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ANIMALS, SCIENCE AND TECHNOLOGY: MULTISPECIES HISTORIES OF SCIENTIFIC  
AND SOCIOTECHNICAL KNOWLEDGE-PRACTICES

# Biopolitics and Becoming in Animal-Technology Assemblages

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**Abstract:** This article critically explores Foucauldian approaches to the human-animal-technology nexus central to modern industrialised agriculture, in particular those which draw upon Foucault's conception of power as productive to posit the reconstitution of animal subjectivities in relation to changing agricultural technologies. This is situated in the context of key recent literature addressing animals and biopolitics, and worked through a historical case study of an emergent dairy technology. On this basis it is argued that such approaches contain important insights but also involve risks for the analyses of human-animal-technology relations, especially the risk of subsuming what is irreducible in animal subjectivity and agency under the shaping power of technologies conceived as disciplinary or biopolitical apparatuses. It is argued that this can be avoided by bringing biopolitical analysis into dialogue with currents from actor-network theory in order to trace the formation of biopolitical collectives as heterogeneous assemblages. Drawing upon documentary archive sources, the article explores this by working these different framings of biopolitics through a historical case study of the development of the first mechanical milking machines for use on dairy farms.

**Keywords:** Foucault; actor-network theory; posthumanism; animal-technology co-becoming; multispecies biopolitics

## Introduction

A growing body of research and scholarship examines the socio-technological history of dairy farming, examining the role of interconnected scientific, technological, economic, socio-cultural and legal changes in reshaping milk production and consumption practices and relations since the late-nineteenth century, particularly in Europe and the US.<sup>1</sup> Prior to this, dairy farming was resolutely local in scale, labour intensive in nature, and umbilically tied to the same rhythms and practices of milking that had persisted virtually unchanged for centuries. But the last decades of the nineteenth century saw the emergence of overlapping processes of technical and economic change which accelerated through the twentieth century, transforming the milk trade into a modernised commercial enterprise wherein milk was routinely pasteurised, homogenised, cooled and refrigerated, before being sent hundreds of miles to the retailer, by rail or by road. Multiple socio-technological innovations and developments were necessary in order to make this possible, from the adaptation of refrigeration techniques initially used in brewing, to the extension of the railway and road infrastructure, the construction of an elaborate sanitary and inspection apparatus of tuberculin testing and pasteurisation, and the emergence of public advertising. The overall trajectory is one of increasing complexity in the multiple assemblages comprising the dairy industry, and these assemblages are not just human, social and technological, but also animal, biological and corporeal.

Human-animal studies scholars examining this history have stressed the importance of recognising the role of nonhuman animals in these historical assemblages, giving rise to critical analyses of the human-animal-technology interface. Among the most significant of these are analyses which take up Foucault's notion that subjectivity is a product of ongoing political processes of subjectivation, so that subjects and subjectivity are perpetually shaped by historically shifting techniques and apparatuses of power, knowledge and discipline.<sup>2</sup> Applied post-anthropocentrically to nonhuman animals in agriculture, and to cows in the context of dairy farming, this renders accounts in which changing technologies generate changing human and animal subjectivities as both cows and farm workers adapt their practices and behaviours, their uses of space and their interrelationships, thus: "[B]ovine and human agency and subjectivity are entrained and reconfigured in relation to emerging milking technologies, so that what it

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<sup>1</sup> Peter Atkins, *Liquid Materialities: A History of Milk, Science and the Law* (London: Routledge, 2010); Richie Nimmo, *Milk, Modernity and the Making of the Human: Purifying the Social* (London: Routledge, 2010); Deborah Valenze, *Milk: A Local and Global History* (New Haven: Yale University Press, 2011); Mathilde Cohen and Yoriko Otomo, *Making Milk: The Past, Present and Future of our Primary Food* (London: Bloomsbury Press, 2017).

<sup>2</sup> Lewis Holloway, "Subjecting Cows to Robots: Farming Technologies and the Making of Animal Subjects," *Environment and Planning D: Society and Space* 25, no. 6 (2007): 1041-1060; Lewis Holloway and Chris Bear, "Bovine and Human Becomings in Histories of Dairy Technologies: Robotic Milking Systems and Remaking Animal and Human Subjectivity," *BJHS Themes* 2 (2017): 215-234.

is to be a cow or human becomes different as technologies change.”<sup>3</sup> This proffers a way to avoid inscribing a given or fixed bovine subjectivity in the way that is often presupposed by other kinds of critical approach to the animal-technology nexus in industrialised agriculture, such as Marxist and feminist critiques focusing on, variously, the alienation, exploitation, and objectification of bovine subjects within capitalist and patriarchal structures. As Lewis Holloway notes in his analysis of robotic milking systems, such approaches “have tended to essentialise the subjectivity of farmed animals in ways which negate the potential for them to become, to be co-constituted as they are entrained within various sets of socioeconomic, ecological, spatial, and technological relationships.”<sup>4</sup> This shift from being to co-becoming is a significant contribution of poststructuralist approaches to analyses of animal agriculture, offering an important alternative to the affirmation of an essentialised animal subjectivity as a rhetorical strategy for challenging objectification, and instead tracing the constitution of animal subjects in relation to particular technoscientific assemblages in animal agriculture.

It is not without some potential problems however. The first concerns technology, and a risk of underplaying the socio-material frictions and contingencies at work in the emergence and development of technologies as well as the precariousness of their stabilisation. This can mean backgrounding the complexities of technological design as ongoing socio-material practice, by treating dairy technologies for example as finished or pre-constituted objects or systems vis-à-vis other human and nonhuman actants, hence casting technologies in the role of tools or instruments of disciplinary and biopolitical power, granted enormous efficacy. The second concerns animal subjectivity, and a risk of overstating the shaping of bovine subjectivity by the disciplinary apparatuses of industrial agriculture and thus under-acknowledging the liveliness of animals as living corporeal beings. This is a conundrum of poststructuralist approaches to the subjectivity of farmed animals, that by stressing the becoming of animal subjectivity within technologically mediated agro-industrial processes, the sense of animal subjectivity and corporeality as in some sense irreducible to their human-designed uses can sometimes be backgrounded or even disappear in the critical narrative; the domesticated animal becomes inscribed as a docile subject constituted within and by the disciplinary technology, which risks reinscribing anthropocentric ontology by reducing animality to little more than raw material for humanisation.

