in different areas through “sympathetic transference” (Foucault, 1973: 11) whilst maintaining its essential essence; “The same, single spasmodic malady may move from the lower part of the abdomen, where it may cause dyspepsia, visceral congestion, interruption of the menstrual or haemorrhoidal flow, towards the chest, with breathlessness, palpitations, the feeling of a lump in the throat, coughing, and finally reach the head, causing epileptic convulsions, syncope, or sleepiness” (Foucault, 1973: 10). Within the classificatory approach there was no need for rigorous documentation of specific bodily signs, since the localisation of illness was not an applicable aspect of diagnostic method; what mattered was the recognition of the qualitative aspect of the disease’s origin (Foucault, 1973: 12), of aspects of pathology which escaped the possibility of quantitative measure, whether this be the tell-tale “light, dry and friable” brains of maniacs, indicating the “lively, hot, explosive” nature of ‘mania’, or the “languishing, inert, anaemic” brains of those suffering phthisis, a consequence of phthisis belonging to “the general class of haemorrhages” (Foucault, 1973: 13).

This exquisitely differentiated model of qualitative interpretation was subject to a different model of abstraction through the clinical gaze, a levelling out of the body into a flat semantic space, by which the symptom attained a privileged position as transcendental signifier; “henceforth the signifier (sign and symptom) would be entirely transparent for the signified, which would appear, without concealment or residue, in its most pristine reality, and that the essence of the signified—the heart of the disease—

would be entirely exhausted in the intelligible syntax of the signifier” (Foucault, 1973: 111). The clinical method involved the introduction of the crucial question, “where does it hurt?”, into the clinician’s repertoire (Foucault, 1973: xxi); from now on disease would no longer exist in terms of realist essences, but according to an austere nominalist logic, by which disease could be localised within a body which was reconceptualised as a flat semantic space.

Foucault never mentions the innovations of Étienne-Jules Marey’s work in medical sensor technologies within *Birth of the Clinic*, or indeed throughout his entire oeuvre, though others have seen Marey’s innovations as a crucial element of the anatomico-clinical gaze (cf. Braun, 1992: 2). This is not to suggest that the development of new sensor technologies either produced the anatomico-clinical gaze, or somehow responded to a historical need for wearable sensor technologies, but that, as per Foucault, “It was not...the conception of disease that changed first and later the way in which it was recognized...but together, and at a deeper level, the relation between the disease and this gaze to which it offers itself and which at the same time it constitutes” (1973: 90).

Lorraine Daston and Peter Gallison (1992) have argued that the role of the anatomist under this *episteme* involved a decisive shift in the mode of representation from that which had been the norm under the classificatory method; a shift which they characterise as moving from an ideal of being ‘true to nature’ to one closer to our understanding of scientific ‘objectivity’. For earlier anatomists, nature was understood in terms of the production of ideal types, which may never be actually represented within the stubbornly idiosyncratic and differentiated examples of actual anatomical specimens. Discussing the sketch of a skeleton by the 18th century Dutch anatomist Bernhard Albinus, which Albinus altered in his final sketch in order to make its proportions more ‘ideal’ than had been the case in real life, they note that:

Albinus believed that universals such as his perfect skeleton had equivalent ontological warrant to particulars, and that the universal might be represented in a particular picture, if not actually embodied in a particular skeleton. That universal can only be known through minute acquaintance with the particular in all its details, but no image of a mere particular, no matter how precise, can

capture the ideal. That requires judgment informed by long experience. (Daston & Gallison, 1992: 91)

It was only in the later 19th century that such practice could be decried, at least in formal experimental scientific discourse, as hopelessly ‘subjective’, and too reliant on a vague and shadowy ‘intuition’ which could not be generalised or tested. By the late 19th century and the era of Marey, the general consensus had emerged “that only particulars were real, and that to stray from particulars was to invite distortions in the interests of dubious theories or systems” (Daston & Gallison, 1992: 91).

Daston and Gallison have argued that the production of mechanical ‘objectivity’ in the late 19th century carried the imprimatur of an ascetic Victorian morality; newly automated forms of measurement obviated the need for direct human contact with the object of study, and thus were to be considered to carry an “aura of stoic nobility” (1992: 120), “miraculously free from the inner temptation to theorize, anthropomorphize, beautify, or otherwise interpret nature” (1992: 119). Daston and Gallison, in their 1992 article *The Image of Objectivity* position Étienne-Jules Marey as the archetypal figure of this tendency, glossing his credo thus:

In 1878 French Physiologist E.J. Marey, surveying the panoply of visual methods in the sciences, concluded: "There is no doubt that graphical expression will soon replace all others whenever one has at hand a movement or change of state - in a word, any phenomenon. Born before science, language is often inappropriate to express exact measures or definite relations." Others might cry out to salvage the "insights of dialectic," the "power of arguments," the "insinuations of elegance," or the "flowers of language," but their protestations were lost on Marey, who dreamed of a wordless science that spoke instead in high-speed photographs and mechanically generated curves; in images that were, as he put it, in the "language of the phenomena themselves". (1992: 81)³

³ Daston and Gallison argue that after 1900 the ideal of objectivity as ascetic withdrawal from human interpretation came to be problematized and supplanted by an ideal of ‘trained judgement’, governed by the credo that “accuracy should not be sacrificed to objectivity” (2007: 324). It is of note that while Marey constitutes the key exemplar of mechanical objectivity in

Many theorists of the medical encounter have argued that the shift towards an understanding of scientific and biological truth predicated upon the elision of subjective interpretation has in turn had an abstracting and ‘dehumanising’ effect upon the diagnostic relation between doctors and their patients. The standard history of cardiology has held that since the mid-19th century, techniques of pulse taking have been progressively automated, with the *tactus eruditus* or ‘educated touch’ of the physician being obsolesced by technologies such as the sphygmograph, the sphygmomanometer, and the electrocardiogram. As Anna Harris has argued, “[t]he growing abundance of medical technologies has led to laments over doctors’ sensory de-skilling, technologies viewed as replacing diagnosis based on sensory acumen” (2016: 31). Medical historian Stanley Reiser has argued that “the decline in physical examination and the use of senses in diagnosis, as technological substitutes are invented, seems...inevitable” (1993: 272).

This critique of the loss of intimacy in the modern medical encounter follows Nicholas Jewson’s seminal and oft-cited article on *The Disappearance of the Sick Man from Medical Cosmology, 1770-1870*, in which Jewson describes the pre-modern encounter between patient and physician as one of a ‘probing’ of the unique individuality of the patient by a caring and engaged doctor at the bedside. Jewson argues that the rise of ‘hospital medicine’ has led to a loss of the intimacy which characterised bedside medicine, as “[t]he special qualities of the individual case were swallowed up in vast statistical surveys...[and] the sick-man was no longer regarded as a singular synthesis of meaningful sensations” (2009: 628). This anxiety is reiterated in the similarly widely cited phenomenological critique of Fredrik Svenaeus, who argues that:

Computer-assisted diagnosis highlights a problem which has become ever more pressing in modern medicine and which concerns the topic of this study: the

their 1992 article on the subject, when Daston and Gallison published their longform analysis *Objectivity* (2007), they focussed on conventions in scientific atlas imaging. Interestingly, discussion of Marey is entirely absent from this longer work. This perhaps speaks to the difficult place that Marey occupies concerning the question of intervention within physiological method, as this chapter considers.

fading focus on the *meeting* in medical practice. If...the voice of the patient is threatened by the loudening hum of medical technology, the computer as a judge in matters of diagnosis and therapy may also gradually replace the voice of the *doctor*. The future scenario of the patient 'meeting' with a computer, instead of with a physician, would mean the end of medical practice as a meeting between two persons.” (2000: 33 (emphasis in original))

We can understand then the standard interpretation of the ‘technologizing’ of the medical encounter as implying a certain withdrawal of the doctor from the clinical encounter, and the disappearance or loss of some essential human, affective, element from the diagnostic moment. Such an interpretation implies that the effect of modern medical technologies has been to introduce an essential and novel distance into techniques of reading and interpreting the body. By contrast, this chapter shall demonstrate how biosensors instead mediate and reproduce intimacy as a necessary correlate of measurement, especially in the negotiation of biosensors’ capacity for error and their concomitant reliance upon a perpetual recalibration.

THE MEANS OF VERIDICTION

If a small mirror be fastened over the radial artery, and a beam of light thrown upon the mirror, the excursion of the pulse can be photographed on a moving sensitised plate. If a small puncture be made in an artery, the jet of blood can be brought to play on a sheet of white paper moved by clockwork, and a haemautograph can be thus obtained. Both these methods yield exactly the same type of curve as the Marey sphygmograph. (Scharpey-Schäfer, 1900: 100)

It was in the context of this transformation of the figuration of the body that the work of Étienne-Jules Marey came to prominence, notably in his efforts to refine the sphygmograph of German engineer Karl Vierordt. The sphygmograph was the first means by which the body’s pulse could be represented as a trace upon a Cartesian grid, what Marey referred to as *la méthode graphique*, or ‘the graphic method’, though the qualitative description of pulse types had been an important part of Galenic medicine

for thousands of years, and there had been sporadic attempts to more precisely measure the pulse in preceding centuries, including a pendulum-based mechanism produced by the aforementioned Santorio Santorio (Reiser, 1978: 97). In her celebratory summary of the significance of the graphic method, Marta Braun argues that

[w]ith his graphic method, Marey had effectively found a way to make the phenomena he was studying trace themselves: his needles defied the eye that attempted to follow them, fixed on paper what occurred in a fraction of a second, and reduced complex occurrences to a simple form so that the laws that governed them could be made comprehensible to the trained interpreter. (1992: 22)

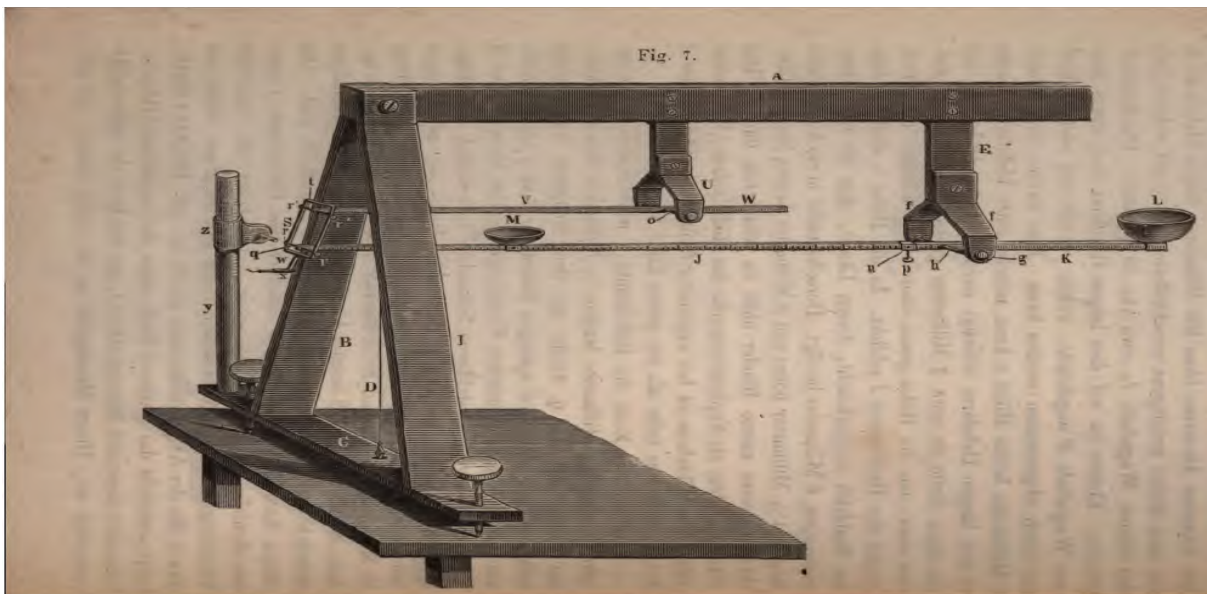


Figure 1

Vierordt's 1855 sphygmograph

Source: Vierordt, K (1855) *Die Lehre von Arterienpuls*, p. 24

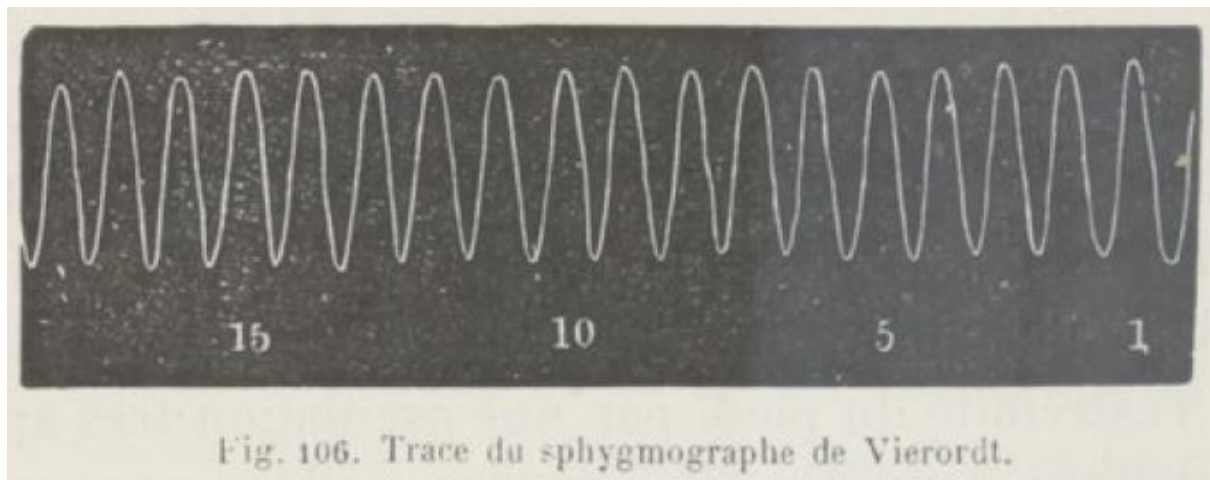


Figure 2

The single notched tracings of Vierordt's sphygmograph

Source: Marey, 1881 *La Circulation du Sang*, p. 210

The sphygmograph consisted of a few simple elements. A plate would rest upon the pulse point of the radial artery, which would absorb the fluctuations of the pulse, abetted by a flexible steel spring. These movements would then be transmitted to a recording arm, which would register the traces of the pulse upon a mechanically rotated strip of paper (see Lawrence, 1978: 197). While Vierordt's 1855 sphygmograph was a large and unwieldy affair, Marey's 1859 sphygmograph incorporated a light and sophisticated mechanical motor designed by the master horologists Maison Breguet, and was light enough to be worn on the wrist, thus constituting, arguably, history's first 'wearable sensor'. Vierordt's machine also employed a fixed and heavy lever on the subject's wrist, while Marey's employed an elastic spring. The increased weight of Vierordt's machine combined with the heavy, immovable lever, produced an inertia within the recording mechanism which obscured its sphygmographic traces. Consequently, the Vierordtian sphygmograph produced a monocrotic pulse tracing, something like a sine wave, while the Mareysian sphygmograph, lighter and more responsive, produced a dicrotic pulse, tracing the swell of the contraction of the diastole and then the relaxed echo of the systole, an image with which we are now familiar as the indexical representation of precarious life in so many daytime hospital dramas. At the time however, there was no definitive way to adjudicate between the two claims, even as Marey's dicrotic pulse held a great deal of common sense appeal, since it seemed to conform to the felt experience of the practitioner trained in the Galenic art of pulse-taking (Mannoni, 2004: 35).

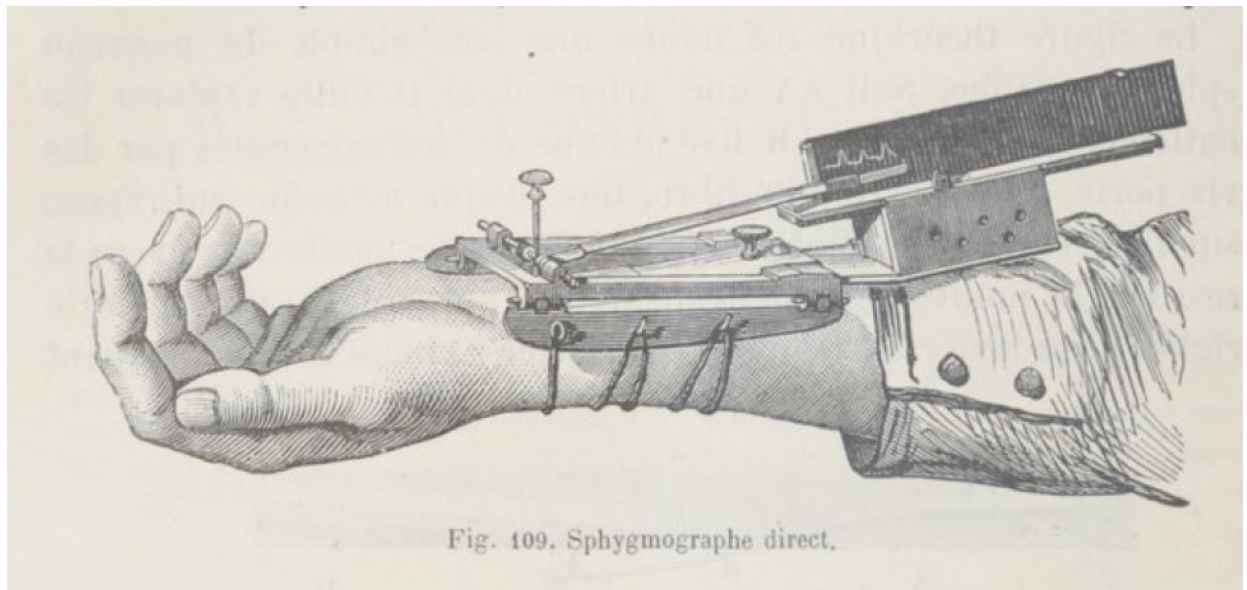


Figure 3

Marey's 1859 'wearable' sphygmograph

Source: Marey, E (1881) *La Circulation du Sang*, p. 214

The question of the superiority of Marey's sphygmograph over Vierordt's was ultimately only settled through the intervention made by the technical innovations of other physiologist-technicians. The work of two German physiologists was accorded particular esteem and credence by Marey; Leonard Landois and his macabre haemautograph (1876, 1892), and the photosphygmographic investigations of Johann Nepomuk Czermak (1864) (cf. Lawrence, 1978: 197; Mannoni, 2004: 66).⁴ The fact of Landois and Czermak being German draws attention to what Soraya de Chaderavian notes was a properly transnational development of *la méthode graphique*, which incorporated important regional differences in the construction and philosophy of sensor technologies (1993: 273).

Today better remembered for his innovations in blood type analysis, Landois' ghoulish invention was celebrated in his obituary as "well known to every medical student" (Anonymous, 1902: 1975) and became world famous as it was featured in his widely translated *Textbook of Human Physiology* (1892). The haemautograph involved the

⁴ Note that both Lawrence and Mannoni mention only Landois' work (and only in passing); the importance of Czermak's photosphygmograph is this author's own contribution.

tying down of either “a large dog” or rabbit to a table, and the placing of a paper cylinder rotated by a clockwork mechanism next to the animal’s tibial artery, which would then be slit, with the rotating cylinder catching the resultant spray of blood. Not the sedate rhythm of the hospital drama here, but a premediation of the slasher film cliché. These haemautographic traces seemed to confirm once and for all that the dirotic tracings of Marey’s sphygmograph were accurate; Marey himself describing the haemautograph as having “completely justified” (*complètement justifiée*) (1881: 218) his own findings, a view which came to be accepted by medical opinion (cf. Luciani, 1911, Scharpey-Schäfer, 1900). However, of note here is the contradictory nature of this ‘confirmation’. Marey had championed his ‘graphical method’ as overcoming the limitations of earlier blood pressure technologies, (such as Carl Ludwig’s kymograph, which had relied upon invasive techniques of ablation, requiring the insertion of liquid-filled tubes directly into the arteries of a dog), noting that the cardiac rhythms of an animal spasming in pain and fear could not be considered to provide a reliable impression of the normal pulse (Mannoni, 2004: 23, cf. de Chaderavian, 1993: 273-274). The belief in “making the blood write its own record” (1879: 1925) in the words of fellow haemautographer Joseph Lister, would appear then to have more to do with the mystical alchemical veneration of blood as carrying the life spirit (cf. Poma, 2005) than with the disinterested Cartesian graphical approach to which Marey pledged allegiance. In addition, Landois’ haemautograms provided little quantifiable information regarding the duration or intensity of the dying animal’s effusions, by which scientific comparison could have been made. Landois’ haemautograms were not projected on the Cartesian axes which were characteristic of the graphic method, but were set simply against the mute whiteness of the bare page, as though the streaks and splatters of the haemautograms were able to speak with a singular significance, independently of the graphical method to which they served as supplement.

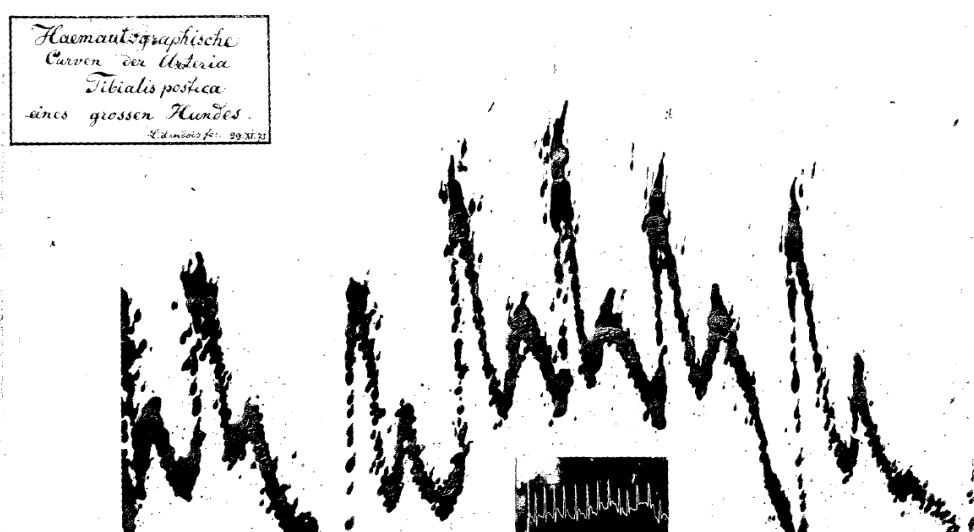


Figure 4

Landois' haemautographic tracing of 'a large dog', with Marey's sphygmographic tracing inset for reference

Source: Landois, L 1876 Hämataugraphie. *Archiv für die gesamte Physiologie des Menschen und der Tiere*. Vol 9(1): Plate 2

Even if Marey, Landois and associates did consider the haemautograph to provide an objective rendering of the value of the blood's pressure, the macabre nature of the haemautograph, and its apparent liberation from the fundamentally Cartesian strictures of *la méthode graphique*, are evidence for the affective appeal of sphygmographic methodology. John Douard has described how Marey constructed a 'visual rhetoric' aimed at seducing the viewer through their powerful depiction of the graceful curves and swells of his sphygmographic tracings (1995: 201), tracings which revealed, in François Dagognet's words, an exciting new "universe made up in reality of surges and drops" (1992: 11-12). It would seem clear that while repudiating the mystical, vitalist and esoteric approach of prior diagnostic methods, the graphic method of Marey and of modern biometrics was nevertheless asperged by the weight of blood, made sensible only through recourse to an intuition supposedly foreign to the sober ideals of the positivist method.

In *Screening the Body: Tracing Medicine's Visual Culture*, Lisa Cartwright (1995) makes a comparable argument in her discussion of the Mareysian and post-Mareysian tools of the graphical method, such as that of an assistant of Marey, Charles-Emile Francois-Franck, who conducted neurological experiments in the 1880s on dogs in order to measure reflex speeds. Cartwright describes the setting of the experiment as follows:

The back leg of a chloroformed dog was held in place within the laboratory setup, the remainder of its body fully hidden from view (covered by a dark cloth). A hammer mounted to a spring was made to strike the unconscious dog's tendon. The jolt triggered the leg, and the movement of the leg intercepted a current, activating an electromagnetic signal transmitted through a wire attached to the Achilles tendon. This signal triggered the inscription of percussion through a myograph (an instrument for recording effects of muscle contraction). A chronometer with a single needle was included in the set to establish a rate of time within each film frame. Finally, a kymograph inscribed a temporal register of the event, stimulated by the vibrations of a tuning fork. The kymographic record appears at the edge of the film frame. (Cartwright, 1993: 42-43)

Cartwright argues that the complexity of the apparatus and the place of the chloroformed, tortured dog within signifies the degree to which the graphic method was not merely predicated upon the capturing and representing of movement and vital physiological functions, but also the *disciplining* of the living subject of the measurement practice, whose life functions must be made adequate to the demands of the machine and according to the strictures of the graphic method. Technologies like Francois-Franck's myograph/kymograph (and indeed, the haemautograph) "[implanted] a technology of observation directly into the body studied—a technique that joins technology and the living body rather than using technology to sacrifice the body for the sake of analysis" (Cartwright, 1995: 25-26). The apparatus served to discipline not merely the subject of study, but also the observer, whose gaze and authority to interpret were diffused across and calibrated through the exigencies of the machine. At the same time, the internal order of the apparatus was challenged by the difficult, or even treacherous place of the body of the test animal, whose docility could never be totally

assured – “the living body, as object of technical knowledge, often functioned as a dynamic force within the experimental apparatus, a force that eluded and reflexively disciplined the gaze of the technical observer” (Cartwright, 1995: 39). The remarkable aspect of the haemautograph, by comparison with Francois-Franck’s docile, chloroformed dog, is the degree to which it attempts to recuperate the sacrificial gesture *within* the graphical method, a ‘regressive’ gesture aimed with deadly irony at validating the newly ‘non-destructive’ methods of the graphical method and its production of a means by which ‘life’ might be enabled to write itself.

In the same paragraph that Marey cites Landois’ work as having ‘completely justified’ his own, he also praises the work of the Johann Czermak, who, “concerned no doubt that the inertia of the lever would alter the traces of the sphygmograph, sought to replace it with an ideal lever, which is to say, a weightless one” (Marey, 1881: 218)⁵. Czermak, better remembered today for his pioneering laryngoscope, outlined his work in two articles published in 1863 and 1864, framing his investigations precisely as a means by which to adjudicate between the competing claims of Vierordt and Marey (Czermak, 1879: 655). Czermak’s photosphygmograph was worn on the wrist, like Marey’s sphygmograph, but in place of the weighted lever of Marey’s invention, the photosphygmograph, in the words of a contemporary, “projected the movements of a ray of light reflected from a small mirror, placed upon the artery, [which were then projected] and photographed upon a screen of prepared collodion” (Power, 1865: 227). As Henning Schmidgen (2001) has described, Czermak was an enthusiastic promoter of the power of magic lantern based projection techniques to illuminate, both literally and philosophically, physiological processes. Czermak was renowned for his Leipzig *Spectatorium*, in which he pursued what Schmidgen has described as a “*cinema of bare life*” (Schmidgen, 2011: 44); demonstrations at the Spectatorium might routinely involve the projection of the still beating heart of a frog, projected to a diameter of two metres, before an enraptured crowd of as many as 400 spectators at a time (Schmidgen, 2011: 43). Czermak pursued a pedagogical philosophy based around the notion of *Anschauung*, a term derived from Goethe, meaning something between “intuition” and “visual perception” (Schmidgen, 2011: 43). Schmidgen describes how Czermak and his

⁵ “Czermak craignant sans doute aussi que l’inertie du levier n’altérât les indications du sphygmographe voulut le remplacer par le levier idéal, c’est-à-dire sans pesanteur”.

contemporaries believed in the pedagogical power of these new, light-based technologies, as imparting an accelerated comprehension of the illuminated processes in the minds of the spectator, as a way of making these temporal physiological processes “palpable” (2011: 60):

In their teaching facilities, physiologists created a thoroughly temporalized visual representation of the functions of life. Through movable screens and powerful projectors and by the use of flags, rolling tables, as well as entire series of specifically designed demonstration devices...physiologists immersed their audiences in a cinema of life. (Schmidgen, 2011: 45-46)

Schmidgen himself describes this apparatus and its corresponding notion of *Anschauung* as incorporating and ‘modernising’ a certain Romantic intuition, not with the aim of pursuing a notion of the sublime, but rather according to a certain pressing need to accommodate pedagogical methods towards a new political economy of time, the need to educate increasingly large bodies of students in increasingly attenuated periods of tuition. Neither slow and painstaking deliberation over texts nor one on one techniques of apprenticeship constituted a feasible pedagogical strategy given the number of students needing to be educated, and the scarcity of time and resources with which to do so (Schmidgen, 2011: 49). Gregory Brophy (2009) has similarly identified the appeal of the sphygmograph’s ‘instant analysis’ within the image saturated world of late 19th century Europe. Within a society being transformed according to the imperatives of industrial capitalism to constantly accelerate the speed of production of both goods and images (cf. Hassan, 2009; Virilio, 1991), the sphygmograph and related technologies’ capacity to provide instant, light-borne analysis held a certain *temporalized* appeal:

The familiar proposition that graphing instruments spoke for themselves appealed to a culture already saturated with writing in that the resulting proliferation of signs need not be accompanied by the burden of interpretation (and the consequent production of more signs in that effort) (Brophy, 2009: 17).

