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Museums and the Implicit Anthropocene: Witnessing in the Science Museum's Energy Hall[1]

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As institutions of cultural memory, museums represent memories (the historical perspectives they exhibit), orchestrate collective memories (through the curation, organisation and narration of what they exhibit), and generate memories (provoking acts of memory in those who visit them). To generalise, given the shift in exhibition methodologies across the global museum sector towards the immersive, the inter-active, the affective, and the spectacular (see, for example, Landsberg, 2004), it is arguably the case that museums are not just spaces of (institutional and visitor) memory work but also witnessing, albeit vicarious, given the design of exhibitions to generate public knowledge experientially as well as cognitively. As contributions to this collection demonstrate, the inculcation of a sense of witnessing enables the apprehension of environmental catastrophes that, outside the walls of the museum, are often beyond the realms of visitors' perceptibility – either because of the temporal or spatial scale of such events or their geographical distance (see, for example, Nixon, 2011). As this essay will argue, witnessing in the museum can also generate counter-narratives and counter-memories, making explicit that which is implicit or subsumed by exhibition narratives. This essay mobilises the concept of witnessing to elicit what is hidden in plain sight in the London Science Museum's Energy Hall and its display of late-eighteenth- and early-nineteenth-

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century coal-powered steam engines, principally the inventions of James Watt, and their contributions to the Industrial Revolution and fossil-fuelled energy regimes that, through greenhouse gas emissions, have changed the climate.[2]

The Science Museum's Energy Hall is more implicit than explicit about what might be called the "implicated objects" it displays. I take the term "implicated objects" from Dutch designer and artist Felix Mollinga, and his project of identifying, replicating and redesigning ornamental artefacts commissioned by European and particularly Dutch colonial traders in their transactions with Asia. These objects, the originals of which were sometimes recovered from shipwrecks, are "implicated" because they reflect colonial visions and the socio-economic exploitation of Asia.[3] Mollinga's design concept is informed by Michael Rothberg's well-known formulation of the "implicated subject," who "inhabit[s], inherit[s], or benefit[s] from regimes of domination but do[es] not originate or control such regimes. An implicated subject is neither a victim nor a perpetrator, but rather a participant in histories and social formations that generate the positions of victim and perpetrator, […] and help[s] propagate the legacies of historical violence that prop up the structures of inequality that mar the present" (2019, 1). Just as Mollinga's ornaments are modelled on objects implicated in

[2] This is not to say that the museum does not engage with climate change in other ways. For example, the museum's website "Object and Stories" features a number of articles on climate science and environmental histories that relate to the collections of the Science Museum group: https://www.sciencemuseum.org.uk/objects-and-stories/our-environment. Moreover, in 2022 the Shell-sponsored exhibition "Our Future Planet" explored global greenhouse gas reduction. Perhaps the most explicit exhibition to date was the "Atmosphere" gallery, which closed in 2022: https://www.sciencemuseum.org.uk/see-and-do/atmosphere

[3] https://felixmollinga.com/implicated-objects/

colonial processes, the Science Museum's steam engines and their inventor are implicated in energy regimes and their ecological repercussions, but, as we shall see, so too is the institution for the way it frames this exhibition and situates the visitor as beneficiary of a fossil-fuelled modernity. This implicatedness is particularly conspicuous in an era when museums have generally become more self-reflexive in reckoning with the socio-environmental effects and legacies of their historical complicity with colonialism and extractive capitalism (Harrison and Sterling, 2023, pp. 94, 96-98).

Mollinga's appropriation of implicatedness to describe objects rather than subjects and his possible conflation of subject and object raise an interesting question about who or what can be a witness to historical processes, and, in the case of this enquiry, who or what has the agency to witness climate change. In mobilising the concept of climate witnessing, this essay asks to what extent witnessing is the preserve of humans or whether nonhuman witnessing is possible. If the latter is possible, what kinds of histories and historical actors emerge from such witnessing? In answer to these questions, this essay explores how the exhibition of the objects of the Energy Hall might be analysed in relation to conceptualisations of climate witnessing that accord varying degrees of agency to the nonhuman, assessing to what extent such concepts can make implicit histories explicit. By way of representative examples of theoretical concepts, the essay pits Susan Schuppli's "material witnessing" (2020) against the new materialism of Fiona Cameron's (2024) museology and Serpil Opperman's (2019) related notion of "storied matter" (p. 111). In doing so, this essay places climate witnessing in the wider context of the Anthropocene, our mooted new geological epoch defined by the unequalled and irreversible impact made by the human species on the Earth's systems. As an expression of the Anthropocene, climate change can be placed in an unfolding history of interrelated human impacts and socio-environmental catastrophes that predate the Industrial

Revolution and augment its effects. It is the framed, implicit presence of the Anthropocene in the Science Museum's Energy Hall that this essay elicits through the theorisation of not so much climate witnessing as Anthropocene witnessing.