These are not inevitable features of this sort of approach, but risks that can be avoided, particularly – I want to argue – by drawing upon theoretical sensibilities from actor-network theory (ANT) and bringing these into productive dialogue with Foucauldian biopolitics. Theoretical syntheses can often be deceptive in their appeal, tending to gloss over subtle yet vital differences between traditions. But synthesis is not what I propose here, but rather a reading

<sup>3</sup> Holloway and Bear, “Bovine and Human Becomings,” 234.

<sup>4</sup> Holloway, “Subjecting Cows to Robots,” 1041.

of biopolitics through certain currents from ANT. In what follows I develop this by exploring Foucauldian biopolitics more broadly as a way to grasp the human-animal-technology nexus, and critically engaging with recent theoretical literatures that have articulated different readings of biopolitics vis-à-vis animals. I then draw upon archive sources to work these issues through an empirical study of a pivotal moment in the history of dairy farming – the emergence of the earliest mechanical devices for the milking of cows.

## Reassembling biopolitics

For all its acuity in other respects, Michel Foucault's vision rarely if ever extended beyond human beings, the relations between human beings, and the things created by humans. It may therefore strike some as perverse that so apparently anthropocentric a philosopher should provide a source of inspiration for many of those studying human-animal relations. Yet many such scholars have been tempted to draw upon aspects of his work. Indeed, whilst Foucault's work is certainly human-centred it is by no means humanist, and therein lies the paradox and the promise when it comes to its usefulness for studying more-than-human relations. His commitment to dispense with the sovereign human subject as the constituent unit of social and political analysis, and instead to trace the historical production of the subject within micro-political processes, relations and techniques, is pivotal. Together with a conception of power as a product of arrangements not only of words, texts and ideas, but always also of things, built structures, technologies and spatial configurations, which act upon the living body of the subject, this reimagines the fields of the political, social and economic as ensembles of social and material practices irreducible to the relations between human subjects. Moreover, by turning from the sovereign subject to "life," and rendering this a socio-historical and political category rather than an a-priori or transhistorical domain, what Foucault makes thinkable is a relational politics of life conceived in more-than-human terms.<sup>5</sup>

This incipient posthumanism was never concretely extended by Foucault in such a way as to encompass nonhuman animals, nor allowed to inform an analysis of the multispecies dynamics of power or the historical constitution of the category of species. Despite his deconstruction of the subject and of humanist epistemology, there is little sense in Foucault that this opens a vista on a more heterogeneous, lively, multispecies ontology, something which Paola Cavalieri aptly

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<sup>5</sup> Michel Foucault, *Discipline and Punish: The Birth of the Prison* (London: Penguin, 1991); Michel Foucault, "Governmentality," in *The Foucault Effect: Studies in Governmentality*, eds. Graham Burchell, Colin Gordon, and Peter Miller, 87-104 (Hemel Hempstead: Harvester Wheatsheaf, 1991); Michel Foucault, *The Birth of Biopolitics: Lectures at the Collège de France, 1977-78* (Basingstoke: Palgrave Macmillan, 2008).

calls “a missed opportunity.”<sup>6</sup> The discourses, apparatuses and micro-political techniques into which the subject is dissolved by Foucault are conceived largely as human constructs, albeit collective, institutional, and incorporating human-created things and structures. This raises the question as to whether Foucault’s poststructuralist anti-humanism can be meaningfully separated from his residual species anthropocentrism and mobilised in studies of interspecies relations and multispecies life. A brief survey of the literature indicates that this has been judged by many scholars of human-animal relations to be a project worth attempting: from Clare Palmer’s early application of Foucault’s theory of power to human-animal relations;<sup>7</sup> through numerous analyses of the disciplining of animals in industrial farming,<sup>8</sup> the dairy industry,<sup>9</sup> the slaughterhouse,<sup>10</sup> and intensive apiculture;<sup>11</sup> to studies of the operation of biopower in biotechnology and genetics,<sup>12</sup> in the management of urban feral populations,<sup>13</sup> or in wildlife conservation.<sup>14</sup>

<sup>6</sup> Paola Cavalieri, “A Missed Opportunity: Humanism, Anti-Humanism and the Animal Question,” in *Animal Subjects: An Ethical Reader in a Posthuman World*, ed. Jodey Castricano, 97-123 (Waterloo: Wilfrid Laurier University Press, 2008).

<sup>7</sup> Clare Palmer, “‘Taming the Wild Profusion of Existing Things?’ A Study of Foucault, Power, and Human/Animal Relationships,” *Environmental Ethics* 23, no. 4 (2001): 339-358.

<sup>8</sup> Anna Williams, “Disciplining Animals: Sentience, Production and Critique,” *International Journal of Sociology and Social Policy* 24, no. 9 (2004): 45-57; Joel Novek, “Pigs and People: Sociological Perspectives on the Discipline of Animals in Intensive Confinement,” *Society and Animals* 13, no. 3 (2005): 221-244.

<sup>9</sup> Richie Nimmo, “Governing Nonhumans: Knowledge, Sanitation and Discipline in the Late 19th and Early 20th Century British Milk Trade,” *Distinktion: Scandinavian Journal of Social Theory* 9, no. 1 (2008): 77-97; Holloway, “Subjecting Cows to Robots”; Nimmo, *Milk, Modernity and the Making of the Human*.

<sup>10</sup> Stephen Thierman, “Apparatuses of Animality: Foucault Goes to a Slaughterhouse,” *Foucault Studies* 9 (2010): 89-110; Jonathan Clark, “Ecological Biopower: Environmental Violence Against Animals and the ‘Greening’ of the Factory Farm,” *Journal of Critical Animal Studies* 10, no. 4 (2012): 109-129.

<sup>11</sup> Richie Nimmo, “The Bio-Politics of Bees: Industrial Farming and Colony Collapse Disorder,” *Humanimalia: Journal of Human/Animal Interface Studies* 6, no. 2 (2015): 1-20.

<sup>12</sup> Richard Twine, *Animals as Biotechnology: Ethics, Sustainability and Critical Animal Studies* (London: Earthscan, 2010); Lewis Holloway and Carol Morris, “Exploring Biopower in the Regulation of Farm Animal Bodies: Genetic Policy Interventions in UK Livestock,” *Genomics, Society and Policy* 3, no. 2 (2007): 82-89.

<sup>13</sup> Diane Michelfelder, “Valuing Wildlife Populations in Urban Environments,” *Journal of Social Philosophy* 34, no. 1 (2003): 79-90; Krithika Srinivasan, “The Welfare Episteme: Street Dog Biopolitics in the Anthropocene,” in *Animals in the Anthropocene: Critical Perspectives on Non-human Futures*, eds. Human-Animal Research Network Editorial Collective, 201-220 (Sydney: Sydney University Press, 2015).

