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Machine Breaths: Assembling the Mechanical Ventilator Body

By *Bjorn Nansen*

In this paper I seek to address the theme of accidental environments by questioning the status of the body within contemporary technoculture. In particular I will focus on the intersection of the mechanical ventilator (MV) and the body, in order to analyse how this relation is "synchronised". Paul Virilio argues via his theory of the accident, that such a relation exemplifies the disorder, loss and unintended consequences that are produced by and immanent to technological invention. He broadly traces these effects across the categories of time and space, but also in relation to the body. I want to contest Virilio's thesis, which situates accidents *upon* the body, to suggest that the body itself is always-already *part* of the accident. This argument places the human body as an environment that does not exist in isolation; rather, the body is characterised by its relations to a heterogeneous range of materials and technologies. As such the accident is not necessarily purely loss or erasure, but part of a larger ensemble of everyday events and relations producing ambivalent results. Recognising that the body is shaped and constituted by its material relations, in opposition to a conception of the body as bounded, invites a situated and differentiated analysis. Elizabeth Grosz notes, "from the moment in which the human appears as such, it appears alongside of both artifacts and technologies, *poesis* and *techné*" (137). The volume and complexity of the mutual dependencies between bodies and technologies has however radically proliferated within the sociotechnical context of late modernity. This is particularly conspicuous within the medical sphere, where such intimacies have produced what Bernard Place describes as "technomorphic" bodies: bodies able to change and grow via the integration of technological artifacts (176). Technologies here breach the boundary of the skin; prosthetically externalise functions; replace internal parts; and map the interior.

Theorisation of the interdependencies between bodies and technologies in our current milieu often appear under the rubric of the cyborg or the posthuman. These discourses "attempt to reconceptualize the relationship between the rapidly transforming field of technology and the conditions of human embodiment" (Waldby 42), in order to open a "critical space in which the techno-cultural forces which both produce and undermine the stability of the categories "human" and "nonhuman" can be investigated" (Waldby 43). The tendency, however – evident in both popular culture and the academy – to polarise around dystopian fears and utopian desires when addressing human-technology relations has been critiqued for neglecting invisible or mundane technologies, despite their pivotal role in shaping both the body and everyday life (Borgmann). This critique prefigures the burgeoning field of analysis from the social sciences of technology that seeks to "turn to artifacts" and "situated relations" (Verbeek), or in the disciplinary parlance, open the "black-box" of sociotechnical hybrids. This approach informs the aim of this paper to analyse the material circumstances and more quotidian coupling of bodies and technologies in the MV-body nexus. Whilst this technology has had radical implications and effects for the human body – creating new ontological categories, such as brain death and persistent vegetative state; participating in a renegotiated definition of death; and instantiating a political economy of

human organs – it has also filtered into the social world in more prosaic ways, reconfiguring the meanings and practices of everyday life for a whole series of patients and conditions.

Mechanical ventilation, as the name suggests, mechanically assists the process of ventilation – that is, the process of oxygen and carbon dioxide exchange in the lungs – by simulating the respiratory muscles and providing the force needed to deliver air to the lungs in a variety of patients whose own ventilatory abilities are diminished or lost through physiological impairment. Thus MV can be used to partially assist or to completely assume the act of breathing for a wide range of acute and chronic respiratory, cognitive and neuromuscular conditions. The MV appears within Margarete Sandelowski's schematisation of medical technologies as a prosthetic device: treating dysfunction by simulating a particular body function or replacing an organ (*Technology Dependency*). Sandelowski contrasts prosthetic technologies with curative and regulatory technologies in a conceptual framework that implicitly sustains an instrumental view of technology: essentially neutral, and merely employed as a tool or instrument in relation to the human. This is a common sense perception that conceptualises technologies as extensions of human capacities, as means to an end, having no effect on their own, only in how they are used. Sandelowski's perspective recognises in very McLuhanesque terms that media are extensions of the self, but, as McLuhan further elaborates, "the extension of any sense alters the way we think and act – the way we perceive the world" (*Medium* 41), so that media extend, but also have consequences, altering our social existence and equilibrium, as "the most dangerous position vis-à-vis technology is to assume its neutrality" (*Understanding Media* 11).

