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Spring 4-5-2017

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Homeostasis: from metaphor to mechanism in the tech – human relationship

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Abstract

Man's relationship with technology dates back many thousands of years. However, it is only relatively recently that scholarly attention has been given to this relationship. Whilst recent conceptualisations of the socio-material or socio-technical have given rise to such metaphors as ensemble, entanglement, and assemblage, these offer limited insight into the dynamic nature of this relationship. The concept of homeostasis offers an alternative perspective focusing upon how stability is achieved, it being assumed that technology exists in a stable relationship with man. This paper examines homeostasis, drawing upon relevant literatures as well as evaluating the case-study of use of a laptop. The findings demonstrate that the notion that homeostasis in terms of homeostatic mechanisms, provide a valid and useful epistemological device to explain the stable nature of relationship between man and (information) technology. Moreover, that homeostasis underpins the resilience of such relationships.

Keywords: cybernetics, homeostasis, theory, socio-materiality, information systems, cyborg.

1.0 Introduction

Man's relationship with technology dates back many thousands of years. However, it is only recently that scholarly attention has been given to the relationship between man and technology, particularly in the workplace. One of the pioneering studies was the work in the 1950s by the Tavistock Institute (Trist, 1981). This triggered the appreciation that the workplace is not merely the application of technical artefacts to the social, but is a complex interplay between artefacts and humans. It has led to many representations of this dynamic, though these have tended to be limited in their explanative power. The aim of this paper is to provide a fresh and deeper look at this dynamic through the lens of homeostasis, thereby exploring how the concept of homeostasis can offer a useful insight on the relationship between artefacts and humans.

Homeostasis contrasts with preceding conceptualisations of the relationship between technology and humans. One perspective is that technology is a 'black box' (Edge, 1995) that has effects upon society, with people adapting to it (MacKenzie & Wajcman, 1999). Technological development is therefore inevitable (the 'technological imperative') (Williams & Edge, 1996). In contrast, a technology deterministic view is one that opens up the black box to reveal its workings in terms of use by people in purposeful action (Winner, 1993). In this lens, technology is socially constructed (Bijker, 1995) or shaped (MacKenzie & Wajcman, 1999). This notion of 'social' embraces such issues as organisation, politics, economic and culture (Williams & Edge, 1996). It restores human participation within the development and use of technology.

One consequence of opening up the black box is the attention it gives to the relationship between human and technology, revealing it to be complex and inviting metaphorical conceptualisations, as exemplified in 'heterogeneous assemblages' (Larkin, 1969, Landstrom, 2000), 'socio-technical systems' (Trist, 1981), 'seamless web' (Hughes, 1986), 'sociotechnical constituencies' (Molina, 1990, 1997), 'mangle' (Pickering, 1993) 'socio-technical ensembles' (Bijker, 1995), complex 'entanglement' (Orlikowski, 2005), 'socio-material assemblages' (Suchman, 2007; Orlikowski & Scott, 2008) and 'imbrication' (Leonardi, 2011). However, one weakness of such terms is that they say little about the nature of the relationship. Whilst the essentialist will emphasise the role of the artefact's properties in determining use (e.g. Winner, 1980), the anti-essentialist is concerned with the meaning ascribed to the artefact and how embedded inscriptions are read (e.g. Grint & Woolgar, 1997). More recently attention has been given to the concept of 'affordance', introduced by Gibson (1966, 1979) and Norman (1988). Technologies afford possibilities for use, inferring the conjoined relationship between the technology and its user. This invokes the dynamic in the relationship that is absent in the previous terms, but this itself is problematic as there are different views about what constitutes an affordance. (Harwood & Hafezieh, 2017),

An alternative way of conceptualising the relationship between man and technology is to draw upon the stable nature of this relationship in the everyday and how this is achieved. Despite the disruption that ensues when technology fails, it can be assumed that the taken-for-granted aim of technology adopters / users is to create a stable ('trouble free') relationship which enhances the everyday: 'We are working together'. This can invoke an Actor Network Theory (ANT) view of man and technology as actants with agency (e.g. Latour, 1996; Walsham, 1997). ANT provides a rich descriptive account which enables innovative insights to be generated, such as into Pasteur's laboratory (Latour, 1983) or the survival of scallops (Callon, 1986). However, ANT fails to explain how this agency functions. A different perspective on this relationship can be found in the biological disciplines, which has been largely overlooked in fields dealing with social systems. This is the concept of homeostasis (Cannon, 1926, 1929). Since, an underlying principle of homeostasis is feedback, which implies there is information, then it is within cybernetics that the concept of homeostasis to explain social systems has been developed (e.g. Weiner, 1948; Ashby, 1952), particularly in the work of Stafford Beer (1984).