Marey's enrolment of Czermak's photosphygmograph should be considered according to the connotational significances which such a 'photo-' prefixed technology held within this context; signifying immediacy, an immediately grasped intuition which freed us from the 'burden' of a temporally extended process of deduction and interpretation. While Marshall McLuhan may have described light as constituting a "medium without a message" (1964: 15), the above discussion adduces the very contrary; light itself indeed contains meanings and ideas which are historically contingent (cf Cubitt, 2014).

In the veridiction of his sphygmographic traces, Marey seems to identify his pulse writings as constituted within a dialectic, between the violent particularism of the blood signifier, with its connotations of mysticism, sacrifice, and violence, and the pristine universalism and painless iterability of Czermak's light source. That is, the peculiarly self-contradictory 'proof' of Landois' haemautographic tracings, combined with the more self-evidently 'scientific' and intuitive photosphygmographic tracings of Czermak, reveal a productive inconsistency within the practice of *la méthode graphique*, and within the definition of scientific objectivity as a correlate of these new tools. It is this disjuncture which I consider under the rubric of the somaethic – the body is positioned here within the apparatus of the graphic method such that it simultaneously confirms and destabilises the coherence of its own recording.

In examining the differing means by which Marey sought to verify the tracings of the sphygmographic apparatus, we are pursuing what Schmidgen himself refers to as a 'deconstruction' or disassembling of the technological apparatus, allowing us to peer inside the 'black box' of the sphygmograph, in order to "redistribute its elements" (Schmidgen, 2011: 60). In the next section of this chapter I shall examine the implications of this tension for the figure of the physician as the embodied locus of medical authority within the clinical encounter.

TOUCH AND THE INTIMACY OF THE MEDICAL ENCOUNTER

As already noted, critics such as Jewson have pointed to the production of mechanical or technological objectivity in diagnostics as portending a loss of intimacy in the doctor-patient relationship. Touch in particular has a significant but fraught place within the cosmology of medical practices. New media technologies have produced an anxiety over the potential sensory deskilling of medical practitioners, especially today as digital technologies are seen to take on much of the diagnostic work which was formerly constituted in the 'hands on' relationship between patient and doctor. The touch of the doctor has often stood as metonymic of the intimacy which is characteristic of the ideal relationship between doctor and patient, and this intimacy has often been construed as threatened by the technologization of medical practice. Pulse palpation, in particular, has been an integral part of world medicines for thousands of years, notably in the Chinese and Indian traditions, as well as in the Greek tradition from which can be traced much of the development of Western medicine.

The previously mentioned 1st century Roman physician Galen produced 18 books on the techniques and analytic framework of pulsology, and his contribution to the *Ars Sphygmica* would be decisive for millennia after his death. Galen developed an intricate qualitative typology of pulses, and emphasised minute variations between pulse types as holding vast diagnostic significance. Galen's typology involved a synthesis of observations related to the quickness or slowness of the pulse, the strength or weakness of the pulse, the hardness or softness of the arterial wall, the 'fullness' or 'emptiness' of the artery, the frequency and infrequency of the pulse, the rhythm and cadence of the pulse, and the evenness and unevenness of the pulse (Bedford, 1951: 427-428). Galen also proposed many finely varied descriptions of particular types of pulses, such as the *pulsus gazellans*, which "[a]s the gazelle is said to leap up, pause in the air, and then to take a swifter and mightier spring, so the expanding artery pauses, then makes a swifter and larger movement" (Bedford, 1951: 428), or the *pulsus formicans*, which to touch resembled the light, nearly imperceptible scurrying of an ant (*formica* in the Latin). Galen believed that it would take a lifetime to develop a truly comprehensive understanding of the range and diversity of the pulse form, and that while this form of knowledge required scholarly study, it was also a form of embodied knowledge:

I therefore urge the student to train both his intellectual faculties and his sense of touch, in order that he may be able to recognise pulses in practice, not just to distinguish them in theory. The starting point for this practice is the learning of the intellectual precepts. Yet the relevant degree of, say, frequency is not something that can be expressed in words, even though there is a very great difference between, for example, what exceeds the level of pleuritis and what falls short of it. (Galen, 1997: 337)

Galen's extensive treatment and valorisation of the sphygmia arts held enormous influence in the training of clinicians for centuries, even millennia after his lifetime. While the broader precepts of Galenic medical theory went almost entirely unchallenged in Europe until the Middle Ages, his promotion of pulsology was even more influential, and still formed a basic aspect of clinical training in the 19th century, prior to, and as shall be explored, after the introduction of the sphygmograph and the Mareysian *méthode graphique*. This 'modern' iteration of pulse taking techniques followed a simplified form of Galen's vast and complex system. The 7th century Byzantine physician Philaretus abridged Galen's 16 volumes of ruminations into an easily memorisable two page pamphlet, which became a popular text throughout the Renaissance, and served as the basis for a longer work on the pulse by Philaretus' contemporary Paulus Aeginata, itself translated into English with added commentary by Francis Adams in 1844 (Marié, 2011: 238-239). In France, a renewed attention to the pulse as a vector for diagnostics was provoked by the work of Henri Fouquet, whose 1767 *Essai sur le pouls* provided detailed anatomical engravings illustrating the different pulse types, the better to aid in the education of the budding sphygmologist. From the 17th century onwards practitioners, especially in England and Germany, also began to consider the possibility of integrating Chinese understandings of pulse-palpation with the ancient Galenic methodology; a key text in this process being Sir John Floyer's 1707 pamphlet *The Physician's Pulse-Watch, or, an Essay to Explain the Old Art of Feeling the Pulse, and to improve it by the Help of a Pulse-Watch*, in which he praised Chinese practitioners for their careful cross-referencing of pulse and respiratory rhythms (1707: 330, cf. Marié, 2011: 341-342).

Most scholarship on the development of the sphygmograph has contended that its invention and dissemination contributed to a dramatic, overwhelming and fatal blow against the imperfect, subjective, overly ‘intuitive’ method of pulse palpation, in favour of the precise, easily communicable and ‘objective’ traces produced by the sphygmograph and its descendants. In this, medical historians have been too quick to take Marey himself as the only discursive point of reference on the significance of the sphygmograph, ignoring the deeply contested reception of the technology amongst mid to late 19th century clinical practitioners. Braun, in her influential and major study of Marey and his technological innovations, strikes a celebratory yet typical tone

Marey’s sphygmograph immediately gained wide acceptance in clinical circles; it overcame the difficulty in transposing into words the information received by touch and then communicating it to others. The sphygmograph transformed the subjective character of pulse feeling into an objective, visual, graphic representation that was a permanent record of the transient event, a record that could be studied and criticized by a single physician or groups of physicians. Marey’s instrument helped demonstrate that objective science could replace the eminently personal art of medical touch. (1992: 18)

The assertion that Marey’s sphygmograph “immediately gained wide acceptance” is very significantly overstating the case; while the sphygmograph as described above certainly occasioned great interest amongst a certain community of experimental physiologists, the device received rather a cool reception amongst clinicians. As Jennifer Wallis has noted, the *Lancet*’s initial reporting on the invention “expressed outright doubt over the instrument’s utility”, even as several researchers were provoked to modify Marey’s design and produce their own versions of the instrument (2015: 25). Braun’s assertion that “Marey’s instrument helped demonstrate that objective science could replace the eminently personal art of medical touch” is consistent with the common argument that the technological revolutions of the 19th century heralded the rise and triumph of the scopic and of visual culture and the obsolescence and corresponding decline of other senses and ways of knowing, such as the haptic. Hence, François Dagognet argues that the sphygmograph exposed a crisis in the distorting effect of doctorly interpretation:

Without knowing it, the doctor's role ultimately was that of a screen: distorting, slowing down and omitting. When he or she intervened, only general phenomena could be grasped; thus, the doctor had to be replaced. This meant putting aside once and for all his or her own receiving devices of sight, touch and hearing, and inventing processes of direct inscription, so as to separate life from its secrets, put it in the open and force a "direct writing" from it. (1992: 20)

This 'direct writing' moreover, is often described as a form of inscription incomparable with those observations wrought from the palpating finger or the naked eye alone; hence Brophy argues that the sphygmograph-enabled physician is transformed in a non-dialectical process from human to non-, as

the body is overridden rather than upgraded. Imaginatively disabled, its senses are switched off one by one as they are pressed to their limits. The role of these machines, for Marey, appears to be less supplementary than substitutive. It is better that the eye cannot see and the ear cannot hear, for this blind and deaf subject does less to interpose its own habits of perception. (2009: 16)

In this understanding, the sphygmograph authorises a form of knowledge holding what Josh Ellenbogen describes as 'autonomy' from the senses of touch and naked sight (2012: 180), even to the extent that, for Snyder, "the displacements registered by mechanical monitors and traced by clockwork-driven inscribers fall outside the scope of human sensibility...[such that] they do not permit even the possibility of human intervention" (1998: 380). The overwhelming power and accuracy of this new form of representation simply extinguished the validity and veracity of the hopelessly subjective art of tactile sphygmology, suddenly obsolete in a new era of mechanical objectivity; "[t]he capacity of the medical practitioner's touch to take a pulse, measure a foetus, detect fever was displaced by a new and dominant scopic regime" (Amoore & Hall, 2009: 454). The sphygmograph signals the degradation and obsolescence of an ancient form of embodied knowledge through the abstract schematisation of the body's vital capacities.

This apparent triumph of the abstract and the scopic, and the degradation and decline of the tactile or haptic, is consistent with what David Parisi (2011; 2018) has recognised as a common discourse surrounding the historical transformation of the senses in the wake of the birth of the clinic and the rise of industrial capitalism; that it was in this period that the visual attained dominance as a technology of science and of governance, with the tactile being buried beneath the glass shards of collodion plates.

It is necessary however to avoid a reductively teleological principle of technical development in examining the impact of wearable sensor technologies on the reconfiguration of the senses and of clinical authority more broadly. Far from abolishing the value of touch through an ocularcentric representational mode, clinical practitioners have drawn upon the representational power of pulse measuring technologies to extend and deepen the authority of doctorly touch, strengthening rather than undermining the authority of the doctor as a literal embodiment of medical knowledge. This point may seem somewhat obvious or otherwise banal; *of course* medical practitioners continue to touch their patients, and Roy Porter has even argued that doctors have touched their patients *more* rather than *less* since the technologization of modern medical practice (1993). Rather than a technological apparatus which clinicians might straightforwardly be able to use to ‘objectify’ their knowledge-practice, or might conceivably reject as anathematic to a certain humanist ideal of the clinical relation, there is a need to account for the working through of the difficult status of the somalethic, sphygmographic trace within clinical practice. What is at stake then is not so much an empirical as much as an epistemological or historiographic questioning – how to give an account of this technical relation which would not unduly privilege the one who touches/is touched, over the apparatus which mediates/produces this relation, and *vice versa*? It is proposed that a method predicated upon the Cultural Techniques school of media theorisation will provide an appropriate conceptual grounding.

THE CULTURAL TECHNIQUES OF (PROPER AND IMPROPER) TOUCH

The intimacy of the bedside doctor is a double-edged sword; there is a fine line between the authorised probing of the physician, and the erotic connotations which have been

attached to touch, especially in the Christian tradition, fixated on the fall which transpired after Eve plucked the apple (Jütte, 2008: 6; Gilman, 1993). Porter has described the ‘touch of danger’ which characterised especially the 18th century medical encounter, “in a culture whose religion inculcated belief in the corruptions of the flesh, medicine suffered from guilt by association” (1987: 206). Hence, beyond a normative ethical argument justifying the touch of the doctor as metonymic of that bond taken as constitutive of the ideal doctor-patient relationship, there is a need to ‘probe’ the ways in which the touch of the doctor has been distinguished from less salubrious forms of touch, how it has been codified and ‘authorised’ as a legitimate means by which to ascertain diagnostic data, and how this authorisation has been transformed over time, and in changing technical and cultural contexts.

The sense of touch is defined by an extreme ambivalence; it is on the one hand that most ‘primordial’ or primitive sense (Hansen, 2006) which makes possible sensory perception *tout court*; at its core consisting of an undefined and undefinable *capacity* for feeling. Touch comprises an irreducible physiological difference which eludes categorisation and representation; it has no obvious ‘seat’ or organ, it is both internal and external to the body. And yet, touch has also been understood as that sense which above all others allows us to ‘get a grip on things’. It is this tension between touch as point of physiological heterogeneity and touch as anchoring a sense of being in the world which has characterised the theoretical difficulties in defining touch as a sense; as Mika Elo has written:

As a sense touch has been considered too complex and obscure to be able to offer a clear model for cognitive classifications, which have traditionally been grounded on visual logic. On the other hand, we rely on Aristotle’s classifications even in the division into five senses where the sense of touch has its place like the thumb in the hand. This ‘full hand’ of the five senses has been apt to tame the structural heterogeneity of touch that threatens cognitive discourse. It has made it possible to present touch as a sense that can serve cognitive interests by guaranteeing an immediate, hands-on touch with reality. (2012: np)

As Elo notes, there is nothing guaranteed about touch's status as guarantor; the transformation of 'touch as heterogeneous field' into 'touch as guarantor of certainty' must be considered as a question of the historical transformation of touch through the technological apparatus (Elo, 2012). Clare Colebrook (2013: 4) refers to the 'stabilising' form of touch as 'proper touch'; touch as a guarantor of meaning, as that which can overcome difference and separation and affirm proximity and intimacy between the toucher and the touched, as distinct from an 'improper' touch, which would fail to bridge the gap between toucher and the object of the touch. While Colebrook questions the possibility of ever producing a purely 'proper' touch, the point here is that, especially in the clinical field, touch in its 'natural' state, as unbounded sensory heterogeneity, represents error and failure; it is undirected, it must be tamed, trained, broken in, in order to get it to reliably reproduce the qualities of intimacy, proximity, stability, for which it is valued. In this context, we can consider the media-historical training of the sense of touch as an example of a cultural technique, concerned as it is with defining proper from improper touch, and with preserving this distinction in the face of the threat to cognitive clarity posed by touch's physiological heterogeneity. This study of the definition and exclusion of haptic error is ultimately a political one, examining how the right touch and the right to touch are produced, and with what consequences.

THE PROPER TOUCH OF THE EDUCATED FINGER

A number of prominent English physicians in the mid to late 19th century took up the question of the place of doctorly touch in calibrating or cross referencing the traces of the sphygmograph, including W.H. Broadbent (*The Pulse*, 1890), John Burdon-Sanderson (*Handbook of the Sphygmograph*, 1867), Robert Dudgeon (*The Sphygmograph: Its History and Use as an Aid to Diagnosis in Ordinary Practice*, 1882), and William Ewart (*The Pulse Sensations: A Study in Tactile Sphygmology*, 1894).

Rather than abjuring the physician's capacity for subjective judgement, Broadbent argued that the cultivated touch or *tactus eruditus* of the physician remained necessary in

order to give meaning to the traces of the sphygmograph and to give a more accurate reading of the ‘vehemence’ of the pulse than could be easily read from the sphygmograph’s tracings (Broadbent, 1890: 42). As Broadbent wrote:

While, then, I think that every student ought to be familiar with the sphygmograph, and will gain from a study of its indications a comprehension of the pulse in its different forms obtainable in no other way, I am of opinion that we learn by means of the educated finger all that the sphygmograph can teach, and more. This instrument is invaluable as a means of educating the sense of touch and of cultivating the faculty of observation. (1890: 34)

This would be a form of touch which, rather than being removed from the interpretative process, would be remediated as a sensibilisation or corporealisation of new forms of medical authority, which would be able to rehabilitate the scope for doctorly intuition within the frame of the new prestige and authority accrued to the graphic method. In line with Daston and Gallison, the sphygmograph has generally been understood as a “replacement for observations formerly made by the tips of an experimenters’ fingers” (Snyder, 1998: 385), an abjuration of doctorly intuition and all accompanying pitfalls and temptations of subjective thought. My alternate reading demonstrates a more complex and contested remediation of the physician’s touch within the new constellation of techniques of scientific representation.

The ‘educated finger’ in this context would constitute an aspect of what Parisi has called ‘tactile modernity’, by which the haptic is understood not as counter to the ocularcentrism often considered constitutive of modernity, but as in itself a “distinctly modern formation, drawing legitimacy from the successful application of rational experimentation to touch within the confines of the experimental...laboratory” (2011: 191; Parisi, 2018). The production of the educated finger may be considered comparable insofar as touch is not subordinated under this new metrological regime, but instead valorised and given new predictive power. This can be interpreted as an attempt to solidify the authority of the hand of the clinician, whose power may have been threatened by the anonymising aura of the sphygmograph’s abstract representation.

The sphygmograph did not enjoy an easy entrance into the clinic of English doctors, and even among those enthusiasts of the device there was widespread agreement that Marey's sphygmograph was difficult to learn to use, and potentially prone to inaccurate tracings if the sphygmograph were inexpertly applied to the patient's wrist. The early sphygmographist Dr John Burdon-Sanderson modified Marey's invention through the addition of an adjustable spring, which could be used to more easily vary the pressure of the plate resting on the radial artery. In his 1867 *Handbook of the Sphygmograph*, Burdon-Sanderson gives instructions on the amount of pressure to apply when affixing the machine; he felt that 300 grammes was the standard for a normal pulse, but the utility of the spring was that it allowed for the physician to apply a differentiated amount of pressure, in cases where the 'compressibility' of the pulse differed according to the 'hardness' of the artery (32). Burdon-Sanderson advised that clinicians work within a range of 100 grammes to 300 grammes of pressure, in order to divine, through practiced trial and error, the most legible and consistent sphygmic reading (9). The correct amount of pressure to apply to the wrist in the application of the sphygmograph was also a concern of the later sphygmographer Robert Dudgeon, who complained in his own sphygmograph handbook, that "All wrists are not equally well adapted for obtaining good characteristic sphygmograms" (1882: 62). The physician, according to Dudgeon, must ensure 'perfect steadiness' of the arm (1882: 68), though the appropriate tightness of the device will vary between patients, and particular care must be taken with:

[t]he wrists of strong athletic young men [which] are generally so encumbered with stiff prominent tendons that it requires some practice to be able to get the instrument properly applied to the artery. In such cases it will often be found advantageous to flex the wrist a little, whereby the cord-like tendons are relaxed and access to the artery obtained. (1882: 62)

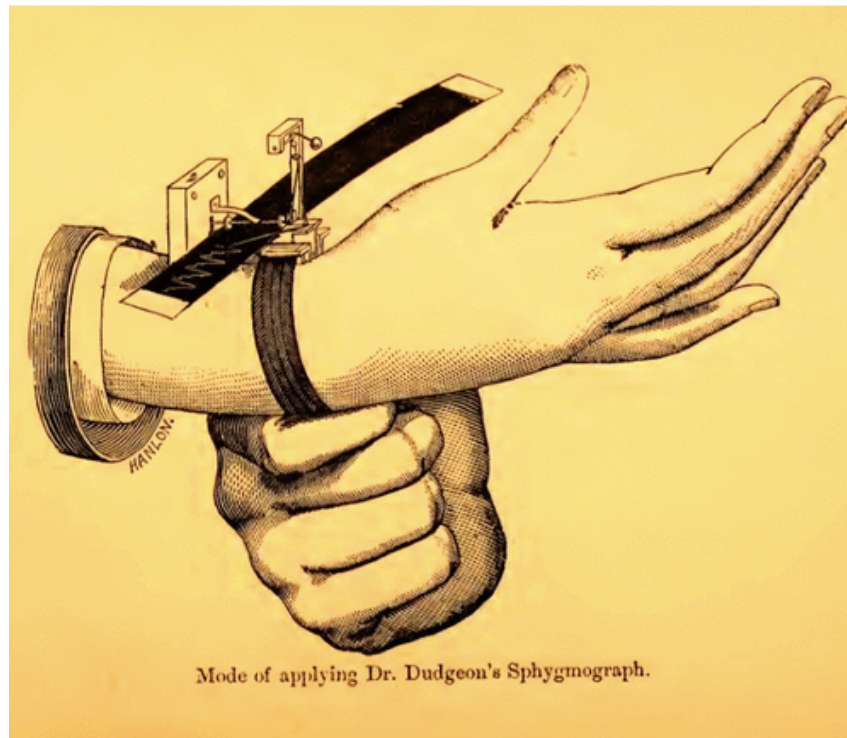


Figure 5

Depicting the 'mode of applying Dr Dudgeon's Sphygmograph'

Source: Dudgeon, R (1882) *The Sphygmograph*, p. II

Other physicians felt that the difficulties in application and standardisation of sphygmographic traces were so intractable as to fundamentally compromise the applicability of the technology in the clinic. As late as 1894 William Ewart was advocating that the sphygmograph be disregarded by clinicians in favour of the finger as the sole vector of analysis, precisely due to the finger's superior adaptability to differing physiological conditions:

The sphygmograph works against varying pressures with a constant energy—the finger, with varying energies. In this the finger enjoys theoretically a great advantage. Any given pressure of the sphygmograph which is most perfectly adapted for some one of the events of the pulse wave, will be much less adapted for all others; whereas the touch is not limited by any rigid scale of pressures. (Ewart, 1894: 13-14)

For Ewart then, it was precisely the finger's ability to account for physiological heterogeneity which constituted its foremost strength; while critics of pulse palpation

would have claimed this ‘adaptability’ as constitutive of touch’s suspect unruliness, this quality is transformed into a virtue insofar as it is conceptualized as isomorphic with the unruliness and variety of the body itself. Broadbent meanwhile advocated a synthesis of the sphygmograph and the Galenic *tactus eruditus*, the use of the sphygmographic tracings to produce an ‘educated finger’, which would combine the authoritative data provided by the sphygmograph on the pulse’s duration with the exquisitely differentiated qualitative aspects of the pulse, such as the firmness of the artery, the ‘force’ of its beat, which were sensible only to the finger of the learned practitioner.

Broadbent provided diagrams which cross-referenced sphygmographic traces with his own idiosyncratic representations of how different pulses might feel according to ‘hands on’ sphygmic techniques. Somewhat in contrast to Ewart’s argument, Broadbent was critical of Dudgeon’s innovations in the addition of the weighted spring, arguing that this variability produced only “a gratuitous provision for exaggerations and for extraneous jerks and vibrations” (1890: 33), thus positioning the learned finger as a bulwark against representational artifactualing.

What is of interest here in terms of considering the sphygmograph as a haptic medium concerned with disciplining touch and making it productive, is how touch is conceptualised as ‘filling in’ for the errors and blindnesses of the sphygmographic apparatus. The unruliness of touch as physiological heterogeneity becomes productive insofar as it is ‘tamed’ through the error of the measuring apparatus. The value of touch emerges as the correlate of the sphygmograph’s own capacity for error; that which the device is unable to account for, those ‘qualitative’ aspects of the pulse’s beat, are now valorised as the province of the educated finger. And yet, Broadbent’s own inscriptions still resemble a sort of quasi-graphical method which serves to produce medical touch as of value to the extent that it might be tied to the project of ‘cultivating the faculty of observation’ (1890: 34). Broadbent criticized the old Galenic pulse palpation handbooks for being over-intricate, introducing distinctions between pulse types and ‘[confusing] the essential features of the important variations of the pulse by overwhelming them in minute distinctions of no practical significance’ (1890: 6). Broadbent’s educated finger could feel elements of the pulse which the sphygmograph missed, its ‘firmness’ and

‘force’, but it had to learn to feel them as the sphygmograph did, translating them into lines which did not look out place next to the sphygmograph’s traces.

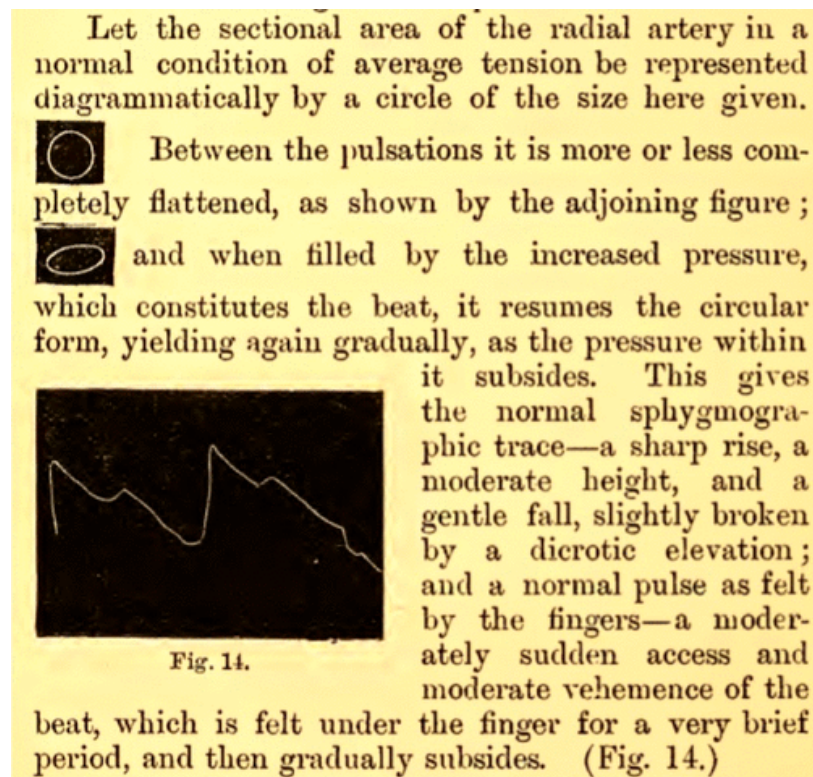


Figure 6

Depicting the ‘felt’ experience of the pulse, alongside sphygmographic tracings

Source: Broadbent, W (1890), *The Pulse*, p. 42

The sphygmograph disciplined the physician’s touch at the same time as it served to expand its diagnostic powers, producing forms of touch which worked in symbiotic relationship to the technology itself; the deft facility with gauging the correct pressure to which the sphygmograph should be tightened on a patient’s wrist, the manipulation of the arm necessary to prepare it for the attachment of the recording device in a ‘neutral state’. While others have noted the issues of doctorly intervention surrounding the sphygmograph, these have tended to be regarded merely as engineering snares, inhibiting the development of a more untroubled and truly ‘objective’ graphic method (see Borell, 1993; Moss, 2006: 586; Reiser, 1978: 103). They were viewed as bumps along the road by which “the physician’s senses gradually came to be replaced by machine based technologies in the twentieth century” (Borrell, 1993: 245), rather than

as defining the hand itself as a mediating and mediated technology of modern clinical investigation.

To examine the rearticulation of touch and the production of the ‘educated finger’ to which the sphygmograph was put, is not to attempt to unearth a buried sensuality somehow resistant to the emergent ocularcentrism of the times, but instead to examine how these new techniques of representation served to rearticulate touch as a diffusion and decentralisation of medical authority. If there is an intuition being drawn upon here, it is one which is not simply free floating, inspired, but instead that which emerges as the very correlate of technologized measurement. Even if acolytes of the graphical method dreamed of a means by which to transcend the vagaries of human intervention, the physician’s touch remained necessary in order to grasp a coherent message from the low murmurs of the body (cf. Foucault, 2001a). In the recursion to a remediated and rearticulated but still inescapable *tactus eruditus*, we witness the frustration of Marey’s desire for a universal and self-evident graphic language, as the stubborn intractability of physiological difference stymies the project of a totalising and fluid abstraction of vital capacity. These lines did not speak for themselves, instead they needed to be coaxed into speech through the careful prodding of the educated finger. The touch described here was not subordinated under the new metrological regime, but instead valorised and given new predictive power. This new form of tactility, made ‘proper’ through its absorption of the analytical power of the sphygmograph, produced a kind of technologically enhanced physiological hermeneutics, empowering the one who touches, who decides to touch, who decides.

Christopher Lawrence has argued that in the 19th century English context devices like the sphygmograph were largely eschewed by gentleman physicians who feared the capacity of such instruments to threaten their class status:

Such devices were a potential threat to the mysterious clinical art which English clinicians had been so anxious to defend. Such tools could make the art mechanical, lay it open, make it merely an applied science. Perhaps also, the use of instruments smacked too much of the artisan – hardly a posture for a gentleman. (1985: 517)

Lawrence cites Broadbent's text as evidence of this eschewal. Conversely, what I argue is at stake here is not a threat to be eschewed, but neither simply a mode of technological domination to be absorbed and put to use. Instead, this new *tactus eruditus* emerges as a means of working through the problematic of *somatheia* which is at work within the graphic method. Marey's desire to unveil the body is obstructed by those troubling forms of biological difference and errancy by which the method is simultaneously tested and 'justified'. The clinicians under discussion here are intervening within this field. As my reading of these handbooks draws attention to, the set of cultural techniques which coalesced around the sphygmograph demonstrates the ambivalence and dispersal of physiological, affective and mechanical intuition and authority which surrounded the sphygmograph as a new way of sensing the body. Moreover, they demonstrate too the way this ambivalence could still be turned to the physician's advantage as reinforcement rather than displacement of their authority.⁶

PHOTOPLETHYSMOGRAPHY AND ERROR

The sphygmograph is now commonly regarded as a failed technology, its finicky application undermining its practical application in the clinic (Moss, 2006: 586). Reiser (1978) has argued that ultimately the sphygmograph's clinical functions were superseded by Scipione Riva-Rocci's 1896 sphygmomanometer (cf. Borrell, 1993), the inflatable blood-pressure cuff which remains in common use today, while in the experimental physiological milieu, the electrocardiograph or EKG attained a growing prestige and acceptance from the early 20th century onwards (cf. Fleming, 1997: 22). There is a need however, to avoid overly deterministic or reductively Whiggish

⁶ Jennifer Wallis has noted that the sphygmograph did experience at least some take-up in British mental asylums in the late 19th century; she discusses the writings of the General Clark and Medical Officer of the Bristol Asylum George Thompson, who promoted the use of the sphygmograph in the asylum as a preferable mode of investigation to the use of microscopic methods of neurological investigation (2017: 300). Wallis goes on to note the entanglement of use of the sphygmograph in the asylum alongside other practices and forms of medical and psychiatric intervention (2017: 307).

accounts of technical or scientific development; it is rarely the case that once technologies and technological competencies become established, that they are then irrevocably superseded or otherwise erased from history.