The iron lung was a particularly salient mechanical respiratory support technology, which emerged during the polio epidemics of the twentieth century, both in hospital wards due to its perceived efficacy, and in the popular consciousness due to its iconic coffin-like appearance. Developed predominantly for young sufferers of poliomyelitis with paralysis of the respiratory muscles, this technology was "viewed as a temporary measure necessitated by the individual's inability to breathe" (Locker 26), and was not envisaged in its subsequent role of maintaining the life of patients with chronic conditions. This situation reveals that although technological design arises out of specific human intentions and desires, unintended consequences and cultural effects – the Virilian accident – emerge. Here the indefinite maintenance of life shifts the MV beyond a simple instrumental function as a prosthetic device or tool intended for a particular end. Whilst the principle of mechanically providing air to the lungs to assist ventilation has not changed, the method has become much more active and involved in response to such effects. Most conspicuously changes occurred following the Second World War, when negative-pressure systems that rhythmically adjusted air pressure around the chest or thorax – such as the iron lung – were gradually replaced and made largely obsolete by positive-pressure systems that work directly on the body by physically pushing air into a patient's airways via a plastic tube. Positive-pressure technology enabled MV models to be manufactured in smaller and more mobile units, making non-institutionalised life in the community more feasible for many people with a wide range of diagnoses and prognoses.

Despite its home use, MV is used predominantly and extensively within hospitals and intensive care units for acute illnesses, operations, and recovery. This space frames images popularised in medical dramas of bodies connected to banks of machines that are actively monitoring and maintaining an array of physiological functions. Generally within hospitals the ventilator is interfaced with the body via an endotracheal tube inserted in the mouth and down the throat, in a process known as intubation; outside the hospital the connection can be maintained through non-invasive techniques, via a wide variety of – often custom-made – nasal, facial and oral masks, or it can be maintained through the invasive technique of an endotracheal tube inserted into the windpipe via an opening cut into the neck. These MV-body interfaces – obscuring the face, piercing the neck, or inserted in the mouth – dramatically impact upon the integrity of the human body. As such the MV-body is aligned with other deviant and grotesque bodies; it is open,

permeable and continuous, in opposition to the clean, closed and finished classical body privileged since the Renaissance. The MV-body is marked, however, with a particular disorder through its intimate association with death. The ventilator is a device that maintains bodies in liminal, ambiguous states between life and death, such as coma and persistent vegetative state, and as Margaret Lock details, this relation actually inaugurated a multiplicity of deaths – social, cognitive and biological (*Twice Dead*). The inseparability of the MV from processes of dying manifests a particular tension in the euthanasia debate: to "pull the plug" is to bring about death, yet simultaneously the person connected to the ventilator is already classified as dead – in at least one sense.

The disorder of the MV-body intersects with Chris Shilling's discussion of current ideological demands for finished bodies. He argues that finishing the body has become an ongoing project that confronts the individual in modern society, through routines of diet, dress, hygiene, consumption, and exercise, and that as the body ages the work of finishing it becomes more difficult (*Body and Social Theory*). The MV body remains permanently unable to be closed or finished, compounding the failure to conform to regimes of health, fitness and normativity privileged in late modernity, broadly entangling it with a range of both aged and disabled bodies. Perceiving the MV-body as in crisis, disorderly or as a disruption to a foundational and natural integrity rests on a view of the human as possessing a bounded, contained and discontinuous ontology, where the disruption of external technologies threatens to destroy, subtract from or "dehumanise" the discrete, whole, unified concept of the body and self. Paul Virilio's thesis posits such a view in defining a natural boundary to the human that is constantly encroached upon by technology. His theory of the accident contests teleological understandings of technology by exposing the negative events that issue from the excessive pace of technological change. Locating the accident within his notion of "dromology" – the logic of speed as the foundation of our technological society – Virilio argues the accident is both a specific event and a general consequence, where "every technology produces, provokes, programs a specific accident" (Armitage 32). He writes:

> "When you invent the ship you also invent the shipwreck; when you invent the plane you also invent the plane crash; when you invent electricity, you invent electrocution …every technology carries its own negativity, which is invented at the same time as technical progress. (*Politics of the Very Worst* 89)