This essay's staging of Anthropocene witnessing in the Science Museum, of making the implicit explicit, is inspired by Astrid Erll's (2022) recent conceptualisation of "implicit memory", which deserves unpacking here. Erll (2022) conceptualises "implicit memory" as a passive *and* generative form of remembrance. Passivity here describes the reception of an unintentionally, non-consciously unremembered past, the material evidence for which is (apparently) invisible. The usefulness of the concept for the present argument is that although implicit memory shares some ground with repression and forgetting, it suggests a departure from the presumption of unconscious desires driving the former, and from the latter's presupposition that there is something there in the first place to be unremembered. Erll's (2022) "implicit memory" allows particular pasts to hide in plain sight, as unremarkable and un-memorable, filtered out of collective historical consciousness by what she describes as a "source amnesia" (p.6). In place of the implicit, the explicit emerges and this is why the implicit is classed as memory, because of its "future-making capacities (Erll 2022, p.6). In other words, explicit memory is generated by making certain pasts implicit. The difference between the explicit and the implicit is a matter of framing, not just in terms of social framing, as Maurice Halbwachs (2023) would have it, from which remembrance is inextricable, but, as Erll (2022) reminds us, the mediation of those frames: "Implicit collective memory is produced and passed on in complex social and plurimedial constellations", and while "this is a social process through and through" involving, for example, "[i]nteraction, collaboration, dialogue, negotiation, agonism – the entire spectrum of the dynamics of social memory-making", the medial forms implicit and explicit memories

take informs the efficacy of their transmission and the priming of their activation (p.8). The Science Museum's Energy Hall is part of one such constellation of national science and technology heritage. As such its exhibition is an example of that past's successive remediation, which, it seems, can lead to "mnemonic premediation" (Erll 2022, p.9), that is, to templates for shaping the remembrance of events as they unfold, implicitly and explicitly. In other words, and as we shall see, rather than see and remember the ongoing Anthropocene in the Energy Hall, the museum visitor is primed instead to focus on national modernity and technological progress. However, before the implicit Anthropocene is rendered explicit by this essay, a fuller conception of our new (but contested) epoch is needed.

The Anthropocene

In October 2023, the Anthropocene Working Group (AWG) of the International Subcommission on Quaternary Stratigraphy (SQS), a subgroup of the International Commission of Stratigraphy, proposed Crawford Lake Ontario as the Global Boundary Stratotype Section and Point or Golden Spike that represents the inception point of the Anthropocene, our proposed new geological epoch. In other words, this site bears the most pristine inscription of the kind of human activity that led to planet-wide transformation: in its muddy sediments can be found the particulate traces of, amongst other things, the fossil-fuel combustion (particularly coal) that energised twentieth-century industrialisation, and plutonium from hydrogen-bomb testing. These markers date planetary, epochal change from the 1950s, which is correspondent with the "Great Acceleration" (McNeill and Engelke, 2014) of polluting and emissive extractive capitalism along with the beginnings of the nuclear age. To be precise, these levels of plutonium could be correlated with the detonation at 7:15 a.m. local time on 1 November 1952 of the first atmospheric hydrogen bomb at the Enewetak Atoll in the Pacific Marshall Islands. However, in March 2024, the SQS voted

down the proposal of a new epoch and its representative site, based on, to generalise, insufficient evidence (Zalasiewicz *et al*., 2024, pp.1-2). Members of the AWG, and the Earth sciences at large, continue to debate the concept and maintain that the Anthropocene is a useful concept for identifying, categorising and analysing fundamental and irreversible anthropogenic, interrelated changes to Earth systems (Zalasiewicz *et al*., 2024, pp.1-5).