With the emergence of the practice of photoplethysmography, it is possible to detect a comparable remediation and transformation of the haptic and of cultural techniques of touch as has been described emerging around the sphygmograph.

Photoplethysmography is a technique for measuring the pulse which relies on the algorithmic processing of “tissue light propagation changes during cardiac cycle” (Lemay et al., 2014: 107). The origins of the technique date to the 1930s, with pioneering experiments conducted by Alrick Hertzman and Clare Spealman ascertaining that “[v]ariations in the light transmission of a finger due to changes in the blood content may be detected by a photo-electric cell and recorded optically by means of an amplifier and string galvanometer” (1937: 334); the photoplethysmographic device would measure the variations in the “absorption of light by a transilluminated tissue...[in order] to detect vascular changes with the photoelectric cell” (Hertzman, 1938: 328). Photoplethysmography has revealed itself as useful in measuring blood flow and pulse information in conditions where sphygmomanometry or electrocardiography would prove inadequate or otherwise sub-optimal, such as in measuring genital blood flow in physiological sex studies (Drucker, 2014).

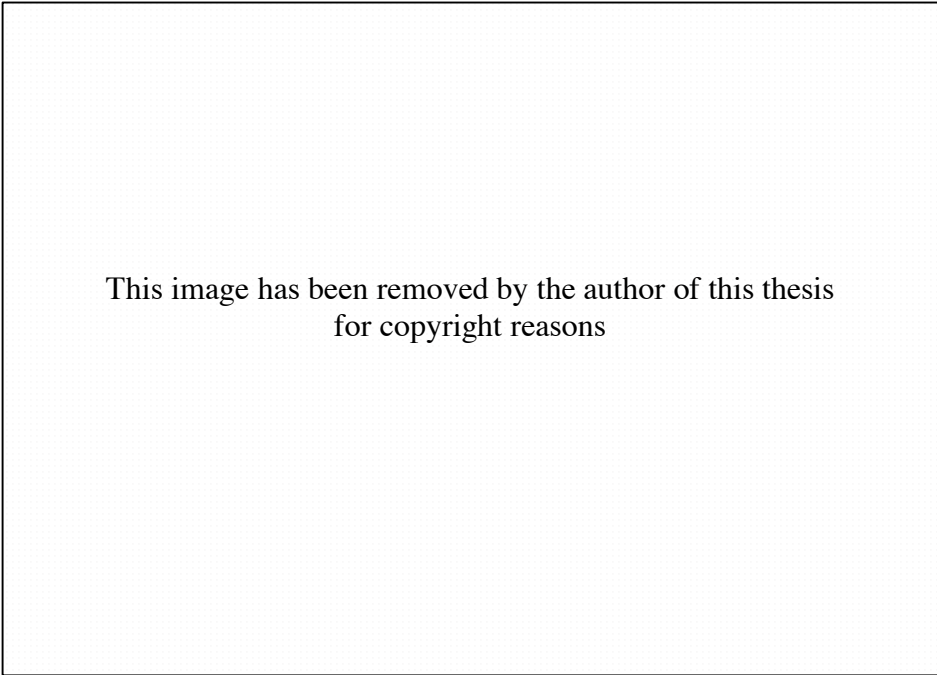
More prosaically, photoplethysmography has recently attained wide prominence through its incorporation in mass-market medical devices, “driven by the demand for low cost, simple and portable technology for the primary care and community based clinical settings, the wide availability of low cost and small semiconductor components, and the advancement of computer-based pulse wave analysis technique” (Allen, 2007: 1). The wide availability and affordability of wearable sensors has formed part of the technological milieu which has encouraged the growth of the Quantified Self movement, which preaches ‘self-knowledge through numbers’, and advocates for the use of wearable sensors as an aid to greater knowledge of and autonomy over one’s health and medical decision making (Wolf, 2010). Self-quantification through wearable sensors has become increasingly banal (Pharabod et al, 2013) and mainstream as wearable medical sensors have been incorporated into a growing range of consumer

products. Notably, a photoplethysmographic mechanism is included as part of the Apple Watch (in both its first and second iterations). Green and infrared LEDs on the underside of the watch rest on the wrist and record information on the wearer's pulse every 10 minutes (Apple, 2015). Photoplethysmography is considered an especially useful mechanism for wearable heart rate monitors, due to its unobtrusiveness and portability (Allen, 2007: 1).

However, despite both the clinical and mass market popularity of photoplethysmographical devices, the technology has been compromised by issues of reliability and artifacting. In a 1938 article, Hertzman detailed several sources of error within photoplethysmographic measurements. Most important amongst these was *movement*, with Hertzman noting that vigorous movement “shifted the position of the skin with respect to the photoplethysmography”, making the measurements unreliable (1938: 331). Another important variable was the “character of the contact of the plethysmograph with the skin” (Hertzman, 1938: 331); there was a necessity to avoid ‘blanching’ of the skin through the restriction of blood flow, which would corrupt the legibility of the photoplethysmographic signal (Allen, 2007). Later studies revealed further concerns in the production of repeatable results through photoplethysmographic testing; a 2014 literature review revealed that motion artifacting and pressure disturbances continue to pose threats regarding the corruption of the photoplethysmographic signal, even in modern devices (Tamura et al., 2014: 285).

Indeed, these problems have not escaped the Apple Watch's use of photoplethysmographic measurement, as many users and technology journalists have noted. Users have complained on online forums that the Apple Watch heart rate data seemed error ridden; the watch displaying for example an unusually sedate heart rate of 60 beats per minute after vigorous exercise, or producing data wildly out of alignment with that produced by (more expensive and cumbersome) chest-worn electrocardiograms (Alger, 2015; Singh, 2015). In response Apple has posted an online ‘explainer’ (Apple, 2015), detailing the workings of the watch's photoplethysmograph, and explaining those factors which might inhibit its successful functioning. These included motion artifacting, as well as skin perfusion (a measure of the deliverance of blood to the skin's capillaries), with the advisory that “skin perfusion varies

significantly from person to person and can also be impacted by the environment”, and hence the sensor might for example not work when exercising in the cold (Apple, 2015). Apple includes a diagram on their explainer page depicting how to tighten the band in order to produce a ‘snug but comfortable’ fit, an uncanny echo of illustrations of the correct application of the sphygmograph in 19th century handbooks. Apple also delivers the caveat, that “[e]ven under ideal conditions, Apple Watch may not be able to get a reliable heart rate reading every time for everybody” (2015). The Fitbit Surge, another popular wearable sensor device which also uses photoplethysmography to measure heart rate activity, has had a class-action lawsuit brought against it by users, angered that it “[does] not and cannot consistently record accurate heart rates during... intense physical activity” (Lieff, Cabrasser, Heimann & Bernstein, 2016).



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Figure 7
Explaining the correct fit of the Apple Watch
Source: Apple (2015)

DIGITAL SELF-MONITORING AND IMPROPER TOUCH

The significance of this capacity for error in some of the most popular self-tracking technologies on the market today lies in the tension between autonomy and surveillance

which underlies the ideology of self-tracking. Considering the Apple Watch as a form of haptic media, as a technology for producing proper touch and distinguishing it from an improper touch, leads us into certain epistemological tensions. The Quantified Self movement can be read as a banalisation and extension of Marey's dreams of a universal graphical method for translating the vital capacity of the body into a fluid and self-evidently 'objective' representational system. The educated finger theorised by Broadbent served to corporealise the project of the graphical method, disciplining touch as a component of a new diagnostic apparatus. The Apple Watch's training of touch is far more ambiguous and fraught. Even as Broadbent's educated finger was calibrated according to the error of the sphygmographic recording mechanism, he could still feel confident that this touch could be made to provide reliable sensory data which could be read alongside the traces of the sphygmograph, which would 'fill in' for the gaps in the sphygmograph and hold a comparable evidentiary authority. The error of photoplethysmography however, rather than being ultimately corrected by the touch of the user, is compounded, dispersed. The knowledge of this error circulates in online discussion boards and collective action lawsuits; Apple's guide to use of the Apple Watch seems only to confirm the unreliability of the recording mechanism, rather than to offer a conclusive solution. The user's touch here then becomes a means of corporealising this failure; the user is instructed on how to correct the watch, but this touch can never be authoritative in the same way as the doctor's educated finger, 'even under ideal conditions'. The truly 'proper' touch lies elsewhere, in the hand of the doctor who remains authorised to give a correct reading of the patient's vital capacity.

In effect, the Apple Watch, while ostensibly offering users a form of empowerment through embodied self-knowledge, in fact serves to generalise a form of 'improper' touch, touch which fails to overcome error, which fails to produce the body as a coherent communicative medium. In this way we can see the distinction between self-monitoring and self-knowledge; even if the instruments of self-quantification demand an intensive form of self-surveillance, such monitoring struggles to attain the status of a definitive knowledge, with which one might be able to truly get to grips with, to act upon one's body. Deborah Lupton (2013a) has written of the ambivalence and anxiety which accompanies the routinization of self-monitoring practices; here we might locate

this ambivalence and anxiety within the cultural techniques of improper touch which are produced through the photoplethysmographic apparatus.

CONCLUSIONS

The body as guarantor of a truth which it also betrays – this is the problematic of somaletheia as produced through the biosensing apparatus. Marey dreamed of a means by which the body could be compelled to write its own truth, but the very tools used to verify his method served to betray and confound this dream. The strange dialectic of the haemautograph's 'blood signifier' does not truly synthesise with Czermak's photosphygmograph to 'completely justify' the graphic method as Marey claimed. Rather, it presences very starkly the problem of a singular physiological difference which will require endless supplements, recalibrations, and interventions in order to 'correct'. It is these supplements that I examine in the consideration of the production of the 'educated finger' by Broadbent and associates. Moreover, this problematic was not, I argue, merely the 'growing pains' of a new technology being met by a new mode of practice – it is rather constitutive of cultural techniques of biosensing within the sensor society. Contemporary biosensors have not 'overcome', but rather extended, banalised, and networked this problematic.

This chapter has considered then the way a set of cultural techniques defining the distinction between 'proper' and 'improper' forms of touch have coalesced around media technologies. While the birth of the graphical method and the sphygmograph has often been considered a threat to the embodied authority of the clinician, the examination of the literature surrounding the production of the 'educated finger' has demonstrated how the technology remediated the *tactus eruditus* of the physician, producing new haptic techniques which served to strengthen the authority of the hand of the clinician as the bearer of proper touch. While the contemporary proliferation of wearable sensor technologies has often been understood as generalizing or banalising this capacity for knowing the body, the analysis of the role of error within the application of the photoplethysmographic sensor has demonstrated how technologies like the Apple Watch in fact serve to produce a distributed form of improper touch. Rather than producing the body as a coherent communicative medium, the Apple Watch

serves to enmesh the body within a network of error, which the ordinary user is unable to ultimately correct, thus denying the promised capacity for bodily enquiry.

Photoplethysmographic sensors' capacity for error serves to produce an intimate co-dependency between self-quantifier and medical practitioner; even as the proliferation of wearable sensor technologies encourages users to practice an intense form of surveillance over their own vital capacity, the 'truth' of the data produced by wearable devices remains compromised, and necessitates validation and confirmation by trained medical professionals. While self-quantification devices seem to offer the promise of empowering the user to define oneself in all of one's individuated biological difference, the place of the doctor is reaffirmed as necessary in order to bridge the gaps in the recording apparatus. The significance of this comparison then serves to contest established discourses surrounding the place of embodied knowledge in the late 19th century and contemporary periods. The tactile remained a significant locus of medical authority post the introduction of graphical recording technologies, while in our own period, the attempt to generalise the project of bodily self-knowledge remains trammelled by a landscape of technical and discursive snares, which serve to generalise and enshrine a form of technologized improper touch.

CHAPTER FOUR

POST-TAYLORISM AND NEO-POST-TAYLORISM: CULTURAL TECHNIQUES OF WORK-MEASURE

The contemporary use of biosensors and data analytics as a form of workplace monitoring is often compared to Taylorist work management practices. This chapter seeks to complicate this framing by comparing the Quantified Self-ication of work to the post-Taylorist European Science of Work, which sought to reconcile Taylorist productivism with the European tradition of physiological enquiry (Rabinbach, 1990), as well as to the statistical analysis of Thomas North Whitehead (1938) within the American Human Relations school. Where Taylorism relied upon a schematic view of the labouring body, European work scientists such as Jean-Maurice Lahy and Jules Amar used sensor technologies to produce physiologically sophisticated analyses of workers' fatigue thresholds and capacity for exertion. Whitehead meanwhile produced an ambitious statistical analysis of the emergent social relations of the workroom, in order to gauge and manipulate the affective relations of the workplace. I argue that it is these intimate and sensuous, sensor-enabled forms of worker surveillance which can be seen to be remediated in the contemporary quantification of work, which draws upon quantified measures of workers' productive capacity to produce flexible and emergent norms of labour management. The significance of this comparison is to challenge contemporary critiques of worker surveillance as rigid and dehumanizing; as this chapter shall demonstrate, such a critique is pre-empted in contemporary workplace monitoring, which pursues the 'soft' domination of workers through ostensibly more 'natural' and flexible forms of workplace organisation.

To consider the question of whether the Quantified Self movement is 'Neo-Taylorist' requires a sharper definition of what such a term may signify within contemporary industrial relations. To do so this chapter shall compare the current proliferation of wearable technologies in the workplace with a prior construction of the quantified worker through the application of the tools of *la méthode graphique* in what Anson Rabinbach (1990) has termed the European Science of Work. It shall be argued that

rather than considering the Quantified Self a contemporary iteration of Taylor's scientific management, a more accurate comparison is to be made with the more intimate, sinuous understanding of human movement and productivity inherent with the European Science of Work and the rich tradition of physiological study upon which it was founded, as well as the experiments in quantifying workplace relations carried out by Thomas North Whitehead in the 1930s.

As Rabinbach has argued, the application of sensor technologies to workers in the period following the introduction of Scientific Management in France had a double-outcome: on the one hand it 'softened' the production process to make it less 'inhuman' and dangerous to workers; however this same softening served to ensure a greater synchronicity between worker and machine, tying the worker closer to the rhythms of the production process (Rabinbach, 1990). Similarly, the use of sensor technologies and big-data analytics in the contemporary workplace has enabled the emergence of new rhythms of production, supposedly more closely aligned with the 'natural' rhythms of worker's attention and biological temporalities. If in the classical Taylorist approach biometric analysis was a tool to adapt bodies to the rhythm of the production line, the contemporary trend is to foster the production of emergent norms requiring the ongoing, intimate surveillance of patterns of employee behaviour. Comparison will also be made with the more psychologically-driven Human Relations approach to worker management typified by Elton Mayo (Mayo, 1933), particularly the often neglected attempt by Thomas North Whitehead to provide a precise, quantifiable measure of the affective relations between production line workers. The analysis and development of worker surveillance technologies over the course of the 20th and 21st centuries can be described as an attempt to create versatile and adaptive means to measure the productive output and capacity of the working body, in both white collar and blue collar working environments.

Through an analysis of the sensor analytics firms *VoloMetrix* and *Humanyze*, it shall be argued that the significance of the comparison between the European Science of Work and the contemporary Quantified Self-ication of work lies in their comparable efforts at the 'soft domination' of workers. Through the careful recuperation of worker fatigue and productive capacity, the opportunities for worker resistance become attenuated, as

such resistance is always already accounted for within the parameters of the system of measurement and control itself.

The intention of this chapter is not to either elide the self-evident violence and exploitation involved in such work environments as the notorious Amazon distribution centres (see Adler-Bell, 2019; Gomez, 2019; O'Connor, 2013), nor to 'defend' such techniques as in fact acting to "reduce work-related stresses and optimise worker creativity" (see Windeyer, 2019: 238-239). Quite to the contrary, it is evident that the development of such techniques in fact produces new and ever more far reaching domains for work-related stress and the recuperation or stifling of creative freedom, as the spatiotemporal limits of the workplace become mutable and subject to interminable, suffocating revision. As in the analysis of the distribution of biosensors in health practices discussed in the last chapter, it is evident here that sensors are used in this context as much to subsume the body of the worker as to enable the recalibration of the workplace around her embodied capacity, the better to enable a fluid dispersion of authority. This is theoretically significant in that it troubles critiques of work predicated upon an embodied phenomenological analysis, such as Lefebvre (2002; 2004), or Thompson (1967), who would argue for an account of worker resistance predicated upon an assumption of certain biological temporalities which could not be ultimately recuperated by the work measurement apparatus. Analysis of the tools and techniques of the European Science of Work and contemporary sensing metrics like 'sociometrics' reveals the double movement of *somaletheia* – we encounter a profound attempt to frame human productive capacity as best brought to light through measurement of the body, while, at the same time, the failure of that very project is made productive through its use to justify endless recalibrations.

In this chapter I begin by examining the popular and academic understandings of the use of biosensing technologies in the workplace as a remediation or 'intensification' of Taylorist workplace management. I then review the development and features of Taylorism as a management ideology, before considering how the European Science of Work and the Human Relations movement served to respond to and modify the tools of Taylorism in order to produce a more adaptive and supple means of accounting for the working body. I proceed to make comparisons between this 'post-Taylorist' turn and

contemporary iterations of workplace measurement – taking as case studies the firms *Volometrix* and *Humanyze*, and the ‘Honest Signaling’ theories of Alex Pentland (2008; 2012). I conclude by considering the implications of understanding the sensing of the labouring body through the lens of somaetheia, both in terms of what it suggests about the limitations of established phenomenological work critique, as well as what this might tell us about the shape of resistance to come. In essence, I argue that the contemporary use of biosensors in the workplace is more accurately and more usefully understood as neo-post-Taylorism. This is an admittedly ungainly neologism, but ‘post-’ is a key modifier here. *Volometrix* and *Humanyze* refine and remediate those cultural techniques of measure which responded to the limitations of the Taylorist approach through the production of an iterative and emergent way of measuring the physiological capacity of the body *from below* and in relation to co-workers and the working environment.

THE QUANTIFIED SELF AS ‘NEO-TAYLORIST’

In *The Data Driven Life* (2010) Quantified Self thinker Gary Wolf assures the reader that the Quantified Self does not constitute any kind of Neo-Taylorist cult of optimisation: “People are not assembly lines. We cannot be tuned to a known standard, because a universal standard for human experience does not exist” (Wolf, 2010). The reader is encouraged to consider the Quantified Self not as harbinger of a new and more totalising time-and-motion man, peering over our shoulder at every moment of the day, but as a practice predicated upon the careful, sophisticated probing of the individual.

While the ‘mainstream’ of Quantified Self discourse has focussed on the incorporation of techniques of self-quantification within the practice of everyday life, there has nevertheless been an enthusiastic embrace of the ‘Neo-Taylorist’ potential of the Quantified Worker in sectors of the business press. Human Resources consultant Josh Bersin has written in *Forbes* of the capacity for more intimate surveillance technologies to drive down theft, increase productivity, and even monitor employee social media data for indications that employees are considering looking for work elsewhere, meaning that “[f]ast-growing companies can quickly figure out who is thinking about leaving and

try to prevent retention problems” (2014). For Bersin these tools are unambiguously good news for management and workers, arguing that “employers already have plenty of data about all of us: our job history, employment history, salary, performance evaluations, and when we clocked in and out each day. If companies start using this information to improve the workplace, we’ll see better management, better hiring, and improved workplace conditions” (Bersin, 2014). Writing in the *Harvard Business Review*, H. James Wilson has written in similarly glowing terms of wearable body sensors and data analytics as “[representing] the next evolution of the time and motion studies done by the efficiency expert Frederick Taylor a century ago. Taylor examined iron workers individually to derive generalizable insights. Physiolytics [Wilson’s term for the study of data produced by wearable sensors] goes much further” (2013).

For critics of the Quantified Self, Wolf’s pre-emptive declaration has been unsurprisingly read as unconvincing. Evgeny Morozov has analysed the movement as part of his polemic against ‘Solutionism’, which he defines as the belief that human inefficiency and error can be overcome through the incorporation of Big Data and digital analytics into every aspect of both work and everyday life (2013). Morozov argues that the urge to self-quantify amounts to a sort of biologicalisation and internalisation of Taylorist precepts, a ‘Taylorism within’ (2013: 228) which threatens to eviscerate life of the lived qualities of spontaneity, creativity and pleasure.

The labour sociologists Phoebe Moore and Andrew Robinson have also described the Quantified Self at Work as a form of Neo-Taylorism. Along similar lines to Morozov they argue specifically that the quantification of the workplace relies upon a reification of the Cartesian (and Taylorist) dualist split between an observing, controlling, rationalist mind, and an observed, controlled and dominated body. “[The Quantified Self at Work] is an attempt to quantify the affective field so as to render it more predictably exploitable, transgressing mind–body dualism from the side of the mind and eliminating possibilities for experience except as an efficient, rational, masculinised, managed subject” (Moore & Robinson, 2016: 2775). Moore and Robinson argue that these technologies seek to monitor and quantify modes of employee behaviour which would have previously existed beyond the ambit of such abstractions, thus minimising the scope of worker autonomy and devaluing tacit, non-formalised aspects of workplace

behaviour. They argue that this also reduces the scope for worker resistance, as such technologies “[render] the sites of everyday resistance, such as worker-to-worker communication penetrable by management, as well as producing data to study the efficiency of communication styles” (Moore & Robinson, 2016, 2779). Invoking the philosophies of Deleuze and Guattari (1987) and Bergson (2001), they argue for the need to reassert the value of those qualitative and affective modes of being in the world which resist measure and validation through quantification, such as the artistic and creative impulses of human individuation and becoming. Labour resistance, they predict, will come to struggle around a demand for “a world without measure”, for an appreciation of “slowness, incommunicability, the seizure of free time, exodus from big data/social media and the refusal of telepresence and visibility” (Moore & Robinson, 2016: 2787). In the call for a ‘world without measure’, Moore and Robinson can be understood as in line with what Alexander Galloway has observed as a turn in critical theory and critical political economy towards a “politicization of absence – and presence – oriented themes such as invisibility, opacity, and anonymity, or the relationship between identification and legibility, or the tactics of nonexistence and disappearance, new struggles around prevention, the therapeutics of the body, piracy and contagion, informatic capture and the making-present of data (via data mining)” (2011: 246-247).

Phoebe Moore has revised and developed this argument in what amounts to probably the most sustained critique of the introduction of sensor enabled technologies into the modern workplace, her 2018 monograph *The Quantified Self in Precarity: Work, Technology and What Counts*. Moore combines historical and ethnographic analysis, including detailed interviews with white collar workers who have been subject to ‘intensive’ quantified tracking of their productivity in the modern office, to produce a Spinozist critique of what she terms the “autonomic self” which has been produced in the cauldron of the precarious and “agile” modern workplace. Moore writes:

Autonomic refers to the nervous system of a physiological self where the mind, sentiment and body are less separable than mainstream Cartesian modernism dictates. Autonomic means self-governing and comes from the Greek, ‘auto’ or ‘self’ + ‘nomos’, or ‘law’. Through intensive and long-term data collection

advocated by the Quantified Self movement... individuals have begun to pursue autonomic self-knowledge to improve ourselves. To gain this knowledge and set out self-improvement plans, we track movement, activity, emotions and attitudes in a quest to gain more intimate knowledge about the self. We wish to control, modify, regulate and understand our 'selves' more precisely in order to control, improve and develop this 'self'...a self that requires constant, uncritical self-improvement. (2018: np)

Moore hence argues that contemporary workplace surveillance has partially recuperated the critique of Cartesian dualism, producing a work environment predicated upon a newly agile, precarious, and intensified relation to the exploitation of labour. Nevertheless, Moore maintains that “Neoliberalism remains a Cartesian subjectivity and system”; despite having abandoned the rigid separations of Fordism and insisting on processual, systems-level thinking, the emergence of the “managerial self, who manages both her/his subjectivity and the outer world, reproduces the Cartesian trope of the subordination of (risky) body to (rational) mind” (2018: np).

Moore provides a history of the developments in workplace management which she sees as crucial to the production of the autonomic, managerial self – periodising her historical analysis as moving from ‘Industrial Betterment’ (1870-1900), to ‘Scientific Management’ (1900-1923), ‘Human Relations’ (1925-1955), ‘Systems Rationalism’ (1955-1980), ‘Organisational Culture and Quality’ (1980-ongoing), and the overlapping ‘Agility Management System’ (2001-ongoing). Industrial betterment describes a form of “welfare capitalism”, by which nominally benevolent industrialists proposed certain ‘improving’ welfare programs for their workers in the effort to promote a more durable working environment for their employees in order to forestall labour militancy. Moore argues that this tendency foundered in the aftermath of the Pullman Palace Car Company Strike of 1894 – while Pullman had offered significant welfare programmes to his employees, social critics and even industrial engineers pointed to the enmity of the strikes as evidence that such programs did not truly provide for the needs of workers, and were only a sop to placate the demands of labour. “Scientific Management” and the “Human Relations” school will be described in greater detail later in this chapter. The key point that Moore identifies in the Taylorist and Gilbrethian

model of scientific management was to identify the most efficient and least wasteful expenditure of worker's physiological effort during the production process, the "conviction that science would perfect the foibles of human experience and that exact measurement would both eliminate any unnecessary waste of spent time and human effort as well as any possible loss of expenditure for a company" (2018: np).

Moore argues that as this goal faced sustained worker resistance and difficulty in its application it was superseded by the Human Relations movement spearheaded by Elton Mayo and associates at the Harvard Business School. The Human Relations approach held that the physiological and environmental factors emphasised by Taylorists were less important than the psychological needs and desires of the workforce – Mayo held that worker discontent could be explained away as 'neuroses' of particular workers who were not receiving adequate attention from managers. The next turn, from the 1950s onwards, the Systems Rationalist school, sought to design company wide processes of production, such that "while Taylor and the Gilbreths looked for correct practices for work and management, researchers in operations research sought idealised processes, introducing a level of abstraction that has not disappeared" (2018: np). Systems rationalists were opposed to the psychological approach of the Human Relations period, arguing according to Moore in favour of a neo-Taylorist emphasis upon process as well as forward planning predicated on an instrumentalised understanding of abstract workers understood in decorporealised goal seeking terms: "The research relied on a supposed objective truth that humans are rational beings and that employees would simply behave as instrumental actors in the workplace. Human behaviors in workplaces were expected to model the performance and terminology derived from early computers" (Moore, 2018: np).

Moore argues that as the corporation as a form of industrial organisation has lost its significance to some degree in an age of precarious work, the emphasis in workplace management has now shifted to "Organisational Culture and Quality". The transformation of workplace "culture" in this respect requires employees to identify with what Boltanski and Chiapello refer to as the "New Spirit of Capitalism" (2005) and to accept their place within the company as key to their own personal and even spiritual fulfilment – "employees were encouraged to embrace the brand and image of their

company and to align personal identities with the norms of their employers” (Moore, 2018: np). This understanding of work has in turn been supplemented in the 21st century by what Moore terms “agility management systems”. ‘Agility’ for Moore can be understood as:

similar in emphasis to scientific management, because its principles are influencing work beyond the technological production line...Agility requires workers to align themselves with specific values and to be constantly prepared for change, because technology inevitably changes, simultaneous to taking more authority over human work, whether through algorithmic management or automation, intensifying management practices or self-management responsibilities. (Moore, 2018: np)

Moore charts a development in managerial practices across the course of the 20th and 21st centuries, while nevertheless arguing for a clear through-line between especially Taylorist and current techniques for monitoring the outputs of workers. Moore argues from an affect-theory oriented critical position, drawing especially upon the monist philosophy of Baruch Spinoza, which insists upon a non-hierarchical understanding of the relation between body and mind, and between particular bodies and the broader environments and social relations in which they are embedded and engaged in a process of becoming: “For Spinoza, affect was an intensely embodied concept which refers to the active ways in which bodies affect one another and co-produce social life. The full positive realisation of affect means that the ‘power to act’ is enacted and solidarity is immaterial, becoming also conscious and corporeal” (Moore, 2018: np). Moore extends and radicalises this position, in line with the political theorisations of Italian autonomist thinkers such as Antonio Negri, arguing that “affective resistance is a serious threat to management. Simply put, affective solidarity would lead to the most difficult form of resistance to stop, akin to invasive management techniques of technological control to infiltrate all aspects of life; affect already infiltrates all-of-life” (Moore, 2018: np). On the one hand, Moore sees this control of affective capacity as constitutive of earlier modes of workplace control, but also argues that under the current mode of workplace measurement such control has become “intensified”. The notion of ‘intensification’ is somewhat ambiguous in her account; her key formulation of the distinction is that

“Where technology was used in scientific management to facilitate work efficiency, in agility innovations in technologies themselves are dominant and work competencies must catch up with these” (Moore, 2018: np). According to such an argument, work surveillance has shifted from a ‘managerial determinism’ to a ‘technological determinism’, by which technology has become unshackled from human intervention and is now ‘setting the pace’ for the work process itself. In opposition to such a tendency Moore endorses an initiative established by the International Labour Organisation (ILO) to enshrine a standard of “dignified work” which she argues is inimical to the quantification and abstraction of work processes – though seemingly oddly congruent with the gilded age ethos of industrial betterment, Moore argues that ‘dignity’ is an intrinsic human quality which has been crushed by the precarity and agility of modern work systems.