Virilio argues that just as the geographic environment was colonised by the speed of transport and communication technologies, the environment of the human body is currently threatened by the speed of medical technologies, in what he labels the "transplant revolution" (*Art of the Motor)*. This revolution – a form of radical ecology extended beyond the geographic world to a desire to preserve space, time and the body (Cooper 115) – is the means by which medical technologies of prosthesis, transplantation and implantation are not actually augmenting or supplementing the internal organs and rhythms of the body, but crucially for Virilio, are interrupting and polluting the body, dictating its pace and movement, and bringing it under erasure. The mechanical ventilator is a paradigmatic technology of the transplant revolution; dictating the size and pressure of breaths, the MV, in addition to simulating the body's functions, alters metabolic rhythms and speed. It is, for Virilio, antithetical to the human, a manifestation of the accident of the technosphere prevailing over the biosphere.

Virilio's accident illuminates the disorder that is endemic to technology, and consequently it addresses the need to assess the dynamic relations of humans and technologies via a critique of the modernist ideology that attempts to maximise efficiency and impose order. Yet, despite offering a counter to uncritical faith in technoscience, and the enthusiasm of technophilic ideology as instrumental panacea – with its affinities to Freud's "prosthetic god" – through sustained opposition to technological colonisation of the body, Virilio's thesis remains problematic because it reiterates earlier deterministic philosophies. These philosophies, exemplified by Martin

Heidegger and Jacques Ellul, have been criticised by Peter-Paul Verbeek, an advocate of the empirical turn in technology studies, for emphasising technology as something that alienates people from "reality," and for being too abstract and sweeping, failing to connect with the concrete practices of relations between humans and technologies in specific contexts and with different technological artifacts (*What Things Do*). Verbeek argues that the classical philosophy of technology – rehearsed by Virilio – approached the subject from a transcendental position, and despite their insights into technological change, these ideas were generalised to all artifacts and failed to take into account complexity of social use. They looked "backward to how it [technology] *originated* or what its *conditions* of *possibility* were," but neglected to look "forward to what it actually *does*" (29). Verbeek sees classical theories as monolithic because they allow no room for alternative technological practice, abstract because they don't focus on specific technologies, and nostalgic because they often lament a lost past exalted above the present. Virilio echoes such earlier theorising by remaining general in his criticisms of medical technologies: he is unable to distinguish between a hearing aid, a prosthetic leg or a heart transplant [1]. I want to suggest that Virilio's critique, by remaining both negative and general, ignores the particular, differentiated, and contingent in the interaction between bodies and technologies, and as a result much of the complexity and ambivalence found in such situated relations.

The mechanical ventilator is often framed within a dialectic that describes it as either radically destabilising human life, creating new and ambiguous states such as brain-death, or as a simple prosthetic device, serving an instrumental purpose through simulating the function of breathing for patients whose own ventilatory abilities are diminished or lost. Bruno Latour argues, however, that both these positions perpetuate a false dichotomy that separates humans and technologies when they are actually continuous and co-emergent. In *We Have Never Been Modern* Latour argues that this false dichotomy is a distinctive product of the practices of modernism and Western enlightenment, involving attempts to ontologically separate and purify subjects and objects, and as a result more and more entities are emerging that fall outside easy classification:

> When we find ourselves invaded by frozen embryos, expert systems, digital machines, sensor-equipped robots, hybrid corn, data banks, psychotropic drugs, whales outfitted with radar sounding devices, gene synthesizers, audience analyzers, and so on, when our daily newspapers display all these monsters on page after page, and when none of these chimeras can be properly on the object side or the subject side, or even in between, something has to be done. (*Modern* 49)

Latour, and actor-network theory, broadly redefine sociology through an inclusive and symmetrical methodology that prescribes researchers the task of capturing movements through the act of tracing associations between a heterogeneous range of elements. Crucially actor-network theory redefines our understanding of the social world, arguing that the heterogeneity found in such associations is not composed exclusively of human connections, and that focusing solely on the human entails a fundamental misunderstanding as it ignores the participation of objects, technologies and non-humans in the social world. Latour does not break down this dichotomy in order to take agency from humans, or to extend subjectivity to things, but rather to capture the movements and interrelations of actants – both human and nonhuman – in collectives, stating that "the modern collective is the one in which the relations of humans and nonhumans are so intimate, the transactions so many, the mediations so convoluted, that there is no plausible sense in which the artefact and subject can be distinguished" (*Pandora's Hope* 197). Latour provides a framework for thinking beyond asymmetrical analysis, inviting us to acknowledge the inextricability of humans and technologies, to re-assess the ways entities are mutually constituted through their relations, and to trace the situated associations of entities or actants. Directed towards the reconfigured and distributed ontology of the human-mechanical ventilator relation, this methodology demands that we analyse the moments of interaction and

points of intersection between the body and the ventilator. These are most conspicuous during the initial stages of connection and interface.