Prior to the 2020s, the Anthropocene was proposed as a geological epoch to the Scientific Committee of the International Geosphere–Biosphere Programme in 2000 by the atmospheric chemist Paul Crutzen, who, working with available data sets at the time, identified the late eighteenth century as the end of the Holocene epoch, due to the Industrial Revolution's coal-burning CO_2 emissions (measured in polar ice cap samples). In a publication of that proposal in 2002, Crutzen noted James Watt's steam-engine design of 1784 as instrumental in this epochal change (n.p.). (Crutzen also noted the scientific conceptualisations of anthropogenic planetary change, dating back to the nineteenth and early twentieth centuries.) The significance of Watt's patent was re-iterated by postcolonial historian Dipesh Chakrabarty in 2009 (p. 209) in what was to become an influential essay on the difficulties and necessities of splicing deep geological time and the time of modernity in historicising the Anthropocene, its causes and effects. Chakrabarty's intervention marked transdisciplinary travels of the Anthropocene, from the Earth sciences to the social sciences and humanities, and the latter's commitment to conceptualising our propositional new epoch. As Zalasiewicz *et al*. (2024) note, the "causes of the Anthropocene necessarily precede the start of the epoch" (p. 4). Thus, Earth systems scientists would view Watt's contribution to the Industrial Revolution as precipitating planetary changes that became supposedly definitive by the 1950s.

That said, for the social sciences and humanities, both these Golden Spikes that represent the possible inception points for the Anthropocene are examples of geological fetishism. The insistence on the coherence of evidence and the legibility of humanity's inscriptions on the planet – the purity of the lithographic signature – overwrites faded, less consistent, illegible and distributed marks of human activity (Menely and Taylor, 2017, 6-8; see also Davis and Todd, 2017). Arguably, the consensus in the environmental humanities is that the origins of the Anthropocene can actually be found in the colonization of the so-called New World and the consequent, also so-called, Columbian Exchange. This transportation of fauna, flora, and microbes, agricultural practices and systems, technologies, peoples, cultures and new social formations was inextricable from the institution of slavery, the genocide of the indigenous, ecocidal settlement practices, a reordering of the colonial biosphere or terraforming of colonial environments, and the inauguration of globalization that had and continues to have planet-wide repercussions.

In an interesting departure from Anthropocene orthodoxy in the Earth sciences, and a rare crossing of the disciplinary divide, Simon Lewis and Mark Maslin's (2015, pp. 171-180) located the beginnings of the current epoch in *circa* 1610, when, as measured in polar ice core samples, planetary CO_2 levels dropped markedly due to the massive reduction of the North American Indigenous population. This decline was brought about by smallpox and genocidal violence introduced to the continent by colonialism. The consequent decline in Native American agricultural practice resulted in the regrowth of previously cleared forest and its consequent absorption of carbon dioxide. Lewis and Maslin's proposition has not gained sufficient purchase on the AWG because "stratigraphic signals related to a 'Columbian exchange' […] occur at distinct times in different places over several centuries. They do not

capture an abrupt, fundamental transition globally on a par with that seen in the mid-twentieth century" (Zalasiewicz *et al*., 2024, p. 3).

As Katherine Yusoff (2018, pp. 1-5) would argue, the geological sciences have overwritten the colonial era because of the presupposition of the Anthropos in the age of the human as a universal subject – an undifferentiated victim and/or perpetrator of planetary, environmental transformation and its repercussions – which masks the racialised, historical implications of geology itself. The prevailing assumption is that geological thinking has always been ideologically neutral, that it has not been complicit in historical violence, and that its identification of epochal markers is not potentially an act of forgetting other contexts of the Anthropocene. However, for Yusoff (2018, pp. 2-5), historically, the colonial extraction of resources from the lithosphere and biosphere (that is, from people, animals, plants, and what lies beneath the surface) was underwritten by geological thinking that determined distinctions between what was deemed human and inhuman – in other words, what or who, because putatively inhuman, could be extracted, consumed and exploited along with the resources beneath their feet. These distinctions or conflations have informed slavery and continue to determine what, or, rather, who, because disposable, can absorb the violence of extractive capitalism (Yusoff, 2018, pp. xviii, 51). This (necessary) fleshing out of the Anthropocene, its multiple historical contexts, and the history of its conceptualisation informs what needs to be witnessed in the museum to make the implicit explicit.

