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Biggish Data: Friedrich Engels, Material Ecology, and Victorian Data

Ecological complexity invokes correspondingly complex interactions and cross-fertilisations of explanation, communication and rhetoric. The scale of our environmental crisis is signified by 'hyperobjects' – mass species extinction, global pollution, climate change – Timothy Morton's phrase for entities or patterns of relation (material and political) so enormous that, though we feel them, we struggle to perceive, comprehend, or describe them (Morton 2014, p. 489). In attempting to perceive hyperobjects, contemporary society often seeks to represent or visualise them by statistics, tables, graphs, or, where the data is particularly vast, computer-generated graphics that seek, in palatable forms, to display, communicate, and generate knowledge about the unseen workings of hyperobjects. 'Information management [has become] central to millennial citizenship' (Houser, 2014, p. 753).

Yet this isn't entirely new. Morton suggests that the nineteenth century witnessed an increasingly fearful perception of its own hyperobjects – geological time, evolution, the conservation or dissolution of energy (2014, p. 489). That anxiety was sharpened by the very factors – intensive agriculture, mass industry, capital, the expansion of cities, and fossil fuel use – that underlie the current environmental crisis. Moreover, as Victorian culture witnessed the development of macro-level problems of an arguably unprecedented complexity, so too big data and information management procedures were developed and deployed to assimilate such phenomena.

This article draws upon one current theme in environmental humanities – the management of 'big data' – to look at another, ecological materialism. I argue that Friedrich Engels, in *The Condition of the Working Class in England*, shared the central tenets of 'material ecology': 'thing power' (Jane Bennett); the agential 'intra-action' (Karen Barad) of matter and society; and 'trans-corporeality' (Stacy Alaimo). Moreover, in doing so, he effected an alignment between 'vital' ecological and historical materialism. Of equal interest is how he did this. In the main body of the paper, I will suggest that, at this early stage in the development of social science, Engels met the complexity of material ecology with a correspondingly complex mesh of data collection and visualisation, survey research and investigation, literary thick description, and political theory. The paper considers, then, what *The Condition of the Working Class in England* says about managing and communicating social-ecological information today. I will argue, in our own age of big data, for a need for mixed methods, for qualitative alongside quantitative modes of understanding, and for perspectives from the humanities as well as the sciences. While such perspectives translate the insights of data into public knowledge and understanding, such a conjunction of humanities modes with data, in revealing complex patterns, also generates new knowledge about social, material and ecological relations.

Ecological and Historical Materialism

The chief insights of a 'new', 'vibrant', or ecological materialism (Iovino and Oppermann, 2012, pp. 449-50, 462) have been three-fold.

1.   matter is not inert but has agency, an idea captured in various terms, notably Bruno Latour's 'actant' – 'something that acts [not necessarily human] or to which activity is granted by others' (1996, p. 370) – and Jane Bennett's 'thing power'. Bennett describes how waste or debris, conventionally 'stuff to ignore', can be transformed – when, for example, it putrefies or pollutes – into 'stuff that commanded attention in its

own right, as existents in excess of their association with human meanings, habits, or projects' (2010, p. 4).

2. What then transpires is what Karen Barad calls material 'intra-actions'. These are premised on an 'agential realism' – agency resides in every form of matter (including inanimate and waste matter) and not solely in the realm of the human or social. Barad's agential realism binds *all* entities – inanimate things, animals, environments, human bodies (2008, p. 128) – within a material interrelationship while also regarding each and every one as 'social actors' (Latour, 2004, p. 76). Moreover, because matter has social agency there are, additionally, intra-actions of matter and discourse (Barad, 1998, p. 89).

3. Lastly, Barad's preference for *intra* over '*inter*action' grounds the principle that human selves cannot be extricated from the networks of matter in which we're entwined. Matter touches, enters, infects, and reconstitutes us, an insight encapsulated in Stacy Alaimo's concept (2008) of 'transcorporeality'.

What is surprising about recent work in material ecology is that the awareness of the toxic nature of ecosystems shaped by a global economic system has engendered relatively little engagement with its most obvious and prominent precursor, Marxist historical materialism. Indeed it's often been hostile. For instance, delineating 'material ecocriticism', Iovino and Oppermann complain that Marxist materialism limits its explanation of 'historical processes' to 'the dynamics between productive forces and the corresponding social relations (mostly, of class and labor)' (2012, p. 450). Arguing likewise that political theory values materiality, but only in relation to human social structures, Bennett, in a critical passage in *Vibrant Matter*, asks:

> How did Marx's notion of materiality – as economic structures and exchanges that provoke many other events – come to stand for the materialist perspective *per se*? Why is there not a more robust debate between contending philosophies of materiality or between contending accounts of how materiality matters to politics […] Dogged resistance to anthropocentrism is perhaps the main difference between the vital materialism I pursue and […] historical materialism. (2010, p. xvi)