Designers, technicians, and operators of the MV are concerned with negotiating this relation in order to achieve what is labelled in medical textbooks as "synchronicity," by adjusting a range of factors such as volume, pressure, and flow, via microprocessors and complex algorithms. These variables are set in relation to the machine's capabilities, the patient's requirements, and the knowledge and preferences of the treating physician, imbricating each of these actants in an imbroglio framed by their particular abilities and limitations. The most common MV settings or modes are volume-cycled and pressure-support modes. Volume controlled ventilation delivers a preset volume of air for each breath cycle during inspiration. Pressure ventilators deliver one of two major pressure regimens. The first is continuous positive airway pressure (CPAP), which delivers a steady pressure of air to assist inspiration. The second is bilevel positive airway pressure (BiPAP), which delivers a higher pressure on inspiration, helping the patient obtain a full breath, and a low pressure on expiration, allowing the patient to exhale easily.

Originally, these settings were limited, with ventilators controlling every breath – a process known as mandatory ventilation – and patients were required to make substantial efforts and adjustments to match the rhythms and speed of the machine. But as MV evolved, particularly through the replacement of mechanical parts with electronic, and of manually set parameters with microprocessor controls which employed sensors and complex algorithms, the patient no longer adapted to the machine. Instead "spontaneous or patient initiated breaths were introduced in synchrony where the ventilator responds to the patient's breathing efforts" (Tobin 49). Known as synchronised intermittent mandatory ventilation (SIMV), this mode allows a period of time where the patient can trigger a breath spontaneously; if no inspiratory effort/breath is detected in relation to a preset threshold or limit (time or pressure) the ventilator automatically delivers a mandatory breath. "In essence, the ventilator must decide which pattern of control and phase variables to implement before each breath, depending on the value of some preset conditional variable(s)" (Tobin 49). Conditional variables function in terms of "if then" statements: that is, if the value of a conditional variable reaches some preset threshold, then some action occurs to change the ventilator pattern. For example if the preset threshold variable is time, and if a certain time has elapsed, then the ventilator takes over. This is more complex when the variable mode is pressure, which operates according to mathematical proportionality, where the machine breath is proportional to the respiratory effort of the patient; the greater the respiratory effort of the patient, the higher the level of pressure support. This form of synchronisation is known as proportional pressure support (PPS).

The latest ventilators are described as multi-mode, and can provide breaths via a range of alternative variables, and this "generation of mechanical ventilators has obtained a level of sophistication unparalleled in previous generations. Most of these units incorporate multiple microprocessors to precisely control the flow of gas, to allow for the provision of ventilatory support by multiple modes, and to allow for the monitoring and alarming of virtually every aspect of the ventilator and patient-ventilator interface" (Tobin 65). This flexibility and complexity allows the needs of an increasingly varied group of critically ill patients to be met, and moves in the opposite direction to that posited by Virilio, in that technology has not increasingly colonised the body as it has become more complex, but rather has increasingly adapted to work in synchrony with a diverse range of bodies and conditions. Whilst older mandatory ventilation determined the size or pressure of breaths, imposing its design constraints onto the patient, the technology existed to support the patient, so its motivation was sustaining patients. The patient's needs were primary. However, in a sense these needs became secondary due to the limitations of the machine. This situation has become more complex, where – with PPS – there is now a proportional sharing of responsibility. No longer an imposition, it is a multidirectional process of familiarising and learning that is mutually constitutive and interdependent, as the set-up requires

that the body learn the machine in a phenomenological sense, and that the machine learn the body in terms of particular calculations and knowledge. The MV uses this knowledge to deliver both extensive and intensive breaths of particular sizes, volumes and pressures to the body. Variables are now adjusted in relation to the machine's capabilities and the patient's requirements to establish synchronicity in attempts to harmonise their relationship on an individual level. This process forms part of Henri Bergson's notion of "creative evolution," in that the body and self must learn to accommodate manufactured devices that are far from perfect and require considerable effort in order to be accommodated (140). The process thus complicates any instrumental or determinist binary in the on-going political and ontological changes in the design and implementation of the MV medical technology.