The concept of homeostasis is examined in this paper by first making reference to the notion of a cyborg. This illustrates the serious attention given to the possibilities of exploiting the homeostatic relationship between human and technology. The concept of homeostasis is then examined in terms of how it can be used to explain the relationship between humans and technology. First, homeostasis is defined through the lens of the pioneering work of Cannon (1926, 1929, 1932). Then its use to explain social situations is reviewed. Since the general literatures on this are limited, with some views contesting the validity of applying homeostasis to social situations, attention then moves to focus upon the contribution of cybernetics where homeostasis has received much attention particularly in conceptualising the notion of organisation. Following this conceptual evaluation of homeostasis, a reflective review of laptop use by one of the authors is presented as a case-study to allow more rigorous consideration of the insights generated. This is written in the style of an Actor Network Theory narrative:

> A good ANT account is a narrative or a description or a proposition where all the actors do something and don't just sit there (Latour, 2005: 128)

The value of using this style is that it permits a symmetrical account of the relationship between human and non-human actants (Walsham, 1999). This thereby allows the agency of the non-human actants to be surfaced, which is essential for any explanation of homeostasis. This case-study provides an empirical base to evaluate the concept of homeostasis, in particular Cannon's (1929) six postulates. The paper concludes with a discussion of the implications of the insights from this assessment.

2.0 Mechanism

The notion of homeostasis is associated with the concept of a cyborg, but its development is to be found in the pioneering work of Cannon (1926, 1929, 1932). Whilst Cannon (1932) proposed the concept of 'social homeostasis', there is little indication that this has been developed other than within cybernetics. This section examines both the concept and how it has been taken up and applied.

2.1 The Cyborg

Whilst cybernetics has been defined as the 'science of communication and control *in* man and machine', some specific attention has been given to the relationship *between* man and machine. A notable view was developed by Clynes & Kline (1960) who proposed the word 'cyborg' to describe the notion of a *cyb*ernetic *org*anism. This is described as a "self-regulating man-machine system… [an] exogenously extended organizational complex function as an integrated homeostatic system unconsciously" (ibid: 27). The reason for such 'futuristic' views was the concern about how to deal with space travel. The aim was to provide a means for a human to exist in unnatural environments by adapting man's body through appropriate "biochemical, physiological and electrical modifications" (ibid: 26). Underpinning this was the concept of homeostasis and the manner in which this mechanism regulates the stable relations between man and machine.

2.2 Homeostasis

The term 'homeostasis' is attributed to Walter Cannon, who coined the term to explain the complexity of physiological reactions that maintain the body in a steady state:

> The coordinated physiological reactions which maintain most of the steady states in the body are so complex, and are so peculiar to the living organism, that it has been suggested (Cannon, 1926) that a specific designation for these states be employed—homeostasis. (Cannon, 1929: 400)

Moreover, not only is the mechanics physiological but also complex:

> The factors which operate in the body to maintain uniformity are often so peculiarly physiological that any hint of immediate explanation in terms of relatively simple mechanics seems misleading. (ibid: 401)

Behaviour is adjusted in response to external disturbances in order to maintain its stability – this is automatic and self-regulatory. Cannon (1929) presents the six postulates about homeostatic regulation he advanced in 1925 and published in 1926:

1. In an open system such as our bodies represent, compounded of unstable material and subjected continually to disturbing conditions, constancy is in itself evidence that agencies are acting, or ready to act, to maintain this constancy. (ibid: 424)

2. If a state remains steady it does so because any tendency towards change is automatically met by increased effectiveness of the factor or factors which resist the change. (ibid: 425)
3. Any factor which operates to maintain a steady state by action in one direction does not also act at the same point in the opposite direction. (ibid: 425)
4. Homeostatic agents, antagonistic in one region of the body, may be cooperative in another region. (ibid: 425)
5. The regulating system which determines a homeostatic state may comprise a number of cooperating factors brought into action at the same time or successively. (ibid: 426)
6. When a factor is known which can shift a homeostatic state in one direction it is reasonable to look for automatic control of that factor or for a factor or factors having an opposing effect. (ibid: 426)

In the epilogue of a later work, *The Wisdom of the Body* (Cannon, 1932) discusses the notion of 'social homeostasis'. The question is posed: "are there not general principles of stabilization?" (ibid: 287). The analogy is made between groups of cells forming organisms and communities of people. Just as each element in the organism has specialist functions, so are to be found specialists in the community. Each part has its role within the whole. The propositions advocating constancy due to the actions of agencies is applicable equally to the organism and the community. The equivalent of the fluid matrix of animals is the distribution infrastructure (e.g. roads, rail) of society and the process of commerce. Stability in the latter invokes constancy of supply and remuneration in a system that is not fixed and rigid but is adaptable. Since stability is the prime importance then this suggests that a 'specially organised control' is invoked that preserves constancy. Since homeostatic devices "keep essential bodily processes steady" (ibid: 305) thus allowing us to engage in everyday activities unconcerned about 'bodily affairs', then social homeostasis might tend towards monotony with regard to the essential, but, in addition, would foster increased freedom and thereby allow us to engage in "adventure and achievement" (ibid: 305).