While both critics and promoters of the Quantified Self movement have invoked the spectre of Taylorism as a point of historical comparison with the contemporary use of sensor technologies either in everyday life or in the workplace, all of the aforementioned commentaries have lacked precision in what precisely it is that ‘Taylorism’ is intended to signify. For Wolf, the Quantified Self inherits from Taylorism only a negative legacy, a point of distinction between the false universalism of assembly line metrological imperatives and the contemporary capacity for an exquisitely differentiated representation of individuated bodies. For the popular business press meanwhile, the Quantified Employee promises to inherit from Taylorism a vague aura of increased efficiency. For Morozov, Taylorism stands as a symbol of modernist alienation which the Quantified Self movement’s cryptofascist spokespeople are only too eager to inherit and accelerate. For Moore (and Robinson), quantified workplace monitoring produces an autonomic self which serves to ‘intensify’ the affective management and exploitation of Taylorism. I would argue that this lack of precision in the definition of the term points to a broader problem in the initial comparison, namely that the Quantified Self-ication of Work owes less to the Taylorist method *per se*, and more to the management theories which sought to alter and transform it. This chapter shall argue that more appropriate and illuminating comparisons can be drawn between the contemporary proliferation of wearable sensors

in the workplace and the post-Taylorist traditions of the European Science of Work and Human Relations theory.

TAYLORISM AND ITS DISCONTENTS

F.W. Taylor's infamous book on Scientific Management described his project as a three-pronged contribution to the pressing question of "national efficiency" (1911: 1). Taylor proposed that a 'scientific' elimination of wasteful acts might not only revolutionise industrial production, but could also be "applied with equal force to all social activities: to the management of our homes; the management of our farms; the management of the business of our tradesmen, large and small; of our churches, our philanthropic institutions, our universities, and our governmental departments" (1911: 7). By eliminating those "rule of thumb" methods with the most efficient use of worker movements, Taylor believed that limitations to production and prosperity could be overcome indefinitely (1911: 16). Key components of the Taylorist managerial philosophy included:

(1) The division of all shop-floor tasks into their fundamental parts; (2) the analysis and design of each task to achieve maximum efficiency and ease of imitation; (3) the redesign of tools and machines as standardized models; (4) the linking of wages to output; and (5) rational coordination and administration of production. (Rabinbach, 1990: 239)

The two key technical elements in the implementation of the Taylor system were job analysis – analyzing the work process to determine the one most efficient way to complete a given task and to eliminate wasteful or otherwise unproductive means of getting the task done (see Gilbreth & Gilbreth, 1916) – and time study – using the stopwatch to determine the optimum time in which a given task should be completed.

As Hugh Aitken has however noted in his classic study of the implementation of the Taylorist model at the Watertown Arsenal, there was an essential ambiguity in terms of what precisely the guiding principle of time study was:

Was it the minimum time in which a job could be done? ...Was it the average time — something Taylor would never have admitted? If so, why the attention paid to the elimination of waste motions and the selection of a particular individual to be timed? Was it, perhaps, an ideal time? In a sense it was. But an ideal — however defined — could not conceivably be measured by a stop watch, nor could it be inferred from any evidence a stop watch could provide. (1985: 26-27)

As shall be discussed, this vagueness and lack of attention to the particularities of measuring workers' vital capacity was to constitute a major point of objection to the implementation of the Taylorist system from both workers and work scientists; that rather than resting on a 'truly' scientific foundation, the system of scientific management promoted and gave a veneer of objectivity to processes of overwork and management control. As Patrick Fridenson has noted, the centralising and standardising normative impulse of Taylorism had contradictory tendencies; on the one hand its fastidious attention to the scourge of wasted movement and the improvement of efficiency helped to boost production, but at the same time contained "the germ of bureaucracy cut off from the daily realities" of the shop floor, producing a hubristic pretension in its claim to define "the 'one sole correct method' of organising work" (1987: 1036-1037).

THE EUROPEAN SCIENCE OF WORK

The introduction of Taylorist methods into Europe met with mixed forms of resistance and transformation, as mass production methods faced resistance from highly unionised craft workers (see Womack, Jones & Roos, 1990: 233-242). Especially in France, Taylorist production methods were revised and altered through the incorporation of physiological data derived from sensor enabled analysis of the work process. The Taylorist organisation of the workplace faced especially fierce opposition upon its introduction into French workplaces, where Renault workers went on strike twice in late 1912 and early 1913, aghast at the perceived inhumanity of a system of management

which treated the individualised, atomised worker as a “desensitized, chronometricized machine separable from any human interaction” (Brauer, 2003: 84). The strikes were supported by physiologists and ergonomists sceptical of Taylor’s abstract and biologically unsophisticated conception of the labouring body (Brauer, 2003: 83-84).

As Rabinbach has extensively described, the reception of the productivist impulse of Taylorism within the European culture of management and physiological studies formed a distinct ideology of worker management, which he has dubbed The European Science of Work (1990). Typified in France by the work of physiologists such as Jules Amar and Jean-Maurice Lahy, this iteration of the European Science of Work was dedicated less to Taylorisation than to ‘tayloring’ the production process to the abilities of labouring bodies. While European work scientists were impressed by the Taylorist promise of increased productivity and efficiency, they argued the need to take into account the inevitability of fatigue, promoting a ‘humanising’ approach to work which aimed at conserving the health and safety of workers, while also serving to dampen worker militancy based on grievances related to alienation and inhumane conditions in the workplace.

Rabinbach argues that the European Science of Work was ultimately underpinned by the project of what he dubs ‘Social Helmholtzianism’, essentially the project of managing physical expenditure and attempting to minimise physical exhaustion within the context of the growth of industrial modernity. Hermann von Helmholtz had in the mid-19th century explored and, through a series of public lectures, popularised the consequences of the first law of thermodynamics, that energy can be neither created nor destroyed, but only transformed from one form into another. The significance of this point for the working body was that work be understood as the expenditure of physical force, that such expenditure could not carry on indefinitely, and that there was a pressing need for scientists to uncover that physiological ‘law of least effort’ which would allow the most efficient expenditure of effort, thus minimising worker exhaustion (Rabinbach, 1990: 122). This line of enquiry was most famously pursued by the Italian physiologist Angelo Mosso, who in his 1891 text *La fatica* attempted to “establish the dynamic laws of fatigue by rigorous experiment and new techniques of measurement” (Rabinbach, 1990: 7). The European Science of Work was also indebted to the research

tradition of Étienne-Jules Marey, whose pioneering use of sensor technologies to measure physiological processes in the second half of the 19th century, as discussed in the previous chapter, produced a newly sophisticated way of representing the intervals of bodily movement.

Rabinbach argues that European physiologists did not attempt to make actual interventions into the organisation of workplaces until the introduction of Taylorist methods into European factories from roughly 1910 onwards. In opposition to the Taylorist method focussed upon maximising productivity, the European Science of Work pursued a careful ergonomic analysis of the labouring body in order to divine the optimal balance between rest and fatigue, “optimizing workers' health, longevity, security and psychology in order for work to become an art” (Brauer, 2003: 84). This sinuous understanding of human movement was reflected in European physiologists’ disdain for the rigid, linear abstraction of movement propounded by Taylor.

In *Le Système Taylor et la Physiologie du Travail Professionnel* (*The Taylorist System and the Physiology of Professional Work*) (1921), Lahy criticises Taylor for his ignorance of the sophisticated legacy of physiological measurement pioneered by Marey and continued into the early decades of the 20th century at the Marey Institute. “The application of the continuous graphic method”, writes Lahy, “has given infinitely superior results to those of [the Taylorist method]. This crucial innovation made by Marey...and ignored by Taylor, would, beyond its superior exactitude, have allowed for a simpler, more cost effective, and more efficient mode of research” (Lahy, 1921: 62).⁷ Taylor’s ‘one best way’, Lahy argued, was significantly compromised by its reliance on the use of an ‘ideal’ worker in a work laboratory setting, aiming to exert himself beyond his usual efforts in the desire to attract bonuses for higher output, and who was thus working at an intensity which would be unsustainable in the long term (Lahy, 1921: 63). Instead of seeking pseudo-scientific ‘laws’ of maximum exertion through the laboratory

⁷ Author’s own translation, from original: “Il faut toutefois signaler ici que l'application de la méthode graphique par inscription continue eût donné des résultats infiniment supérieurs à ceux des moyennes. C'est l'innovation capitale faite par Marey et par Imbert, ignorée de W. Taylor, qui, outre son exactitude supérieure, aurait permis des recherches plus simples, moins coûteuses, plus brèves”.

observation of a worker completing a given task, Lahy proposed researchers seek to study workers in the complex environment of the workplace itself, in order to provide a more intimate and more holistic analysis of the worker under ordinary conditions:

Beyond the ‘theoretical’ study of the cut of a carpenter’s plane, one will study there the physical and moral conditions of the milieu, the lighting, any extra tools and accessories at hand, the proximity (*voisinage*) of other workers, the obligation to work constantly or not, etc...All conditions which can modify profoundly the results of the experiment. (Lahy, 1921: 210)⁸



FIG. 45. — Travail d'un apprenti limeur et analyse de sa fatigue.

Figure 8

An apprentice filer working equipped with Amar’s spirometer

Source: Amar, J (1917) *L'Organisation Physiologique du Travail*, p. 128

⁸ “On y étudierait, outre le coup de rabot « théorique », les conditions du milieu physique et moral, l’éclairage, l’outillage accessoire, le voisinage des autres ouvriers, l’obligation de travail assidu ou non, etc. Toutes conditions qui peuvent modifier profondément les résultats de l’expérience”.

In *The Physical Organisation of Work (L'Organisation Physique du Travail)* (1917) Jules Amar details the function and results of one such experiment, analysing the exertions of file operators. The filers were equipped with a spirometer which supplied the worker with pure oxygen and could record the force of his exhalations, thus providing a measure of his degree of fatigue over time. Amar conducted experiments comparing the exertions of experienced workers, in order to determine the most sustainable and productive work process. Over a period of 8 months Amar manipulated and calibrated elements of the work process, including the rhythm of the file movement, the stance towards the work bench, and the length of time spent working compared to resting between exertions, comparing these with levels of output and worker fatigue. Ultimately Amar was able to recommend what he felt were certain guidelines enabling the most even and sustainable work process:

The body of the subject should be vertical, relaxed, standing 20cm from the vice, which should be at the level of the navel; the position of the feet should be open at a 68 degree angle, with 25cm between each heel...the cycle of the file should glide simply, without putting weight on the arms. Finally, the rhythm [of the task] should consist of 70 movements per minute. All such conditions being fulfilled, one will pursue work for *5 minutes followed by 1 minute total of rest*, with the arms resting along the side of the body...Local fatigue in the right forearm is sustainable (*supportable*), and general fatigue is barely visible. The maximum amount of work [which can be produced if such directions are followed] is at least *double* the ordinary amount of work of the great majority of workers. (Amar, 1917: 130 emphasis in original)⁹

⁹ “Le corps du sujet doit être vertical, sans raideur, distant de 0m,20 de l’étai, et ce dernier au niveau de l’ombilic; la position des pieds telle que leur angle d’ouverture soit, de 68° et la distance entre les talons de 0m,25...Les retours de la lime doivent consister en un simple glissement sans appui des bras. Enfin, le rythme des mouvements est de 70 par minute. Toutes ces conditions étant remplies, on fera suivre *un travail de 5 minutes d’une minute de repos complet*, les bras tombant le long du corps...La fatigue locale de l’avant-bras droit est supportable, et la fatigue générale se laisse voir à peine. Le travail maximum est au moins double du travail ordinaire de la grande majorité des ouvriers”.

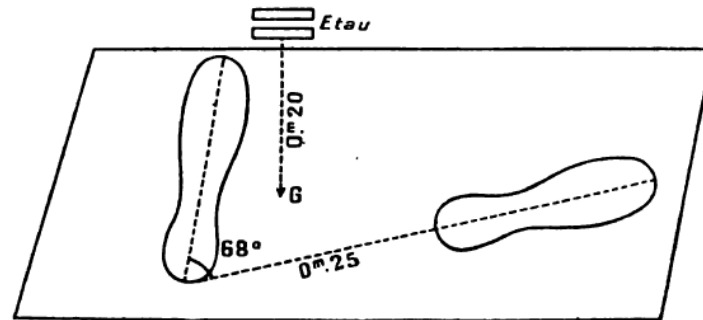


FIG. 46. — Attitude économique du limeur.

Figure 9

Amar's diagram of the optimal distance and stance for a file operator to take in relation to his vice

Source: Amar, J (1917) *L'Organisation Physiologique du Travail*, p. 129

Beyond studying and refining the techniques of seasoned workers, Amar was able to promote his findings as a means of instruction to younger workers. Applying the same techniques of study to a 15 year old apprentice, Amar observed that the young worker quickly exhausted himself – “after two minutes, the young man is exhausted, his breathing uneven and shaky” (Amar, 1917: 132)¹⁰. Amar determined that the apprentice was overexerting himself, pushing his chest over the vice, with his feet poorly set, such that he had to constantly twist his body in order to manipulate the tool (Amar, 1917: 132). Amar blames over-rigid instruction for this ‘awkward’ technique:

Generally, the so-called instructors, in order to correct beginners, advise them to stand up stiff and straight. However, this lack of flexibility creates fatiguing contractions of the muscles in the torso... There is a great deal of nonsense (*gribouille* – literally ‘scribble’) in the lessons of classical apprenticeship. (Amar, 1917: 132)¹¹

¹⁰ “...le jeune homme est essoufflé, ses respirations sont accidentées et procèdent par saccades”.

¹¹ “Généralement, les prétendus instructeurs, pour corriger les débutants, leur conseillent de se tenir droits et raides. Or, cette absence de souplesse crée des contractions fatigantes dans les muscles du tronc... Il y a du gribouille dans l'apprentissage classique”.

By contrast, Amar himself drew upon the tracings produced by the spirometer to demonstrate to the young apprentice how his poor technique was causing him to overexert himself by comparison with the effort of the more experienced filer. Rather than following the rigid didacticism of the foreman's instruction, the young man was "guided by the graphic method" (*guidant d'après la méthode graphique*):

He read for himself, in the irregularity of the trace, the effect of his own inexperience, and corrected himself accordingly...He received a true lesson in things from the worker who, trained (*dressé*) intelligently, does more useful work and exerts less of his energy. The dynamographic curves and the data on oxygen consumption testify to it. (Amar, 1917: 132)¹²



FIG. 25. — Graphique du travail d'un bon ouvrier limeur.

Figure 10

The even spirometric readings of the work of "a good filer" working at an optimal and sustainable pace

Source: Amar, J (1917) *L'Organisation Physiologique du Travail*, p. 73

¹² "Il lisait lui-même, dans l'irrégularité du trace, l'effet de son inexpérience, et se rectifiait à propos... il recevait une véritable leçon de choses de l'ouvrier qui, dressé intelligemment, fait plus de besogne utile et prodigue moins ses forces. Les courbes dynamographiques et les valeurs de la consommation d'oxygène en témoignent".

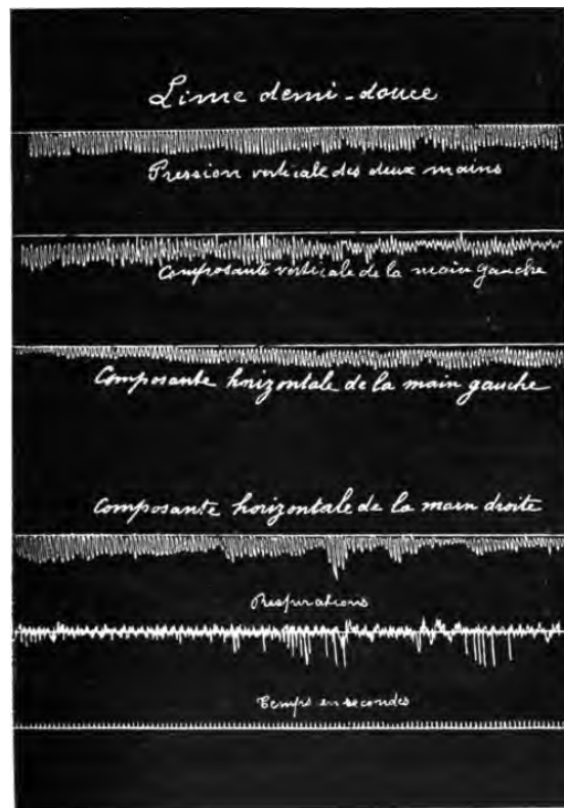


FIG. 47. — Graphique du travail d'un apprenti limeur.

Figure 11

The erratic spirometric tracings of a 15 year old apprentice filer

Amar, J (1917) *L'Organisation Physiologique du Travail*, p. 131

If in the previous chapter we saw that for Broadbent, the utility of the graphic method was the production of an 'educated finger', here we see its use to develop the 'educated filer' – a mode of management and instruction which again traverses the somalethic problematic. For Amar, it is a matter of moving from the 'scribble' of classical apprenticeship, to the productive errancy of the 'irregular trace'. The effectiveness of such a 'correction' is that the mode of comportment to be adopted by the apprentice filer is supposedly self-evident – it is a case of recalibrating and being recalibrated in line with the norm established through the careful consideration of the more experienced filer.

As Laura Levine Frader has noted in her study of the application of the European Science of Work within telephone exchange rooms, this ostensibly more sophisticated, adaptive, and sinuous model of work-process instruction and management was well received by many workers in France (Frader, 1999). Frader notes that in some

workplaces, it was workers themselves who encouraged the implementation of these tools:

workers blamed the engineers of the PTT [the French telecommunications ministry] for the problems with the service and proposed using the research of Lahy, Fontegne, and Solari for guidance to end operators' overwork. This would allow the administration to introduce “more humanity in the length of rotations, breaks, and regulation”. (Frader, 1999: 145)

Indeed, workers saw the more intimate surveillance of the European Science of Work as potentially constituting “an antidote to the worst abuses of Taylorism” (Frader, 1999: 145). Rabinbach has argued that the interwar period represented in Europe an ultimate rapprochement between Taylorism and the European Science of Work, as French and German firms, while transfixed by the increased efficiency of the Taylorist methods, were also incorporating more ‘humanising’ touches, the better to preserve workers for the long haul and to stymie worker militancy. The ‘top down’ methods of Taylorist efficiency could be usefully ‘softened’ through the ‘bottom up’ incorporation of detailed physiological data on fatigue and sustainable degrees of exertion, in the production of a workforce ultimately more disciplined and productive than had been the case through the simple imposition of Taylor’s schematic and abstracted approach.

MAYO AND THE HUMAN RELATIONS SCHOOL

Another important ‘response’ to Taylorism was the Human Relations management theories developed by Elton Mayo and his colleagues at the Harvard Business School following a series of tests at the Hawthorne plant of the Western Electric Company between 1924 and 1932. Elements of psychological testing, particularly aptitude testing, also formed an important part of the German school of the European Science of Work, especially in the theories of Industrial Psychology pioneered by Hugo Münsterberg (Rabinbach, 1990: 253-258). The Hawthorne tests are famously touted as revealing the importance of the social aspect of the workplace, providing a ‘rehumanized’ vision of the ideal working arrangement, at odds with the alienation engendered through Taylor’s

‘superproduction’.

Mayo’s original investigations took in a similar approach to the physiologically-oriented researchers of the European Science of Work; using blood pressure sensors to measure rates of fatigue and exhaustion in the workplace for example. However, rather than verifying the ‘Social Helmholtzian’ thesis, he became convinced that physiological problems were of only secondary importance at work. Mayo argued that fatigue resulting from physical overexertion was of only minor significance in the consideration of worker dissatisfaction, noting that “increasingly in industry the machine does the work and man merely directs it” (1933: 18). Physiological determinants were downplayed by Mayo and the other Hawthorne researchers in favour of psychological and social explanations for worker productivity and job satisfaction (Gillespie, 1991: 181).

The Hawthorne tests were originally begun as an experiment in determining which levels of lighting in a workroom produced optimum levels of productivity within a workgroup, however it was determined that worker productivity seemed to increase regardless of the change in lighting conditions. The first part of the study followed six female workers in a special relay assembly room, studying their rate of output as they assembled telephone relays over a period of five years. A mechanical sensor registered the time it took for each worker to assemble one relay, and this measure was taken as a proxy for productivity. Over the period of the study this six-woman group produced millions of bits of data, which it was the task of the researchers to parse. The researchers measured changes in production rates after certain alterations were made to the structure of the working day, finding that productivity seemed to go up after almost any change was made. Seeking to explain this phenomenon, the Hawthorne researchers formulated what became known as the ‘Hawthorne Effect’; the thesis that the increase in productivity could be traced simply to the fact that the test group were responding positively to the fact of being treated with special attention and interest from the researchers and management (see French, 1953).

Downplaying the place of financial incentive, Mayo argued that “the industrial worker ...does not want to develop a blackboard logic which shall guide his method of life and

work. What he wants is more nearly described as, first, a method of living in social relationship with other people and, second, as part of this an economic function for and value to the group” (1933: 173). Mayo argued that ultimately worker discontent and low productivity stemmed from the *anomie* of industrial civilization, and that a managerial elite needed to be trained in the capacity to interpret worker neuroses and encourage social cohesion amongst the workforce. As Gillespie has argued, it was this turn towards the promotion of psychological rather than expensive and difficult physiological and environmental change which served to render the Human Relations approach more attractive to managers than the conclusions and recommendations drawn from the physiological tradition of worker management (Gillespie, 2004: 430). As Jason Oakes points out however, this was not a wholesale rejection of Taylorist productivity:

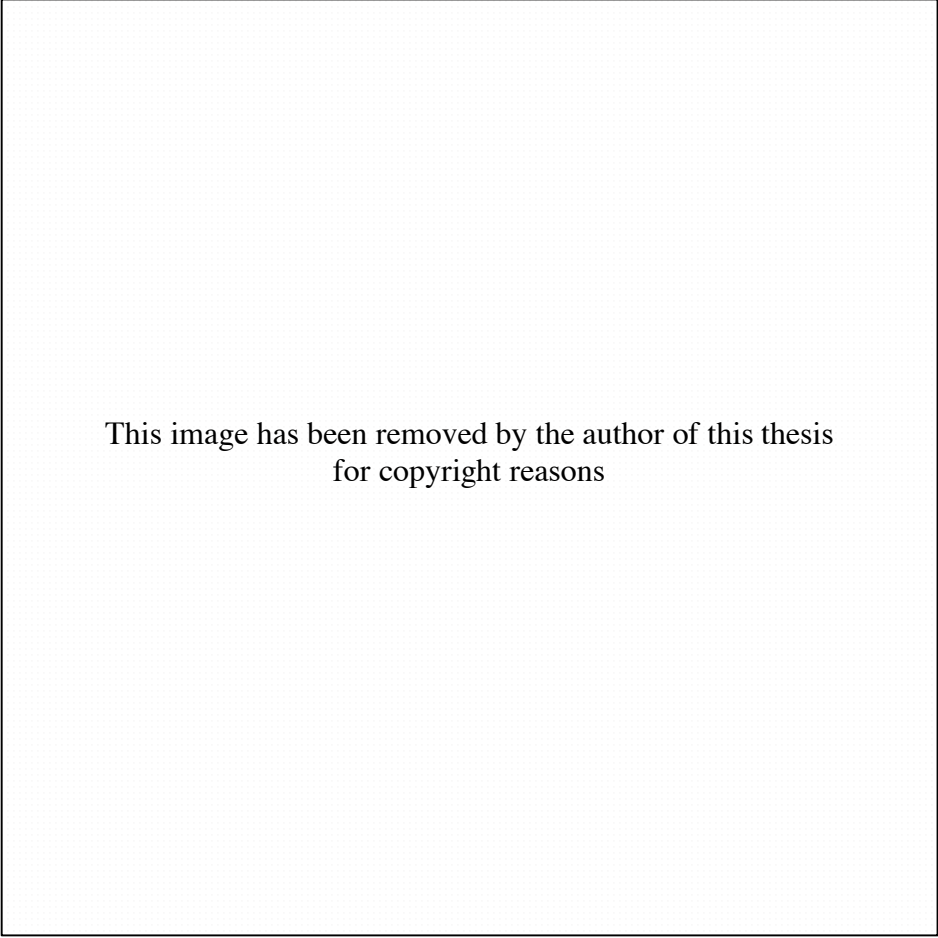
Mayo’s group theorized unionization, wildcat strikes, low productivity, and high turnover to be partly physiological and partly social in origin, and their overall aim was to optimize the organization of small groups of workers so that the things that worked well were promoted and the things that did not work well were avoided. (2015: 378)

Mayo’s interpretations were informed by his fractured training in psychology and psychoanalysis, and amongst other factors, are remarkable for their *lack* of quantitative rigour: as Bruce and Nyland note in their reading of Gillespie’s analysis of the Hawthorne experiments (1991), “Mayo’s theory of human relations was based almost entirely on his own political interpretation of worker motivation” and that in turn “his career can be seen as the rise of causal knowledge above statistical fact and the emergence of high theory masquerading as factual evidence” (2011: 385). Management, under this model, was encouraged to ‘govern the soul’ of their workers (Rose, 1991); Mayo argued that it was only a technocratic managerial elite who could be trained to accurately determine the cause of particular worker dissatisfactions and to recommend the appropriate workplace adjustments, that “before the worker’s comments could be of any use they had to be reinterpreted by managers trained in the techniques of psychopathology” (Gillespie, 1991: 183). This lack of quantified evidence and emphasis upon an enlightened manager’s psychological judgement marks the Human Relations

approach as distinct from the Taylorist and European Science of Work approaches previously described.

A notable exception in the early Human Resources school was the researcher Thomas Whitehead, who was a part of the research team at the Hawthorne plant and who spent six years submitting the data collected at Hawthorne to statistical analysis, attempting for example to determine the effect on group solidarity and productivity of changes in seating arrangements within the work room (1938: 192-236). Whitehead attempted to produce statistical correlations of the social sentiments in the relay test rooms, and of the relation between individual's productive capacity. Whitehead produced a series of quite complicated figures in his attempt to show how the relationship between workers in the assembly room correlated with increased or decreased production ratios. In Whitehead's own explanation:

Each diagram consists of five circles in a row representing the five operators. Each circle has in it the distinguishing number of one of the operators, and they are so arranged as to show the actual order in which the operators sat...A line joining a pair of operators in any diagram indicates the presence of a relationship having a strength of 9% or more; the actual strength is given closer to the line. A relationship having a determination of $\pm 50\%$ or more is shown by a thick line, and [is] referred to as a strong relationship. A weak relationship...is shown by a thin line. Negative relationships are indicated by thin or thick broken lines as well as by the negative sign... (1938: 210)



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Figure 12

Diagrams E & F, depicting the positive influence of operator 5a, and the disruptive return of operator 5

Source: Whitehead, T (1938) *The Industrial Worker*, p. D-23

The actual diagrams are, as Gillespie notes, somewhat difficult to follow, but diagram E demonstrates, according to Whitehead, the positive influence of a new operator, 5a, who had replaced a disruptive former worker. Diagram F meanwhile represents the chaotic disruptive state of affairs when the old operator 5 replaced operator 5a and the other operators moved seats within the assembly room. For Whitehead, these pair-relationship diagrams reflected the intense importance of intragroup social relationships, as well as the importance of maintaining a unified and consistent group setting. “Social sentiment”, Whitehead explains:

is based on habitual activities pursued in common. And any threat to the continuance of these activities is apt to arouse a common emotion of defense or

fear. The effect is likely to be an exhibition of group solidarity which may assume a number of alternative forms. Whatever its particular form, such an exhibition will tend to reassure the group as to its assured integrity. (1938: 212-213)

For Whitehead then, these diagrams attempt to produce a quantifiable measure of the developing affect of intra- and whole group relations and senses of solidarity, as these served to fragment and reunify in the wake of disruption and disquiet.

Despite his immense efforts, “[t]he results of Whitehead’s years of statistical analysis were not that impressive. The pair relationships could be used too selectively to be very persuasive” (Gillespie, 1991: 194). Nevertheless, Whitehead’s studies hold significance in so far as he sought to avoid projecting a predetermined evaluative criteria; instead he sought to put in place a form of measure which reflected an emergent and co-dependent understanding of group dynamics and unity, a bottom-up rather than top-down form of measure which would nevertheless not eschew statistics or quantification, but make use of them to give a potentially more totalising and consequential account and valorisation of group productivity.