The Energy Hall and James Watt

For this essay, the focal point of Anthropocene witnessing is the exhibition of the Boutlon and Watt "Lap" rotative beam engine, which was built in 1788 (object number 1861-46).[4] It is an example of an early rotative engine and was used in Boulton and Watt's Soho Manufactory, in Birmingham, where it drove 43 polishing machines, and from 1797 blanking presses for the production of coinage; it was decommissioned in 1858 (Cameron, 2024, pp. 58, 77). The first Boulton and Watt rotative beam steam engine was put to work in Henry Goodwyn's Red Lion Brewery in London in 1784 (Cameron, 2024, p.77). (Watt's design enabled steam to condense above and below the engine's piston, powerfully mobilising the flywheel and beam.) The 1784 engine, one of three surviving examples of this type of engine from the 1780s, is a prominent feature of the museum's Energy Hall and represents a seminal stage in the energisation of the fossil-fuelled Industrial Revolution, and, as Crutzen (2002) and Chakrabarty (2009) have argued, a possible inception point for the Anthropocene (see also Cameron, 2024, p. 77). By the end of their partnership in 1800, Boulton and Watt had built 451 engines, 268 of which were rotative. Watt's engine was originally housed in the Watt Hall, which opened at the Science Museum on 14 January 1936 (to celebrate the bicentenary of Watt's birthday, 19 January 1736) (Cameron, 2024, p. 78), and is now a centrepiece of the Energy Hall, which presents the history of steam-engine technology and its contribution to Britain's fossil-fuelled and non-renewable energy regimes – with exhibited examples dating from the 1770s through to the late 1800s. Watt's attic workshop, as it was when he died in 1819, was also transplanted to the Science Museum (in 1924) and is now located adjacent to the display of historic machinery in the Energy Hall.

[4] Limitations of space prevent a detailed history of the evolution of the Science Museum and the Energy Hall: see Cameron, 2024, pp. 68-69; Bud, 2010, pp. 11-40; McDonald, 2002, pp. 25-30.

Given the Energy Hall's signage and how it frames its objects, it seems the museum remains wedded to a historical narrative of industrialisation, modernisation, technological innovation and progress. The signage that introduces the Energy Hall reads: "This is the story of steam and how it shaped the world we live in today. Steam has been the driving force behind British Industry for 300 years. Without it, the Industrial Revolution could never have happened." In a subsequent panel, the implication is that steam power is an unquestioned successor to animal, human, wind and river power:

> From the moment the power of steam was discovered, it fascinated philosophers and inventors. Until then, power had been generated by the flow of rivers, by wind, or by the sheer muscle power of horses, oxen or even human beings. Steam power was to change all that. But where did the steam come from?

Understanding and harnessing steam power was a technological and philosophical challenge, which, accepted, propelled the progression of Britain. Other panels suggest the burning of coal to drive steam engines (and to pump water from mines to enable larger-scale coal mining) seemed a logical solution to the energisation of the Industrial Revolution. The tone of the text panels that accompany the exhibits highlights the progressive technical innovation and mastery of engineering challenges, and there is a note of triumphalism in some of the exhibition's concluding statements – particularly around the evolution of turbine technology. Here the visitor is, in effect, asked not to "take electricity" and their energised lives "for granted" but to remember the different stages of steam-engine technology from the 1700s to the 1800s that paved the way for the modern steam turbine, which "still deliver[s] 75% of our power needs at home and at work". The visitor is prompted to appraise not just the relatively

recent history of energy generation but, retrospectively, the history of its technological origins. James Watt is, of course, celebrated as the engineer whose technical ingenuity made the energisation of the Industrial Revolution possible, and as such, he represents (and contributed to) the nation's increasing, progressive control over the relationship between technology and matter and its energetic properties. Watt's (and the nation's) technical mastery is most conspicuously symbolised by the reconstruction of his transplanted workshop, complete with his tools and instruments, all meticulously identified and listed. This softly lit space sits like a crucible of national inventiveness in the Energy Hall.

The Exhibitionary Complex

The Energy Hall's narrative of national energy arguably positions the visitor in something like the "Exhibitionary Complex", as conceptualised by Tony Bennett (1996) in a seminal contribution to museum studies. Bennett's complex really describes the ideological work of nineteenth-century museums but is, I think, still useful in diagnosing the nationalist logic of some twenty-first-century exhibitions. In the nineteenth century, innovative exhibitionary techniques, in, for example, the Great Exhibitions and the British Museum, enabled the mapping of the so-called progression of peoples, civilisations and nations: the emergence of the nation could be seen as a historical progression from antiquity; and advances in the geological and biological sciences saw the evolution of the nation as an extension of the evolution of "man" and life itself (Bennett, 1996, pp. 98-99). In this expanded museum temporality, the visitor could now see the spectacle of the progressive contemporary triumphs of industrial capitalism as a pinnacle of civilisation in contrast to the colonised peoples of the world, who were more akin to past and primitive societies in their so-called arrested development. The visitor was situated as the beneficiary of this imperial and national

narrative and could witness, and was witnessed by, other visitors so situated. In this specular economy, visitors saw "themselves as (ideally) known by power, interiorising its gaze as a principle of self-surveillance and, hence self-regulation" (Bennett, 1996, p. 84). Of course, museum studies has long drawn attention to the ways the narratives of museums are negotiated by their visitors, whose intellectual and physical navigations of exhibitions perform narratives that counter such imposed meanings (for example, see Crownshaw, 2010, pp. 205-238). However, the rhetoric of the Energy Hall works hard to separate the Industrial Revolution from its environmental and, as we shall see, racialised contexts, clearing this space for the visitor's identification with a sanitised version of modernity as its beneficiary and, potentially, to see others do the same.