The application of the concept of homeostasis to social systems, despite Cannon's proposal, appears to have received little attention.

Arguing that a biological metaphor "should be able to supply us with basic principles underlying social co-ordination" (Emerson, 1954: 68), Emerson examines this comparing genes with symbols; key to biological and cultural inheritance respectively. However, underpinning their efficient functioning is the need for 'self-control' or 'homeostasis': "homeostatic effects are often web effects with many feedbacks. There may be homeostasis of homeostatic mechanisms" (ibid: 73). In other words, the homeostats of different functions may interfere with each other, requiring their co-ordination - homeostasis is dynamic. Emerson defines homeostasis as "the regulation, control, and maintenance of conditions for optimal existence" (ibid: 73).

However, in contrast, Henry (1955) argues against the notion of homeostasis being applied to society. In Cannon's (1932) *The Wisdom of the Body*, Henry identifies fifteen features associated with homeostasis. Moreover, he views homeostasis as related to

> the conception of homeostasis as used with respect to the body involves two ideas, "normal" state and state of maximum efficiency (Henry,1955: 306)

However, the argument that undermines the notion of homeostasis applied to society is summed in the following statement:

> For most states outside the body, therefore, it does not seem to me that the conception applies; for on the whole society strives to maintain itself as it is, and "efficiency" generally turns out to be some sort of operating constancy that does no violence to traditional motivations, however conflict-producing they may appear. (ibid: 306)

In other words, society, on the whole, is not efficiency seeking. Moreover, Henry questions the validity of a number of the features of bodily homeostasis in a social context. For example what is the baseline for society? The fundamental issue appears to be that Henry can provide examples that question the validity of homeostasis. Indeed, he draws upon the cybernetic view expressed by Wiener (1948) [following section]:

> but we cannot speak of homeostasis if the process works one day and not the next… I cannot agree with Norbert Wiener's guess that ". . . small, closely knit communities have a very considerable measure of homeostasis; and this, whether they are highly literate communities in a civilized country, or villages of primitive savages" (20). (Henry,1955: 307)

Henry's argument is that society is inherently unstable, which renders the notion of a homeostat invalid in this context.

A more recent interest in homeostasis is presented by Conrad (1993) in the context of how computers are assimilated into society. For Conrad there is a necessary homeostatic relationship between humans and developments in computing: humans are "homeostatic controllers for computer systems" (Conrad, 1993: 17). However, the nature of this homeostatic relationship is unclear.

2.3 Homeostasis within Cybernetics

Feedback is an integral feature of homeostats and feedback as a concept has been the focus of cybernetics, which concerns not only technology but society as a whole. Can cybernetics therefore offer insight into the homeostatic nature of society?

Cooper's (2008) narration of how the concept of homeostasis emerged reveals that Cannon's notion of homeostasis was introduced, though his colleague Rosenblueth, to Wiener. Wiener had been concerned with a challenge that had originally emerged with early naval interest in how to hit a moving object with gunfire, that of how to hit a flying plane. Underpinning both homeostasis and anti-aircraft fire was the principle of negative feedback, which was explained in 'Behavior, Purpose and Teleology' by Rosenblueth, Wiener, & Bigelow (1943).

The subsequent conceptualisation of homeostasis appears in the published material of a number of those working in the cybernetics domain.

For example, Wiener (1948: 135) introduces the concept of homeostasis drawing attention to the important role of feedback. Moreover, he comments that there is an "extreme lack of efficient homeostatic processes" in the 'body politic' (ibid: 185), questioning the example that 'free competition' is a homeostatic process, concluding that it is a "game of power and money" (ibid: 188) and that "there is no homeostasis whatsoever" (ibid: 186). In contrast, he argues that "small, closely knit communities have a very considerable measure of homeostasis" (ibid: 187), this exhibited in their customs.

A few years later Ashby (1952) provides a definition of homeostasis:

> I propose the definition that a form of behaviour is adaptive if it maintains the essential variables (S. 3/14) within physiological limits (ibid: 57).