<sup>14</sup> Krithika Srinivasan, “Caring for the Collective: Biopower and Agential Subjectification in Wildlife Conservation,” *Environment and Planning D: Society and Space* 32, no. 3 (2014): 501-517; Jamie Lorimer, *Wildlife in the Anthropocene: Conservation After Nature* (Minneapolis: University of Minnesota Press, 2015).

Chrulew and Wadiwel provide an overview of some of the diverse work thus far undertaken in this area.<sup>15</sup> They posit a transition in such work away from studies drawing mainly from Foucault's archaeological period,<sup>16</sup> which they characterise as focusing chiefly upon the politics of knowledge of animals and the discursive construction of animality, and towards studies which engage more thoroughly with the possibilities of Foucault's later micro-political genealogy,<sup>17</sup> as an approach to the inter-corporeal politics of lived human-animal relations. They argue that whereas the archaeological approach always retains an anthropocentric core in its treatment of animals as objects of human knowledge, the latter has greater posthumanist potential, insisting that "what is needed is a genealogy which, 'situated within the articulation of the body and history', pays attention not only to human but also *nonhuman* bodies."<sup>18</sup> It is not enough then to draw upon Foucault's political epistemology to problematise the category of the human subject and open up the possibility of a critical exploration of the discursive conditions for the production of humanity vis-à-vis animality; it is necessary to move beyond this to an ontology that reckons more directly with the lived and corporeal relations between humans and non-human animals, a "political and materialist approach attentive to the productive apparatuses of power that govern and regulate animal lives," and thus to the "disciplining and shepherding of animals as beings who can act and resist."<sup>19</sup>

The notion that the foregrounding of the category of "life" in Foucault's work potentially offers a way to transcend the humanist framework is also expressed by Asdal, Druglitrø and Hinchliffe in their recent *Humans, Animals and Biopolitics*.<sup>20</sup> They suggest that in order to realise this potential, an analytics of life cannot focus narrowly upon human life and human populations, in the manner of Foucault himself, but must instead reckon with "an assemblage of matters of life."<sup>21</sup> Life, in other words, must not only be purged of its latent anthropocentrism but also disaggregated and grasped in its empirical specificity and heterogeneity, rather than being treated metaphysically. They further argue that this must go hand in hand with a similarly nuanced approach to power, and hence to the relation between power and life, thus rejecting any implicit notion of a self-evident or totalising power *over* life; instead Asdal et al. insist that

<sup>15</sup> Matthew Chrulew and Dinesh Wadiwel, *Foucault and Animals* (Leiden: Brill, 2017).

<sup>16</sup> Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences* (London: Tavistock, 1970).

<sup>17</sup> Michel Foucault, "Nietzsche, Genealogy, History," in *The Foucault Reader*, ed. Paul Rabinow, 76-100 (London: Penguin, 1984).

<sup>18</sup> Chrulew and Wadiwel, *Foucault and Animals*, 6.

<sup>19</sup> *Ibid.*, 6, 7.

<sup>20</sup> Kristin Asdal, Tone Druglitrø, and Steve Hinchliffe, eds., *Humans, Animals and Biopolitics: The More-Than-Human Condition* (Abingdon: Routledge, 2017).

<sup>21</sup> Kristin Asdal, Tone Druglitrø, and Steve Hinchliffe, "Introduction: The 'More-Than-Human' Condition: Sentient Creatures and Versions of Biopolitics," in *Humans, Animals and Biopolitics: The More-Than-Human Condition*, eds. Kristin Asdal, Tone Druglitrø, and Steve Hinchliffe, 1-29 (Abingdon: Routledge, 2017), 2.



“the relation between life and politics needs both theoretical and empirical specificity.”<sup>22</sup> There is some overlap here with Chrulew and Wadiwel, who insist that actual living animals must be reinserted into what are sometimes overly abstract conceptions of a politics of life, and who are critical of the metaphysical and transhistorical tendencies of some Foucauldian work on biopower, an accusation they level at philosophers Giorgio Agamben and Roberto Esposito for example.<sup>23</sup> What distinguishes Asdal et al.’s position is that they propose actor-network theory as a corrective to these residual problems in much Foucault-inspired work and stress the potential fruitfulness of an encounter between ANT, biopolitics and animals.

In an ANT-inflected ontological sensibility, the human subject is not just a historical, political and epistemic construct, but is also intricately and constitutively entangled with multiple nonhuman others.<sup>24</sup> It is this that underpins Asdal et al.’s contention that a reading of biopolitics through ANT commitments provides a way to mitigate some common shortcomings of the Foucauldian tradition. But this goes deeper than just remedying anthropocentrism, as the conception of power and biopower in Foucault-inspired work on multispecies relations, they claim, is too often seemingly unidirectional, tendentially totalising or universalising, and insufficiently relational. This problem is diagnosed as one rooted in a misreading of Foucault which “stresses the disciplining of subjects and the development of what are understood to be essentially repressive techniques.”<sup>25</sup> In this way, biopolitics can slide into an essentially “negative” reading of power. For Asdal et al. a biopolitical analytic informed by ANT helps to avert this by reading biopolitics as a methodological rather than philosophical injunction; that is, biopolitics is better understood as an invitation to trace how biopolitical collectives are formed, held together, stabilised and disassembled, rather than as a substantive assertion about anthropocentric biopolitics as pre-constituted or determinate. They suggest that this more methodological and empirically-oriented reading of both “life” and “politics” in Foucault goes hand in hand with reimagining biopolitics in more relational, heterogeneous and more-than-human terms, more open to “the lively openings and irreducibilities that may be opened up in this more than human world.”<sup>26</sup> This openness to liveliness and irreducibility, I want to suggest, well equips an ANT-inflected reading of biopolitics to remedy the tendential asymmetries of more straightforwardly Foucauldian approaches to human-animal-technology relations.

<sup>22</sup> Ibid., 7.

<sup>23</sup> Giorgio Agamben (1998) *Homo Sacer: Sovereign Power and Bare Life* (Stanford: Stanford University Press, 1998); Giorgio Agamben, *The Open: Man and Animal* (Stanford: Stanford University Press, 2004); Roberto Esposito, *Bios: Biopolitics and Philosophy* (Minneapolis: University of Minnesota Press, 2008).

<sup>24</sup> Mike Michael, *Reconnecting Culture, Technology and Nature: From Society to Heterogeneity* (London: Routledge, 2000); Mike Michael, “Roadkill: Between Humans, Nonhuman Animals, and Technologies,” *Society and Animals* 12, no. 4 (2004): 277-298.