Whitehead’s statistical analysis of the Hawthorne tests remains far more obscure than other key analyses of the experiments, such as Roethlisberger and Dickson’s *Management and the Worker* (1939) and Mayo’s *The Human Problems of Industrial Civilization* (1933). It is notable that a lack of quantifiable assessment remains a key feature of the contemporary Human Resources school of management, and indeed forms a point of anxiety amongst some Human Resources theorists regarding the continued relevancy and justification of the school in an age of Big Data and worker quantification. As Angrave et al. have described in their account of *why HR is Set to Fail the Big Data Challenge*, there is a continued reluctance amongst Human Resources practitioners to consider humans and their social relations at work in terms of metrics (2016: 4; see also Rasmussen & Alrich, 2015). This reluctance though is now rearticulated in terms of an anxiety – while HR has defined itself as counter to the abstract schematicism of Taylorist approaches, it must now find a way to redefine its mission in order to stay ‘relevant’ in the big data era. Thus, though he was neglected in

his own time, Whitehead's interest in attempting to produce statistically significant findings related to the Hawthorne experiments seems to pre-empt contemporary concerns with the quantification and statistical analysis of workplace. Where the Human Relations school was recognised as a turning away from the rigorously quantifiable and schematic approach of the Taylorist school, with the rise of big data analytics and ubiquitous sensors, we may now be entering or returning to a situation by which Whitehead's approach becomes normalised or indeed normative.

THE CONTEMPORARY MEASUREMENT OF WORK: FROM THE AMAZON WAREHOUSE TO 'HONEST SIGNALING'

In this light it will be relevant to examine contemporary applications of the measurement and quantification of labour. Certain crude applications of sensor management at work, such as the use of the Motorola WT41N0 wearable terminal, can be seen as exemplifying a 'maximist' concern with productivity, reflecting the precarious state of low skilled warehouse workers in an age of austerity. A 2013 exposé by the *Financial Times* described the conditions of exploitation at British Amazon's warehouse in Rugeley; taking advantage of the cheap labour supply of the depressed Midlands, the company required warehouse workers to hurry anywhere between seven and fifteen miles per shift, their routes plotted by a wearable GPS computer which calculated the most efficient route to take between points on the shop floor, while also monitoring whether workers were keeping up with frenetic packaging schedules and relaying text messages from supervisors telling them to speed up (O'Connor, 2013: 14). Wearable terminals like the WT41N0 are advertised to potential warehouse clients like Amazon as offering the potential for "[m]ore throughput with the same staff, driving staff utilization up...[with] less time spent capturing more information on item movement, driving the cost of compliance with traceability regulations down" (Motorola, 2014). Workers quoted in the *Financial Times* piece record being fired after missing a single shift due to pain from blisters developed over the course of gruelling shiftwork (O'Connor, 2013: 14). The use of wearable sensor technologies and work terminals with the aim of pushing the working capacity of a precarious workforce to unsustainable extremes certainly does appear as a recuperation of the very worst

excesses of Taylorist exploitation and alienation, an expression of all the dystopian possibilities for the Quantified Worker described by Morozov, as well as other critics of contemporary performance management (cf. Taylor, 2013. For similar accounts see Adler-Bell, 2019; Gomez, 2019).

The use of sensor-enabled management techniques in the surveillance and control of white collar workers, which attempt to derive insights into productivity and time management through the analysis of employees' interaction in face to face and digital communication contexts, may be seen as more comparable to the post-Taylorist promotion of more nominally 'natural' and emergent norms of human conduct. Contemporary use of digital sensor management technologies such as *VoloMetrix* and *Humanyze* (formerly *Sociometric Solutions*), incorporating Alex Pentland's theories of 'Honest Signaling' (Pentland, 2008; 2014), presage a new iteration of the post-Taylorist project of intimate surveillance of gesture and worker capacity, in the effort to produce a sort of pseudo-harmony in the synchronisation between worker and the production process. While these forms of analysis take up analytical categories seemingly derived from the Human Relations tradition, the emphasis remains upon their inscription within the *body* of the worker, rather than on their conceptualisation within the social space of the workplace *per se*; these forms of analytics must therefore also be understood in relation to the physiological tradition of the European Science of Work.

In his 2008 book *Honest Signals*, Alex Pentland describes the organising principles behind his 'sociometer', a wearable sensor worn around the neck which "[measures] face-to-face interactions between people using an infrared transceiver (to detect when people were facing each other), a microphone (to collect sound), and a two-axis accelerometer (to measure body motion)" (2008: 102). The data collected by the sociometer is used to probe for what Pentland calls 'honest signals', defined as "behaviors that are sufficiently expensive to fake that they can form the basis for a reliable channel of communication" (2008: 17). Pentland argues that it is those habits and gestures which we are least likely to pay attention to which are the hardest to 'fake', and hence the most revealing about ourselves.

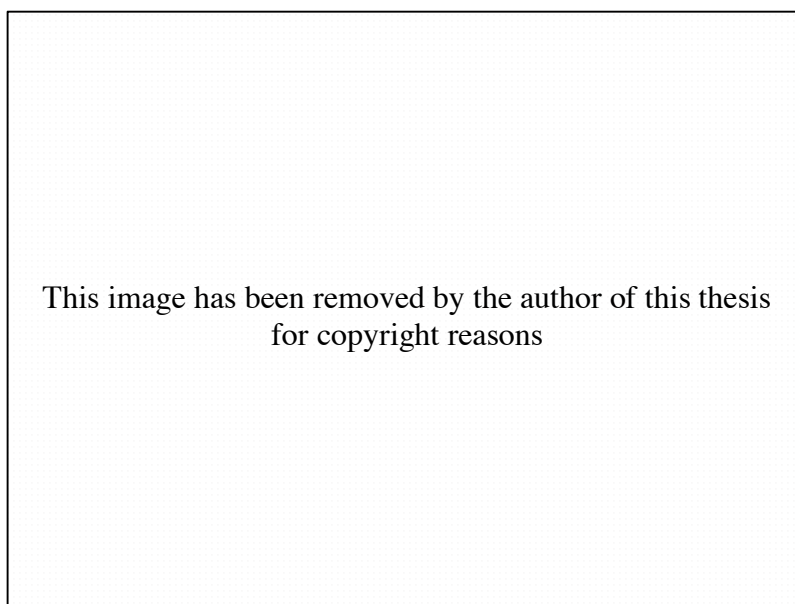


Figure 13

A sociometer worn around the neck

Source: Chandler, D (2008) Tuning in to unconscious communication. *MIT News*.

In particular, Pentland is interested in capturing the ‘honest signals’ of ‘influence’, measured as the degree to which a person’s speech patterns come to resemble their interlocutor’s; ‘mimicry’, considered as the extent to which a person’s hand movements and other gestures come to resemble those of the person with whom they are interacting; ‘activity’, with greater or more frenetic movements taken to indicate interest and excitement; and ‘consistency’, the degree to which one’s speech and gesture exemplifies a smooth and consistent pattern taken as indexical of ‘mental focus’, while “greater variability may signal an openness to influence from others” (2008: 4).

Pentland’s thesis is that through the analysis of these embodied ‘honest signals’ and their correlated values, businesses will be able to identify key aspects of workplace dynamics, and identify the most productive of employees and workforce structures. A study conducted by *Humanyze*, Alex Pentland’s research firm, of a Japanese-American office in Tokyo for example, purported to show that the closer communicative patterns between workers came to an optimum of ‘even, engaged discussion’, the higher their level of productivity (Pentland, 2012). Based on this sort of data, firms have in some cases rearranged the partitioning of office space with a view toward producing greater degrees of ‘engagement’ and ‘energy’ within the workplace (Pentland, 2012).

A similar project is the *VoloMetrix* software and analytics business helmed by Chris Brahm and Ryan Fuller. Specialising in ‘People Analytics’, the *VoloMetrix* software applications “contacts email and calendar servers and other business systems and pulls header metadata in order to create aggregate, anonymous analytics about collaboration between different organizations” (VoloMetrix, 2015). *VoloMetrix* uses this metadata for a productivist analysis of workplace’s temporal economies, with a particular emphasis on cutting down on the ‘time tax’ of bloated, overattended meetings (Schumpeter, 2014), which *VoloMetrix* argues tends to chew up working hours which could be more productively spent outside of the conference room. A key analytic pursued by *VoloMetrix* in this vein is what it calls the Organisational Load Index (OLI), an analysis of the time ‘demands’ which employees make on others within the workplace, which is ‘officially’ defined as “[t]he hours you consumed from the rest of the organization based on meetings you organized and emails you sent” (Barnett, 2014). While *VoloMetrix* specifies on their website that a higher OLI score is not necessarily a sign of less productivity, and that it may be ‘appropriate’ for a senior executive to have a higher OLI than her junior counterpart, nevertheless “it can still be helpful for the senior executive to benchmark against herself and attempt to reduce her OLI month-over-month in order to free up peoples’ time. She also may want to benchmark against others at her level and ensure she’s not an outlier” (Barnett, 2014); that is, the worker is encouraged to internalise the OLI as a measure of autarchic capacity.

This emphasis on the diminution of OLI is coupled, in the company’s official communiqués, with a recuperation of certain aspects of the French ‘spirit’ of the Science of Work. In one blog post marketing coordinator Nathan Barnett praises higher levels of productivity in France, which according to a study he cites are due to the French penchant for the two hour lunch; Barnett praises this as evidence of a well-rounded understanding of the relation between productivity and fatigue; “taking breaks allows time for the brain to recover, improving productivity and creativity, while preventing stress and exhaustion” (Barnett, 2015). This productivist recuperation of rest and fatigue can also be seen in the use of *VoloMetrix* analytics to reconfigure the structure of the working day. In one example of this, *VoloMetrix* analysed levels of employee disengagement in meetings by measuring the number of emails they sent during them; the analysis found a high number of emails sent during meetings held at

the beginning and ends of the day, while there were few emails sent during meetings held between 10am and 2pm, with the result that all meetings are now set aside for this part of the day (if employees are willing to increase their OLI by scheduling them at all) (Lam, 2015).

THE BOTTOM-UP PRODUCTION OF FLEXIBLE AND EMERGENT NORMS

Though Pentland's 'Honest Signals' are certainly concerned with measuring psychological categories such as 'focus' and 'engagement', the analytical heuristic may be characterised as 'post-psychological' in the sense that it does not posit a psychological subject *per se*, but is only concerned with the inference of certain productive attributes through their embodied correlates. Rather than seek to produce a socially harmonious workplace which would fulfil workers' psychosocial needs, this mode of worker analytics produces a portrait of the worker as an individualised unit, whose productive capacity is rendered in positivistic terms and made subject to monitoring and discipline. It is in this analysis of workplace productivity as a correlate of *embodied* and *quantifiable* gestures and conduct that we can locate the Quantified Self at Work within the physiological tradition typified by the French European Science of Work as well as the experiments in emergent statistical modelling of workplace relations pursued by Thomas North Whitehead. The methodology does not seek to attain its legitimation through the expertise of a managerial elite claiming the capacity to maximise workers' psychosocial needs and happiness within the workplace; rather the emphasis is placed purely upon the accrual of physiological data from which productive capacity can be inferred.

The methods employed by *VoloMetrix* and *Humanyze* represent a trend in workplace management and Big Data analytics towards a preference for adaptive, emergent norms, which are conceptualised as more resilient, more supple, than 'top-down' dictates, even if the overarching concern to increase productivity is retained. Pentland describes how the methodology behind the sociometric analysis of 'Honest Signals' differs markedly from established social science practice; rather than testing a pre-established hypothesis against a test group and making comparisons between their response and that of a

control group, in machine learning “performance and contextual data are collected from subjects doing a naturalistic task, with the natural variations between people playing the roles of test and control groups. In this way, a rule that relates contextual variables (like social signaling measures) to performance data (like salary) can be deduced” (Pentland, 2008: 108). Matteo Pasquinelli has identified what he describes as a shift in the constructions of norms and normalising tendencies in the era of Big Data and digital management; “in the society of metadata” he writes, “the construction of norms and the normalization of abnormalities is a just-in-time and continuous process of calibration. A norm that is no longer defined from above, but calculated from below. The norm as an emergent property” (2015). The use of the term ‘naturalistic’ in Pentland’s description is significant; in this calculative regime, the new norm resembles what the philosopher of biology Georges Canguilhem described as the vitalistic capacity of biological norms, by which what is normal is not the achievement of any particular biological state, but is instead the very capacity to adapt itself, to produce new norms responding to qualitatively different circumstances and problems (Canguilhem, 1994).

The metrics defined by *VoloMetrix* and *Humanyze* have no teleological end point (cf. Sutherland 2014); there is no ‘optimum’ Organisational Load Index score for any particular employee to meet, no optimum smoothness of conversation and interaction to be attained. Similarly, there is no one optimum arrangement of the office space or reorganisation of the rhythms of the working day which can be implemented as a general model for the promotion of the aforementioned smoothness or for cutting employees’ ‘time-tax’ or promoting their alertness in meetings. Rather, the organisational principle rests upon a continued process of adjustment and recalibration, requiring the intimate surveillance of the workforce’s honest signalling patterns, in order to produce something like an ‘organic’ evolution of workforce management, which would in theory be more receptive to ‘on the ground’ stressors and incentives than a distant management executive would be capable of perceiving.

This interpretation is at odds with that provided by Moore in her *Quantified Self in Precarity*. Moore addresses sociometric solutions and the use of gesture analytics in the workplace, writing:

...applying 'socio-metric solutions' (which involves a device worn around the neck) tracks and records workers' movements around offices, tone of voice and communication, and are used to identify patterns of movements and to assist management decisions regarding where to place furniture, best practices in communication or otherwise answer questions about efficiency. Management would like to observe and know about the labour involved in the processes of deciding, consciously or subconsciously, how to move one's arms, what tone of voice to use and where to go in the office. It is very easy to see how this will move into a discourse of what physical movements are required and most effective in offices, resonant of Taylor's depiction of the supposed correct movements for a pig-iron shoveller. (2018: np)

While it is relevant and worthwhile to note how such technologies remediate the unconscious and unintentional in terms of phenomenological intentionality, such a reading disregards the iterative and emergent nature of the norms produced through these technologies. As has been noted, the Taylorist/Gilbrethian 'one best way' was still at best an at least somewhat arbitrary measure, confused on the question of whether it defined an absolute minimum time in which a given task could be completed, an average minimum time, a deliberately unattainable aim, or what have you. The ultimate interpretation was at the discretion of Taylor himself, who in turn invested particular managers with the authority to define a particular course with quasi-scientific authority.

Sociometric solutions are not any less nebulous, but in fact much more so, insofar as there is no pretence to defining any 'one best way' ahead of time, or as a generalizable rule. The point rather is that *no one, not even the manager* can define ahead of time what such a 'one best way' might amount to. It is then quite distinct from Taylor's pig-iron shoveller. Rather than there being a particular definable standard to which one might fall short, one can never be sure whether or not one has or has not succeeded or fallen short, and nor can anyone else tell you once and for all whether you have succeeded or fallen short. It is this state of non-certainty which is important for managers – employees must of course strive to be more productive, but this is a form of productivity which, as Mel Gregg argues, has become an end in and of itself, a labour process without a clearly defined end, both in the sense of being ultimately without aim,

as well as without a clear spatio-temporal limit (2011; 2018 – see further discussion of Gregg’s argument in this thesis’ conclusion). While this point chimes with the emphasis that Moore puts on the significance of precarity as the ontological substrate of the Quantified Workplace, I would argue that it is still necessary to note that this precarity is not the ‘truly’ new element to the managerial logic of sociometric solutions as opposed to its Taylorist or Human Relations era antecedents. The workers Whitehead and Mayo were studying at the Hawthorne Works for example were employed during the Great Depression, prior to the improved labour bargaining rights established in Franklin D Roosevelt’s New Deal and the National Labor Relations Act of 1935. Their position was certainly tenuous, and as noted, several participants in the assembly room analysed by Whitehead were fired for extremely minor acts of subordination or for the expression of dissatisfaction with conditions. It is then, a shift in the logic of organisation, rather than in the ‘intensification’ of work measurement or conditions of precarity, that we can seek to understand the significance of contemporary work surveillance and measurement.

CHALLENGES TO PHENOMENOLOGICAL WORK-CRITIQUE

The significance of re-examining alternate histories of worker management to Taylorism is to challenge the standard critiques of contemporary quantification of work through a more nuanced account of the history of labour management techniques. The point here is not to suggest that the European Science of Work was somehow genuinely less alienating than unreformed Taylorism had been, nor that its implementation should be deemed an unmitigated success in terms of recuperating labour militancy in Europe between the wars and thereafter. Instead, in comparing Taylorism and the European Science of Work the distinction is drawn between two different approaches by which the Foucauldian dictum, that *les rapports de pouvoir passent à l’intérieur du corps* (relations of power pass through the interior of the body) (2001b) can be seen to be exemplified. In Lev Manovich’s summation, the difference can be drawn in terms of a Taylorist model which aimed at ‘maximum productivity’ without concern for the ongoing maintenance and reproduction of the labour supply, while post-Taylorist work management theories reflected a concern with ‘optimum productivity’, in effect a more

‘totalising’ project, concerned as it was not just with the primary act of production, but with a total view of the body and its place within a grid of biological and social relations (Manovich, 1995).

The theoretical significance of this distinction lies in the degree to which it troubles humanist and phenomenologically inflected accounts of worker management and resistance, such as those in the tradition of Henri Lefebvre or the work of E.P. Thompson. In Lefebvre especially there is a sharp dichotomy drawn between the *linear* time, or rhythm, of capitalist development and production, and a *cyclical* time, more properly constitutive of the human and of nature (2004; 2002). For Lefebvre the rhythms of “the days, nights, seasons, the waves and tides of the sea” (2004: 8) constitute those cyclical rhythms which find their origin in the “cosmic, in nature”, and which can be compared to the linear rhythms of social practice, “the monotony of actions and of movements, imposed structures” (2004: 8). For Lefebvre, these two conceptions of rhythms constitute an “antagonistic unity” (2004: 8). While holding that “rational and...industrial techniques have shattered cyclical time” and that ‘Man’ “detaches himself” from the cyclical in order to control it (2002: 48), he nonetheless maintains that cyclical time is never completely dominated: “(n)o matter how highly developed an industrial civilization may be, hunger, sleep and sex are still bound up with customs and traditions linked to cyclical time” (Lefebvre, 2002: 49). In his final published work on the project of ‘rhythmanalysis’, Lefebvre describes how this interaction and imbrication of the cyclical within the linear and the linear within the cyclical produces at times a *eurhythmia*, or state of healthy metastability of the polyrhythms which make up the everyday, and at times an *arrhythmia*, a pathological state whereby a particular conception of temporality, a particular *isorhythmia* comes to dominate the other and to effect a potentially “fatal desynchronisation” (2004: 68).

In his essay on *Time, Work-Discipline and Industrial Capitalism*, E.P. Thompson notes a similarity between Lefebvre’s distinction between the cyclical and the linear, as well as between Lucien Febvre’s ‘lived’ and ‘measured’ time, and his own distinction between the more natural, and accordingly less alienated, temporal rhythms of the fisherman’s or farmer’s work, conditioned as they are by the organic rhythms of the tides and the seasons, compared to the ‘task oriented’ work of industrial capitalism (Thompson, 1967: 60). Thompson describes the gradual encroachment of the discipline

of the clock over these ‘natural’ rhythms of work as coming up against the strong resistance of entrenched temporalities of work and Sabbath, even as worker resistance, such as demands for a shorter working day, increasingly came to struggle upon the terrain of measured time itself (cf. Thompson, 1967: 85).

The significance of the recuperation of worker’s biological temporalities and rates of fatigue by the proponents of the European Science of Work is in the demonstration that worker management can as a discipline incorporate this kind of rhythmanalytic work; not merely in the pursuit of an oppressive *dressage* which serves to ‘break in’ the labouring body to conform to an abstract rhythm of production (cf. Lefebvre, 2004: 38-53), but in the incorporation of bio-feedback in order to, to some extent, manipulate the production process to better accommodate biological processes of fatigue and regeneration. Considered in this context, the question is no longer ‘Is the Quantified Self a Taylorist movement?’, but instead whether the Quantified Self-ication of work owes more to the Taylorist heritage, or to those ‘post-Taylorist’ traditions which reacted to and sought to modify it.

In this sense it is clear then that the management philosophy predicated upon sensor analytics corresponds much more closely to a form of Neo-Post-Taylorism than to a remediation of Taylorism *per se*. Just as post-Taylorist approaches to work management sought to effect a more totalising analysis of human conduct through the close physiological analysis of labouring bodies and so sought to reconstitute a more ‘sustainable’ production process than the intolerable accelerated pace of unreformed Taylorism, so do management tools like *VoloMetrix* and *Humanyze* seek to incorporate ‘bottom-up’ analysis of workers’ physiological and social rhythms in order to more closely mould workers’ productive capacity to the structure of the workplace and the working day. In this way we might consider this Quantified Self-ication of the workplace to constitute a kind of instrumentalised rhythmanalysis (cf. Gregory, 2011: 195), an attempt to reconcile those ‘cyclical’ rhythms of the living body and of social interaction with the ‘linear’ rhythms of work and production, in the effort to perfect a pseudo-eurhythmia; a utopian workplace as seen from the c-suite, in which all social interaction and capacity for attention are perfectly recuperated towards productivist ends.

However, even this analysis would not be exactly precise. The question at stake here is not – ‘How did linear time come to dominate or absorb the rhythms of the cyclical?’. What is demonstrated instead is again the deepening and extension of the somalethic problematic. There is a certain rhythm of the production or work flow process, which accords to the pressure of the market. This pressure is not ‘of’ the body, but it is the very biological errancy which is produced through the measure of working bodies which authorises and enables the corrections of management. This ‘pseudo-eurhythmia’ then can be described, in Lefebvrian terms, as a kind of arrhythmia, but one which never leads to a total or catastrophic ‘desynchronisation’. The working through of the somalethic problematic produces a mode of measurement by which the ‘normal’ rhythm of production has always already fallen outside the ‘optimum’.

The aim of management then becomes the extension of the working day not only through crude intrusions upon employees’ leisure and rest time (cf. Crary, 2013) but through the elimination of the capacity to waste time, as those gestures and interactions and conversational habits which previously existed outside of conscious manipulation and productivist significance are given new value as correlates of creativity, mental acuity, and so on. This softening of the rhythms of work will rely on a continual process of refinement and manipulation of the working day, the bottom up production of emergent and flexible norms, as employees are invited to in effect rearrange the bars of their own cages. This analysis of the transformation of the work place and working day reveals the potential shortcomings of political economic critique in the Lefebvrian rhythmanalytic or Spinozaist, affect-oriented tradition, as even upper management comes to see the wisdom of ‘change from below’ and of attention paid to the productive aspect of the gestures and habits which make up the interstices of the everyday.

CONCLUSIONS

‘Taylorism’ has loomed as a key signifier for both boosters and critics of the Quantified Self and of the growing ubiquity of wearable technologies as tools of workplace management. However, the term has lacked conceptual and rhetorical clarity. As has

been demonstrated, while the term ‘Neo-Taylorism’ can easily be applied to some aspects of wearable sensor use in the brutal exploitation of precarious blue collar warehouse workers, the use of sensor-enabled white collar surveillance can be more fruitfully compared with the post-Taylorist physiological philosophy of the early 20th century European Science of Work and the statistical experiments of Thomas North Whitehead within the Human Relations School. The data analysts behind *VoloMetrix* and *Humanyze* practice a kind of rhythmanalysis which aims to produce a ‘pseudo-eurhythmic’ synchronisation of biological, social and productive rhythms. The pernicious element of this project lies in the extent to which it recuperates worker downtime in supple and sensuous ways; rather than simply extending working hours or performance targets, this analytic pursues an intimate surveillance of the interstices of everyday conduct, moulding a ‘bottom-up’ reconfiguration of labour temporalities and spatialities. In this way it can be seen how the Quantified Self-ication of work can be convincingly advertised by Quantified Self acolytes as counter to the schematic and rigid rigours of Taylor’s time and motion studies, while nevertheless pursuing a productivist recuperation of the wasted gesture which aims at an ultimately more totalising analysis of work and the labouring body.

This ‘softening’ of the working day through the incorporation of sensor analytics should be considered an integral aspect of the analysis of the migration of Quantified Self discourses into the cultural techniques of contemporary management (cf. Parikka, 2014). If there is an ‘intensification’ of existing management practices, it is not necessarily the intensification of speed or precarity which are truly novel (which is not to say that threats to workers’ wellbeing stemming from overwork and underpayment should be dismissed), but in the intensification of the aporia which defines what I have referred to here as *somaletheia*. These cultural techniques of work measurement have been designed in order to produce a mode of measuring the body which is fluid and vital, while at the same time able to exploit the inherent ambiguities and difficulties of such a project through the incorporation of a literally incessant manipulation of corporeal feedback. There are no hard or predetermined limits to such a form of measure, nor the guarantee of an effective resistance to be founded upon the definition of any particular bodily limit, as such a post-Taylorism seeks to recalibrate both the

norms by which conduct and workplace arrangements are measured, as well as the very arrangements themselves, in a ceaseless, and ultimately 'purposeless' restructuring.

CHAPTER FIVE

EXTRASERVOMECHANISMS: THE CULTURAL TECHNIQUES OF HOME SURVEILLANCE

This chapter shall examine the cultural techniques of sensor-enabled home security technologies. Home Security technologies as a subject of media history or science and technology studies remain relatively understudied by comparison with work on the history of sensor-enabled medical technologies like the sphygmograph or the biosensors associated with the European Science of Work. This chapter will argue that studying the historical cultural techniques of home security as they have been remediated by sensor technologies can shed light on the contemporary significance and proliferation of home security sensors, especially as an aspect of the smart home movement.

Drawing upon Markus Krajewski's theory of servomechanisms, or of service as a cultural technique (2010; 2012; 2013; 2018; Canales & Krajewski, 2012), this chapter will argue that burglar alarm systems in the 19th century New York upper-middle and upper class home constituted *extraservomechanisms*. I use this term to describe a technology which was parasitical upon the service techniques of domestic workers within the home, and which aimed to produce the home as a site of choreographed affective relations in order to manage the danger and the inevitability of mixing between classes and races. These were technologies aimed at coordinating the *circulation* of bodies within the home, and of managing the obscurities of the home, with a view towards maintaining order while avoiding undesirable mixing as far as this was possible.

The first half of this chapter will proceed in this analysis through a description of technical developments within 19th century home security systems, before turning to a close reading of the example of Mark Twain, who had a sophisticated but troublesome burglar alarm system set up within his house in Hartford, Connecticut, and who left accounts of its functioning in his letters and autobiography, as well as indirectly through

his short story, *The McWilliamses and the Burglar Alarm* (1922). Twain's case demonstrates the ambiguities and ironies of the intimate forms of surveillance produced by security technologies, indicating both a profound suspicion of them as well as a delight in the degree to which they bolstered his authority as the patriarch of the family home.

The second half of this chapter will chart 20th and 21st century developments in home security technologies. This chapter will demonstrate that contemporary home security technologies respond to and remediate a similar preoccupation with how to manage the flow of non-family members and strangers within the home. The recent rise of precariously employed service workers, who have taken on many of the duties and functions previously performed by domestic servants, has served as the foundation for the development of a variety of home security technologies targeted specifically towards managing this relation. This chapter shall examine several of these technologies in close detail, including Amazon's *Key* service, Walmart's 'in-fridge' delivery service, and Vivint's smart lock proposals. These technologies have been designed with the intention of regulating the movements of workers employed in domestic service roles, especially delivery of packages and groceries, but also home-cleaning services, dog walking services, gardening services, and so on. These new systems can be seen to remediate earlier systems, representing a new iteration of 'extraservomechanisms', designed to ensure the orderly spatiotemporal coordination of the household, and the integration of the traditionally 'private' sphere within the broader service economy.

This analysis of the broader historical trajectory of home security systems will extend and expand existing critical theorisations of modern home security, by demonstrating how the materialisation of these contemporary anxieties can be seen as, at least to some extent, the remediation of Victorian-era anxieties related especially to the management of cross-class and interracial interactions and relationships, and the way these were organised architecturally, discursively, and through the management of conduct within the home – in short, through cultural techniques. This chapter shall argue that the key distinction to be made between these earlier systems and their current iterations is that where earlier technological home security systems sought to define a certain limit of disorder within the functioning of service work within the home, to discipline service

workers in order to compel them to conform to the bourgeois norms of domestic order, contemporary systems serve to make a virtue out of contingency itself, to produce the home as one space within a broader and more fluid service economy.

HOME SECURITY HISTORIOGRAPHY

The history of electric home security technologies has been relatively little studied. The few dedicated studies have tended to be presented from a commercial perspective, such as the (nevertheless invaluable) *A History of Alarm Security*, by William Greer (1979), the manager of public relations for the National Burglar and Fire Alarm Association, which itself drew heavily upon Edwin Holmes Jnr's *Fifty Wonderful Years* (1917), a celebratory (and again, still valuable) account of the early history of the protection industry, written in Holmes' capacity as the president of the Holmes Electric Protective Company. These US-centric accounts have been supplemented by the work of Robert McCrie (2004; 2006), as well as Mike Calahane's (2015) *History of the UK intruder system*. All of these accounts, while containing valuable historical information, have tended to pursue a somewhat Whiggish vision of this history – of the development of new and better technologies and the rise in home security ownership as a logical response to the rise of crime in the industrial era, and as response to the ever more desperate and cunning techniques of burglars themselves.