While an introductory panel in the Energy Hall mentions the structural dependence on fossil fuels brought about by how the Industrial Revolution was powered, the exhibition otherwise subsumes the history of climate change and the implicatedness of what is displayed. The Energy Hall exhibition is more concerned with framing the narrative of Watt and his engines by reference in several panels to the imperial and colonial context of the Industrial Revolution. For example:

> James Watt made the steam engine capable of driving any type of machinery, anywhere, at any time. It was at the heart of the new industrial towns and a global production network that included new British colonies, markets and the transatlantic slave trade. Steam was closely linked to the existing plantation system dependent on enslavement of Africans, and its output of raw materials such as cotton and sugar.

Perhaps more prominent in the main panel introducing the section of the Energy Hall in which Watt's workshop is housed is this concession to his changing reputational profile:

> James Watt and Our World: the Workshop, the Man and the New Industrial Age
>
> When James Watt died in 1819 he was seen simply as the founder of the Industrial Revolution. Britain was getting richer, Watt's steam engines pumped its mines and drove its factories.
>
> We now know that his early career included the trafficking of enslaved Africans. In this respect, Watt was not unusual. By the time slavery was abolished in the British Empire following the 1833 Slavery Abolition Act, some 46000 Britons owned slaves. Watt's past trafficking of enslaved people is a reminder of the uncomfortable truth underpinning our industrial age.
>
> While we consider Watt's slave trading activity early in his career, we also acknowledge that his engineering prowess greatly shaped the world we live in today. In trying to understand this history, scholars of the Industrial Revolution visited Watt's attic workshop. They included Bennet Woodcroft, one of the Science Museum's founders. In 1924 the whole workshop, with all its contents, was transported here.

And a nearby panel reads:

> James Watt – a Complex Hero

> When Watt died in 1819 the nation was ready for a new kind of hero. Nelson and Wellington had saved Britain in the wars against France. At that time, Britain's strength was thought to come from manufacturing. Many credited Watt for this.
>
> Numerous portraits of Watt exist. Engravings sold widely, promoting the virtues of hard work and invention. They show the changing way Watt was seen, and how his image and reputation also suited the politics of the new industrial class.
>
> Now we understand that Britain's power and influence came not just from industrial and manufacturing power but also through colonial expansion and oppression. This understanding causes us to reflect on our shared past and rethink what it means to be heroic.

Of note in these text panels is the use of the pronoun "our", through which the exhibition ostensibly positions the visitors as implicated subjects: we are beneficiaries of the energy regimes that originated with Watt's engines, and of a modernity that was built on slave labour, colonialism, and extractive capitalism, which is "our shared past". While the exhibition points out that Watt's involvement in slavery was not atypical, it suggests that we need to break from enduring Victorian criteria for lionisation that naturalised if not forgot what the nation's heroes and their machines did offshore. This surely self-reflexive moment potentially provokes the visitor into thinking about whether the museum's representation of Watt has sufficiently broken with past commemorative paradigms.

That said, if we are called to understand our implicatedness in the historical processes exhibited as well as the politics of their exhibition, opening up the possibility of alternative readings of the Science Museum, the plural possessive pronoun "our" raises the question of who exactly belongs to this "we". In other words, what is intimated here is a universalisation of historical and cultural experience. That universalisation resonates with early and ongoing critiques of conceptualisations of the Anthropocene that assumed everyone has experienced "our" new epoch in the same way, therefore overwriting particularly racialised and geographically specific histories of socio-environmental harms (see, for example, Yusoff, 2018). If this signage does manage to stage a differentiated historical memory of the Anthropocene, the "now" of remembrance, whenever that may have begun, suggests that historical memories of colonialism and slavery are only the stuff of the recent memory work of a homogenised Anthropos and its museum culture – a further containment of differential pasts.