<sup>25</sup> Asdal et al., “Introduction: The ‘More-Than-Human’ Condition,” 5.

<sup>26</sup> Ibid.

Its emphasis on the relational precariousness and heterogeneity of biopolitical assemblages underlines how co-becoming is always a partial and unfinished process, helping to avoid any tendency to subsume the lively subjectivity of animals under the co-productive power of the socio-technological apparatus.

In the following sections I explore the possibilities and problems of these different inflections of biopolitical approaches to bovine subjectivity, agency and becoming, as ways to grasp the human-animal-technology nexus. To do so I firstly take up Asdal et al.'s injunction to empirical specificity, drawing upon primary archive sources in order to work these theoretical framings and the issues they raise through a case study of the emergence of the earliest mechanical devices for the milking of cows. This was a significant moment in the mechanisation of dairy production, marking the initial intermediation of technology between animal and machine, which enabled the subsequent industrialisation of the industry, making possible firstly the large-scale pipeline milking systems of the mid-twentieth century and then the automated and robotic milking systems that have proliferated since the nineties. Early milking machines are examined here not as pre-constituted technological objects or systems, but as technologies-in-the-making, in an ANT-inflected historiographic approach which initially prioritises the empirical tracing of connections and developments. It also draws from actor-network theory a sensitivity to messy and heterogeneous processes full of relational frictions and incoherencies, resisting the temptation to render these coherent and to smooth their rough edges into a critical narrative.

## Milking machines: trials and translations

Probably no machine of modern times, in the agricultural world, has aroused so much discussion, criticism, praise and censure as the milking machine. Perfected after years of endeavor and research; struggles against prejudice and almost insuperable difficulties [...] No other machine has a closer connection between the three elements, mechanical, human and animal; and potentialities for good or bad, are very great.<sup>27</sup>

The demand for a mechanical device for milking cows emerged in the mid-nineteenth century,<sup>28</sup> and grew partly from the sharpening contrast between dairy farming, which was still practised in much the same way as it has been for hundreds of years, and the rapid mechanisation of other spheres. Another driver was the changing labour relations on dairy farms, which made dairy

<sup>27</sup> Aubrey Hoyland, *Machine Milking: A Bane or a Boon* (London: Nichols and Co. Ltd., 1939), 3, 17.

<sup>28</sup> J. P. Sheldon, "Dairy Farming," *Journal of the British Dairy Farmers' Association* 1, no. 1 (1878): 53.



labourers who were willing to work for the low rates of pay on offer increasingly scarce.<sup>29</sup> The first attempts to satisfy the demand for mechanical milkers consisted of “milk tube” designs. These were adapted from the earlier practice, observable since the 1830s, of inserting straws into the udder, and worked by inserting a narrow tube or catheter into the teat, forcing the sphincter muscle open, so that the milk would flow out.<sup>30</sup> It is striking just how mechanistic and disembodied were the principles of operation of these initial devices, which conceived of the udder as a container of something of value that had to be extracted by the most direct means possible:<sup>31</sup> “As milk is prevented from escaping from the udder by the sphincter muscle of the teat, it was felt that it would be possible to release the milk if the sphincter muscle could be opened by force.”<sup>32</sup> The cow as a living being, the skill of experienced hand milkers, let alone the suckling of calves, barely figured in the rationale of these early designs, which were directly functional in their approach. Some such devices were briefly marketed in the 1870s, but they were soon found to be unworkable, soon resulting in either infection or physical damage to the teats and udder.<sup>33</sup>

As milk tubes were abandoned, the new type of design for a mechanical milking device attempted to simulate and reproduce the complex hand motions of a human milker by employing systems of rollers and pressure plates in order to squeeze and massage the teats and udder.<sup>34</sup> Such designs went through numerous iterations, each of which tried to more closely approximate the dexterous wrist, palm and finger movements of a skilled milking hand; earlier devices were designed simply to squeeze the teat via mechanical rollers which applied progressive pressure, whereas later designs tried to reproduce the combination of squeezing and tugging characteristic of hand milking.<sup>35</sup> However the difficulty of accurately mimicking a hand with all its tendons, muscles and joints, to produce an equivalent set of subtle

<sup>29</sup> J. C. Morton, “Dairy Farming,” *Journal of the Royal Agricultural Society*, series II, vol. XIV (1878): 647-673, on 667; F. S. Courtney, (1900), “The Trials of Milking Machines at York,” *Journal of the Royal Agricultural Society*, series III, vol. XI (1900): 466-471, on 466.

<sup>30</sup> Tage Jansson, *A Historical Review of the Development of the Milking Machine with Special Reference to Technical Advances and Improvements* (Tumba, Sweden: Alfa-Laval AB, 1973), 5.

<sup>31</sup> R. Henderson, “The Murchland Milking Machine,” *Journal of the Royal Agricultural Society*, series III, vol. II (1890): 645-652; O. Erf, “Milking Machines,” *Agricultural Experiment Station Bulletin* 140 (Manhattan: Kansas State Agricultural College Printing Department, 1906).

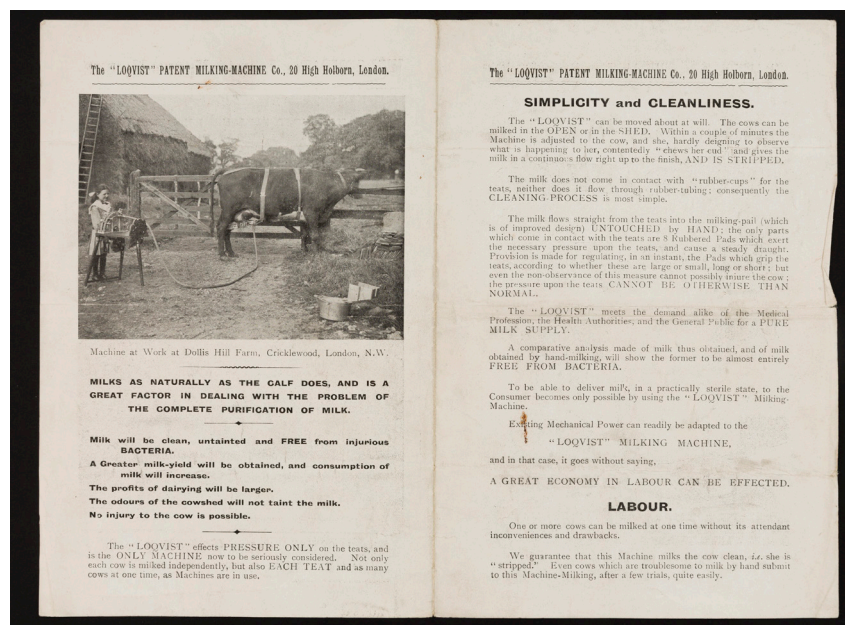
<sup>32</sup> Jansson, *A Historical Review of the Development of the Milking Machine*, 5.