Allowing for 'contending philosophies' Bennett does leave open a potential rapprochement between vital and historical materialism. In fact, in related fields this 'robust debate' has been occurring. It underlies a disagreement between representatives of contemporary ecological Marxism such as John Bellamy Foster and 'posthumanist' writers such as Jason W. Moore. This seems to boil down to whether Marxist theory leads us to understand that nature and society co-evolve dialectically – as entities which, 'outside their interaction', remain essentially separate – or whether society (e.g. Capitalism) emerges from within a 'web of life' that humans, like all other animals, occupy (see Foster and Clark, 2016; Moore, 2017, pp. 286-8). Ecological materialism's critique of Marxism is, then, remiss where it neglects aspects of historical materialism in which the social dynamics of capitalist political economy have not been abstracted from ecological conditions and consequences. That includes further recent work by (for example) James O' Connor, Kate Soper, or Peter Dickens, but also key foundational paradigms, 'social metabolism' and 'metabolic rift' (see Foster and Clark, 2016, p. 4), Marxist theories that Engels helped develop (see Moore, 2017, p. 313).

Related to a decreasing agricultural and increasing industrial and urban population, metabolic rift refers to a carrying away of soil nutrients, most notably in food and fibre production, that strips the land of its 'vitality' and fertility and then 'destroys the health of the urban worker' once these nutrients end up as waste, putrefying and polluting in the way

Bennett describes (see Marx, 1976, p. 637). Accordingly, while Bennett suggests that 'Historical materialism would not focus on matter but on human power-laden socioeconomic structures' (p. 129), it actually does both. Disrupted in the process of metabolic rift is, correspondingly, the 'social metabolism'. By this Marx meant networks of 'interchange between organisms and their environment' (Foster, Clark and York, 2010, p. 160). While this refers to the mutual co-existence and intra-actions of air, land, earth, food, minerals, toxins, animals, humans, and bodies, the metaphor extends, as signalled both by Barad and Marx, to a parallel discursive metabolism of nature, environment, society, politics, economics, culture, and language.

The theory of social metabolism, as developed in the *Condition of the Working Class in England*, offers three insights into what an alignment of vital and historical materialism can offer:

1. material ecology and political economy are connected. Engels suggests that human existence resides in nature; that nature is transformed by human labour; and that where the organisation of labour subverts natural processes social-ecological crisis will ensue. Economic and political ideologies create material entanglements which in turn rebound upon us. Within the remorseless expansion of capital and subsequent state of metabolic rift, he identified 'the division of labour, the application of water and especially steam, and the application of machinery' as 'the three great levers with which manufacture, since the middle of the last century, has been busy putting the world out of joint' (p. 33)[1].

2. these intra-actions rebound disproportionately on the working class or the poor (i.e. the concept of 'environmental injustice'). As Alaimo says – writing about a corresponding example, early twentieth-century American activist writers – a person's class position is evidenced in the differential material impact of political economy on the body; she draws here on Richard Lewontin and Richard Levin's *Biology under the Influence* to suggest that one can speak of 'the pancreas under capitalism' or the 'proletarian lung' (Alaimo, 2008, pp. 27-8).

3. thirdly, because the metabolic metaphor incorporates both the social agency of matter and the material agency of social and political institutions what becomes obvious, as indicated above, is that matter and discourse shape each other (Barad, 2008, pp. 128-9; Iovino and Oppermann, 2012, p. 454). How we describe and make sense of matter, matters.

Ways of narrating information and big data are inevitably required to isolate, crystallise, represent and illuminate complex ecological phenomena. Yet these should include affective, qualitative, human modes that can render data legible and even transformative with regard to public consciousness or action. This, in essence, has been the argument of recent work in environmental humanities which suggests that the complexities, urgency, and human dimensions underlying the 'Anthropocene' – including, perhaps, a need to develop models for a 'new human condition' – call forth 'long-tested humanities practices' (see Adamson, 2016). Such practices encompass analysis, critique, synthesis (Heise, Christensen, and Niemann, 2016, pp. 8-9), but also poetics, storytelling, narrative, visualisation, thick description, etc. Those more imaginative modes, write Iovino and Oppermann, can translate environmental data (e.g. about climate change) 'into narratives and socio-cultural discourses that capture the public attention as well as political and economic agencies more arrestingly

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[1] References with page number only refer to the edition of *The Condition of the Working Class in England* listed in the reference list.

than scientific reports can do' (2017, p. 7). If language produces meaning, and social meaning acts on matter, then modes that transcend the instrumental, and dominant ideology, might generate what Susan Signe Morrison has suggestively called a 'waste aesthetics' in which 'literature enables culture to acknowledge what it has to deny, such as […] bodily, cultural and societal waste' (2013, p. 464).