What is more, despite the invitation to scrutinise the Energy Hall, these panels' combined rhetoric works to ensure that, once confronted, slavery is consigned to the past; modernity is represented by the energetics made possible by Watt's engineering and not by the legacies of slavery. Watt's identity, distanced from its (confessed) past relationship to slavery, can be resurrected and remembered for its contributions to an engineered modernity. It is not just slavery that is left behind, but its relationship with the energy regimes to which Watt contributed. In other words, and recalling the conceptualisations of the Anthropocene with which this essay began, it is the racialised origins and unfolding of planetary change that are forgotten. While the exhibition points to the use of industrial technology in the plantation system and colonial extractive capitalism, and puts this usage in the context of global trade, it does not indicate the ways that plantation slavery and the operations of colonialism were

terraforming with planet-wide repercussions, how resource extraction was enabled by the lack of distinction between the human and the nonhuman, and where the continuing conflation of these two categories still determines what and who is disposable in bearing the brunt of planetary change (as it manifests itself, for example, in extreme weather, floods, rising sea levels, pollution, and ecosystemic and life-world destruction). It is the continuing intimacy between fossil fuels and environmentally mediated violence that remains unarticulated. Borrowing Ann Stoler's (2016) conceptual terminology from a different postcolonial context, the Anthropocene and its racialised contexts are here "disabled histories […] shorn of the capacities to make connections" with what is exhibited (p.123). Arguably then, this is an exhibition that produces a form of "aphasia" in its visitor, a "difficulty in retrieving both conceptual and lexical vocabularies" to recognise what is on display and interrupt the institutional "disremembering" at work (Stoler, 2016, p.128).

Although these engines fill the first exhibition hall that visitors encounter (when entering via the street on Exhibition Road), which makes the Energy Hall a preface to the museum's overarching narrative of the history of science and technology, Watt's engines have not gained sufficient purchase on the popular historical imagination to be controversial. In academic discourse, Watt's engine is an icon of the Anthropocene, and similar historical technology has been re-signified by other museums. For example, the J. Edward Earnshaw and Co. Trestle steam engine built in 1862 to power Nuremberg's Municipal Gasworks was a centrepiece in the Deutsches Museum exhibition "Welcome to the Anthropocene: The Earth in Our Hands" (2014-2018) (Cameron, 2024, p. 64). However, the engines of the Science Museum have not gained, as Ann Rigney (2022) might put it, the collective public traction through their remediation, elaboration and adaptation "across different media and platforms" in an ecology of cultural memorative forms to become a "material resource for counter-

memory" (pp. 15,17).[5] To risk a generalisation, then, the large objects contouring the Energy Hall's exhibition are not affective beyond, possibly, their scale (relative to the hall that houses them), and their mechanical sophistication (relative to the popular understanding of the progress of late-eighteenth- and early-nineteenth-century engineering). In other words, the Anthropocene remains implicit in the Energy Hall, wherein the artefacts of the Industrial Revolution have effectively been naturalised as part of a narration of benign progress.

Anthropocene Witnessing at the Science Museum

The Science Museum needs to be seen or witnessed anew. Cameron's (2024, p. 80) methodology for doing so does more than identify steam engines as static material remnants of historical forces, as in the fact that engines were transported to the Caribbean (1790-1800) to power the processing of sugar cane and cotton grown there by slave labour; and that Bolton and Watt's enterprise was funded by a bank founded by plantation owners. Rather, Cameron (2024, pp. 86-91) looks to the way in which the museum's objects, and indeed the museum itself, are an emerging materialisation of nonhuman and human things, forces, matter and entities. For example, the wooden components – beams, frames, flywheels and rods – of Watt's steam engines bear traces of rising levels of atmospheric CO_2 that have been

[5] Interestingly, while the Science Museum has been the focus of a number protests about oil-company sponsorship of its other exhibitions, to my knowledge the Energy Hall has never attracted the attention of these protestors. See, for example, https://www.theguardian.com/environment/2021/aug/29/extinction-rebellion-protesters-science-museum-shell-sponsorship and https://www.theguardian.com/culture/2021/sep/09/science-museum-to-remove-climate-placard-from-shell-sponsored-show?CMP=Share_iOSApp_Other.

absorbed by the trees felled and milled for use in the manufacture of these machines. Cameron (2024, pp. 86-91; see also Cameron *et al*., 2023) has drawn on the atmospheric composition data collected, analysed, modelled and simulated by David Ellsworth. Ellsworth drew his data from trees – particularly English oak – growing in areas such as Staffordshire, from which timber was supplied to Bolton and Watt's manufactory. Cameron's (2024, pp. 86-91) research has established the supply chain. Biochemical indicators of levels of CO_2 absorption, and of the variants of CO_2 absorbed, found in trees, correspond to the changing atmospheric levels and ratios of different types of CO_2 brought about by the burning of fossil fuels. Samples taken from trees can be used to model and track arboreal absorption (and corresponding atmospheric compositions) from the late eighteenth century to the present day (Cameron, 2024, pp. 86-91; see also Cameron *et al*., 2023).