Whilst a process of negotiation, accommodation, and learning generally constitutes the MV-body, there are some ventilation regimes – old and new – that impose machine settings or rhythms. Regimes such as CPAP, with continuous pressure, as well as high frequency ventilation (HFV), which deploys radically increased frequencies of machine breaths, but with lower volume and pressure levels, are designs that diverge from imitating "normal" physiology. It appears with such modes that body rhythms are compromised by the machine, forced to adapt their physiology to the ventilator, and breathe at the machine's "unnatural" pace, conforming to the transplant revolution laid out by Virilio. However, these settings and designs are implemented with particular bodies in mind. The continuous pressure of CPAP is not sufficient to inflate the lungs completely; instead its purpose is to maintain an open airway, and for this reason it is used in conditions such as sleep apnoea when a patient's airway closes frequently during sleep. The lower volume of air delivered with HFV is less taxing on the lungs, reducing the destructive effects associated with other forms of MV, such as barotrauma. As such, what may appear on the surface to disrupt, pollute or erase the internal rhythms of the body, actually enables possibilities for life.

It is evident that in the process of accommodation and mutual integration, the MV has a material presence and acts. Initially it "recognises" the patient's effort to breathe; then it "examines" each breath; then it "decides" what kind of breath to give; and finally it "delivers" a breath. Latour allows us to see that it is not simply a tool or instrument; it doesn't simply provide a different means to the same end in replacing the patient's muscular function in performing the work of breathing. This is a radical simplification that effaces complexity in the distribution of actions and negotiations that occur in the relationship between bodies and technologies. The ventilator enters and cohabits the social field, actively participating in the synchronisation and mutual construction of this new entity. Synchronisation, however, is not necessarily stable or teleological; rather it remains potentially unstable and precarious. Instability in the relation centers around the potential for disconnection, and uncertainty or fear of machine performance and breakdown. The relation to the MV can oscillate then between self and other, shifting between categories of human-technology relations outlined by Don Ihde [2]. Medical textbooks state that, "an ideal ventilator would sense the body's physiologic gas exchange needs just as the brain does and would provide assistance in proportion to the deficit in the trigger, limit or cycle values" (Tobin 51). This "perfect patient-ventilator interaction, [when] the ventilator would trigger in synchrony with electrical impulses originating in the central nervous system" (Tobin 88), imagines a future where the intimacy of this distributed ontics is compounded and where any point of distinction between body and machine is thoroughly blurred.

Fundamentally the MV-body impacts on conceptual understandings of what a body is. The body here is neither a biologically given entity, nor a social construction, it is a contingent series of events or accidents, with a materially distributed ontics; it is a manifestation of what Felix Guattari – following on from his work with Gilles Deleuze – articulates as a machinic assemblage or "existential territory" : a singularity or actualisation within flows of virtuality (*Chaosmosis*). Guattari implicates all activity and interaction under the notion of the machine, broadening the

term beyond technology. He states, "common usage suggests that we speak of the machine as a subset of technology. We should, however, consider the problematic of technology as dependent on machines, and not the inverse"(*Chaosmosis* 33). Thus the machine encompasses both technological and non-technological objects in its focus on the formation of assemblages, complicating any neat opposition between the organic and inorganic as autopoietic and allopoietic respectively [3]. Assemblages operate, then, within a field of complexity, a situation where, as Grosz puts it, we are always with our technologies. Interaction is activity and production, where new things are not only produced, but also destroyed and unravelled. Within this thought, Guattari thinks the body is better viewed as an ecology: an event or series of events where new connections and syntheses open up new fields of the virtual, rather than a discrete entity. This view comprises a relational understanding, where activity and interaction is a situated and contingent process, and where an entity's ontics are distributed and co-constituted through relations to other things. Grosz takes an analogous position, recently arguing for the inclusion of others, such as the inhuman, subhuman, and extrahuman, and an understanding of these others in terms of continuity rather than opposition to the human. In this sense, both the human and the body are understood as modes of practices, actions and events that extend the human into the material, transforming both the body supplemented and the object that supplements it, in what Grosz describes as a "mutual metamorphosis" (148).