Iovino and Oppermann also quote Donna Haraway: 'we need stories (and theories) that are just big enough to gather up the complexities and keep the edges open and greedy for surprising new and old connections (2017, p. 7). Engels told one such story, about the materiality of early industrial capitalism as it was experienced, and often tragically embodied, by the early nineteenth-century English working class. Yet he shaped that story through methods (quantitative and qualitative) drawn from social science, literature, and embryonic Marxist political theory. As such, he offers a precedent for an ambitious, multidisciplinary environmental humanities which can unravel ecological complexity by 'mediating between stories and statistics, local experiences and global scenarios, images with instant impact and ideas about long-term transformation' (Heise, Christensen, and Niemann, 2016, p. 7). After briefly introducing the book, I will describe and assess that model in four sections: looking, first, at Engels' deployment of (relatively) big data; and then at how this was supplemented by three further modes – qualitative survey research; thick (near literary) description; and political theory.

The Condition of the Working Class in England

In recent years, numerous articles in social science, humanities, and the arts have assessed how big data has been 'unsettling the intellectual foundations of the social scientific and humanistic disciplines' while simultaneously creating opportunities in the cultural and political sphere (see Wagner-Pacifici, Mohr, and Breiger, 2015, p. 1). This has encompassed recent work – for example by Heather Houser – which seeks to identify how big data might align with the humanities in supporting environmentalist objectives. Key aspects (drawn principally from Houser (2014, pp. 742-3)) include:

- the use of visualisation or narrative: on the one hand, to translate and communicate vast and complex information to a broader audience; on the other, to transform or animate data. Such modes facilitate quantitative data becoming interpretive, generative, and affectively charged, or 'capable', in Johanna Drucker's words, 'of producing new knowledge through […] aesthetic provocation' (cited Bailey and Pregill, 2014, p. 191);
- developing representational strategies that 'hold diverse forms of data in tension';
- deploying qualitative modes to provide information about 'material conditions behind the data' and the value of 'depict[ing] the singular and the specific as an antidote to the aggregate';
- balancing raw data with prior theorising or modelling;
- the ethics and politics of who gathers information and who becomes the object of it.
- historical perspectives on how 'mapping data to visual representations has been used for centuries to reveal patterns, to communicate complex ideas, and to tell stories' in order to generate new knowledge (see Bailey and Pregill, 2014, p. 2; Friendly, 2008, pp. 48-9).

Engels was highly attuned to the condition of urban landscapes, factories and houses as a result of his upbringing in Barmen-Elberfeld (now Wuppertal). Documented in articles he wrote for the *Telegraph für Deutschland*, Barmen was 'red-roofed stone houses rising

spaciously between gardens and green bleacheries, woods and meadows' (cited Barer, 2000, pp. 483-4); Elberfeld, conversely, was 'a dreary industrial slum': 'smoky' chimneys; a river purple from the 'Turkey red' used in local dye-works; low working rooms in which 'people breathe in more coal fumes and dust than oxygen' (see Clark and Foster, 2006, p. 377). In 1842 he was sent to Manchester to work in his father's cotton-spinning business where he stayed until 1844. On returning to Barmen Engels wrote *The Condition of the Working Class in England* between September 1844 and March 1845.

After a brief description of an earlier, relatively idyllic rural society, its main body offers an account of the factories, houses and environment of Manchester, before a final chapter indicts the attitudes of the 'bourgeoisie' to the working class. In the process Engels confronts a succession of Victorian hyperobjects – the roots of Anthropogenic change in the exploitation of fossil fuels; a new Capitalist political economy founded upon agriculture, industry, and the cities; and chronic environmental injustice – in a discussion vitalised by materialist ecology. Engels' information came from an array of sources: data from the new statistical societies or government sources; independent social investigation; newspaper and magazine journalism, and pamphleteers; social, economic, and political theory; and occasionally literature and cultural criticism (e.g. Thomas Hood and Thomas Carlyle). Yet he also collected his material empirically, from 'personal observation and personal intercourse' (p. 12), seeing factories, travelling the North-West of England, walking Manchester's streets 'at all hours', and visiting households with his Irish working-class partner, Mary Burns.

Biggish Data

Our own preoccupation with big data has a parallel in the rise of statistics and statistical activity in the early nineteenth century. Large scale data became available at this time due to rapidly increasing census activities undertaken by government agencies (Lazarsfeld, 1977, p. 214). This was motivated by an emergent liberal-state's need for social, economic and commercial information in a rapidly industrialising society (see Goldman, 1991, p. 415; Schweber, 2006, pp. 3, 6). Government information departments and statistical societies were established in Britain as elsewhere, including the General Register Office (GRO) in 1837 and, throughout the 1830s and 40s, numerous regional statistical societies such as the Statistical Society of London and the Manchester Statistical Society (Goldman, 1991, p. 419). Correspondingly, writes Michael Friendly, 1800-1850 'witnessed [an] explosive growth in statistical graphics and thematic mapping' in which 'all of the modern forms of data display were invented' (2008, p. 25). He notes, however, as does Harro Maas, a preference amongst British researchers for tables over graphs (Friendly, 2008, p. 28; Maas, 2013, p. 507).