Whilst, Ashby introduces the notion in terms of bodily functions, he argues

> The homeostatic mechanisms thus extend from those that work wholly within the animal to those that involve its widest-ranging activities; the principles are uniform throughout." (ibid: 61).

Not only does homeostasis extend beyond the body, but there exists a homeostatic relationship between man and machine. The example is provided of man's home to illustrate both 'physical and physiological effects'

> The first requirement of a civilised man is a house; and its first effect is to keep the air in which he lives at a more equable temperature. The roof keeps his skin at a more constant dryness. The windows, if open in summer and closed in winter, assist in the maintenance of an even temperature, and so do fires and stoves. The glass in the windows keeps the illumination of the rooms nearer the optimum, and artificial lighting has the same effect. The chimneys keep the amount of irritating smoke in the rooms near the optimum, which is zero (ibid: 62)

This section concludes with the statement:

> The thesis that ' adaptation ' means the maintenance of essential variables within physiological limits is thus seen to hold not only over the simpler activities of primitive animals but over the more complex activities of the ' higher ' organisms. (63)

Adaptation takes two forms, "development of the mechanism itself… [and] when the mechanism is stimulated into showing its properties." (ibid: 63). Ashby tested his ideas about homeostasis by building a machine, "The Homeostat". Perhaps understated, Ashby revealed "in elementary form, this power of self-reorganisation" (ibid: 110)

Pask's (1961) contribution to this debate is to reveal that the earliest thoughts in cybernetics concerned the concepts of homeostasis (control) and reflex (information feedback). These are self-regulating mechanisms, though do not act in isolation but as many interacting mechanisms:

> The overall homeostasis, preserving the organism, can be expressed as the conjoint action of many homeostatic systems, each preserving a structure or condition needed for the functioning of the others (ibid: 73)

This invokes a multi-level view of homeostasis creating a complex whereby the homeostasis of the organism is an outcome of the effectiveness of the functioning of the homeostats within the organism.

Bateson (1972) provides insight into how homeostasis functions, recognising societal homeostasis. He ascribes not only 'the individual human organism' but also 'human society' and 'the larger ecosystem' as homeostatic systems in his paper *Effects of Conscious Purpose on Human Adaptation* (Bateson, 1972). He argues:

> All biological and evolving systems (i.e., individual organisms, animal and human societies, ecosystems, and the like) consist of complex cybernetic networks, and all such systems share certain formal characteristics (ibid: 415)

These characteristics include the presence of subsystems, which are potentially regenerative, but through homeostasis, do not 'runaway'. In this sense, "all biological change is conservative and all learning is aversive" (ibid: 417). The distinction is made

between first-order and second-order homeostasis, the former relating to adjustment to external disturbance whilst the latter relates to the internal adjustments that occur amongst the many internal interconnected homeostats, to maintain the steady state. For this to be effective there is a need for coupling of these self-corrective systems, which is problematic, especially if is imperfect. This requires consciousness, which feeds back into the mind. This uses (often incomplete) information selected about man and environment on the basis of 'purpose': "coupling through consciousness is present, incomplete and probably distortive" (ibid: 419). In this sense there is a distinction between "conscious views of self and the world and the true nature of self and the world" (ibid: 419). However, from a cybernetics perspective, "the cybernetic nature of self and the world tends to be imperceptible to consciousness" (ibid: 419). Conscious data selection is conducted without any comprehension of the homeostatic network. Bateson is clear that little is known about these mechanisms.

Whilst Ashby built his machine, "The Homeostat", Stafford Beer developed a model – the Viable System Model (VSM) (Beer, 1972, 1979, 1984, 1985) – which he grounded in the notion of homeostasis as developed by Ashby:

> The model of any viable system, V.S.M., was devised from the beginning (the early 'fifties) in terms of sets of interlocking Ashbean homeostats. (Beer, 1984: 11)

Further, the relationship of entities is not that within a unity, but between the inside of the unity and its outside:

> industrial operation, for example, would be depicted as homeostatically balanced with its own management on one side, and with its market on the other. But both these loops would be subject to the Law of Requisite Variety. (ibid: 11)

Moreover, it draws attention to a different set of principles to those Henry (1955) specified. The Law of Requisite Variety (Ashby (1956) states that "only variety in R can force down the variety due to D… Only variety can destroy variety" (Ashby: 1956: 207), which in simple terms, states that for any disturbance there is a need for an appropriate response. The VSM allows the complexity of human organisation to be modelled recursively in such a way as to understand how human organisation self-regulates in order to maintain its existence over time within the context of an environment that is potentially turbulent.