Very few academic scholars have sought to account for the relatively longer history of electric home security. Many actively 'historical accounts' of home security neglect to consider the role of early forms of sensor-enabled electronic security which in fact date from the 19th century. Rowland Atkinson and Sarah Blandy's (2016) *Domestic Fortress* is typical, noting of the 19th century only the rise in fashion of neo-medieval style home design in the United Kingdom as an "[expression] of nostalgia for the medieval period, which...exemplified an idealised, socially ordered society, based on religious principles" (2016: np). The emphasis here is on non-electrified architectural forms, such as "pointed arches and gables, crenellations, turrets, pinnacles, external stair turrets, tracery and leaded windows" (2016: np).

However, it was in fact during the Victorian era that electrified home security systems emerged as serious and at least relatively successful commercial product, at approximately the same time as the sphygmograph was being pioneered and developed by Marey et al in France. The first patent for an electrified burglar alarm systems, “An Improvement in Electro-Magnetic Alarms”, was filed by a Boston priest, Augustus R. Pope, in 1852. Pope’s invention can in turn be tied to William Channing’s development of central station fire alarm services in Boston, also in 1852, though he had the germ of the idea in the late 1830s. Pope was to sell his patent to Edwin Holmes in 1857, who, through his Holmes Protective Company, would become the most successful and innovative burglar alarm developer in the second half of the 19th century.

Both of these early alarm systems made use of the technologies of the telegraph system, patented by William Cooke and Charles Wheatstone in 1836. Contact sensors would be attached to the doors and windows of the residence being protected, with an open circuit being connected to an ‘annunciator’, usually located in the bedroom of the house. When a window or door was opened this would close the circuit, which would set off an alarm, as well as send a signal to the annunciator, upon which the room or area of the house being entered would be indicated. Later innovations introduced time locks and allowed different areas of the home to be shunted in and out of use at different times of the day. As shall be examined in further detail later in this chapter, a key provision of these systems was designed to regulate or choreograph the movements of servants. Later models in particular made possible intricate arrangements by which sleeping servants would be awoken by a personal alarm clock which, upon being deactivated by the servant, would in turn deactivate the alarm system in the areas of the home the servant would need to move through to complete their morning duties (such as the kitchen). The system would meanwhile remain active in other areas of the household.

As noted, there have been relatively few accounts of these earlier systems of home security technologies and management. There are three key texts which are exceptions to this tendency: Carolyn Marvin’s chapter on electricity entering the home in the 19th century in her *When Old Technologies Were New* (1988); Rachel Plotnick’s PhD thesis *Signal and Switch: A Cultural History of the Push-Button Interface* (2013 [unpublished manuscript]), (later adapted into *Power Button : A History of Pleasure, Panic, and the*

Politics of Pushing (2018)) ; see also Plotnick, 2012), in which burglar alarm systems are briefly examined during her account of the use of push button systems for summoning help from servants; and Karen Donnelly's Master's thesis *Domestic Security: The Holmes Burglar Alarm Telegraph, 1853-1876* (1992 [unpublished manuscript]). Donnelly's analysis provides valuable information on the materiality and technical developments of the early alarm systems, as well as providing in her appendices copies of Holmes' advertising brochures and customer testimonials, which will be analysed as primary sources in this chapter. Donnelly's analysis was written as part of the University of Pennsylvania's Graduate Program in Historic Preservation, and so is aimed at enabling a cultural preservationist approach to historic alarm systems. Donnelly is thus less interested in rigorously considering social or cultural contexts, only briefly positioning the rise of historic alarm systems as a response to rising crime rates in the era of industrialisation. By contrast, both Plotnick and Marvin draw attention to the way in which alarm services went beyond provisions for keeping burglars or intruders at bay and also served to regulate the movements and actions of the domestic staff, in Plotnick's words allowing the creation of "communication and feedback loops within domestic spaces, making them intelligible to their owners and disciplining the bodies that inhabited them" (2013: 150). Marvin argues that these technologies helped contribute to a fantasy home ideal, in which "the emphasis was on enhancing domestic tranquillity and improving the facility with which messages passed from masters to servants" (1989: 81).

The analysis in this chapter will aim to contribute to and extend these analyses, seeking to go beyond the 'disciplinary' schema invoked by Plotnick and Marvin, which would tacitly position these technologies under the category of the panopticon, the ideal technology of the disciplinary society, as famously outlined in Michel Foucault's *Discipline and Punish* (1977). A media genealogical perspective informed by Cultural Techniques theory allows us to divine productive insights through the comparison of contemporary and historical electrical security systems. While 19th century home security technologies undoubtedly served to discipline or 'break in' the bodies and movements of servants, they are remarkable too for their prefiguring of later technologies of control. Electrical home security served to remediate the dense corridors and spaces of the home in remarkable ways, introducing a degree of modularity,

mutability, and emergent order to a domestic space which has typically been understood as resting upon a rigid and inert separation of gendered and classed spaces. This chapter will examine this dynamic through the example of Mark Twain, who used his elaborate and expensive home security service as a means by which to discover and investigate the sexual liaisons of one of his servants, Lizzy Wills. Twain's home security service served to give form to the obscurity of the house's borders, the disorder and spontaneity of the home, in order to re-establish bourgeois norms of respectability.

While in these early systems the intention was to reveal such contingencies in order to sublimate them within the order of the household, in the contemporary home this contingency becomes the point in and of itself. That is to say, the unsettledness of the home is no longer figured as a problem to be resolved, but an opportunity to be exploited. While relatively few households have 'live in' servants any more, the home service economy is a rapidly growing industry. There has been a concomitant need to 'manage' the entrance of 'on-demand' home service workers – the gardeners, dog walkers, and cleaners, that homeowners are able to access through platforms like *Amazon Home Services*. Contemporary 'smart' home security draws upon the long history of electric security through the sophisticated division of permissions, which allow particular service workers to access specified parts of the household at specified times. These permissions can be extended or revoked at the whim of the homeowner, thus allowing a constant redrawing of the internal boundaries of the home, a state of affairs I describe using the term 'the fleeting home'. Smart home security secures the home as a node within the broader service economy, ironically through its exploitation of the obscurity of the domestic border. The boundaries of the home can now be endlessly recalibrated, modulated, the better to profit from the fluidity and precarity of the reserve army of service worker labour.

We can understand the use of electric home security as another expression of the paradox of *somaetheia* – the registering of the body of the service worker interrupts the order of the home, but in bringing to light this disruption, security technologies serve to make this threat legible and manageable. In the final analysis, the 'success' of home security technologies is that they are able to redraw the boundaries of the home such that its border comes to take on the contours of the body itself. Rather than affording the

surety of a sense of ontological security, smart home security services compel the homeowner towards an iterative and ceaseless choreography of the movements of its inhabitants and its modern day servants.

THE BIRTH OF ELECTRIC HOME SECURITY

The first mechanical alarm system has been attributed to an Englishman named Tildesley, who in the early 18th century developed a chime alarm system designed to thwart lock-pickers. The benefits of the system were described by Tildesley in a promotional pamphlet – “The bells associated with it are constructed in such a manner that no sooner is the skeleton key of an intruder applied to the lock than the (bells) begin to chime a plaintive air that inspires such sentiment in the mind of the housebreaker that will doubtless prompt him to take precipitate flight” (from Gibson, 1962, cited in Greer, 1979: 7).

However, the birth of ‘modern’ home security systems can be dated to the filing of US patent no. 9802 on the 27th October 1852 by a priest, Augustus R. Pope of Somerville, Massachusetts for an “Improvement in Electro-Magnetic Alarms”. Pope’s patent employed simple magnetic contacts, attached to one or more windows or doors within a house, and connected to an electric circuit attached to a ringing bell. As Pope describes in the patent:

While the door is closed or the window-sash down the magnetic circuit is broken, because the spring of the key is thrown out of connection with the upper wire of the door or window frame; but as soon as the door is opened or the window-sash lowered so as to allow the spring of the key to come into contact with the upper wire or the metallic plate at the lower end thereof, the circuit will be closed, the current of electricity being made to flow through the circuit-breaker and around the magnet. As soon as this takes place the magnet becomes charged and draws the armature toward it, and thereby throws the hammer of the bell against the bell. (1852: 1)

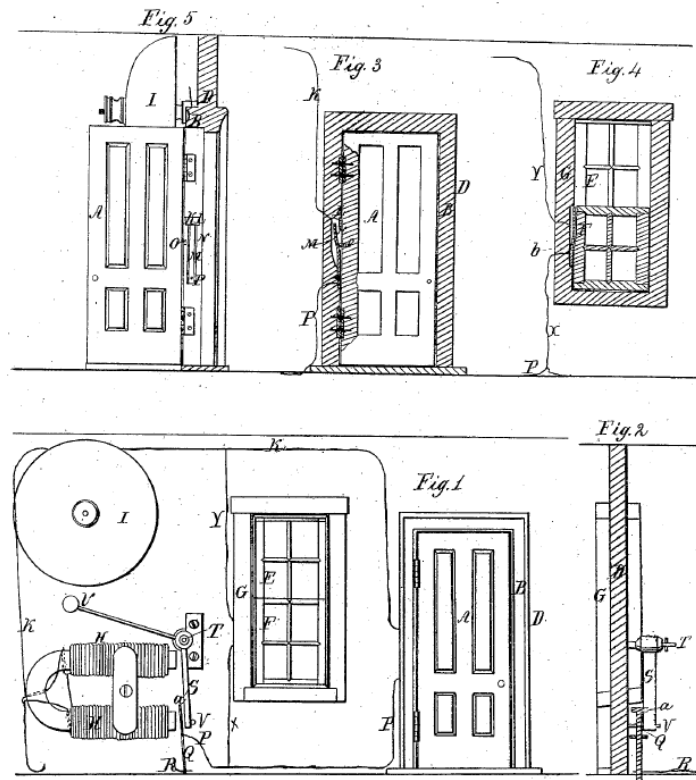


Figure 14

Detail from Pope's Burglar Alarm Patent

Source: Pope, A (1852) *An Improvement in Electro-Magnetic Alarms*. US Patent No. 9802.

In essence then Pope's invention can be considered the first electrical home-sensor technology, using an electro-magnetic sensor to sense the intrusion of burglars, and to thus activate an automated alarm. It is unclear whether Pope ever attempted to commercially exploit his invention, and if he did he seems to have made little impact (Greer, 1979: 25). In 1857 he met Edwin Holmes, who was at the time operating a 'Yankee Notion Store' (a haberdashery) in Tremont Row, Boston, where he manufactured ladies' hoop skirts (Holmes, 1917: 11). The entrepreneurial Holmes bought Pope's patent, and began attempting to find potential clients. However, he initially had little luck, and assuming that this was due to the relatively low crime rate in Boston at the time, moved with his young family in 1859 to the higher crime rates of New York City.

While it was Pope who developed the initial invention, Holmes quickly established key innovations within the technology, including the introduction of what was termed a

‘switch annunciator’, a board usually placed in the bedroom of the homeowner which “indicated the point from which the signal originated in the circuit. The annunciator designated the room in which a window had been left open when the house was closed, or, in case of an alarm, would show in which room an opening had been made” (Donnelly, 1992: 28). Holmes also made other innovations which he outlined in two pamphlets, *A Treatise Upon the Best Method of Protecting Property from Burglars, and Human Life from Midnight Assassins*, and *Your Attention is Respectfully Requested to the Following Testimonials*, published in 1861 and 1868 respectively. Key amongst these was the inclusion of time controlled alarms, which Holmes patented on March 26th 1867 as an *Improvement in Electric Circuit-Breaking Clocks*, and which could:

disconnect a circuit at any designated time of the day and leave it unconnected for a predetermined period of time. Additionally, it could reconnect at a predetermined hour. The attachment was introduced into the circuit attached to the doors and windows used by servants as they went about their early morning chores. By breaking only this particular circuit the sounding of the alarm which would awaken the residents of the house was prevented. However, opening of any other door or window would, as usual, activate the alarm. (Donnelly, 1992: 46)

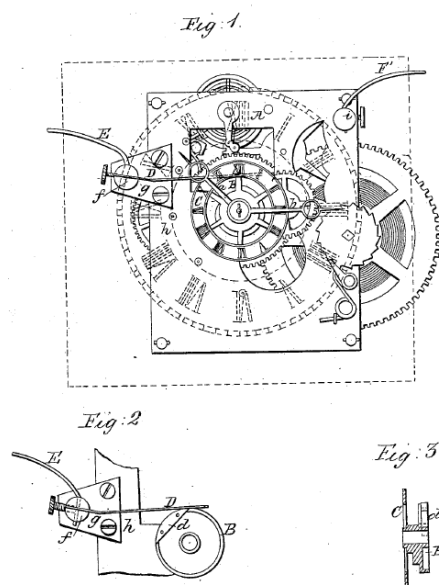


Figure 15

Detail from Holmes' patent for time controlled alarms

Source: Holmes E (1867) *Electric-Circuit Breaking Clock*. US patent No. 63,158

A further improvement outlined in the 1868 catalogue was the ability to divide the house into different zones, with the ability to turn off different parts of the house's security system at different times of day. As Donnelly explains:

a household might be divided into upstairs and downstairs zones. While a party was taking place on the first floor - doors and windows in these public rooms would be in use by guests, and therefore, this zone would be turned off. The second floor however, would probably be empty - with servants and residents alike, all involved in the entertainment. (Donnelly, 1992: 46-47)

In this way, Holmes' home security systems were able to divide the house in ever more spatio-temporally individuated ways, reflecting the complexity of coordinating flows of household-members and guests within the home, and the different ends to which the home might be put. Already we quickly see that home security systems went beyond simply maintaining the boundary between inside and outside, instead developing along increasingly variegated differentiations and specifications of use within the home, introducing even a certain modularity to the functioning of the home. As Plotnick notes, designers of these alarm systems aimed to "provide complete alarm solutions that considered how these bodies would interact; they thought holistically about alarms as networks rather than independent mechanisms" (2013: 150). As Greer noted, writing in 1979, "[t]hus, at an early date, Edwin Holmes developed local alarm protection to a point near where it stands today, employing magnetic contacts, timing mechanisms, bells and lights" (1979: 27-28).¹³

Holmes' pamphlets collected testimonials from apparently satisfied customers, among whom Holmes could count many of the wealthiest citizens of New York society. These testimonials constitute a key primary source for understanding early discourses around electric alarm systems and their patterns of use. Donnelly has cautioned against

¹³ These lighting systems were gas lights which could also be attached to the alarm circuits – electrified alarm systems predated the invention and installation of electric lights in the home by around 30 years (Donnelly, 1992: 107) – later systems would be connected to electric light sources as well.

accepting them as an unbiased primary source, noting that “Only a small fraction of these specifically mention actual alarm incidents. Many of these letters were solicited, those published were probably hand chosen and edited. The accuracy and representative nature of these incidents cannot be assured” (1992: 104). While this is true, the testimonials are of interest at least partly because so few actual incidents of them preventing burglary are mentioned – one could imagine a more sensationalistic pamphlet produced by Holmes in which every customer has an exciting story to tell about their system being used to thwart an enterprising thief. The fact that many users have no such tales to tell points to the fact that their more everyday functioning was instead as providers of a *sense* of security, and beyond this, as a way of monitoring the behaviour within the home of servants and family members. Furthermore, the fact that during the period in which the pamphlets were being produced Holmes was still developing his client base amongst the upper echelons of New York society gives us reason to assume that he would not risk offending his client base by embellishing their accounts. Several of the accounts also mention that the systems were faulty when first installed and required further work by Holmes’ engineers to complete them – a somewhat embarrassing detail which it does not seem in Holmes’ interests to publish if he was in fact seeking to modify his user’s accounts to paint himself and his invention in a more flattering light.

Several key themes emerge from the customer testimonials, including evidence of their efficacy at monitoring the conduct of servants and other family members (especially the sexual relationships of younger members of the household), a description of the sense of ease and security provided by the alarm as a “faithful silent sentinel”, and several descriptions of users coming to consider the alarm as essential to the construction and maintenance of the “modern home”.

The use of the system to monitor servants is promoted both through customer testimonials as well as in Holmes’ own rhetoric within the pamphlets. In a testimonial from the 1861 pamphlet by one Nathan Wheeler, he writes:

Mr E Holmes,

Dear Sir: -- I have used your “Burglar Alarm” in my house, and consider it admirably adapted to the purpose designed. It operates, moreover as a capital Index and Regulator of the movements of those *within the house*. I regard the cost as a good investment for the feeling of security afforded, and take pleasure in recommending its general introduction.

Yours truly,

N. Wheeler (Holmes, 1861: 10 (emphasis in original))

Similar testimonies can be found in other accounts: “It also regulates the movements of servants, if they are in the habit of keeping late hours, and prevents the admission of their friends at late hours” (‘Scott’ in Holmes, 1861: 13), “With [the Burglar Alarm] I feel perfectly secure, and also find it useful in knowing the hour at which my domestics arise and retire” (‘Addison’ in Holmes, 1861: 14), “As a watchman upon the movements of your servants, it is invaluable” (‘Meios’ in Holmes, 1868: 4), “My servants cannot possibly leave a door or window partly open without my knowledge, and yet I do not leave my room to ascertain this; in fact it is almost like magic in its wonderful truthfulness and certainty of action” (‘Chase’ in Holmes, 1868: 9), “I now retire at night knowing that all the doors are closed, (for the bell of the Telegraph will not be still until every door and window is closed.) It has disputed with Bridget several times, when she has reported, ‘*All shut below, sir*’ and I have invariably found that the Telegraph spoke the truth.” (‘Sawyer’ in Holmes, 1868: 18). The term ‘Bridget’ here is a derogatory term used to denote young female Irish domestic servants, and Holmes’ 1861 catalogue also includes a (possibly fabricated) ‘testimony’ from a ‘Bridget’, written in a patronising approximation of the Irish accent:

WHAT THE “BRIDGETS” ALWAYS SAY

And sure that bell o’ yours is a grate botherer. I’m thinkin you’d better be takin it out o’ this house. We must be too steady entirely, and after sendin our beau home as soon as ever the clock struck nine: a botherin bell is that for a bit of a door can we get open neither, that the Missus don’t know it; you had better be takin it along with ye, and not leave the botherin bell here. (Holmes, 1861: 59)

A similar, also possibly fabricated account is given in the same pamphlet, slyly attesting to the alarm's capacity to monitor the illicit actions of the young men of the family:

WHAT THE YOUNG MEN USUALLY SAY

After seeing how nicely the bell rings upon opening the door or window, when the house is closed and bell set for the night: "Well, we don't want that in our house". (Holmes, 1861: 59)

Two further accounts in the 1861 pamphlet also attest to this capacity: "Now I know how long the young gentlemen stay with my daughters" (Holmes, 1861: 58) notes one anonymous patron, while another is quoted that "It is a great family regulator, all know that they must be in their places at my bedtime" (Holmes, 1861: 58).

These testimonies speak to the anxiety with which servants were held in American society in this period, as well as to the question of the sexual regulation and gender segregation of the household. Servants were on the one hand regarded as pillars of civilisation, necessary for the successful functioning of any even vaguely well-to-do household, but at the same time were feared for their capacity to bring the social disorder of the lower classes across the boundary of the family home. As Vanessa May describes, middle-class housewives complained that domestics had the power to alter their employers' household routine, forcing middle-class families "to change their habits, to eat dinner at unconventional and depressing hours" (2011: 28), as well as to introduce sexual licentiousness into the household, the common fear being that "that sexually aggressive, attractive young women might prove too much for the self-control of employers' sons and husbands", even as the more present danger, that of sexual predation upon domestic servants by their employers, was often ignored (May, 2011: 31).

The regulation of this tension was a key problematic of 19th century architectural theory and practice. The 19th century saw an increasing codification of the distinctions between public and private space (Munro & Maddigan, 1999: 107), which Clifford Clark has argued reflected the broader societal tendencies of laissez-faire economics, "houses as self-contained entities which reinforced the cohesiveness of the whole family while also

providing for the needs of each individual member” (1986: 40). In the middle-class context at least this distinction was strongly gendered, as “[t]he doctrine of separate spheres equated the public sphere with men and the private (i.e., domestic) sphere with women. Men satisfied their purported basic nature by concentrating on politics, business, and other areas of public life, while women fulfilled their purported natural role by overseeing domestic life” (Shapiro, 1998: 281). Within the home meanwhile there was also an increasing codification of the separate functions of the household, along both gendered and class divisions:

Middle- and upper-class homes subdivided domestic space into male and female areas. Women inhabited the drawing-room, while men had the library, the billiard room and the smoking room (Chase, 1996). Women servants had the kitchen as their headquarters, although they moved throughout the house in order to clean it. This class/gender division of domestic space encapsulated the distance between worlds. Domestic activities were relegated to one set of spaces shared by women of all classes; middle-class women inhabited a limited social space with men. Space usage thus exemplified hierarchies of gender, with male spaces such as the library being preserved from female intrusions. (Kleinberg, 1999: 148)

Many middle and upper-middle class homes also included separate staircases for servants, designed to separate their duties from the functioning of the rest of the household, “[r]ising from the kitchen or rear hallway, these narrow stairs minimised cross-class contacts despite residence under the same roof” (Kleinberg, 1999: 148). At the same time, the large number of doors within the home allowed for a certain degree of modularity within the home, such that:

If a party were in progress, a large area for entertainment could be created by opening the doors between the front and the back parlors. But if there were few visitors during the cold winter months, certain rooms could be closed off to conserve heat. The house itself, by virtue of its size and the diversity of its enclosed spaces, provided a flexibility that matched the changing needs of the Victorian family. (Clark, 1986: 62)

The key space of potential for intermingling between servants and family members was the corridor. On the one hand the corridor emerged as an architectural solution to what Jarzombek calls the problem of “how to allow different classes to spatially coexist in the same institution” (2010: 753). Though Jarzombek is describing the uses of corridors in the space of English public institutions, it held a similar function in the US middle class home, channelling the servants from their quarters to the kitchen and thence to the dining room, while hopefully avoiding their embarrassing intrusion into the parlour room or bedrooms of family members. On the other hand, these distinctions could not always be maintained – it was in these liminal spaces that certain interactions could not always be avoided, given that “[a]lthough [they] were designed to facilitate the segregation of women from men and family from servants, these spaces also significantly connected disparate locations within the home. It is this position as simultaneous separators and connectors that renders these spaces thresholds, permeable boundaries that in their very design facilitate movement as much as prevent it” (Tange, 2010: 177-178).

It is within this context then that we can see the function of home security services as enabling both greater modulation and greater codification over the interior of the domestic space. Many ‘innovations’ in burglar alarms in this period made quite explicit the goal of monitoring the movements of servants within the home. The full ‘potential’ of this capacity can be seen in ‘mature’ home security systems from later in the 19th century, which took up the innovations of Holmes, and worked to add greater fluidity and flexibility to their functioning. One such example was the 1890 Bogart Improved Burglar Alarm, which was promoted as incorporating improved servant monitoring capability, and which involved an alarm clock set up in the servants’ quarters which was connected to the alarm circuit, such that:

in the act of pushing the button the servant also disconnects all such parts of the house as it is intended she shall have access to, from the burglar alarm, leaving the other apartments still connected. Unless she arises at the sounding of her alarm or waking bell, and pushes the button, the whole house remains connected and protected by the apparatus. The position of the clock switch will show in the

morning whether she has arisen or not. (Anonymous in *Electrical Engineer*, 1890: 163)

MANAGING OBSCURITY: THE CASE OF TWAIN AND THE McWILLIAMSES

The celebrated American humourist Samuel Clemens, better known by his penname Mark Twain, provides an unusually detailed account of the functioning and understanding of burglar alarms within 19th century American homes, which does well to exemplify the above identified themes of anxiety around illicit servant behaviours. Twain had a burglar alarm system installed in his home in Hartford, Connecticut, sometime around late 1877 or early 1878 (Gannaway, 2007: 28), and his difficulties in its operation would form the basis for his short story *The McWilliamses and the Burglar Alarm*, originally published in *Harper's Bazaar* in 1882. The key theme of the text is a certain wry, ironic critique of the follies of the overreliance upon mechanisation within the home. This story was to serve as the ur-text for the microgenre of 'burglar alarm fiction', which found some outlet in magazines like *Harper's Bazaar* and *Good Housekeeping* – specifically it appears that Twain coined the gag by which burglars end up stealing the alarm system itself, repeated in Clifford Howard's short story *Merriwether's Watchdog* (1909), and in *Facetiae: What They Stole* (Anonymous in *Harper's Bazaar*, 1887: 900).

In *The McWilliamses* Twain recounts the saga of the installation and malfunctioning of a burglar alarm system, as though told to Twain himself by Mr. McWilliams during a train journey. McWilliams recounts to Twain how he and his wife, having a little extra money left over after constructing their house, decided to invest in a burglar alarm system. The system is installed, but almost immediately starts displaying its ineffectiveness. After a month of feeling a relative sense of security, Mr McWilliams discovers a burglar within his home late one night; the burglar is able to enter without setting off the alarm, and McWilliams discovers him only after smelling smoke and finding the burglar smoking his pipe on the landing. Upon enquiring as to how he was able to enter the house without setting off the alarm, the burglar replies amiably that he

was able to enter through the unalarmed second floor window (Twain, 1922: 317). McWilliams compensates the burglar for the goods he was to steal, and then proceeds to have the second floor of his home also alarmed, only to later discover another burglar, who has this time entered through the *third* storey window (317). McWilliams goes on to have the alarm system further installed in the third floor at considerable expense, while complaining of the increasing complexity of the system:

By this time the 'annunciator' had grown to formidable dimensions. It had forty-seven tags on it, marked with the names of the various rooms and chimneys, and it occupied the space of an ordinary wardrobe. The gong was the size of a wash-bowl, and was placed above the head of our bed. There was a wire from the house to the coachman's quarters in the stable, and a noble gong alongside his pillow. (Twain, 1922: 317-318)

Further trouble with the system is still to come, as McWilliams complains that his cook struggled to understand the functioning of the alarm, and would inevitably set it off every morning upon arising to prepare breakfast. This problem is 'solved' by having the technician sent for, who fixes things so that opening the kitchen door will disable the alarm – however, this leads to greater problems, since now “as soon as the lights were out the burglars walked in at the kitchen door, thus taking the alarm off without waiting for the cook to do it in the morning” (319). McWilliams also faces the problem that a band of burglars sets up a hideout within his very house itself, “not exactly to steal, for there wasn't much left now, but to hide from the police, for they were hot pressed, and they shrewdly judged that the detectives would never think of a tribe of burglars taking sanctuary in a house notoriously protected by the most imposing and elaborate burglar alarm in America” (319). The McWilliamses are also plagued by false alarms, to the extent that they eventually stop paying attention to the alerts of the alarm, and simply turn the system off in the affected rooms. Eventually every room in the house is disconnected, with the end result being that the burglars enter unannounced and proceed to steal the alarm system itself, “every hide and hair of it: ripped it out, tooth and nail; springs, bells, gongs, battery, and all; they took a hundred and fifty miles of copper wire; they just cleaned her out, bag and baggage” (322). McWilliams then proceeds to have a new system put in, with new spring loaded contacts to avoid false alarms, and a

clock system to automate the system, but this too malfunctions, and eventually McWilliams decides that he has had enough: “I took the whole thing out and traded it off for a dog, and shot the dog” (324). He concludes bitterly that burglar alarms “are made solely in the interest of the burglars. Yes, sir, a burglar alarm combines in its person all that is objectionable about a fire, a riot, and a harem, and at the same time had none of the compensating advantages, of one sort or another, that customarily belong with that combination” (324).

The McWilliamses is obviously an exaggerated and satirical account of the difficulties posed by automated alarm systems, but these difficulties, as well as the theme of alarms amplifying the sense of living *amidst* disorder rather than of being able to correct it, reflect at least to some degree the real circumstances of Twain’s experience. Twain built an imposing three story house (just like that owned by the McWilliamses) in a wealthy area of Hartford, Connecticut, with a retinue of domestic servants and a Neo-Gothic domestic architectural style typical of the period, with a series of labyrinthine corridors and doors separating out the different functions and areas of the house. Like McWilliams, Twain eventually had all the exterior doors and windows of the house connected to his system, as well as many of the interior doors and corridors through which the domestic staff of the home would pass, as Gannaway describes:

Clemens put the passageway to the dining room on the alarm. Similarly, a servant in the cellar fetching wood for Clemens's fireplace in the Billiard Room could not enter the main house directly. Instead, he would carry it up a narrow, cramped staircase from the laundry room to the kitchen. Here again, the door into the kitchen from the staircase was wired into the burglar alarm system. To further thwart unscrupulous servants or burglars, the Clemenses could also lock up especially valuable silverware, china, and beer, bourbon, and other spirits in the butler's closet, only accessible from within the butler's pantry. The burglar alarm provided the best opportunity for monitoring all these doors, windows, and discrete containers. (Gannaway, 2007: 31)

Twain’s fears of burglary appear to have been well founded, and the house was robbed in 1888, the thief apparently undeterred by the complex system Twain had installed.