Engels both knew and drew upon these sources and methods of visualisation. *The Condition of the Working Class in England* is packed full of information and evidence gathered from reports of the statistical societies, in government reports, enquiries or commissions, or by doctors, gynaecologists, or factory inspectors. The material ranges across children's employment, conditions in factories and housing, or the state of the urban environment. He shared in early nineteenth-century data practices, collecting information and presenting it in (albeit) rudimentary tables, maps and diagrams. These would illustrate, for example, how a 'customary construction of working-men's quarters in Manchester' could harbour disease by allowing matter – filth, offal and standing water – to accumulate and by preventing air from escaping.
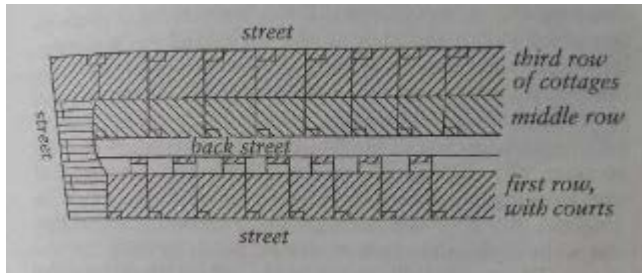
Engels' use and visualisation of data was designed to generate knowledge about the prevailing social ecology. Friendly and Libby Schweber have both described a gradual development, in the early decades of the nineteenth century, from pure statistics to comparative, moral, or 'vital statistics'. Designed to itemise, illustrate, and predict life expectancy, birth, and death rates vital statistics evolved as a way of informing public health policy. A key graphical innovation was the development of 'life tables' which demonstrated the probability of a person in a given place or of a given age dying before their next birthday. In her study of the history of statistics in Britain and France, Schweber highlights that the GRO's creation of life tables facilitated national government policy by fixing a cut off point for intervention where rates exceeded 23/1000 (2006, pp. 109-10). Life tables gave glaring visual evidence of how deeply unequal patterns of risk were determined by geography and social class. In an example presented by Engels, we see that, per 10,000 of the population, a staggering 5,000 or so children died under the age of 5 in factory towns as compared to 'only' about 3,000 in 'agricultural' districts.

	Under 5 years	5–19	20–39	40–59	60–69	70–79	80–89	90–99	100+
In Ruthlandshire, a healthy agricultural district	2,865	891	1,275	1,299	1,189	1,428	938	111	3
Essex, marshy agricultural district	3,159	1,110	1,526	1,413	963	1,019	630	177	3
Town of Carlisle, 1779–87, before introduction of mills	4,408	911	1,006	1,201	940	826	533	153	22
Town of Carlisle, after the introduction of mills	4,738	930	1,261	1,134	677	727	452	80	1
Preston, factory town	4,947	1,136	1,379	1,114	553	532	298	38	3
Leeds, factory town	5,286	927	1,228	1,198	593	512	225	29	2

Such innovations in data visualization arose from a practical 'need or desire to see phenomena and relationships in new or different ways' (Friendly, 2008, p. 49). Consequently, they could 'provoke […] epistemological and methodological shifts' (and thereafter social intervention) in much the way contemporary commentators have attributed to 'radically data-driven 'big data' studies' (Bruns, Burgess and Highfield, 2014, p. 114). Nevertheless, *au fait* with emerging practices of gathering and visualising statistical data, Engels appears to have concluded that effectively detailing and representing the human dimension to the 'condition of the working class' would require more qualitative means too.

Survey Work

Assessing contemporary implications for the social sciences and humanities, Pacifici-Wagner, Mohr and Breiger argue that a comprehensive understanding of 'social life' means measuring data against people's lived experiences, or what they call a 'phenomenology of the social' (see 2015, pp. 2-3, 9). Correspondingly, Bode and Arthur argue, regarding digital humanities, that while the strength of data-rich analysis lies in seeing culture from a 'distance', in observing 'patterns and conjunctions that could not otherwise be perceived', there ought to be an integration, nonetheless, with empirical observation on the ground. This can be achieved, they continue, via ''analogue' means (such as interviews, archival research, or textual analysis), or [by] moving iteratively between these two levels of analysis' (2014, p. 5).

Eileen Yeo locates the nineteenth-century origins of social science in perceptions of social crisis that 'dictated urgent new priorities and discredited older modes of analysis and action' (1996, p. ix). Specifically, she suggests, the period between 1832 and 1850 constituted 'an age of enthusiasm for the statistical idea and for investigations into the condition of the working class' (p. 58). Statistics, graphs, charts, and tables evolved as methods for gathering and examining large scale social data and for isolating patterns, impacts, and causes (Stigler, 1986, p. 166). That this alone wasn't enough to address critical social questions is indicated by Yeo's identification (likewise foregrounded by Schweber and Maas) of two competing traditions of early social science, statistics and survey research. Schweber defines survey research as 'various forms of qualitative exploration' such as in-depth case studies (see 2006, pp. 3, 227). For Yeo, it also encompassed, for a time, investigative work often (initially) carried out by journalists (1996, p. 83) such as Engels. Her example is Henry Mayhew's *London Labour and the London Poor*, published in 1851 though commissioned in 1849 as a series of articles for the *Morning Chronicle*. Survey work offered a distinctly different methodology from statistical research in two significant ways.