<sup>33</sup> Andrew M'Candlish and James Cochrane, “A Comparison of Hand and Machine Milking,” *The West of Scotland Agricultural College Bulletin* 121 (1930): 260; Henderson, “The Murchland Milking Machine”; Jansson, *A Historical Review of the Development of the Milking Machine*, 5; Richard Van Vleck, “Early Cow Milking Machines,” (1998). Online at <http://www.americanartifacts.com/smma/milker/milker.htm> (accessed September 1, 2018).

<sup>34</sup> M'Candlish and Cochrane, “A Comparison of Hand and Machine Milking,” 260; Jansson, *A Historical Review of the Development of the Milking Machine*, 7.

<sup>35</sup> T. Orr, “The Production of Clean Milk,” *Journal of the Royal Agricultural Society* 80 (1919): 31-32; Erf, “Milking Machines.”

motions rather than a straightforward application of forces, was beyond the technical capacities of the time, and unlike the hand of a skilled human milker the mechanical pressure on the teats tended to force some milk back up into the udder.<sup>36</sup> It was not just the anatomical complexity of the human hand that thwarted these machines, nor just the corporeal complexity of cows' teats and udders, but the complexity of their living interaction. In particular these designs overlooked the fact that the teats contract towards the end of milking. Whereas an experienced human milker would adjust their grip intuitively and organically in-relation to the change in feel of the cows' body, in order to ensure "stripping" or milking to completion, even the most precisely calibrated pressure machines tended to lose their effect as the teats contracted, requiring the milking to be finished by hand or time-wasting adjustments to the machine to be made part-way through milking.<sup>37</sup> Together with the complexity of these designs and the multiple mechanical parts, which were awkward to clean as regularly as required, this meant that pressure machines were in the end impractical for commercial use. Whilst they were less damaging to the cow than milk tube devices, they tended to increase rather than reduce the overall human labour involved and were less efficient than the hand-milking they were intended to replace.



**Figure 1** - Promotional pamphlet for an early pressure machine.

Reproduced with permission from the Museum of English Rural Life, National Institute for Research on Dairying Collection, University of Reading.

<sup>36</sup> Jansson, *A Historical Review of the Development of the Milking Machine*, 7.

<sup>37</sup> Ministry of Agriculture, Fisheries and Food, *Machine Milking*, MAFF Bulletin 177 (London, HMSO, 1959); Jansson, *A Historical Review of the Development of the Milking Machine*, 7.

The development of pressure machines coincided with an increasing scientific interest in the anatomy and biology of the udder, which was slowly becoming acknowledged as crucial to understand for the purposes of effective milking machine design. As one dairy technology researcher observed in 1953, reflecting upon the preceding few decades of milking machine designs, “it is obvious that the milking process was not understood and it is not surprising therefore that many of these inventions failed to function properly [...] Through the intervening years [...] any effort to improve operation has concentrated on altering the machine mechanism only rather than considering it in relation to the anatomy and physiology of the cow. Mechanical considerations alone are not enough in determining the overall efficiency of machine milking.”<sup>38</sup> Indeed, where milk tube devices had conceived of the udder as a container to be drained, and pressure devices had tried to approximate the massaging, squeezing and pulling of a human hand, the subsequent type of machine employed a different principle, moving from pressure to suction, with the use of an air pump together with a tube and suction cup to create a localised area of lower pressure, hence to exert a suction force around the teat.<sup>39</sup> This marked a belated recognition that the calf sucking, and not pure mechanics or the human hand, provided the best model of how the udder and teats had evolved to function.

Suction machines used a pump to create a low-pressure zone within the teat cup, which exerted continuous suction upon the teat. It was readily observed that this enabled a cow to be fully milked much more quickly than via hand-milking or even by a calf, and this increase in speed and efficiency was hailed as a great benefit of suction machines.<sup>40</sup> However it was not long before the unintended consequences of mechanical efficiency began to become apparent, with cows that were milked frequently in this way suffering from increasingly severe bloating and bruising of the udder and a subsequent diminution of milk.<sup>41</sup> At first the cause was assumed to be excessive suction, and machines were designed with lower vacuum force applied to the teat, but this only delayed the same outcome. Eventually it was acknowledged that the problem was continuous suction, which unlike the intermittent suction that characterises a suckling calf, caused a pooling of blood and fluids and a build-up of pressure in the lower udder, leading to the bruising and swelling.<sup>42</sup> The intermittent nature of the suction created by a calf had shaped the anatomy of the udder, and was not something that could be set aside or transformed by

<sup>38</sup> Ewart W. Hughes, “The Technique of Assessment of the Performance of a Milking Machine,” (Thesis submitted to the University of Reading for the degree of Master of Science, Museum of English Rural Life, Dairy Collection, 1953), 1.

<sup>39</sup> Erf, “Milking Machines”; Orr, “The Production of Clean Milk.”

<sup>40</sup> Henderson, “The Murchland Milking Machine,” 651; Courtney, “Trials of Milking Machines at York,” 468.

<sup>41</sup> Jansson, *A Historical Review of the Development of the Milking Machine*, 6.

<sup>42</sup> Erf, “Milking Machines,” 63; D. McDonald and C. Lapenta, “Technological Advances in Dairy Farming,” (Bennington County Conservation District, 2008). Online at <http://www.bccdvt.org/benningtonashistory/Lapenta-McDonald/technology.htm> (accessed September 1, 2018).



engineering in the name of greater efficiency. This was addressed by the next class of machines, pulsator machines, the first of which appeared in 1895, and which used a rotary valve to create a continual alternation between vacuum and atmospheric pressure within a rubber-lined teat cup. In the vacuum phase the teat was elongated and distended and the milk was sucked out; when atmospheric pressure was restored, the teat reverted to its normal shape.<sup>43</sup>

The **CLEANEST** and **PUREST MILK** is obtainable only by the  
**"KLIM" MILKING MACHINE.**  
 WORKED BY PEDALLING.  
 (PATENT APPLIED FOR).