Within cybernetics, the argument about homeostasis appears to have elevated from that which is specific to the human body to the general principles that Cannon (1932) inferred in his epilogue, manifesting in the model (VSM) of what is essentially the complex of interacting homeostats that comprise the organisation of humans in collective purposeful behaviour. However, other than the cyborg, cybernetics appears to have said little specifically about the role of technology in societal homeostasis.

The following case-study about laptop use provides the opportunity to explore this.

3.0 The Case-study of a Laptop(s)

The following case-study is a reflective narrative of one of the author's relationship with a laptop with the aim to draw out that which we experience in the everyday, yet perhaps take for granted until things go wrong. It is written in the style of an Actor

Network Theory narrative, in order to expose the agency of the non-human actant. Thus, the two laptops referenced are given the names ‘old’ and ‘new’.

A laptop computer is a common technology that is embedded into the everyday in many societies, particularly within Higher Education settings. My own ‘new’ laptop (item A, figure 2) together with a range of ‘accessories is presented in figure 1. Also in the picture is my previous laptop (item I, figure 2) which is now dead as a functioning machine. Nevertheless, it has an important role in this narrative.

The need for a new replacement laptop arose from an accident in which coffee was spilled over the keyboard of the ‘old’ laptop. For three years, this device served my needs, evolving in its configuration as new agencies in the form of software applications were added. Moreover, its wireless connection with the ‘TimeCapsule’ (item H, figure 2) meant that backups were automatically conducted whenever ‘old’ was within wireless reach of the ‘TimeCapsule’. I had a stable relationship with ‘old’ and took it with me on my travels, with it connecting me to others whenever it could link itself to the internet.

However, it was not always this harmonious, for on several occasions ‘old’ failed. First there was a hard drive failure, then water damage, followed by overheating causing damage to the hard drive with coffee spillage finally putting an end to this relationship. With each of these failures there was a need to find a work-around until ‘old’ was fixed and normality was restored. However, on one of these occasions, the internal battery failed to connect due to damage to the power board, so that when the ‘repaired’ ‘old’ was returned it could only be used if connected to a mains power supply. This was an inconvenience, requiring a change in how ‘old’ was used, changing our relationship. ‘Old’ had lost some of its mobility. Indeed, the frustration of limited mobility led to the decision to incur the cost of getting the power board fixed. The restored mobility re-established our relationship until the unfortunate event, when someone in passing spilt coffee, some of which landed on the keyboard. The damage caused signalled the end of the relationship. The hard drive was removed, inserted into a caddy and the data downloaded onto an external hard drive (item D, figure 2).

In the interim, the need for a laptop was served with a cheap refurbished note-book, with work being saved on the external hard drive. However, this was not a sustainable solution as the notebook had limited capability compared to ‘old’. The decision was taken to acquire a ‘new’ laptop.

The appropriation of a ‘new’ laptop drew upon the expertise of others on the basis that whatever was sourced would become an integral part of my every-day in terms how I functioned as an academic. It would be my main instrument of work and as such would travel with me. It would allow me to engage with people using different media forms. It would also serve as a repository for all my digital material. This was intended to be an intensive long term stable relationship.

When ‘new’ arrived, our relationship commenced with its configuration with the requisite software. One included malware – virus protection software to automatically protect ‘new’. Another task was to wrap insulating tape around the junction of the cable into the power unit, based on the experience of the first power unit of ‘old’, which deteriorated, exposing bare wires. Although not fully configured, ‘new’ started to

perform. Over the next few months additional accessories were acquired, these including an external DVD drive (item C, figure 2) and another external hard drive (item E, figure 2). The two hard drives were set up as 'TimeMachines', to automatically back up 'new's memory. This duplication was designed to provide one backup that would reside at base, whilst the other would backup when travelling. Other accessories included a new laptop case to protect 'new' and a dongle to allow 'new' to connect to the internet when there was not internet readily accessible.