'Statistics' originally referred to data of service to the state (Yeo, 1996, p. 27). The top-down utilisation of statistics to support new forms of policy and state intervention in the early-mid nineteenth-century was premised on 'a science of social aggregates'. Replacing 'classical political economy with its focus on the choices of rational individuals in the market', aggregation – 'masses of data drawn from studying society as a whole' – came to be seen as the best means by which social laws could be traced, predictions made, and recommendations offered (Goldman, 1991, p. 424; Poovey 1995). While facilitating often necessary state intervention, nineteenth-century social researchers recognised that addressing social crises would, nevertheless, require an understanding of lived experience acquired by qualitative means. Maas notes that more politically motivated investigators such as John Stuart Mill preferred 'the hard-won results of door-to-door questionnaires' to an examination of government statistics which 'had nothing to add to their principles' (2013, p. 507). Likewise, Stephen M. Stigler cites both Auguste Comte and Mill castigating an application of positivist approaches in social science for lacking the human or moral dimensions to social life (1986, pp. 194-5). Engels shared this view. For he, in fact, despaired of an inability to communicate the true quality of this reality, regarding his account as 'far from black enough to convey a true impression of the filth, ruin, and uninhabitableness, the defiance of all considerations of cleanliness, ventilation, and health which characterize the construction of this single district' of Manchester (p. 65).

Qualitative survey research was often preferred, secondly, because it was seen to better, and more authentically, represent the working class. A significant aspect of Yeo's narrative is that a progressively more scientific, professionalised, and data-driven statistical research allowed the State to commandeer social investigation. Consequently, her account of

The Contest for Social Science in the nineteenth century shares Alaimo's more recent contention that the social investigation of transcorporeality raises questions about 'who is socially positioned to articulate those revelations given most accounts depend on expertise and legitimacy' (2008, pp. 27-8). For Yeo, Mayhew's near ethnographic practice circumvented such difficulties in his 'willingness to make room for the voices of working people in his investigative practice' (1996, p. 85). He did so by various means: he developed methods of sampling a representative cross-section of the population; he interviewed people one-to-one (even providing dinner!); he integrated his respondents' opinions into his arguments; and literally quoted them in his articles (Yeo, 1996, pp. 85-6). Both these things – the tempering of big data with empirical, qualitative modes and the aspiration to give the working class a voice – characterised Engels' practice too.

Engels gathered most of his material from the ground, both his own sources and others'. Seeking to counter works of capitalist apology such as Andrew Ure's *Philosophy of Manufactures*, he deployed, for example, *Stubborn Facts from the Factories*, compiled by the Chartist James Leach, as an authentic source of 'inconvenient truths'. Nevertheless, 'personal observation and personal intercourse' took primacy. Engels used statistical data 'to supplement my observations by recourse to the requisite authentic sources' (p. 12) not the other way around. Believing that 'we German theoreticians still knew much too little of the real world to be driven directly by the real relations to reforms of this 'bad reality'' (p. 13) the evidence he collected by walking the streets, seeing factories, and visiting houses shaped his analysis, understanding, and arguments:

> I wanted more than a mere *abstract* knowledge of my subject, I wanted to see you in your own homes, to observe you in your everyday life, to chat with you on your condition and grievances, to witness your struggles […] (p. 9)

Engels' account lacked the first-hand character of Mayhew's yet he nevertheless conveyed the human dimension through a 'vivid attention to detail' (McLellan, 1977, p. 40). Using graphic examples drawn from his own observations, and some personal accounts and stories, Engels utilised a method similar to what is now called thick description. A qualitative method developed by Clifford Geertz in which rich, detailed descriptions of social and cultural life are mapped against their historical or social context, thick description has been seen as particularly adept at knotting together, and making sense of, interconnected contexts or concepts (Geertz, 1973, p. 10) such as, some might say, complex material ecologies.

Thick Description and Literary Affect

Writing from environmental humanities, Rob Nixon has asked a salient question – 'how', in a sea of data, 'can we imaginatively and strategically render visible vast force fields of interconnectedness?' (cited Houser, 2014, p. 753). Taking the challenge up Houser argues that narrative and data need not be antagonists. She suggests that affective modes such as narrative and visualisation can (to quote Cynthia Wall) make '"the invisible present, bring the unthought of into awareness, gather circumstances into meanings" in an effort to arrange perception of matter and behavior' (2014, p. 754). Such is demonstrated by Engels who visualised one Victorian hyperobject, metabolic rift, via thick and affective descriptions of the ground level, working-class experience of it.