A—FEED-TAP	B—GLASS PULSOMETER	C—STOP COCKS	D—LAW
E—SIGHT-GLASS	F—RUBBER HOSE (FEED)	H—HOLDER	K—FEET
M—MOUNT	MC—MAIN CUP	MR—MILK RECEIVER	R—RETAINER
S—OUTLET SPOUT	T—TREADLE	U—FORK	

ALL PARTS ARE STANDARDISED AND CAN BE SUPPLIED AT SHORT NOTICE.

**Price: £15 15 0 delivered Free on Rail, or Free Wharf, London.  
 Packing for Export, 2½% extra.**

**MADE METAL TO METAL; NO LEATHER WASHERS TO GET SLACK OR FOUL!**

Case for 1 machine, approximately, 4 feet 8 inches × 1 foot 10 inches × 2 feet.  
 Approximate weight including case, 1 cwt. 2 qrs. 2 lbs. (77.031 kilos).  
 Case for 2 machines, approximately, 5 feet 3 inches × 2 feet 7 inches × 2 feet.  
 Approximate weight including case 2 cwt. 1 qr. (114.187 kilos).  
 Tin-lining, if required, 6/- extra for 2 machines; 4/- extra for 1 machine.  
 The "KLIM" is delivered, as shown above, with accessories, such as Milk-Pail with Lid,  
 1 spanner, Oil Burette, 6 Brushes, and 8 Spare Rubber Caps for the Teat-Cups.

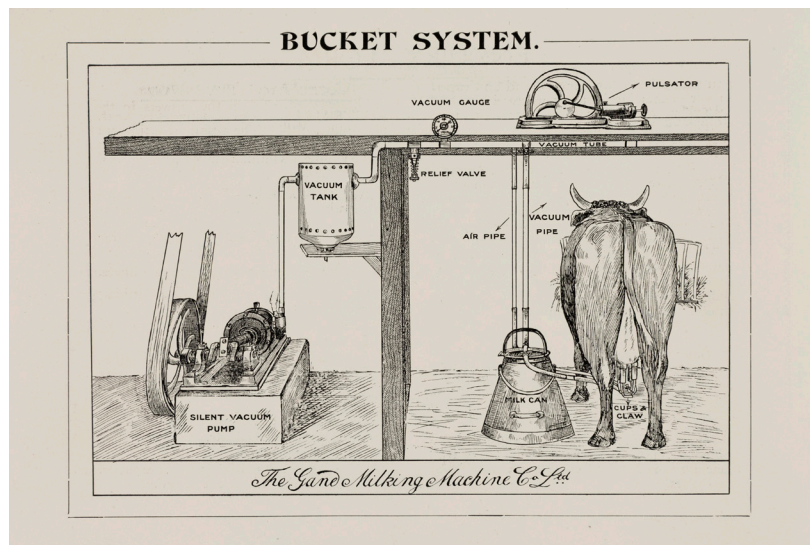
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The "KLIM" is the perfection of MILKING-MACHINES and comprises all that  
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<sup>43</sup> Erf, "Milking Machines," 18, 27; Jansson, *A Historical Review of the Development of the Milking Machine*, 9-10, 12.



**Figures 2 and 3** - Promotional pamphlets for early suction machines. Reproduced with permission from the Museum of English Rural Life, National Institute for Research on Dairying Collection, University of Reading.

Though pulsator machines were a significant innovation, the problem of effective mediation or translation between the complexity of the cow's living body and the inorganic technology was still only half solved. The anatomy of cows is subject to a high degree of natural variation in terms of the sizes and shapes of teats and udders, which created a particular problem for machines that relied upon an air-tight fit in order to create the pressure difference with which to produce a suction effect.<sup>44</sup> It was found that a device which fitted one teat or one cow would not fit another, and even with the application of suction these machines were prone to falling off and onto the floor below, exacerbating the milk hygiene concerns which were a key focus of the dairy sanitary reforms of the time. The designers resorted to providing rubber-lined teat cups of up to nine different sizes, relying upon the milker to determine which was the best-fit for each teat, in what was felt to be an imperfect and haphazard solution.<sup>45</sup> The pivotal breakthrough was the development of double-chamber teat cups, with a flexible rubber inner chamber connected to the milk tube and an outer chamber connected to the vacuum pulsator, in order to create not a vacuum around the teat itself as in the earlier single-chamber designs, but instead a pulsating vacuum in the outer chamber resulting in a massaging action upon the teat by the rubber liner, combining suction with intermittent pressure. These designs also allowed a small quantity of air to enter the inner chamber with each pulsation to assist the flow

<sup>44</sup> M'Candlish and Cochrane, "A Comparison of Hand and Machine Milking," 290.

<sup>45</sup> Orr, "The Production of Clean Milk," 31-32; Erf, "Milking Machines," 16.

from the teat into the milk tube.<sup>46</sup> Though there were many subsequent small but significant refinements to machines which combined pulsating suction with the double-chamber teat-cup, particularly changes which rendered them easier to clean, this class of machines represented the last major innovation in milking machines of the kind that could be used on farms of most sizes. Their core design principles in terms of the animal-machine interface were durable enough to be largely retained even in the large-scale pipeline milk systems which began to replace them from the 1960s.<sup>47</sup>

## Heterogeneous becoming

What inferences then can be drawn from this history of a dairy technology in emergence? The earliest mechanical milking devices reflected and attempted to enact a particular conception of the cow, as a composite object, a collection of functional parts, and a container of a commodified fluid which required extraction. But the failure of the early designs demonstrates that this mechanistic conception encountered significant and ultimately decisive friction in its encounter with the bio-corporeality of the animals. The early “milk tube” designs proceeded from an almost entirely mechanistic and anthropocentric point of view, in which bovine bodies were simply passive obstacles to be overcome and dominated by science, but this led to abject failure; by treating animal bodies as machines amenable to the application of simple engineering principles they were unable to effectively mediate between the inorganic machine and the living body of the cow. The subsequent type of milking machine design marked a partial move away from such anthropo-mechanistic thinking in an attempt to better accommodate to the cow’s specific corporeality; cows were still broadly seen in terms of machines, but this was mitigated by an acknowledgement of their organic complexity and there was a correspondingly more nuanced attempt to translate bovine corporeality into machinic principles. This is nicely illustrated by the vocabulary used in the contemporary descriptions of pressure machines, in which, as the machines become more entrained to the corporeality of the animal, an increasingly organic terminology is used in reference to the various parts of the machines as “bodies” with “lips,” “mouths,” “fingers” and “arms,” in a distinctly hybrid terminology of “leg-engaging arms,” “teat-engaging apparatus,” “udder pressing devices” and “teat-engaging rollers.”<sup>48</sup> At first the cows appear to be conceived of here as appendages of machines, but a more careful reading shows that there is slippage in both directions; the machines are also becoming conceived of as appendages of the cows as their designs become based more closely on the observation of living

<sup>46</sup> Ministry of Agriculture, Fisheries and Food, *Machine Milking*, 24-26; Jansson, *A Historical Review of the Development of the Milking Machine*, 10-11, 13.