Figure 1. **The artefact: a laptop and the rest…**

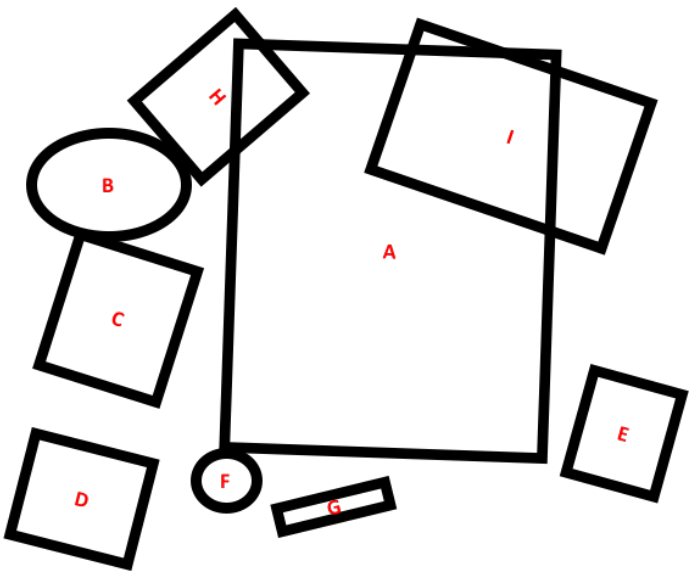

Figure 2. **Key to figure 1: The artefact: a laptop and the rest… A) replacement laptop, B) Power cable, C) External DVD drive, D) 1T external hard drive, E) 1T external hard drive, F) Wireless receiver, G) Wireless pointer H) TimeCapsule, I) original laptop**

When ‘new’ was introduced to perform in lectures, a wireless receiver (item F, figure 2) was connected via the USB to ‘new’, which allowed me to use the wireless pointer (item G, figure 2) to remotely change the slides without having to physically connect to ‘new’. As I get to know ‘new’ better’, I discover more functionality which allows me to function better. What’s more, ‘new’ protects my data with the automatic backups and the malware – virus protection. I just hope I do not compromise our relationship by doing something such as inadvertently opening up a suspicious email which infects ‘new’ or by contaminating ‘new’ with a liquid spill.

One of the benefits of both ‘old’ and ‘new’ was the ability to connect to networks wherever the author was located, *if* there was an accessible internet connection. Connectivity permitted the author to maintain relations with others, having conversations and exchanging messages using instant messaging apps (e.g. Skype) or sharing files using cloud based collaboration and storage platforms (e.g. Google Drive). However, this relationship broke down when there was no accessible internet service, or when the other was not connected. Indeed, a sense of dependency or addiction was revealed when on a five hour train journey, with the only connectivity being provided by the train operating company but at a cost. Was it essential to read any emails that might be posted in the inbox? Whilst it was accepted that there was not an absolute need to read emails in real time, the anxiety of not doing so led to the acquisition of a dongle. Thus, when internet connectivity was an issue, should the temptation arise, the dongle could be connected to the laptop, connectivity restored and emails accessed – ‘relief’. However, there is another side to this. I may be avoiding responding to someone, feigning lack of connectivity, but WhatsApp, my Tweets and my online Skype status reveal my presence. Through the connectivity of the laptop social relations and presence are maintained, highly visible and can indeed be traced or tracked.

4.0 Discussion

The preceding case-study provides a succinct narrative concerning the relationship between a laptop and its user. It draws attention to a complex dynamic involving both that which was made explicit, but also with that which is implicit. The manner in which this narrative has been written has endeavoured to draw attention to the agency in the different actants, where agency is defined as the ability to act within prescribed parameters, as opposed to the ability to elect to act in a manner which may be at odds to the logic of the observers of the resultant action (Archer, 2002).

4.1 Making sense of the case-study

In terms of making sense of this case-study, a variety of conceptualisations are possible. Metaphors such as ‘seamless web’ (Hughes, 1986), ‘mangle’ (Pickering, 1993), ‘entanglement’ (Orlikowski, 2005) and ‘socio-material assemblages’ (Suchman, 2007; Orlikowski & Scott, 2008) draw attention to the existence of the relationship between the laptop and user. The appropriation, configuration and embedding of the laptop into the everyday life of its user is a process which can be conceptualised as the domestication of the laptop (Harwood, 2011). The manner in which the user recognises the possibilities of use can be explained using the concept of affordances (Gibson, 1966, 1979; Nelson, 1988). However, there is an intermediary level of conceptualisation that concerns the nature of the maintenance of the relationship between laptop and user and how disturbances are handled.

It is proposed, in accord with Ashby (1952) and Conrad (1993), that homeostasis offers a conceptual device to makes sense of this. Implicit is the co-ordination within the complex that constitutes the relationship between the laptop and its user, and also that within the context of which the laptop is being used e.g. the lecture. Likewise, is the reciprocal nature of the relationship, with its implicit feedback mechanisms. For example, the laptop notifies me that its battery life is close to depletion which requires me to "plug in or find another power source". However, this is just one of the features of the relationship.

Homeostasis is not a simple mechanical relationship (Canon, 1929) but a complex one. First is the distinction between stability of the relationship with that outside and stability within the relationship, with the implications of change in one upon the other (cf. Bateson's (1972) first and second order homeostasis). This is illustrated with the example of the laptop and user who adjust their behaviour appropriate to the situation, e.g. the lecture. Simultaneously and unbeknown to the user, the laptop deals with performance issues, in this case, switching on the fan to address overheating, which is caused by heavy demand by the presentation upon the processor.