Engels believed not only in nonhuman agency but in the superiority of a nature which, wherever we change it, acts back upon us. This is underlined in his later, unfinished *Dialectics of Nature*:

Let us not […] flatter ourselves overmuch on account of our human victories over nature. For each such victory nature takes its revenge on us […] The people who […] destroyed the forests to obtain cultivable land, never dreamed that by removing along with the forests the collecting centres and reservoirs of moisture they were laying the basis for the present forlorn state of those countries […] at every step we are reminded that we by no means rule over nature […] like someone standing outside nature—but that we, with flesh, blood and brain, belong to nature, and exist in its midst. (Engels, 2007, pp. 182-3).

Evidencing an all too visceral material ecology, *The Condition of the Working Class in England* transitions through the three dimensions of thing power, intra-action, and transcorporeality.

Thing power is evident throughout the book. In the context of what Engel describes as the 'Victory of Machine-Work over Hand-Work', the straps and wheels of machines 'seize' the limbs of inattentive workers (173-4). Likewise, the air is filled with matter: fibrous dust in cotton- and flax-spinning mills (p. 172); the similarly 'dust-filled atmosphere' of mines 'mixed with carbonic acid and hydrocarbon gas' (p. 253); and metal grinding workshops where 'sharp-edged metal dust particles' fill the air and are inhaled (p. 211). Matter acts; agential verbs fill the book: the air in courts is '*corrupted by* putrefying animal and vegetable substances' (p. 64); wind '*drives*' the smoke of the factories towards where working people live (p. 72; all my italics).

In these descriptions, there is no escaping the condition of the working class as a social ecology formed out of a dangerously vibrant materialism. Thing power operates, in Barad's sense, along paths of intra-action.

machine oil […] almost everywhere smears the floor, sinks into it […] (p. 165)

Especially unwholesome is the wet-spinning of linen-yarn which is carried on by young girls and boys. The water spirts over them from the spindle so that the front of their clothing is constantly wet through to the skin; and there is always water standing on the floor […] (p. 172).

The environment, likewise, is pervasively toxic. Assorted refuse from the tanneries, bonemills and gasworks '*find their way* into' the River Irk which is itself agential – it '*deposits*' that 'residue', and the residue from privies and sewers, onto its banks acting in tandem with the surrounding industry and housing (p. 62; my italics). In this picture metabolic rift (historical materialism) intra-acts with putrefying waste (vital materialism).

So, thirdly, as Latour describes, inanimate things, hazardous matter, and putrefying waste, 'with uncertain boundaries' do indeed 'enter the collective', 'quake, and induce perplexity', and function as 'social actors' (2004, p. 76). 'Carbonic acid gas, engendered by respiration and fire' lingers in the streets and 'the lungs of the inhabitants fail to receive the due supply of oxygen' (p. 107). There are more examples in the factories. For instance, the water spurting from the spindle predictably results in 'a constant succession of colds and affections to the chest'. Gradually Engels builds a thick description of health hazards, spanning from surface afflictions to chronic threats to life: external bodies are reconstituted – diminished eyesight; deformities of knees, ankles, legs and shoulders, curvature of the spine; internally, bodies are attacked by illness, infection and fever – scarlet fever, chest infections, asthma, anaemia, intestinal disorders, consumption, or typhus. The material consequences of industrial labour permeate bodies, undermining their capacity for labour, their human being. In the mines, smoke, dust, and lack of oxygen 'seriously *affects* the lungs, *disturbs* the action

of the heart, and *diminishes the activity of the digestive organs*' (p. 249; my italics); the skin of children working in the stoneware industry around Stoke-on-Trent, dipping products in fluid containing lead and (often) arsenic, falls off. In 'the absorption of this dangerous substance' they can suffer constipation, intestinal damage, consumption, even epilepsy (p. 214). Ultimately, Engels describes these intimate transcorporeal intra-actions as effecting long term changes on the body, reshaping and distorting human life: in retarded puberty; irregular, delayed, or premature menstruation; increased incidence of miscarriage or women unable to give birth; decrepitude; or premature death.

Bennett cites Deleuze and Guattari's conception of life as a generalised, circulating 'force-presence' – a 'matter-movement' or 'matter-energy' – which 'does not coincide fully with any specific body'. Shaped by the conditions of the material world, life enters bodies and leaves them (Bennett, 2010, p. 54). In *The Condition of the Working Class in England* Engels had already modelled the agency of an economic system, characterised by metabolic rift, draining life. It was a condition, he wrote, that 'undermines the vital force of these workers gradually, little by little, and so hurries them to the grave before their time' (p. 107). Having fittingly deployed 'vivid' (vibrant) language to describe a vital, material ecology, he ultimately attached his rich descriptions, and data, to Marxist political theory.