<sup>47</sup> Paul Hamby, “History of the Surge Bucket Milker,” (2014). Online at: <http://www.surgemilker.com/history.html> (accessed September 1, 2018).

<sup>48</sup> Erf, “Milking Machines.”



bodies. The final type of milking machine underlines this, with the emergence of devices based firstly on continuous vacuum suction and then pulsating intermittent suction, as well as moving from single chamber through to double-chamber teat cups, as the principles of the machines became increasingly modelled on close observation of the biology and physiology of the udder in relation to the actions of a suckling calf.

This historical case points to the value of reading multispecies biopolitics through an ANT-informed theoretical sensibility, and lends itself to this in several respects. Grasping dairy technologies in terms of the ANT principle of symmetry,<sup>49</sup> which undertakes to account for failed and successful technologies in the same terms, that is to say, agnostically, rather than assuming that success and failure are their own explanations, enables the full messiness and contingency of technological design as socio-material practice to be foregrounded. This in turn helps to avoid any slippage into an overly centred and stable conception of technologies, of the kind that can occur when technologies are grasped in relation to a conception of an overarching biopolitics that is always already present. In an ANT-inflected view, technologies are regarded as themselves heterogeneous assemblages in a state of perpetual emergence or relational becoming, always unfinished, only ever precariously stabilised, and subject to shaping by multiple other forces and actants.<sup>50</sup> This is important in this case, where it is abundantly clear that milking machines emerged through iterative and fragmented processes characterised by multiple failures, false-starts and wrong turns. It would be misleading to explain these teleologically as temporary obstacles on the road to inevitable technological progress, as a reflection of the advance of science conceived as a relentless driving force for technological innovation, or indeed as the determined unfolding of an epochal biopolitical logic. A more agnostic reading of the historical sources rather suggests that the lived dynamics of technological design are better grasped here as contingent socio-material practice beset by problems, frictions and frustrations, the overcoming of which was a matter of effective negotiation and translation between multiple actants and was by no means assured. This underscores the value of attending closely to the socio-material specificities of particular technologies-in-the-making in particular historical moments, avoiding treating these as expressions or reflections of broader socio-historical processes, whether scientific, structural or political, and instead tracing more agnostically how emergent socio-technological assemblages are formed and provisionally stabilised.

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<sup>49</sup> Michel Callon, "Elements of a Sociology of Translation: Domestication of the Scallops and the Fisherman of St Brieuc Bay," in *Power, Action and Belief: A New Sociology of Knowledge*, ed. John Law, 196-233 (London: Routledge, 1984), 196-198.

<sup>50</sup> Michel Callon, "Society in the Making: The Study of Technology as a Tool for Sociological Analysis," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, eds. Wiebe Bijker, Thomas Hughes, and Trevor Pinch, 77-98 (Cambridge Mass: MIT Press, 1987).

The historical case of milking machines also suggests the value of reading biopolitics in terms of processes of heterogeneous assemblage formation in which human and nonhuman actants are entangled in relational co-becomings. This helps to avoid any tendency to drift into a vision of human-animal-technology assemblages wherein the animal becomes tacitly inscribed as a pliable element and the supervening agency lies disproportionately with technologies viewed as apparatuses of disciplinary power. The historical case of milking machines suggests that this would underemphasise not only the material messiness and precariousness of these multi-actant assemblages, but the agency of living animal bodies in mediating and shaping the possibilities of technological design. In the brief discussion of early milking machines that precedes their analysis of contemporary robotic milking technologies, Holloway and Bear claim that “the subjectivity and experience of the cow changed, becoming something different as technologies changed from hand milking to machine milking.”<sup>51</sup> But it would be a mistake to overstate the extent to which the animal was transformed in these assemblages and its subjectivity remoulded by the machine. Rather than a docile body subjected to the disciplinary technology, in these emergent human-animal-technology assemblages the cow was a lively, stubborn and recalcitrant body which the other actors were obliged not merely to discipline but to negotiate with and successfully enroll, if the assemblage was to be stabilised and made durable. In this respect the cow’s role is akin to what actor-network theorists call an “obligatory passage point,”<sup>52</sup> a vital node in the assemblage which all of the other actors must pass through in order to engage with the network. As John Law puts it, “the actor that is able to force others to move along particular channels and to bar access to other possibilities is one that can impose him/herself upon the others.”<sup>53</sup> In this case, the cows imposed themselves on the would-be designers and operators of milking machines, effectively vetoing many designs and reshaping them through an iterative process in which bovine bodies were corporeal agents.

In most ANT accounts, for all their symmetry, the status of obligatory passage point is usually accorded to technoscientific assemblages which encompass nonhumans but are constructed by scientists, engineers, architects, in short human actors with quite a high degree of intentionality. Here however I want to take the symmetry principle further in a posthumanist direction and suggest that the nonhuman animals themselves were an obligatory passage point, acting corporeally to modify the human and technological actants with which they were entangled.<sup>54</sup> This was manifest not only at the organismic level, where bovine bodies proved to be stubbornly assertive elements in the nascent socio-technological assemblage, but also at the behavioural

<sup>51</sup> Holloway and Bear, “Bovine and Human Becomings,” 222.

<sup>52</sup> Callon, “Elements of a Sociology of Translation.”

<sup>53</sup> John Law, “On Power and Its Tactics: A View from the Sociology of Science,” in *Actor-Network Theory Research: Volume I*, ed. Richie Nimmo, 121-150 (London: Sage, 2016), 126. Reproduced with permission from *The Sociological Review* 34, no. 1 (1986): 1-38.

<sup>54</sup> See for example Malcolm Ashmore, “Behaviour Modification of a Catflap: A Contribution to the Sociology of Things,” *Kennis en Methode* 17 (1993): 214-229.

level, where cows had a known tendency to kick away the milking machines, thereby interrupting the milking, spilling the milk, and sometimes even damaging the machine. These actions were widely interpreted as a sign of the animal's discomfort, irritation, annoyance, or of the rebellious temperament of a particular cow (Courtney 1900: 470; Jansson 1973: 6).<sup>55</sup> They often cited in trials and evaluations of particular machines, which were deemed more or less satisfactory according to whether they provoked such reactions more or more less frequently than other designs, in a striking example of animal agency and of the corporeal and material frictions that so pervade and shape the always messy assemblages of humans, animals and technologies.