Twain was however able to watch, through the alerts on the annunciator placed in his bedroom, the progress of the burglar through the house as he made his way through the rooms of the house – moving from the cellar, to the ground floor, before escaping out of a window in the mahogany room (Gannaway, 2007: 38). Twain also had difficulty understanding the technical details of how the system worked, and had a tendency to set off the alarm through inadvertently opening windows which had been attached to the alarm, leading to a sense of frustration at the encumbrances of the system.

A more ‘successful’ use of the burglar alarm was in monitoring the sexual liaisons of Twain’s domestic servants, in particular the episode of July 1877, when Twain used his burglar alarm to determine the circumstances of an affair his English servant girl Lizzie Wills was having. Twain was on holidays with his wife in July 1877 when he received reports of his burglar alarm going off, leading him to return to carry out an investigation which he would detail in letters sent to his still holidaying wife. Messent describes the affair:

After questioning the house servants, Clemens realized that one of them, an English girl called Lizzie Wills, had in fact been letting her lover, Willie Taylor, in and out of the house—and so setting off the alarm. Discovering that Wills was apparently pregnant but that Taylor did not intend to marry her, Clemens decided to intervene. He therefore set up an interview with the couple, with a plainclothes detective in one room close at hand, and with [his friend, a pastor named] Twichell in another. He then “persuaded” Taylor to marry Wills, and had his pastor friend immediately on hand to perform the ceremony. Calling in the other servants to celebrate with cake and wine, Clemens also gave the couple a hundred dollars to start their new life together. (Messant, 2009: 42)

Twain was able to correlate the alarm with the reports of his servant staff – “The alarm went off very early one morning, before we went away; it was Lizzie’s Willie going out of the basement door; George saw this. George, Patrick, & the two Marys & Rosa all believed Willy was sleeping with Lizzy [sic]...occasionally here in the house, before we went away” (Twain, 1877a).

In his letters to his wife Twain describes his obvious delight in pursuing the ‘case’ against Wills, writing “I haven’t had so much chin-chin for some years...I am judge, jury, & lawyer for both sides...I love you my darling... — & yet it chuckles me with comfort to be in this big authority for once” (Twain, 1877a), describing in another letter how he was delighted to “have been detective Simon Wheeler for 24 hours, now” (Twain, 1877b), making reference to the main character in a detective story he was also working on at the time (Messent, 2009: 42).

It is clear in this case how Twain used the burglar alarm in his home to re-establish or bolster his patriarchal dominion over the household. The chaos of illicit sexual encounter is, with the aid of the burglar alarm, returned to the order of formal matrimony, before Twain proceeds to expel the problem servant from the household altogether. Twain’s alarm system is able to detect threats to the internal cohesion of the household and then to correct this threat and eliminate the threat of disorder. Beyond this function however, Twain is also able to draw upon the sensing capacity of the alarm system to extend his knowledge regarding the circulations and assignations of his domestic staff – the alarm system does not merely discipline his workers, but in tracking their errant mobilities, it mobilises Twain’s own dominion over the meaning of his home’s border. It is in this sense that we can understand the home security system as refiguring the home in terms of the somaletic problematic. The electromagnetic sensors of the home’s doors and windows, the time alarms, these certainly serve to govern and to limit the movement and the mixing of difference within the home within acceptable limits, and without sacrificing the productivity of this movement *per se*. However, in doing so, it also prescribes movement as the order of security – freedom of movement even to the point of transgression is itself made legible and productive, and is able to rewrite the ‘meaning’ of the border of the home. The limits of the home become ‘an open question’ – an aporia which is settled, and even then only contingently, by the ‘master’ of the home.

A remarkable postscript to the Lizzie Wills episode serves to further illustrate the nature of this aporia. Twain, it would appear, ruminated upon the events and significance of this episode for decades, and dictated an autobiographical account of it on April 10 1907. According to Twain, ‘three summers’ after the initial investigation and marriage

took place, he chanced to run into the married couple on the streets of Hartford. Lizzie and Willie were travelling in an expensive carriage and were “finely and fashionably dressed” (Twain, 1981: 73). Willie proceeded to extend his fulsome thanks to Twain for the opportunity he had afforded the couple in arranging the marriage and granting them a financial start in life. The money had been used by Lizzie to start a restaurant which had become prosperous through the patronage of the rich Hartfordians she had met in Twain’s service, while Willie had become a successful builder and contractor (Twain, 1981: 73-74). As Willie summarises the situation, “We owe it all to you, Mr. Clemens, *and your arbitrary and mistaken notions of justice*, for if you hadn’t forced me to marry [Lizzie]...it never would have happened” (Twain, 1981: 74, emphasis added). There is a sting in the tale [sic] however – as Twain goes on, “He paused; then he added, without any bitterness in his tone, “But as to that child, it hasn’t ever arrived, and there wasn’t the damndest least prospect of it at the time that she told you that fairy-tale – and never *had* been! (Twain, 1981: 74, emphasis in original).

Astonishingly then, there had never been any illicit pregnancy after all. Lizzie Wills had lied, and in doing so been able to manipulate Twain’s investigation to her benefit, transforming what would have amounted to a simple dismissal into a beneficial marriage and productive wedding gift. Twain’s judgement here is “arbitrary and mistaken” in that it emerges as a corollary of the errancy produced through the sensing apparatus itself. Twain is not simply *wrong* in his judgement – rather he must make his decision amidst the ambiguous mode of ‘unveiling’ which this thesis argues is characteristic of somaetheia. The biosensors of the home security apparatus reveal new detail about the ‘borders’ of the home, but this revelation is immediately troubled by the potential effacement of its own trace. Twain’s intervention then can only ever be to some degree “arbitrary and mistaken”, and not the imagined ‘final gesture’ which would ‘eject’ the problematic of disorder and complexity once and for all.

EXTRASERVOMECHANISMS

The theorist who has most considered the master-servant relationship in terms of media theory is the German media theorist Markus Krajewski, in his *The Server* (2018),

several sections of which have been previously translated from the German into English (see Krajewski, 2010; 2012; 2013). The central thesis of Krajewski's work is that "practices of service or serving represent a fundamental cultural technology (*Kulturtechnik*) akin to reading and writing, navigating and designing, painting and playing music", and that these cultural techniques of service have been progressively automated since the end of the 19th century, culminating in the server-client relationship of modern computing (Franzel, 2012: 107). Krajewski's analysis draws attention to the often hidden, and yet nonetheless integral power that servants have traditionally held in the coordination of households, especially in their capacity to filter the mobility (of people, of information) between their masters and the outside world:

Particularly with the bundling of these characteristics, the subaltern's ability to act accumulates to form a power structure. It is true what the lowest of Kafka's doorkeepers says: 'But note that I am powerful. And I am only the lowest doorkeeper. From hall to hall, keepers stand at every door, one more powerful than the other' (Kafka, [1915] 1995: 23). Service may be based on small gestures that obstruct or enable, permit or exclude. In their interconnection and catenation, in their bundling and accumulation, the various practices by which a servant organizes the life of his master generate power (to act) that is by no means minor. This enables the servant to contribute to the refinement of culture from below, so to speak, from the valet's perspective, with inconspicuous technical manipulations, in infinitesimal gestures. (Krajewski, 2013: 108)

In terms of automation, it is easy to see how the burglar alarm system could be understood as an automation precisely of this very doorkeeper function – indeed many of the Holmes testimonials describe their appreciation of the new burglar alarm system in almost precisely these terms, as a 'silent sentinel', much improved upon the human variety, as one testimonial put it, given that it "never sleeps in times of danger" ('Smith' in Holmes, 1868: 24). The burglar alarm here would relieve the old flesh and blood watchman of their capacity for discretion and discrimination, in favour of a more totalising distinction between inside and outside, to be maintained in all circumstances. In place of the minoritarian micropowers of the wily servant would be substituted a

systematised method of control, catering to a Victorian homeowner's fantasy of maintaining a strict delineation of space and maintenance of social order.

However, a more detailed close reading of the functioning of these alarm systems reveals a more ambiguous relation – these alarm systems were not aimed at replacing or automating the work of servants so much as they were directed towards coordinating their movements within the household. As Sean Franzel notes in his review of Krajewski's work, "Krajewski himself recognizes that his story of the replacement of human servants by electric and electronic media does not address the continued employment of individuals in service positions in our globalized world today" (2012: 108, see Krajewski, 2018: 12). The burglar alarm systems here do not so much automate the service functions of domestic staff, nor do they straightforwardly lay bare the machinations of servants for the surveillance of their masters, even if this was perhaps the desired or intended effect. Instead, what they attempt to do is to attach themselves to the subaltern, and to enable their controllers to 'know' the household in as fluid and mobile a manner as the servants themselves do. Rather than servomechanisms, we might label these technologies *extraservomechanisms*, or service technologies attached to service workers. Instead of attempting to recuperate and formalise the functions of service as a cultural technique, extraservomechanisms constitute the formalisation of the cultural techniques by which service itself is ordered and managed. The significance of the burglar alarm used in this way as an extraservomechanism then is the ambiguous position it holds between modern disciplinary societies and postmodern postdisciplinary societies. While these burglar alarms served to reinforce the rigid social hierarchies and division of labour within the labyrinthine walls of the 19th century Victorian home, they were not predicated purely upon the imposition of a rigid standard of order. Rather, the work of the servants here goes on beneath the workings of the burglar alarm system, producing an immanent and modular production of order out of the ambiguous relations underpinning the homeowner/servant relationship.

THE LACUNA OF THE EARLY 20TH CENTURY

As noted previously, the study of home security technologies remains underdeveloped. One of the most glaring gaps in the literature is the question of the lacunae which appears in the historical record in the first half of the 20th century with respect to home security technologies. As William Greer notes, burglar alarm systems reached something like ‘maturity’ as a home technology, at least at a formal engineering level, if not in terms of wide take up, before the end of the 19th century (Greer, 1979: 27-28). However, following these early innovations, it appears that interest in home security alarms waned significantly both in terms of technical developments and consumer interest. Firms instead invested in commercial-grade technologies, such as the *Phonetalarm* (1916), which used microphones to detect the sounds of burglars attempting to enter room-sized vaults, or the development in the 1930s by the Holmes company of a pneumatic detection device, also aimed at commercial vaults, which could detect pressure differentials therein (Greer, 1979). Such technologies would of course have had little utility in the domestic setting. It is difficult to find record of home security technologies in the popular press in the first half of the 20th century, beyond the scattered discussion of gimmicky and impractical ‘do it yourself’ technologies in magazines like *Popular Science* and *Good Housekeeping*.

Several such examples give an idea of the typical style of such suggestions. An article from *Popular Science Monthly* in 1918 details the workings of a hidden pressure sensor placed at the foot of a staircase, which in the given scenario tricks the unsuspecting burglar, who “knew where the stairs were but...did not know that first step was hinged on a spring hinge so as to break an electric circuit while the step was not in use” (Anonymous in *Popular Science Monthly*, 1918: 688).

A 1922 article described how to erect a “Burglar Alarm that Shoots” by yourself, “at the cost of but a few cents, from an ordinary spring rat trap” (Lyman, 1922: 482). An article by B.F Miessner in the January 1925 edition of *Popular Science* describes a burglar alarm, apparently developed by the author himself, which rather than contact or pressure sensors utilises a selenium cell light detector; the cell would detect the light produced by the burglar’s flashlight, and upon detection set off the various functions of the security system:

In the writer's apparatus one of these was an electric gong, the burglar alarm; another an ordinary revolver whose trigger was pulled by an electromagnet; a fourth a charge of flashlight powder, which was set off by the heating of a short piece of fine resistance wire; and on one occasion a fifth was a phonograph with a specially prepared record, which without a doubt would frighten out of his wits the boldest thief who heard its weird and uncanny warning. (1925: 756)

This extremely dangerous apparatus, which the author himself describes as having come close to shooting himself during one test, is described as unpatented, and seems to be an exercise in expressing the author's own creative ingenuity, rather than as a suggestion of 'best practice' for security-conscious home owners. Another article in *Popular Science* in 1930 describes how to erect a simple contact sensor closed circuit system in your own home by which "you can efficiently protect a garage, chicken house, barn, or similar building against burglars" (Stewart & Bryan, 1930: 136).

I suggest that the decline in commercial applications of home security technologies can be put down to two key factors. The first is political-economic. In the early 20th century the industry saw a consolidation of the largest security companies into only a few large conglomerates, which in turn would agree to non-competition clauses with each other. The two major players after 1906 were Holmes' company and American District Telegraph (ADT), with Holmes controlling the north-east of the USA, and ADT controlling the remainder of the country (Greer, 1979: 57). These anti-competitive monopolies would only be broken up after the Second World War, and deterred new entrants to the field. As noted, Holmes and ADT focussed their expansion efforts in the lucrative commercial sphere, where they had a distinct advantage, especially in being able to support the prohibitive costs of maintaining centralised watch-house monitoring.

The second is architectural. The late 19th and early 20th century saw the beginnings of a shift away from the dense passages and corridors typical of Neo-Gothic Victorian architecture (such as in Twain's residence). The architectural historian Vincent Scully identifies an "openness and flow of space" (1955: 88) emerging from the early 1880s which he termed 'The Shingle Style', and which would later be consolidated by the Prairie School Movement of Frank Lloyd Wright, Walter Burley Griffin, and others, in

the Modernist tendency towards open plan housing, which gradually gained hegemony over the course of the 20th century. Such a transformation had significant implications for home security systems predicated upon the use of contact sensors. Holmes' security systems would have been unable to 'keep up' with these transformations of the domestic interior. The replacement of doors dividing a dense network of rooms by open spaces would have removed the necessary physical substrate for the successful functioning of the system within the home's interior space. Without a door to attach the contact sensor to and thus set off the burglar alarm within the house, there would be no way of being able to successfully monitor the house's interiors. The kind of 'narrative' that Twain for example was able to follow, as he 'watched' via his annunciator the movements of the burglar moving from his basement through to his mahogany room and then out the window, would not be possible without the utility of doors and windows to act as triggers for the movements of the burglar (or servant, or family member).

The problem of monitoring open plan spaces would not be 'solved' until after World War II. In 1947 Samuel Bagno patented the UltraSonic alarm, which drew upon wartime developments in radar using the Doppler effect to detect frequency differences within a room filled with ultrasonic radiowaves. The UltraSonic alarm filled a space with a given frequency, which would be altered by the presence of another body within the room, thus activating the alarm (see Bagno, 1953). Early iterations of the device had the difficulty of being set at too sensitive a frequency and being often set off by the scurrings of mice and pets; the device's sensitivity could be lowered to allow for the undetected movement of these small bodies, though still produced the problem that the "delicate ears [of the mouse could] hear its high-pitched sound, and the uproar frighten[ed] them so much that they die[d] of a heart attack" (Anonymous in Time, 1953: 93). Beyond the problem of the system working as an overeffective mouse trap, the system was also prone to false alarms, such as those occurring from "percussive shock sounds", such as hammer blows occurring within the vicinity of the alarmed room, or "the sounds produced by structural elements as they expand or contract in accordance with changes in the temperature" (Bagno, 1956: column 1-2). Bagno would attempt to remedy this problem in later iterations of the device by distinguishing between 'transient' and 'continuing' conditions within the environment through

measuring for “numerical pulse duration”, ie, for determining if the body or object which had entered the room activated the alarm system for longer than would be the case for the fleeting presence of a ‘shock sound’ (Bagno, 1956).

Nevertheless, the UltraSonic alarm ‘solved’, at least schematically or conceptually, a significant problem of monitoring the interiors of rooms without the binary on-off ‘switch’ of either a door or window, instead effectively saturating the interior of a room with the fluidity of radio-waves. As Gilbert Caluya has noted (2014: 809), home security technologies here constitute an example of what Beatriz Colomina has recognised as the way in which “the techniques, materials, and ways of doing that were developed for the military” during World War II were “recycled” for the domestic interior during the early years of the Cold War (2006: 12).

THE ‘SERVANT PROBLEM’ AND ITS RESPONSE

We might identify another reason for the drop in popularity of home surveillance technologies used as a way of maintaining domestic order within the home, and this is the drop in the number of live-in domestic servants across the first half of the 20th century. By the turn of the 20th century, what had become known as the ‘Servant Problem’ was a pressing concern of the American middle and upper classes. As noted prior, there had been several aspects of cohabiting with live-in servants which had threatened or complicated the strict spatial segregations and moral economies of the 19th century home, and electric security alarm services were positioned as a means by which to regulate these tensions. By the turn of the 20th century America was rapidly industrialising, and women who would have previously gone into domestic service employment were finding that factory work provided better and more regular pay, as well as more freedom in one’s social life. The real ‘servant problem’, some commentators at the time suggested, was with the households themselves, now that “domestic service lacked the standards and organization that would make it as attractive to working-class women as the store or factory” (May, 2011: 18). The number of women working as domestic servants dropped precipitously in the first few decades of

the 20th century, to only 9.5% of all women workers by 1944 (Palmer, 1989: 154) and 8.4% by 1950 (Palmer, 1989: 156).

There were two key responses to this ‘crisis’ in master-servant relations; the attempt at producing a scientific management-inspired rearrangement of the household, and the electrification of the household. Christine Frederick, the wife of George Frederick, one of the early proponents of Taylor’s Scientific Management theories, argued that the principles of time and motion analysis could be applied in the domestic realm to make household management more efficient. Key to this increase in efficiency was the reorganisation of space within the kitchen, with Frederick noting that “The first step towards reducing time spent in the kitchen is to have a kitchen small and compact, without loosely connected pantries and cupboards. The small kitchen costs less to build, but even more important to the worker, the small kitchen saves steps by concentrating the working processes” (Frederick, 1915: 19). Where previously the lady of the house had been tasked with choreographing the movements of servants within the boundaries of the domestic sphere, her responsibilities came to design a dance for one – as the mother of the household took on the burden of transforming their domestic routine into as efficient and productive a use of time as possible (see Cieraad, 2002; Delap, 2011; 2012; Gregg, 2018).

In this they were at least partly aided by the development of labor-saving electrical devices. As Devin Heckman notes, the electrification of various home appliances developed rapidly, with the first popcorn poppers appearing in 1907, the toaster in 1909, the electric egg cooker in 1916, and so on (Celehar, 1985: 15-16, cited in Heckman, 2008: 34). This reimagining of the spatiality of the household and its augmentation through increasingly ‘smart’ electrical appliances was a process which proceeded in tandem with each other; as Heckman argues, “From the open plan, which was made to be flexible, to various smart appliances, which were intended to make efficient use of this flexible space, the home has come to increasingly resemble an ‘open architecture’ or a space built to accommodate technological changes” (2008: 94). However, the early electrification of the home lacked the kind of unifying, synthetic quality which might have made it ‘truly’ possible to make up for the labours of an in-house servant; Christine Frederick lamented that “in the future it is believed that the servantless

household will be far more unified than at present. That is, instead of such small devices made by different firms and bought separately, there should be a larger installation or ‘system’ (scientifically) planned for a specific kitchen, with the *various pieces related to one another*” (Frederick, 1915: 393-395, cited in Heckman, 2008: 35).

It was only in the 1980s and 1990s that computing technology was capable of networking and automating separate electrical appliances – the contemporary smart home can be traced to innovations such as the development of X-10 wiring, which allows for power wiring to also send communications, thus “[enabling] the home’s electrical wiring to function as a communications network, finally making home automation possible” (Heckman, 2008: 96). It was with this development that the groundwork for the contemporary smart home and its place within the Internet of Things was laid, with its capacity to integrate ‘smart’ lights, ‘smart’ entertainment services, and, most importantly in the context of this chapter, ‘smart’ home security.

FROM THE ARCHITECTURE OF FEAR TO CHOREOGRAPHING SERVICE WORK IN THE SMART HOME

While the critical analysis of the smart home has expanded in recent years, relatively little analysis has concentrated on home security systems as an element of the smart home, with many analyses only considering home security in passing or not at all. This is somewhat surprising, given that as Brush et al (2011) note, home security is arguably the main field in which home automation systems have found success. Home Security systems have become so common and so mundane that perhaps they are not even generally thought of as an element of the ‘smart home imaginary’; their deflationary discourse of the home, one characterised less by the potential wonders of a techno-utopian future and more by an anxious discourse of the threat posed by (post-)modernity, perhaps renders modern home security systems an unappealing object of study for media scholars. However, the intersection between home security alarms, smart home imaginaries, and the re-emergence of domestic service, provides a compelling nexus through which to examine contemporary anxieties surrounding the

Sensor Society, especially on the place of the body and its imbrication within the digital environment.

These anxieties particularly can be seen to coalesce around recent ‘innovations’ in the management of domestic service workers within the home, such as the Amazon *Key* service, Walmart/August’s so called ‘in-fridge’ home delivery service, and Vivint’s ‘smart lock’ service designed with the intention of modulating the comings and goings of “service personnel” (2017: np). There are remarkable convergences between these forms of surveillance of domestic staff and their imbrication with the economy of the home as has been examined in the work of Holmes and his 19th century successors. Following Heckman (2008: 8), it shall be argued that the key distinction between the contemporary smart home surveillance systems examined here and their genealogical antecedents is in the question of temporal mastery – where earlier systems sought, however unsuccessfully to corral and to discipline instability, these contemporary systems make a virtue of contingency itself. They serve to choreograph and to coordinate what I will define here as the ‘fleeting home’, a home whose borders can be withdrawn and re-established at the whim of the homeowner, as insecurity itself is mastered through its reincorporation back into the home’s own technological system (see Hand, Shove & Southerton, 2007).

THE CULTURE OF FEAR

Critical theorisations of electrical home security have tended to situate their development within the context of the growth of ‘fear’ as an organising principle of American social life. Caluya has also convincingly argued for the relevance of the post-Civil Rights movement ‘white flight’ and increasing paranoia on behalf of white, middle-class homeowners over the prospect of greater propinquity with African-Americans as key to the growth in demand for home security technologies from the 1960s onwards. The Civil Rights Act of 1968, also known as the Fair Housing Act, outlawed the racial segregation of housing in the United States. As the racial ‘purity’ of neighbourhoods could no longer be guaranteed, Caluya sees the secured white home, hermetically sealed from the turmoil and change of the Civil Rights era, as thus gaining

in symbolic significance: “Not only did they protect against the outside world,” Caluya rights, “home security systems promised ‘master control’ over private space at the very moment that conservative white Americans felt they had ‘lost control’ over a racially uncertain public space” (2014: 815).

These discourses of urban fear and heightened or privatised personal security only intensified in the following decades of the 20th century. Steve Macek (2006) has described how fear of the ‘urban’ and of the threat of crime manifested in advertising discourses, especially around home security, throughout the 1980s and 1990s. Home security installations grew in the US by 10% per year throughout the 1990s, with expenditure increasing from \$10 billion in 1995 to \$13.2 billion in 1997, a trend Macek sees as being underscored or fuelled by a runaway discourse of fear in advertising (Macek, 2006: 263-264).

This culture of fear has also been further reflected at the broader level of urban design and security, as the latter decades of the 20th century saw the growth of what Mike Davis terms ‘Fortress Cities’, by which the urban landscape became “brutally divided between ‘fortified cells’ of affluent society and ‘places of terror’ where the police battle the criminalized poor” (Davis, 1990: 224). Graham and Marvin have similarly argued that urban infrastructure has, since the 1960s, increasingly been characterised by what they term ‘splintering urbanism’, as “[d]isjointed, decentralised urban landscapes thus [proliferate], studded with grandiose real estate developments and their customised infrastructure links” (2001: 228). Graham and Marvin describe how the privatisation of the urban fabric has resulted in its fragmentation, as those who can afford to do so retreat into a domestic space withdrawn from the chaos and tumult of the urban centre, in favour of homogenised gated enclaves connected by private roads to equally homogenised shopping districts, patrolled by private security guards, and designed to keep any threatening hint of the outside world out of sight and out of mind. Thus it is that those who have the means can purchase a sense of “ontological security” and escape from the fear of the urban, at the further social cost of “the regulating out of ethnic and social difference, diversity and chance encounters” (Graham and Marvin, 2001: 272).

SOMATICISING THE HOME

Several critical theorisations however have pointed to the difficulty involved in producing technological remedies to a lack of ontological security at the domestic level; just as the introduction of domestic technologies led to ever higher standards of cleanliness and hence ever more domestic labour (see Schwartz Cowan, 1983), so it is that new home security technologies increase expectations over what an acceptable degree of security is, as “locked doors and shuttered windows can give way to a fenced-off perimeter with motion-detecting sensors, surveillance cameras, and sound detectors, each innovation raising the bar for standards of household security and control” (Heckman, 2008: 106). Michal Rapoport (2012a, 2012b) has argued that modern home security technologies are riven by the question of how to synthesise the ‘sense’ of security with its somatic manifestation within the home. Rapoport argues for an analysis of the electronically surveilled home as a “tripartite assemblage”, with her analysis focussing on how electronic security systems serve to reorder and resituate the categories of “technology, humans and space/place” (2012a: 320). For Rapoport, while home security technologies are marketed as ostensibly serving to reify the border between home as a protected, purified safe-zone, and the dangerous, unpredictable outside world, in practice home security technologies in fact serve to break-down this barrier, to expose home-owners to greater scrutiny of their own actions. Rather than a place of refuge, she argues that home security technologies serve to produce an injunction to place oneself under constant surveillance and to manage one’s own security at all times. Moreover, the comfort of home as that most personally significant of *places* is undermined by the intrusion of electronic surveillance, as “[s]een from practically anywhere (through internet access, for example) and at any time of day, the home as place becomes segmented into observable, monitored, deterritorialized spaces detached from singular, unique and unrepeatable time and from the tangibility of site” (2012a: 325). Consequently Rapoport argues that home itself loses its phenomenological sense of security, in place of a privileging of a somaticized *presence*, by which identity becomes commensurate with the physicality of the homeowner:

Biometric technology in home use...takes the static, machine-like qualities of the programmed, datafied body...further, adding behavior and action as information to be read and recorded. Three-dimensional, spatial, and temporal, the body is numericized, recorded, stored, and used as a reference. How the body performs in space, and how it moves over time is translated into numerical data to be used in the constitution of a mirror identity to which the “real” individual is continuously compared. When dealing with identification, these technologies must continuously refer back to a digitalized mirror image, to a simulation of the “real” comprised of perceivable features, behaviors, and actions. And it is at the interstice between the real and the simulated that the identity of friend or foe is determined. (Rapoport, 2012b: 215)

For Rapoport, the digital inscription of bodies in the surveilled home serves to operate as an intrusion of an outside technological assemblage into the purportedly private sanctuary of the home, as home security technologies serve to “render the home a site in which individuals, in their desire for comfort and safety, are primarily read as datafied bodies lending themselves to processes of abstraction, codification and normalization” (2012b: 217). Caluya has similarly read the function of contemporary home security technologies as operating according to a Deleuzian deterritorialising impulse, such that “whereas previous devices merely reinforced certain architectural or engineering aspects of the home, contemporary security products actually constitute the home as a feeling, architectural body capable of being affected...Body organs are deterritorialised from the human body and reterritorialised on contemporary residential architecture, while our senses are extended through modern security technologies” (Caluya, 2007: 24). In both of these accounts there is an argument that contemporary home security systems have reversed the original distinction they were ostensibly designed to maintain; rather than keeping out the fear of the outside world and preserving a sense of hearth and an inviolate, indissoluble domestic sphere, home security technologies now dissolve this boundary, rendering the inhabitants as objects of a technological system which exists in order to exteriorise their own fears. Rather than keeping fear *out*, fear becomes the substrate of the secured home itself.

ON THE 'STRANGE SURVIVAL' OF SERVICE WORK AND ITS CHOREOGRAPHY WITHIN THE SMART HOME

This capacity for the home itself to function as a perceiving environment is tied also to the growth in smart home technologies, as from the 1980s onwards the development of the 'smart home' became more and more within the grasp of middle class Americans. However, this trend has also served to complicate the security industry's investment in the discourse of fear, as smart homes have instead moved to promote "pleasance" (Strengers & Nicholls, 2018), a sense of comfort and ease, as being at the centre of their mission to remediate the home.

In the literature on smart homes and digital home automation, the rise of the smart home from the 1980s onwards and its coincidence with the re-emergence and growth of domestic service workers is an irony that has been little commented upon. Indeed, perhaps the most prominent contemporary smart home theorist Lynn Spigel (2001; 2010) argues for a post-Marxist analysis of the smart home, asserting that in place of traditional Marxist-Feminist critiques of the place of domestic labour within the home, what is needed now is an Actor-Network Theory inspired analysis of the entanglement of relations and technologies within what she describe as the "cybernetic lifestyle loops" of the modern smart home:

Unlike an Orwellian surveillance screen or a Foucauldian panopticon, the smart home is essentially an architecture of feedback where humans and artefacts communicate in what might be called a cybernetic lifestyle loop. As in Bruno Latour's 'actor-network' theory, in the smart home technological artefacts and human agents are not conceived in binary terms or top-down relations of control, but rather as components in feedback circuits, as equal partners in mutual force fields of action and reaction (Latour 2005). The smart home creates a circuit of communication in which the classic Marxist binaries of subject-object – or humanist binaries of man vs. machine – no longer apply. If everyday life is commodified, this occurs through the feedback among and between artefacts and humans rather than through the classic Marxist explanations of alienation, the commodification of labour, or commodity fetishism *per se*. (Spigel, 2010: 240)

Spigel argues that the contemporary smart home represents a new possibility for the introduction of a home which is able to respond emergently to the desires and imaginaries of its owners. Though she acknowledges that the smart home still needs to be thought of in terms of “struggle, conflict and necessary negotiations” (2010: 253), she analyses this struggle in terms of intramural gender antagonisms amongst the family, critiquing for example the anxieties displayed by men regarding automated technologies usurping their position within the home.