Political Economy

The method by which Engels sought to make sense of the Victorian social ecology was, of course, the application of theory – his own burgeoning Marxist paradigm. Engels' experience of Manchester had, at this time, also underpinned his 1844 article 'Outlines of a Critique of Political Economy' often attributed as the first statement of the Marxist critique of Capitalist political economics (Clark and Foster, 2006, p. 375). In this Engels was following a classic methodological trajectory – marrying empirical observation with theory. Theory necessarily guides research; we cannot simply note down every pattern or relationship in a dataset without trying to make sense of it. But theory also remains answerable to observation and data. Consequently, inventive ways of organizing knowledge – in which theory and data (big or otherwise) adapt and co-evolve – can kindle new, potentially transformative ways of thinking (Bode and Arthur, 2014, p. 7). This, though, was already recognised in the early nineteenth-century as policy-makers, social investigators, and writers grappled with how to engender transformative knowledge from data. Schweber emphasises as much, detecting a link between politics and 'styles of reasoning' in which 'New modes of political action were intimately linked to new ways of knowing and new types of object' (2006, p. 31).

A convergence of data and theory in Engels' work is perhaps unsurprising given the context and traditions in which he worked, ones that pre-existed a later cementing of structural boundaries between qualitative and quantitative disciplines or methods. Engels' approach to gathering and engendering knowledge may well have been influenced by a Prussian tradition of social science that explicitly rejected the primacy of statistics in establishing social laws and/or by British social science which, until the late 1870s, 'spent little time reflecting on the hierarchy of knowledge, the boundaries between disciplines, and the status of vital statistics as a science' (Schweber, 2006, pp. 23, 94). It was certainly shaped by the influence of Hegel – Engels having come into contact with the Young Hegelian Movement in Berlin in 1841. This led him towards a dialectical ontology of history as a process of change and evolution which gained a political dimension through his friendship and working relationship with Marx. Beginning when they met at the offices of the *Rheinische Zeitung* newspaper in November 1842, Engels subsequently translated Hegelian idealism into Marxist historical materialism through an understanding of historical change as driven by economic, class, and ideological struggles in how material human needs are met.

Consequently, his early analysis of the evolution of industrial capitalism gave to *The Condition of the Working Class in England* an historical and conceptual framework (McLellan, 1977, p. 43) that positioned the social-ecological condition of the working class as arising from the motivations and purposeful actions of the bourgeoisie.

Engels' attribution of blame culminates in the closing chapter – 'The Attitude of the Bourgeoisie Towards the Proletariat' – but runs through the book, emerging from his data: in the lace industry, damage to the eyes (from cataracts through to blindness) and to the spine, digestion and 'functions of the uterus' (all caused by posture) are 'the price at which society purchases for the fine ladies of the bourgeoisie the pleasure of wearing lace' (200-202); the wind that drives the factory smoke to where working people live does so because their houses, not those of the middle classes, are built downwind (71-2). The clearest example, however, of toxic intra-action as a result of capitalism occurs with a recurring theme, ventilation. Factory air is 'impure, heavy, deficient in oxygen, filled with dust' principally 'when the ventilation is not *very* good' (p. 165); in coal-mines, 'black spittle, arising from the saturation of the whole lung with coal particles' only doesn't occur when the mines are 'properly ventilated' (p. 254); likewise, Engels' account of 'customary' housing construction in Manchester (reproduced in figure 1) focuses on how especially bad ventilation in the middle row leaves inhabitants prey to polluted air and disease-laden putrefaction (p. 108). All this is motivated by profit: to save space, and build more houses, housing was 'laid out without the slightest reference to ventilation, with reference solely to the profit secured by the contractor' (p. 75; and see pp. 68-9); factory conditions were 'engendered purely by the hateful money-greed of the manufacturers' (p. 175); while in the mines, Engels places 'responsibility' for disease squarely on the 'profit-greed of mine owners which prevents the use of ventilators' (p. 254). In attributing blame Engels directed the narrative from one in which risk could, to some extent, have been seen as a lottery to one in which conditions of material and social ecology were systemically circumscribed: 'Some constitutions can bear it, some cannot; but the operative has no choice'. Why? Because of 'the small consideration shown by most of the manufacturers for the health of the girls who do [the work]' (p. 172). As thick description fed political analysis, material and social ecology, vital and historical materialism, thing power and social power became one and the same thing. This is evident when Engels uses the same agential word to describe machine accidents which 'seize' the limbs of inattentive workers with the 'children […] *seized* naked in bed by [factory] overlookers' forcing them back to work (p. 175; *my italics*).

The Condition of the Working Class in England is frequently commended as (in the broadest sense) what a 1955 International Sociological Association bibliography called 'a masterpiece of ecological analysis' (cited Henderson and Chaloner, 1971, p. xviii). For Steven Marcus, while 'The city is experienced as estrangement because it is not perceived as a coherent system of signs […] communicating to us in a language we know' (2015, p. 73), Engels demonstrated that 'this apparently conglomerate chaos is also something that in fact approximates to a coherent whole' (Marcus, 2015, pp. xviii; see also Clark and Foster, 2006, p. 380). He achieved that via an imaginative deployment of mixed modes of analysis and by unifying, through Marxist theory, 'patterns and conjunctions that could not otherwise be perceived'. Though Engels' analysis is perhaps coloured by distinct political objectives (see Henderson and Chaloner, 1971), that it was nevertheless transformative can be seen in that his identification of culpability for a parlous material ecology, remains central to environmental Marxism, sociology, and humanities today. Whether capitalists *per se*, a global economic system which has arisen from the origins Engels described, or the individualised culpability of consumers, much the same analytical framework can be traced across recent books such as Alaimo's *Bodily Natures*, Rob Nixon's *Slow Violence*, Andreas Malm's *Fossil Capital*, or, Richard Maxwell and Toby Miller's *Greening the Media*. The

latter in much the same way as Engels describes the West's culpability in purchasing, discarding, and offshoring unsustainable hardware, the materials of which pollute, harm, even kill workers in distant, now seemingly far removed, countries.