Therefore, for Cameron, "cultural heritage objects are not simply items of material culture – understood as bounded, discrete entities and expressions of human-centric histories – but are semio-material assemblages, which emerge in an alliance of discourses" (be they ideas of progress underwriting the Industrial Revolution and enshrined by the museum), "human bodies" (be they eighteenth-century engineers, free and unfree labourers who worked their machines, climate scientists and museum curators) and the "biological systems, earthly processes, and elemental materials" that fuel, bring about and register anthropogenic, fossil-fuelled atmospheric change (Cameron, 2024, p. 73). The assemblage and re-assemblage over time and space of human bodies, ideas and agencies and nonhuman forces and matter represented in these objects demand the reconfiguration of Anthropocene witnessing. To witness these objects and the histories they represent (or materialise) is to witness an ecology (of the human and nonhuman), but witnessing is also ecological in the sense that the witness is immersed in the ecology witnessed (Richardson and Zolkos, 2023, pp. 3-12). As Cameron

reminds us, just as humans act on the planet to consume its resources and change its systems, so the planet acts on us in terms of the food we metabolise, the air we breathe and the pollutants we absorb. We are ecologically composed (Cameron, 2024, p. 72), and that is true for the historical actor of the eighteenth century as much as it is for museum curators and visitors. Cameron therefore reads Watt's engine, "to make visible the vital entanglements and articulations of human and non-human convergence embedded in an object's composition" (2024, pp. 73-74) and, as she might put it, to make "legible" the relationality of those who would witness the Anthropocene in the museum (2024, p. 65).

However, given the ecological composition of witnessing, the human agency of witnessing is somewhat diminished. The capacity of in-formed matter to, as Cameron (2024) puts it, "bear witness" (p. 74) in this theory of more-than-human witnessing arguably subsumes rather than just subverts the centrality of the human witness. In other words, there is a slippage between agency defined as the ability of things to be materially affective and affected as they assemble with other things and humans and so to bear the traces of the materialisation of past events, and what Cameron (2024) describes as the "curatorial agencies" of trees, whose "tissue remains as a testimony (p. 90). "Curatorial agency" implies a degree of self-organisation and, indeed, self-presentation and or self-narration – in other words an autopoietic form of nonhuman witnessing and testimony (Cameron, 2024, p. 86).

Such readings of museums are aligned with versions of the new materialism in which the nonhuman is attributed narrative agency, and a brief excursion into this theorical terrain will help flesh out the implications of a new materialist framing of the Science Museum and its Energy Hall. Serpil Opperman's "material ecocriticism" is consonant with Cameron's theoretical approach. Opperman, rather like Cameron, seeks to correct the subject-object

dualism in Western thought in which the nonhuman is inert, objectified and acted upon and spoken for by human subjects. What is central to Opperman's (2019) argument is that "the assertion that only humans can make sense of the world through language and nonhuman species are devoid of this capacity is simply wrong" (p. 109). Drawing on Donna Harraway's (2008) conceptualisation of the "becoming with" (p. 244) of matter, the co-constitution of things and the transformative effect of that which assembles, Opperman (2019), like Cameron, equates this emergence of matter with communication itself: "becoming with demands an affirmation of semiotic relations in which both humans and everything beyond the human participate" (p. 111). Therefore, "telluric powers" become "Transformative stories", which suggests that matter speaks for itself and has "narrative agency" (Iovino & Opperman, 2014, in Opperman, 2019, p. 113; Opperman, 2019, p. 111). Despite this new materialist separation of agency from intention and its redefinition in terms of what matter does, the logic of the attribution of "narrative agency" (Opperman, 2019, p.111) to the nonhuman suggests otherwise.