Furthermore, the multi-level view of homeostasis as revealed by Emerson (1954), Pask (1961) and Beer (1972, 1979, 1984, 1985) is of relevance. For example, there are the homeostats relating to the temperature of the laptop, the connectivity of the laptop to the projection equipment, the harmony between the PowerPoint presentation on the laptop and the presenter and between the presenter and the audience. Homeostasis involves a homeostatic complex involving many homeostatic systems in conjoint action (Pask, 1961), within which co-ordination has a significant role.

This leads to the conclusion that homeostasis comprises a homeostatic complex, comprising a congruent, coordinated, complex dynamic of relationships among elements, who individually appear and then disappear, with each element self-adjusting to the adjustments of the others, in an on-going evolving and emergent dance among the elements. The metaphor of 'dance' draws attention to the co-ordinated and purposeful nature of individual relationships. It exhibits stability through the continuity of the dance, irrespective of how bad some of the dancers are and whether there are external potentially disruptive disturbances. Bad dancers and external disturbances are absorbed. It is only when they are not absorbed that there is breakdown. This, then shifts the situation into a mode where attention focuses upon being able to endure the damage, after which there is hopefully recovery (Ouyang, Dueñas-Osorio & Min, 2012). This introduces the notion that homeostatic mechanisms are resilient implying that resilience is a feature of homeostatic mechanisms.

4.2 Can Cannon's six principles be found in the case-study

In terms of identifying possible criteria that define homeostasis, then Cannon's (1929) six postulates offer a useful framework:

First, the evidence for constancy in the face of external disturbances or internal instability is the action of agency that maintains constancy: For example, viral protection is an on-going mechanism for protecting the integrity of the laptop, but this also requires that the user is responsible for not carrying out actions (e.g. opening potential virus carrying emails or working on unsecured networks) that might compromise this integrity. Likewise, data back-up provides continuity if the hard drive fails as experienced with 'old'.

Second, is the manner in which resistance to unwanted change becomes more effective. The first experience of a malware attack should lead to greater diligence about future attacks. Likewise, experience of water damage should result in greater care in protecting the laptop from future possibilities of damage by liquids. This is perhaps evident in the accumulative learning of virtual assistants and online search engines, drawing attention to the growing influence of artificial intelligence on our everyday behaviours.

Third, is the unidirectional mode of any action to maintain a steady state in that it is not both negative and positive in terms of effect. This is self-evident in the purposive nature of use of the laptop to optimise productivity in the everyday. For example, we may be accessing a single folder through two devices. If the folder is open on one device we may be unable to delete the folder on the other device. In-other-words, we may be undertaking multiple tasks at any one time, but a conflict may arise when an action interferes with another action. Another form of this relates to contention issues when multiple devices are competing for speed, access and storage. Then we experience applications freezing or, worse, a blue screen system crash.

Fourth, is the potential for co-operation in one mode of work and antagonism in another. PowerPoint is a useful application to create diagrams for embedding in a Word document. However, if giving a presentation using the laptop which makes heavy demand on the processors, then Word will be competing for processing capacity, creating a load balancing issue.

Fifth, is the generation of homeostatic activity though the cooperation of different elements either simultaneously or successively. For example, when giving a presentation, the laptop offers the capability to be connected to screen-projector facilities through a HDMI connector. The connection via the USB connection of a wireless receiver (item F, figure 2) to the laptop allows the slides to be changed remotely using a wireless pointer (item G, figure 2) thereby giving the presenter mobility to move around the presentation space. Video and hyperlinks embedded into the presentation allow the appropriate applications to be successively called into action at the appropriate times. The harmonious and sequential performing of the different elements greatly contributes to the success of the event.

Sixth, is the correcting action of one factor upon another. Thus, if there is high demand for processing power, then the processor heats up. In this situation, a fan is activated to cool the processor down, thus mitigating the possibility of overheating.

This succinct analysis supports the utility of the six postulates in examining homeostasis. It also supports the notion that that homeostasis is a feature of laptop use. The laptop and its user, are not in an isolated conjoined union, but are part of an evolving space that comprises humans and artefacts in constant reconfiguration of transient relationships amongst each other.

4.3 Social Homeostasis

The notion of social homeostasis is not new, with Cannon (1932) acknowledging it in his epilogue. One of the fundamental questions he asks is “are there not general principles of stabilization?” (ibid: 287). Perhaps his six postulates provide insight into this. However, it is to cybernetics and specifically to Beer’s VSM, that principles appear to be found, though, this needs to be more firmly established.