Conclusion

It is relatively straightforward to propose *The Condition of the Working Class in England* as a work of social ecology. In 'pursuing' Bennett's alignment of vital and historical materialism, Engels challenged, suggests Jason W. Moore, approaches to social science which assume that 'human activity is, for practical analytical purposes, "exempt" from the dynamics of the web of life' while also exemplifying Moore's further argument that if we regard 'not just humans, but human organizations' as 'products and producers of extra-human nature, a fundamental rethinking of storytelling, concept formation, and methodological orientation follows' (2017, pp. 289, 313).

Alaimo encapsulates the complexity of ecological materialism in Latour's definition, in *We have never been modern*, of a 'nature-culture' that is 'simultaneously real, like nature, narrated, like discourse, and collective, like society'. While to encompass reality, narrativity, and collectivity in a single study appears, for Latour, 'grotesquely' inconceivable and, to Alaimo, 'no small feat' given that scholars are usually 'trained […] in only one of these three modes of investigation' (Latour, 1993, p. 6, Alaimo, 2010, pp. 9, 28) it is possible. For Karen Barad, developing social and collective knowledge out of the intra-action of matter and discourse means interrogating the boundaries that separate the different know-how and methodologies of disciplines. Matter, nature, and humans are discrete entities but they are also always in a state of becoming (not 'being') which emerges not from our individual selves but from our intra-action with other 'things' (see 2008, p. 135). Correspondingly, while disciplines have constructed but necessary traditions, boundaries and identities, we can only continue to understand an ever-shifting, vital, ecological materialism by allowing those disciplines to respond, adapt, and evolve in dialogue. 'If we follow disciplinary habits of tracing disciplinary-defined causes through to the corresponding disciplinary defined effects, we will miss all the crucial intra-actions among these forces' (Barad, 2008, p. 128).

Barad's formulation indicates how closely related the two themes of this article – big data and ecological materialism – are; likewise, the two historical periods under discussion. A central reason why the 'new' ecological materialists and Engels think alike, notwithstanding the former's misgivings about Marxist historical materialism, is that, in the 1840s, the boundaries between disciplines, methods, and ways of seeing and knowing were yet to be institutionalised. Engels shares a perspective with the new ecological materialism precisely because his pre-disciplinary ways of working shared traits and boundary-crossing impulses with current, post-disciplinary ecological work. Each has developed modes of enquiry perceived to be better adapted at deciphering ecological complexity.

Engels' use of statistics indicates that he was enmeshed in a Victorian explosion in data parallel to our own. Yet he barely gets mentioned in histories of Victorian statistics or data visualisation. In a fleeting exception, Helga Nowotny does mention Engels and points out that his work bridged a gap between two very 'different discourse culture[s]' – abstract political economy (a deductive method) and statistics (an inductive method) – which between them provided the foundation, eventually, for an 'institutionalization of the social sciences' (37-8). Preceding the separation of discourses, *The Condition of the Working Class in England* in fact exemplifies a far wider set of discursive alignments which, in Engels' thick description of material ecology, glides across and rearranges boundaries precisely as Barad suggests. Pure quantitative data co-exists with vital and moral statistics. Vital statistics co-

exists with qualitative approaches – survey work, journalism, reportage – and with vivid, near literary description. The book is shaped and maintained as a 'coherent whole' by the Marxist critique of political economy. As Tristram Hunt puts it, Engels made

> a series of intellectual and ideological advances instrumental to the development of Marxism. Lancashire delivered to Engels the essential data to flesh out his pre-existing philosophy. If Berlin had been a city of the mind […] then Manchester was about matter. (2009, p. 80).

The Condition of the Working Class in England demonstrates that to twine together the microscopic complexities of vital matter and the macroscopic complexities of hyperobjects necessitates correspondingly complex and agile methods of data collection, visualisation, and representation. By marrying his big(gish) data with an affective rendering of phenomenological and qualitative sociology, and modes from the humanities, Engels offers a template rich with implication and possibilities for how to manage, communicate, and, most importantly of all, produce new knowledge out of the complexities of environmental and social-ecological information.

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Figure Captions

Figure 1: Engels' illustration of a construction of working-class housing in Manchester, 1840s (p. 69)

Figure 2:   Life table of mortality rates, reproduced by Engels (p. 119).