The problem, though, with the extension of narrative, curatorial and testimonial agency to the nonhuman is that when ecocriticism leaves nonhuman matter to speak for itself, can nonhuman matter really articulate what humans do to matter (including the matter of other humans)? It is not just the distribution of narrative agency that is at issue here but rather a general over-distribution of agency in what has become an inversion of human exceptionalism in which it is difficult to discern what agencies matter most, make the most difference, and are responsible for, say, climate change, colonialism, and the engendering of environmental catastrophe – and how these pasts are represented in the Energy Hall. Andreas Malm (2018, pp. 58-59) makes a related point, focused upon what he sees as new materialism's conflation of the natural and socio-cultural in assemblages of the entangled

human and nonhuman. For Malm, only by maintaining the distinction between the natural and the socio-cultural can critical theory identify what society does to nature, or, in this case, what humans to do humans via the so-called natural world (Malm, 2018, pp. 61, 73, 82, 93). In the absence of that distinction, the logical implication of new materialism is the potential for agency to extend as far as, well, every and any thing, because any thing has the potential to effect material change. This universalisation of agency means that, in this case, the anthropogenesis of environmentally mediated violence would be subsumed (Malm, 2018, p. 89).

While the nonhuman bears the imprint of human actions – it is "storied matter" as Opperman (2019, p. 112) puts it – when it is left to speak for itself, it is also freed from the social and cultural discourses, institutions and systems that mediate and give it meaning – and, therefore, from the history of meaning-making of which it actually bears the imprint. To be more precise, the history of cultural remembrance staged by institutions such as the Science Museum becomes less legible in the objects exhibited. What is needed is a conceptualisation of witnessing that apprehends the imbrications of the human and nonhuman and understands that the latter, be it organic or inorganic, is not inert but emergent, transformative and forever assembling with and without us to make things happen. What is also needed is a concept of witnessing that can determine what makes the most difference in making things happen, where the intensities and intentions of agency are located. In short, a concept of witnessing is needed that does not lose track of human historical responsibilities for, in this case, colonialism, slavery and climate change, and for shaping the cultural memory of those events in museum exhibitions. Susan Schuppli's concept of "material witnessing" is useful in this respect.

Schuppli (2020) proceeds on the basis that material evidence for an event is never "self-evident" but rather produced through "investigative, discursive and rhetorical" processes that mediate the trace of something that happened. Put another way, "material witnessing" encodes the "evidential role of matter as registering external events as well as exposing the practices and procedures that enable the matter to bear witness [… as well as the] different orders of knowledge and the regimes of perceptibility that enable materials to become evidential and bear witness" (Schuppli, 2020, pp. 3-4). To paraphrase Schuppli, matter is informed not just by events it has given shape to, but by the way culture makes sense of it, producing an artefact of the production of meaning. Crucially, for this argument, "Matter becomes a material witness only when the complex histories entangled within objects are unfolded, transformed into legible formats, and offered up for public consideration and debate", otherwise matter remains a "virtual" archive of "encrypted data", "mere latent potential" or, in the terms of this essay, implicit (p. 14). Schuppli's theory reinstalls the role of the human in the more-than-human scene of witnessing the Anthropocene. When mediated by acts of human witnessing, the nonhuman can testify to its traces of the past, which might include its past roles in cultural remembrance and forgetting. In other words, in the context of the Science Museum, the concept of "material witnessing" makes legible the operations of cultural memory that position Watt's engine as the focal point of explicit over implicit pasts.

As Michael Richardson and Magdalena Zolkos (2022) have argued, the "'human' in testimonial theory is no longer the sole agent, author, and architect of witnessing, who displays unquestioned capacity for historical agency and exerts formative influence on 'non-humans' (objects, environments, plants, animals, etc.) that have been consequently assigned the role of props and background in this hubristic cultural imagination of testimonial performance" (pp. 3-4). A witnessing of the Anthropocene in the Science Museum is indeed

an act of more-than-human witnessing, in which the human is not the sole but, as this essay has argued, the most testimonial and historically culpable agent. This is surely where the ethics of witnessing must lie – in reconstituting the role of human agency in past events and in how they are remembered (or not). As Richardson and Zolkos (2022) put it, a reconceptualising of witnessing to accommodate the nonhuman entails an "oscillating in and out of the human", which "returns political and ethical responsibility to the human" even though the human cannot separate itself from the nonhuman world (p. 5). A return to "the human", though, begs the question, which human? In counterbalancing an over-distributive sense of agency, this argument risks reinstalling a transcendent concept of the human resonant of the historically exceptionalist figure against which other things and other people were mere matter (Yusoff, 2018; Richardson and Zolkos, 2023, pp. 3-4). If the human is to be reinstalled in Anthropocene witnessing, then it must always be a placeholder for the historically specific positionality of the witness.

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