The case in question also suggests the need for a caveat to be added to any endorsement of ANT-inflected readings of biopolitics however, as it is impossible to properly understand this techno-historical moment, the failure and adaptation of numerous incipient technologies, and the heterogeneous relations involved, without also grasping the role of an economic rationale in these emergent formations and processes. Early milking machine designs were not just projects of socio-material reordering and heterogeneous engineering, but were also driven by a logic of increasing productivity and economic value. This points to the connection between biopolitics and questions of utility, value and surplus extraction, which is more clearly foregrounded in other posthumanist readings of Foucault. In Cary Wolfe's posthumanist rendering of biopolitics for example, there is a clear sense that biopolitics serves processes of economic valorisation by coordinating power relations in order to extract a surplus from living beings.<sup>56</sup> In this framing, regimes of governmentality seek to classify, subdivide, organise and reassemble various matters of life in such a way as to continually increase disciplinary control over processes of life and death, that is to say, over mortal bodies both individually and collectively, as a means to maximise utility or productivity.

It is significant in this respect that Foucault's conception of modern disciplinary power was first articulated through a discussion of the measures developed to control and contain outbreaks of plague, encompassing techniques of separation, individuation, quarantine and the control of movement, which for Foucault are the basis of disciplinary power, or biopower where they operate at the level of populations.<sup>57</sup> Indeed power for Foucault is intrinsically bound up with the imposition of forms of order through the construction of boundaries and borders, the policing of zones of contact, and thus of the mixtures and cross-fertilisations that movement of bodies and materials engenders. What is sometimes missed is that this implies

<sup>55</sup> Courtney, "Trials of Milking Machines at York," 470; Jansson, *A Historical Review of the Development of the Milking Machine*, 6.

<sup>56</sup> Cary Wolfe, *Before the Law: Humans and Other Animals in a Biopolitical Frame* (Chicago: Chicago University Press, 2013).

<sup>57</sup> Foucault, *Discipline and Punish*; Foucault, *The Birth of Biopolitics*; Foucault, "Governmentality."

a lively conception of bodies, not merely as passive objects of power, nor just as productive resources for biopolitics, but as living systems that are not easily malleable and which have their own internal tendencies, modalities and limits. This is what makes bodies productive, and therefore the object of biopower, but in turn it entails the possibility, indeed the necessity, of frictions between complex biological and ecological systems and the biopolitical logics of intensification, continuous production and value extraction, as contrasting forms of order, leading to proliferating unintended consequences as one logic of surplus engenders its opposite.<sup>58</sup> So ANT conceptions of biopolitical collectives as heterogeneous assemblages, whilst foregrounding the mutual irreducibility as well as the relational co-becoming of the multiple actants and entities involved, must also remain attentive to the ways in which biopower operates to increase utility or productivity and extract a surplus from living beings and bodies.

## Conclusion

This article has critically explored Foucauldian approaches to the human-animal-technology nexus so central to modern industrialised agriculture, and in particular those which focus on the becoming of animal subjects and subjectivities in relation to agricultural technologies. Such approaches have been situated in the context of key debates in recent literature addressing animals and biopolitics, and worked through a historical case study of a pivotal moment in the socio-technological history of the dairy industry. It has outlined how Foucault's movement away from the sovereign human subject as the constituent category of social and political analysis makes possible a biopolitical analytic which eschews an apriori human/animal distinction and traces the constitution of those categories and the disciplinary technologies that act upon human and nonhuman bodies; but it has argued that Foucauldian approaches also entail certain tendential risks for the analysis of human-animal-technology assemblages. In particular, a risk of neglecting the irreducibility of animals, animal bodies and subjectivity, in conceptions of co-becoming which inadvertently inscribe the animal as a highly malleable element in the face of the biopolitical socio-technological apparatus; and a parallel risk of treating technologies as if they are pre-constituted objects or systems with supervening agency and power vis-à-vis organic and non-technological actants including nonhuman animals. It was argued that neither is inevitable, and that they can be avoided by bringing Foucauldian approaches into dialogue with currents from actor-network theory. Drawing upon Asdal, Druglito and Hinchliffe,<sup>59</sup> who articulate a reading of biopolitics oriented to tracing the formation of biopolitical collectives as lively heterogeneous assemblages, the article has considered these issues in relation to the development of the first mechanical milking machines for use on dairy farms.

<sup>58</sup> Nicole Shukin, *Animal Capital: Rendering Life in Biopolitical Times* (Minneapolis: University of Minnesota Press, 2009); Nimmo, "Biopolitics of Bees."

<sup>59</sup> Asdal et al., "Introduction: The 'More-Than-Human' Condition."

With reference to documentary archive sources, the article has traced how the emergence of milking machines was a messy and material process full of trials and errors, wrong turns and failures. The three main types of milking machine design developed during the late nineteenth century – milk tubes, pressure machines and suction machines, were each thwarted in different ways by the seemingly insuperable problem of how to mediate between the animal body and the technology in a way that did not damage the organic tissues and lead to infection and a diminution or cessation of milk. A distinct trajectory in the development of these designs was identified, beginning from devices based upon abstract and functional principles with little regard for the cows which were their intended object, through devices which were increasingly grounded in close observation of organic bodies and attempts to mimic their operation; firstly pressure machines attempted to reproduce the hand motions of a skilled human milker, then continuous suction machines and finally intermittent suction machines sought to imitate the mouth of a suckling calf. In this case, it was argued, cows were not docile bodies reshaped as subjects by disciplinary power mediated by changing technologies; rather, they were obligatory passage points in the assemblage, immutable bodies which the other actants were forced to negotiate with and to enroll in order to assemble a durable collective. Those nascent technologies that proved unable to translate the cow's corporeality and subjectivity into their principles of operation, and thus to mediate between living organism and machine, quickly disappeared into the history of failed inventions. Thus, insofar as bovine subjectivity was to some extent moulded by the technology, the reverse was at least equally true, underlining the bodily agency of animals in shaping what and whom can act upon them, in what ways, and by what means. This affirms the value of reading Foucauldian biopolitics through an ANT-inspired sensibility, oriented to empirically tracing the formation and dissolution of heterogeneous assemblages, and emphasising liveliness, intercorporeality and irreducibility in processes of animal-technology co-becoming.

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