The metaphysics of Guattari and the pragmatic sociology of Latour stand in contradistinction to Virilio and the desire for preservation of the body; they don't treat technology as anathema, as if "technology is leading us to a situation of inhumanity and of rupture with any kind of ethical project" (Guattari, "On Machines" 9). Rather they connect the body into a broader material world, revealing that the accident is not something happening *to* bodies – the body is not lost to the accident, it still exists – rather, the accident is something that imbricates bodies. Humans and technologies are not separate, but inextricably entwined as *part* of the accident. Instead of the accident being erasure and the production of negative accidents, Guattari and Latour allow for the possibility that the accident and the renegotiated body-ventilator environment can transform the parameters and possibilities of life. Such a consideration does not conceive technological prosthesis as instrumental restoration and replacement of lack, but as reorganisation and the exceeding of limitations. Crucially the body is no longer conceived as natural, essential, a-historical or discontinuous, but rather as continuous, permeable, and in process; there is no longer a "body" but rather instantiations of bodies that rest upon a distributed and heterogenous network of relations and artifacts, in what Donna Haraway has labelled a "material-semiotic generative node" (*Simians*). This understanding shifts the categories of normativity and disability towards a realisation that material and technological dependencies are not solely the realm of the disabled, but rather the condition of the human and its bodily environment (Moser). Traditionally, ideologies of rehabilitation emphasised separation from technological assistance as virtuous, and dependence as idleness. [4] These ideologies are compatible with broader cultural values of independence and achievement, circumscribing the MV-body with failure in its inability to conform to the curative goals of medicine, as well as connecting humans and technologies into similar trajectories based on usefulness, novelty, and obsolescence. The MV, adopted through necessity, imposes a range of constraints on bodily freedoms, denying notions of choice and flexibility privileged in late modernity. There is, however, an ambivalence in this reconfiguration as such attenuations are countered by the MV extending and prolonging bodies, enabling both mobility and new ways of existing outside institutions.

The Latourian approach places bodies in relation to both symbolic and material culture, where "what produces them is not simply biological events, not only the phenomenology of bodily experience, and not merely structures of symbolic and discursive meaning – although all of these are important – but also the patterns of material organization and their modes of ordering" (Prout 15). Tracing the varied array of materials, practices, and representations involved in the construction and maintenance of bodies, "and in some circumstances their unravelling and

disintegration", offers productive possibilities for both epistemological and ontological understandings of the body-technology nexus in late modernity (Prout 15). This paper has attempted to extend Virilio's notion of the accident beyond its limited and negative formulation via illumining some of the material complexities in the MV-body relation; however, further analysis, incorporating a phenomenological methodology to complement the dominance of semiotics within cultural studies [5], is required. A broad methodological approach will help map a more sophisticated understanding of how both the MV-body in particular and bodies more broadly are conceived, constructed, experienced and shaped in our sociotechnical context, where patterns of intimacy and identity emerge through technical relations.

Bjorn Nansen is a PhD candidate in the Department of Communication and Culture at the University of Melbourne. His research is supervised primarily by Professor John Frow, and focused on technoculture, embodiment and speed.

Endnotes

[1] Andrew Feenberg makes an analogous criticism of Martin Heidegger: "he literally cannot discriminate between electricity and atom bombs, agricultural techniques and the holocaust" (*Questioning Technology* 187).

[2] Don Ihde, drawing on the earlier work of phenomenologists such as Merleau-Ponty, distinguishes between embodied, hermeneutic, alterity, and background relations between humans and technology (*Technology and the Lifeworld*).

[3] For Guattari, to describe technologies as allopoietic (dependent on external processes to exist) and biological organisms as autopoeitic (self-creating and independent) is an illusion as all assemblages contain elements of both external relations and maintain some sense of a processual core ("On Machines").

[4] For further analysis and discussion in relation to post-poliomyelitis syndrome see Locker and Kaufert.

[5] Thomas Csordas argues phenomenology should operate as a "dialectical partner" to semiotics, in order to analyse "embodiment as the existential condition of possibility for culture and the self" (12).

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