However, it is important to note that domestic service work as a form of paid employment never fully disappeared, and has especially since the 1980s been a growth industry. Accordingly, it is misleading to suggest that the domestic space has ceased to function as a site of struggle or antagonism over the division of labour. As Lucy Delap (2011) argues, there has been a “strange survival” of domestic service throughout this period. Delap pursues a close reading of British housekeeping magazines over the course of the 20th century, noting that even as British households and kitchens modernized, there was not necessarily a concomitant assumption that they were moving towards a servantless future. Delap cites one remarkable but illustrative discussion of modern kitchen design from 1938, in which the journalist Geoffrey Bournemouth “advocated that the space saved by reducing the kitchen to a minimalist, functionalist cooking area ‘should be used for a servants’ hall or maids’ sitting room’” (in Delap, 2011: 197).

While in the US there was a decline in the number of women working as domestic workers in the first half of the 20th century, with some forecasting the demise of the profession, “in the late twentieth century new domestic demands arose and new recruits were found, now crossing the southern border to reach the doorstep of domestic work” (Hondagneu-Sotelo, 2001: xii). Especially as middle class women increasingly came to be expected to enter the workforce themselves, thus having to balance professional careers with household duties which were still gender coded as the prerogative of wives or mothers, “many of them—guiltily but wistfully—[yearned] for the bygone days of servants...They are guilty because they don’t quite approve of anyone’s working as a servant in someone else’s home” (Mead, 1976, cited in Romero, 1992: 14). Delap

argues that it is a mistake to see domestic service in the 20th century in terms of a narrative of ‘residualization’, as simply a holdover from a less enlightened era of domestic arrangements, arguing that this “residualization narrative overly stresses discontinuity and does not acknowledge the extent to which the institutions of domestic service remained intimately bound up with the changes in...domesticity in the twentieth century” (Delap, 2011: 191).¹⁴

The continued and indeed growing presence of service work in the home serves to complicate the argument that the smart home suppresses or elides the question of ‘Marxist binaries’ within the home. Although some critiques of the smart home have noted the ‘legacy’ of the master-servant relation within the design of smart homes, few have acknowledged the continued relevance of this relationship within contemporary smart home design.

There have been several recent innovations in smart home security designed with the explicit intention of choreographing and monitoring service work. In 2017 Amazon caused a stir when it announced its Key service, which would allow Amazon delivery workers to enter the front door of users’ homes. Similarly, Walmart has recently announced plans to produce a smart lock system which would allow homeowners to remotely monitor delivery workers as they deliver food directly into the customer’s fridge. Vivint meanwhile have patented a smart lock designed at regulating the movements of service workers, which would allow the home owner to choose a “predetermined level of access [which] may include a duration of usage, a time frame of usage, access limitations to selected areas, or some combination thereof” (2017: np).

¹⁴ It is perhaps worth noting that in the study of late 20th century and contemporary forms of domestic service, technologically mediated surveillance has been accorded relatively little import in the management of relations between family member and domestic worker. As the research of Mary Romero (1992) and Pierrette Hondagneu-Sotelo (2001) has made clear, even the much vaunted ‘nanny cams’ of the 1990s appear to have held relatively little significance by contrast with more ‘low tech’ surveillance techniques such as dropping in unannounced during a housecleaning period, or even simply staying near a domestic worker while they were completing their duties.

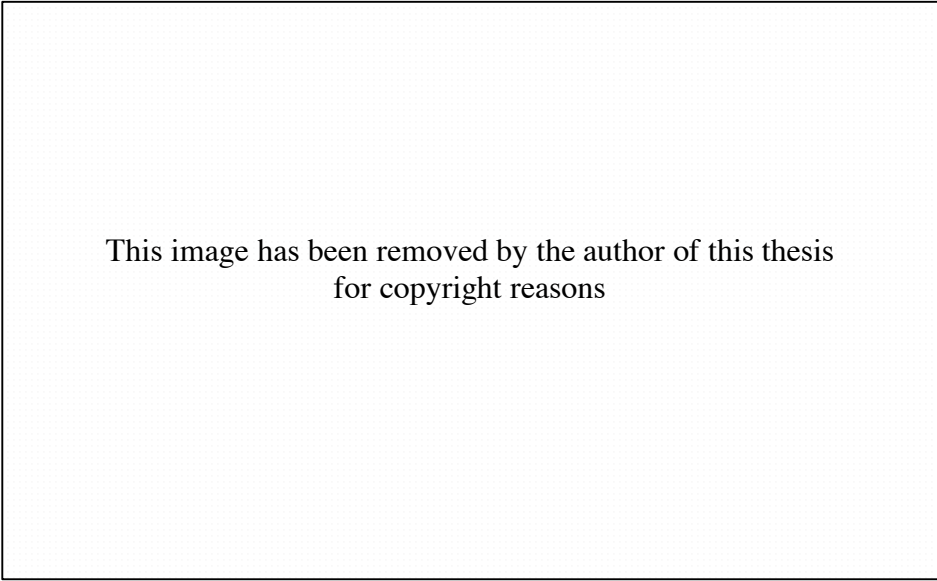
This section of the chapter shall examine how service work is being imbricated within the design of the smart home.

Heckman (2008) has drawn attention to how the smart home becomes a ‘set’, scripted to produce the elements of “The Perfect Day”, or of “pleasance” (Strengers & Nicholls, 2018). What these new developments demonstrate is the capacity for smart home security technologies to modulate the boundaries of the home, enabling differentiated degrees of access which can be extended and withdrawn at the discretion of the homeowner. This implies new forms of “digital housekeeping” (see Tolmie et al, 2007), but also compels attention to how the smart home is integrated within a broader economy of service work, and how domestic service is choreographed and imbricated within other lifestyle scripts.

SMART LOCKS, SERVICE WORKERS, AND THE “MOST SENSOR PERSON”

Perhaps the most high-profile of these ventures has been the Amazon *Key* service, announced by Amazon in 2017. The core offering of the Amazon Key service is a smart lock designed by Yale which allows authorised Amazon delivery workers to enter the home of subscribers, and to leave packages ordered through the Amazon website *inside* of the home, rather than on the porch (where they would be vulnerable to potential ‘porch pirates’) or at the local post office (which would require the tedious labour of collection). Delivery workers approach the home of users, and if no-one responds to an old-fashioned knock on the door, they use their scanner to request access to the door. Amazon then ‘verifies’ the delivery and grants access to the delivery worker, which also turns on a webcam placed beside the front door, filming the delivery. The deliverer then places the package just inside the front door, requests to lock the door, and leaves the premises. Using the Amazon Key app on their smartphone, users of the service receive a notification when the deliverer is approaching their house, and when they leave, and they are also able to watch live video of the deliverer carrying out delivery, or to record and watch the video later. If the homeowner is unhappy with an aspect of the delivery they can use this video to file a complaint with Amazon, under the terms of the *Amazon*

Key Happiness Guarantee (Anonymous in Amazon, 2018a).



This image has been removed by the author of this thesis
for copyright reasons

Figure 16

An excerpt from Amazon Key's promotional materials

Source: Anonymous in Amazon (2018) *Amazon Key*. Available online at
<www.amazon.com/key>

Going literally beyond front door delivery, the American retail corporation Walmart has partnered with August to produce a smart lock system which will enable groceries to be delivered directly into the fridges of subscribers. The system operates very similarly to the Amazon Key service, with the central difference being that the Walmart app allows a series of security cameras to track the path of the delivery worker as they move from the front door to the kitchen, and put away the groceries directly into the subscribers' fridge. If the promotional website and videos are to be taken as an accurate representation of the service, users will be able to watch live footage of the delivery workers as they move about the house, make their delivery, and then exit the home (see Walmart, 2019).

While the focus in Amazon's and Walmart's promotion of this service so far has been on the delivery of packages and/or food, Amazon especially has also made clear that they plan to expand the service to include the provision of access from other kinds of service workers as well, as "a convenient way to provide unattended access to professional service providers" (Anonymous in Amazon, 2018b). Amazon has

announced partnerships with the dog-walking service Rover.com and the cleaning service Merry Maids, as well as the “over 1200 services” provided by the employees of Amazon Home Services. Amazon Home Services provides a searchable database of particular services provided by service workers in the users’ local area; under the ‘plumbing’ tab for example users can search for ‘faucet installation’, or ‘clogged drain repair’; under the house cleaning tab users can choose from a drop down menu specifying the number of rooms in the house, the kind of cleaning products they would prefer to be used, and the number of hours they would ‘recommend’ for its cleaning. Amazon has not at the time of writing announced how this service would function. In late March 2018 reports emerged that Amazon had recently begun directly hiring housekeepers in Seattle as part of a new housecleaning service called Amazon Home Assistants. Bucking the trend of outsourcing service workers, commentators have speculated that Amazon is using the well-known Amazon branding on its own team of housekeepers in order to instil trust in the notion of allowing ‘unseen’ service workers into one’s home (Soper & Eidelson, 2018).

A potentially significant drawback for potential users of the Amazon Key service in particular is that they have not yet served to integrate Amazon Key with existing home security services, meaning that any potential users would have to disable their existing home security service on any days when they were wanting to make use of the Key delivery service. However, other smart home security service providers have been developing patents for home security technologies which would serve to integrate the kind of features Key provides with existing home security products, as well as to enable a more sophisticated form of service worker monitoring than simply enabling the use of security cameras for homeowners to keep an eye on delivery workers. The smart home security provider *Vivint* has filed in 2017 a patent for a ‘Smart Door Lock’ designed precisely with the intention of enabling a variegated and emergent form of monitoring of home service workers, able to be reconfigured and adapted to as many different configurations of the home as would be amenable to the homeowner. The patent describes a package-delivery element seemingly modelled on the drop-off-inside-the-door model of Amazon, but also describes the potential for delivery worker authorisation to enable the worker to “perform select services at a residence” (Vivint, 2017: 29). As the patent goes on to specify, this would be predicated upon the enabling

and disabling of, for example, proximity or motion sensors, such that:

the personnel profile may allow a delivery person to place a package proximate a door to a residence. It may additionally disarm other sensors and/or settings to allow the personnel access to the home for preapproved actions. For example, cleaning personnel may be automatically granted entry to certain areas of a residence. In some embodiments, select security sensors may remain activated. For example, a home office may remain activated to alert a user if the cleaning personnel enter the room. (Vivint, 2017: 29)

Other service workers mentioned by the patent include dog-walkers and gardeners (Vivint, 2017: 40). The patent goes on to specify that this degree of access “may include a duration of usage, a time frame of usage, access limitations to selected areas, or some combination thereof” (Vivint, 2017: 31). The patent also specifies that the ability to grant permissions could be differentiated according to family hierarchies – all members of the household would be granted a certain user profile, which would enable each member of the household to enter and exit the household freely. However, administrator status may be granted only to what the patent describes as the “most sensor [sic – presumably should be most *senior*] person” (Vivint, 2017: 39), given that an “administrator and/or parent may not want actions taken that perhaps a teenager might desire” (Vivint, 2017: 39). While the Vivint patent does not yet seem to have been ‘embodied’ in any particular technology, it does give a sense of the way in which it is projected that service actions more complex than simply dropping a package off in a vestibule might come to fruition. Authorised service workers, their movements monitored by motion sensors, would have their movements choreographed, allowed access to particular parts of the house at particular times and for particular durations, at the discretion of the “most sensor person” in the house.

We can thus read the smart lock as in dialogue with or as a remediation of past practices of master-servant or employer/employee relations within the home. The smart lock is still a security, surveillance technology, but a markedly ‘feminized’ one; rather than a masculinist ‘fortress’ connotation to the technology, these ads position the smart lock as producing a provisional entrance, one which can and must be monitored at all times,

and which can be withdrawn at the discretion of the homeowner.

In the development of smart-home security/service worker monitoring technologies like the Amazon Key and the Vivint system we can detect the emergence of a form of monitoring which is able to exploit the contingent, emergent nature of service work, with a more closely and securely monitored form of job evaluation. Heckman has argued, in his account of the rise of the smart home, that the key distinction between the modern home and the smart home is that where the modern home sought to corral and constrain chaos, the smart home seeks to make a virtue of contingency itself: “Unlike past utopias, which yearned for a state of completeness, this one would achieve perfection in the process of change” (2008: 6). It is in this distinction that we can frame contemporary smart lock as both in continuity with and in contrast to the earlier systems of servant monitoring analysed in this chapter. The analysis of 19th century Holmes security systems, and the close reading of Twain’s use of such systems to monitor the interiors of his home and the comings and goings of his servants, served to extend the awareness of the homeowner throughout the corridors of the household, by which he could come to know the movements of his servants in an intimate and intensive fashion. This regime of surveillance served to ‘descend’ to the level of the household, but still sought to maintain the movements of the household within its spatial limits, to circumscribe and constrain activities of servants within acceptable parameters. The smart locks of contemporary systems, by contrast, while also constraining acceptable behaviour under an intensive surveillance regime, serve to mediate service work between the home interior and the broader service economy, thus producing the home as an open and expansive space, and reconstituting home security in terms of the mastering of contingency, rather than the sealing off of intrusion *per se*.

CONCLUSIONS: SOMALETHEIA AND THE CULTURAL TECHNIQUES OF DWELLING WITHIN THE ‘FLEETING HOME’

This chapter has re-examined the history of home security technologies as biosensors directed towards the surveillance and choreography of domestic service workers.

Though emerging in a different sociotechnical context to the work of Marey et al, we

can divine remarkable convergences in the forms of monitoring that they afforded. Although they emerged fifty years prior to the forms of post-Taylorist worker surveillance examined in the previous chapter, we can see a similar emphasis on the emergent and iterative control of space and (service) worker activity, understood in relational and mutable forms.

We can understand these systems as biosensors in the sense that, although these technical systems were not organised around the intensive measurement of human biological capacity, they were nevertheless predicated upon the sensing of the body, and produced a specifically *somaletic* reimagining of the home. On the one hand, electrical security systems allowed the master of the house to exert greater control and regimentation over the movements of [his] servants and other family members, and to compel them to organise their routines around [his] schedule and needs. The capacity to redraw the boundaries of the home through electrical home security enabled a greater fluidity and modularity of use of the domestic space. By the same token such technologies also produced a new kind of ambiguity and absence – the reports that Mark Twain heard of his alarm system going off did not ‘speak for themselves’, but required him to return and to ‘play detective’, organising his investigations and interrogations in order to ‘fill in’ the gaps of the alarm system. If the sphygmograph produced the ‘educated finger’, and the spirometer the ‘educated filer’, here we see the alarm system produced an ‘educated father’, whose authority is exerted in his capacity to manage the obscurity of the home, which the alarm at once affirms and brings to order.

This capacity for the ambiguous redrawing of the house afforded through electrical home security is remediated in contemporary systems. In the modern open plan smart home there is less ‘obscurity’, but the ambiguity of the relations between homeowner and service worker are remediated and extended. Access to the smart home is contingent upon the desires of the homeowner – it can be altered or revoked at any time, in essence allowing a redrawing of the limits of the household itself, as these limits become moulded around the very body and movements of the service worker. While this allows homeowners to exploit the precarity and contingency of service work itself, it also means that the sense of ontological security within the home is undermined – this

is the 'fleeting home', whose borders are in flux, unstable, offering less a sense of 'placeness' than a more ambiguously rewarding 'freedom' in the command one holds over the movements of the service workers in one's employ. Rather than offering a clear distinction between the safe within and the unknown without, the boundaries of the home extend within and throughout the home, variegated, malleable, and requiring of constant choreography, monitoring, and recalibration.

CONCLUSION

APORIA BEYOND SOMALETHEIA

This thesis has examined the genealogical descent of the cultural techniques of biosensing. I argue that these techniques have coalesced into a certain ‘operative ontology’ by which the body is understood as both able to ‘speak its own’ truth through the biosensing relation, as well as being that which most surely obscures this truth. I have termed this aporetic relation *somaletheia*. Somaletheia has emerged as a certain way of figuring and understanding the body, which has arisen as a way of conceptualising and managing the difficulty of the body as it misaligns with biosensors. This productive failure is ‘worked through’ in each milieu such that interpretative authority is typically ‘disrupted’ only in such a way as to extend, or redistribute, the authority of the ‘one with the right to know’.

The thesis I put forth draws upon the methodological tools of Cultural Techniques theory to make this argument. One of the key points of disposition or orientation which this method helps to clarify is that somaletheia *not* be understood as constituting the essence of the technological relation ‘holding sway’ between and across the double births of the sensor society in the mid-19th century and the beginning of the 21st century. Somaletheia is a particular problematic of the arrangement of the biosensing apparatus which has ‘hardened’ into a particular concrescence over time. However, this does not mean that the dynamic has remained static, or that it has simply fulfilled itself teleologically across the different fields I examine, in a way which would simply reflect some inescapable ontological condition characterising the body-media relation. Cultural techniques unsettle and resettle – as a method we can use it to map mutations and continuities, in order to help us better grasp the condition of our present situation.

In my third chapter, I considered how the graphical method of Marey was troubled by the problematic of biological errancy, in a way which we can see being ‘worked through’ or corrected for by the ‘educated finger’ of the British clinician. I do not read these ‘cultural techniques of touch’ as rejecting the ‘challenge’ of technological

measurement, but as a sensualisation and distribution of its interpretative affordances. The contemporary example of the use of photoplethysmography within commercial devices like the Apple Watch does not simply ‘repeat’ this process. My analysis demonstrates how the practice of working through remains riven by power differentials, such that the promises of the Quantified Self to ‘empower’ ordinary people to better know their own vital capacity are frustrated as they remain enmeshed within a medical gaze itself transformed by the capacity of digital analytics.

In my fourth chapter, I examined how the failure of the Taylorist ‘one best way’ to capture the differentiated capacities of industrial work and workers was recuperated by the physiologically guided tools of the Marey-inspired European Science of Work. I further consider how Human Relations theory, and particularly the sensor enabled statistical analytics of Thomas North Whitehead, served to prefigure later management techniques like sociometrics, through the devising and measurement of immanent forms of experimentation and reorganisation of the workplace. In the somalethic workplace, the protest that the work process is not aligned with properly human capacities of rest and productivity becomes the animating principle of biosensor analytics, rather than a disruptive force. Biosensing-enabled management techniques attempt to expand the suzerainty of management over the ‘wasted’ gesture, without thereby eliminating ‘waste’ as such. Rather than the telos of the ‘one best way’, the neo-post-Taylorist workplace reinscribes the crisis of productivity within the aporia of somaletheia, where it is never resolved, but merely recalibrated and reworked, extending the control of a managerial class who has no clear ‘end’ in mind beyond the refinement of management itself.

In my fifth chapter, I considered how the cultural techniques of biosensing within the home security apparatus have served to function as ‘extraservomechanisms’, as means for managing and directing the movements of domestic servants, or in more recent iterations, service workers. The reports of home security alarms alerted the master of the house to their servants’ transgressions, thus allowing the re-establishment of the norms of bourgeois domestic order. But the double movement of somaletheia also served to extend the knowledge of the master of the house, deepening, if ambivalently, their understanding of the contingencies of the home’s borders. In the contemporary iteration

of sensor-enabled home security, this form of knowledge is refigured and made productive, as contemporary home service technologies allow homeowners to redefine, recalibrate, and re-establish the meaning of the home's borders, the better to integrate it within the circuits of an on-demand service economy. Rather than simply reinforcing the 'domestic fortress', contemporary smart home security is predicated upon a remarkably fluid or open relation to the outside, a reimagining of its borders which I term 'the fleeting home'. Within this imagination, the borders of the home become somaticized, in the sense that they are capable of being constantly remoulded and remodelled around the movements of the bodies which occupy or visit it, according to a hierarchy which elevates (in the Vivint smart lock patent's most astonishing typo) 'the most sensor person'.

Part of the significance of this argument is that it demonstrates clearly the limitations of the form of 'praxis' the Quantified Self movement has tended to promote as its response to the difficulties of life in the sensor society. I discussed in my literature review section how scholars have already critiqued the limitations of the production of a more 'idiosyncratic' form of measurement as reflecting a tendency towards reproducing agile forms of life predicated upon an ethic of neoliberal self-management. My own analysis also extends the critique and observations of what I have termed the 'aporetic' school of interpretation. The key point here is that 'empowerment' or 'resistance' to sensor-enabled modes of governmentality cannot be understood to emerge simply or easily from the reapplication, reconfiguration, or alternative modes of use promoted by Quantified Selfers, however creative or novel such applications may be. This is because the way that biosensors are used to write the 'truth' of the body depends less on their configuration *per se*, and more so on the way that such configurations are accepted as refigurations in responses to acceptably demarcated modes of error, or what I have termed 'biological errancy'. Cultural Techniques theory demonstrates that modes of use do not simply 'inhere' in the material of the technological apparatus – they are instead tied to complex chains of ontic operations, which work beyond or to some degree 'outside' the intentionality of any given subject of any given technodiscursive moment. Although the Quantified Self movement has, as noted, served to 'problematize' the biosensing relation, its decline in relevance as a means for considering the problematics of the sensor society (as charted in my account of the chronological development of

academic responses to biosensing) is an expression of the limitations of the self-centred approach to contesting its limits and norms.

If the reconfiguration of the sensing apparatus itself has clear limitations in terms of critical praxis, so too however does the sort of vitalist or affect oriented critique which has often predominated in analysis of the body's mediation or 'enframing'. This is most clearly demonstrated in my study of work and work-measure, where the post-Taylorist approaches of the European Science of Work and the (Thomas North) Whiteheadian approach to statistical analysis of the workplace demonstrates the degree to which biosensing can respond to and be reconstituted around the problematic of a biological errancy – I describe the way such errancy has been transformed from a threat to the maintenance of productivity to its very condition, through its reabsorption into the biosensing apparatus. The body resisted the impositions of the Taylorist method, but this biological errancy served as the correlate of the biosensing apparatus around which the new cultural techniques of work-measure could be formulated. Similarly, the pernicious element of biosensors like the sociometer leave the subject of its monitoring no 'freedom to fail' – the errant or non-productive gesture, or indeed the affective gesture that 'exceeds' the metrological parameters of the device, can be and have been used to authorise the recalibration of the workplace or of work processes. The point is not to argue that the embodied stress or pain or violence of work oriented around such systems do not matter, or that workers should not seek to fight for less constraining or binding modes of surveillance and workplace organisation. Rather, just as the aporia of biosensing cannot be meaningfully resolved on the side of the device, neither can we rely upon the 'wisdom of the body' to guide us through the challenge of the somaethic relation.

The aim of this thesis then has been to consider in greater depth the difficult question of how the somaethic problematic has concretised and reconstituted itself as a means of extending the 'reach' of the cultural techniques of biosensing. Part of the difficulty of considering 'biological errancy' is the errancy of errancy itself. That is, there is no such thing as biological errancy in a singular sense – the 'problems' of the affluent white west-coast quantified selfer are not the problems of the Amazon home services worker or even the homeowner tasked with recalibrating the 'borders' of their home around the

movements of their dog walker or gardener. Although not the focus of this thesis, part of what this thesis has revealed is the place especially of race and gender as elements of the development of the biosensing apparatus. The immigrant female domestic servants who were subject to the tests and recalibrations of home security technologies in the 19th century, the first generation American female workers at the Hawthorne Works – it is surely not any coincidence that it was these marginalised populations who were used as the test subjects for developing the techniques of ‘working through’ that emerged through the biosensing relation, even as these cultural techniques are in turn reworked and redeployed for a broader population.

Recent work by Mel Gregg has demonstrated how further investigation of these links can yield even more telling insights. In *Counterproductive: Time Management in the Knowledge Economy* (2018), Gregg analyses the links between domestic management and time and motion management, arguing that proto-Taylorist principles were at work in the techniques developed by home economists like Catharine Beecher and Lillian Gilbreth, and that these subsequently moved into techniques of workplace management, rather than the more commonly held argument that the base of workplace management served to infiltrate the superstructural milieu of the home. Gregg’s analysis suggests further paths for the consideration of the intersection and relation between the ‘extraservomechanisms’ of the somaethic home as a form of feminised workplace management which is in turn concretised in the form of cultural techniques of biosensing, and used to develop and promote ‘masculinised’ forms of workplace control. The benefit of the Cultural Techniques approach is that it allows the scope for such analysis – where German media theory in the Kittlerian mould has often understood gender for example in narrowly conceived Lacanian-Cybernetic terms (or more often simply not at all), the consideration of the extension of ontic operations as they arise, coalesce, and shift around particular technical apparatuses, allows for a broader consideration of the contributions of materialist media theoretical analysis alongside insights from critical gender, race, and disability studies (see Parikka, 2013).

Whither ‘resistance’ to the somaethic? This thesis has purposefully avoided adopting a normative critical approach in favour of the development of a descriptive genealogical analysis of the conditions of the sensor society. In part this is due to a recognition of the

means by which prior normative critiques have been ineffective or indeed even recuperated in the ‘working through’ of the cultural techniques of biosensing. The Cultural Techniques approach does not lend itself readily to the proposal of alternative paths – although it is a ‘gay science’ in the sense that it happily draws from multiple critical methodological tools, it is also ‘modest’ in its conclusions. Such modesty can be seen as a part of the turn away from the militaristic bombast of Kittler, who as Winthrop-Young notes (2001: 853), adopted something of a cavalier accelerationist streak in his own advice on disruption – for Kittler, the way to fight the ‘controlling’ function of negative feedback is through the ‘scrambling’ power of positive feedback. “Create endless feedback loops,” Kittler counsels, “until VHF or stereo, tape deck or scrambler, the whole array of world war army equipment produces wild oscillations of the Farnborough type. Play to the powers that be their own melody” (1999: 110). The problem with such an approach within the context of biosensing is that it essentially entails a kind of praxis of misuse not dissimilar to the ‘non-cohesive’ (Nafus & Sherman, 2014) modes of data production promoted by the Quantified Self (even as Kittler’s approach is admittedly far more generative from a technopoetical perspective), and hence also ‘resolves’ the problematic of somaletheia on the side of the machine.

In a recent article, the critical algorithms studies scholar Louise Amoore (2019) has considered how we might respond to a related problem within the sensor society, that of the value of ‘doubt’ as an element of the algorithmic decision making process. Machine learning algorithms, Amoore argues, work through the processing of the statistical values of a given data set, in order to produce an output which itself can take on a single probabilistic value between 0 and 1. As Amoore writes:

That is to say, the machine learning algorithm must reduce the vast multiplicity of possible pathways to a single output. At the instant of the actualization of an output signal, the multiplicity of potentials is rendered as one, that moment of decision is placed beyond doubt. To be clear, this condensing of multiplicity to a single output matters because it is the output that becomes actionable by the border guard, the security analyst, or the police officer, for example (Amoore, 2019: 151).

There are both engineering and ethical issues which result from this form of algorithmic thinking and practice. For Amoore, the danger of the algorithmic transformation of variegated probabilistic possibilities into a single output is that it serves to obscure the *difficulty* of decision making by eliding doubt as an element of the decision-making process. Algorithmic analysis hides the place of doubt from us as end users, such that “[t]he algorithmic technique promises to resolve the political by holding together a multiplicity of possibilities, whilst carving out a space for a singular decision. This is not to say that the decision is made without doubt. On the contrary, it is doubtful, full of doubt, and *yet it decides with indifference*” (Amoore, 2019: 162 emphasis added). Amoore calls for a mode of techno-critique which would serve to reemphasise the doubtfulness of doubt, and to revalue contingency not as simply the grounds for ever finer recalibrations or recalculations, but as an ethically generative principle, and a valuing of the contribution that ‘embodied forms of doubt’ might contribute to new modes of knowledge.

Amoore’s analysis is directed at the doubt or aporia of statistical, probabilistic reasoning. But we may similarly consider the question of how to interrogate the aporia of somaetheia and the ‘biological errancy’ it produces. Beyond the body-politics of the Quantified Self, is there a possibility to consider how to become more attentive to the difficulties of biological errancy, without seeking to draw upon such as the ‘raw material’ for new iterations of the biosensing apparatus? Is there a ‘way out’ of this problematic, which does not sacrifice this errancy (as Landois ‘sacrificed’ his dog to the calibration of the graphic method), but is able to produce new spaces in which to examine, admire, or value it? Such a technopolitics would have to take on a much broader remit than the narrow self-focus of the Quantified Self. It would have to involve the production of new spaces of work, of dwelling, and of ‘life itself’, wherein we might become comfortable with the problematics of errancy, and appreciative of its creative, generative qualities.

The difficulty of such a project is that it not merely ‘reveal’ the function of biological errancy, because this errancy is not something which is hidden within the cultural techniques of biosensing. Rather it is the cultural techniques of biosensing which themselves produce and reproduce misalignment as a productive aspect of a sensor

apparatus which succeeds through, rather than in spite of, its failures. The key contribution of this thesis has been to compel a closer analysis and understanding of the materialities of this ‘working through’, the better to understand our collective implication within the aporetic space of somatheia.

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