In response to Henry's (1955) critique of the notion of social homeostasis, Henry perhaps took a too narrow and literal view of 'homeostasis' as presented by Cannon (1932). His pre-occupation with 'efficiency', was at the cost of failing to recognise the significance of 'resilience', with its emphasis upon dealing with and recovering from any damage (Ouyang, Dueñas-Osorio & Min, 2012). Likewise, his view of society as inherently unstable ignores the periods of stability. Indeed, this notion of stability resonates with Cannon's (1932) proposal that homeostasis would produce monotony. Monotony perhaps manifests in the everyday routine that characterises social behaviour, more-so in terms of how everyday disruption is handled to maintain stability in the lives of individuals, with the aggregate effect of producing 'stable' societies. There is conservation (Bateson, 1972). When disruption pervades and the emphasis is upon survival, stability is threatened becoming a crisis when the homeostatic complex breaks down.

4.4 Is there a place for innovation?

If monotony and stability are a characteristic of society, is there a role for innovation? How does stability and change reconcile itself? They are not incommensurate. A simple explanation might suffice. When the new (e.g. virtual reality) is introduced, it is domesticated (Harwood, 2011). There is initial disruption, but the new is brought into a stable relationship, embedding itself. This is likely to involve mutual adjustment; perhaps the configuration of the smartphone or the adoption of new practices relating to its use, such as walking down the street oblivious to all except the text that is being composed. That momentary feeling of instability is overcome. 'Runaway' (Bateson, 1972), might occur if the complexity of the technology overwhelms. It might also occur with addiction, e.g., to Facebook, or when there is abuse, e.g. cyberbullying. This raises ethical issues about what constitutes the norm and stability.

Whatever, a form of stability will prevail. Over time, simultaneous incremental changes to each of the elements occur as more and more elements experience the change, thus giving rise to an evolved form. For example, the social behaviour imparted by the ubiquitous uptake of the smartphone contrasts sharply with that in the pre-mobile phone era. People in physical proximity to each other no longer need to be engaged with each other, as they can be engaged with distant others through virtual proximity creating greater connectivity, though at the same time creating new risks (O'Keeffe & Clarke-Pearson, 2011). A more serious longer-term issue is the incremental introduction of robotics into the work-place. The displacement of human workers creates the dilemma that whilst the work-place maintains an equilibrium, there is the challenge of how to maintain broader social stability, as employment opportunities potentially reduce. Such concerns about the impact of automation (robots) on the workplace and society are not new, these being featured in Life Magazine, 19th June 1963. Whilst robots make inroads into the work-place, will social stability be maintained by newer forms of activity, such as is emerging in the relatively recent phenomenon of 'makerspaces'?

4.4 Moving Forward

This evaluation commenced with a discussion of a cyborg to introduce the notion of homeostasis. However, it is appropriate to consider homeostasis in the context of technology and man by revisiting the notion of the cyborg itself. Clynes & Kline's (1960) presented a cyborg as a self-regulating homeostatic complex. This is perhaps becoming a reality as people become more coupled to their multifarious devices which

enable and connect. It is beyond the scope of this paper to elaborate, but Haddow, Harmon, & Gilman (2016) draw attention to the emergence of the cyborg in society. They reveal the increasing conversion of the human being into the cyborg through health products. They propose three generations: the first is external and attachable (e.g. glasses, prosthetics), the second is penetrable (e.g. insulin pumps) with the third being smart implants (i.e. implantable smart technologies (ISTs)). Homeostasis, it is argued, is the underlying principle.

5.0 Conclusion

Homeostasis is a concept that emerged in the 1920s and has become embedded in the biological disciplines. However, despite the notion that it could be applied to the social disciplines, it appears to have received scant attention. Instead, it is within cybernetics that the notion of social homeostasis appears to have been attended to, culminating in the VSM developed by Stafford Beer. In the context of the relationship of technology within society, there appears to be little attention to homeostasis, despite this being a fundamental mechanism in the cyborg of Clynes & Kline (1960). Nevertheless, an evaluation of the use of a laptop indicates that homeostasis provides a valid and useful epistemological device to understand the relationship between man and technology. It extends the insight offered by such metaphors as 'mangle', 'socio-technical ensembles', 'entanglement', 'socio-material assemblages' and 'imbrication', complementing the more processual conceptualisations of 'affordances' and 'domestication'. Moreover, an evaluation of the case-study reveals that Cannon's (1929) six postulates provide a germane framework to identify homeostasis, particularly in the context of the relationship between man and technology. Nevertheless, this is an underdeveloped area and thus offers the opportunity for deeper evaluation. Whilst metaphors such as ensemble, entanglement, and assemblage foreground the existence of a messy relation between man and technology, homeostasis provides a concept to penetrate this mess and untangle the many relationships that constitute the homeostatic complex.

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