Reverse engineering and the archaeology of the modern world: Response to comments

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It is a humbling experience to reach the limits of one's scholarly imagination, as was the case with my opening paper, which I fiddled about with and revised for more than five years with valuable input from friends. To solicit formal responses from respected colleagues seemed the optimal way to carry the concept of archaeological reverse engineering further in new and interesting directions, and to correct errors that I might have introduced. I am extremely grateful to the authors of the responses and to the editors.

One of the most valuable critiques of my paper was that it was insufficiently archaeological, as Piccini asked, 'why restrict reverse engineering only to artefacts'? This point is also noted by Edgeworth and Müller who raise the possibility of reverse engineering archaeological site formation processes and the layering of strata in a landscape. Edgeworth suggests that reverse engineering could and perhaps should move swiftly beyond industrial-age or technological artefacts – ditching the methodological training wheels – to become a form of archaeological reasoning. My first, last and main hope for archaeological reverse engineering is that it might serve as a thinking-tool, a sandbox for exploring archaeological reasoning and praxis: this was taken up by several of the respondents, and by Piccini in particular, who links reverse engineering and experimental archaeology to the more playful world of re-enactment. The concept of re-enactment and its inherent performativity offer another viewpoint on reverse engineering, linking reasoning with action in the process of tinkering with things, turning them in one's hands, fiddling about, taking apart and reassembling. Re-enactment is a fiddling about with entire material assemblages, sites, buildings and landscapes: a window on to reverse engineering beyond the industrial artefact.

Several of the responses push the model of reverse engineering where I was perhaps too timid: out of the factory gate and into capitalist society as a more wide-ranging socio-economic critique, as Dawdy says, "from 'how things work' to 'how society works'". Here I am particularly interested in Müller's notion of archaeological reverse engineering (in its digital forms at least) as a mode of activism: a blending of anti-capitalism and hacker culture, demanding a democratisation of technology. I don't own an iPhone, the foremost symbol of modern technology as Müller notes, but two recent news stories touch on some of the practical, ethical and commercial complexities of reverse engineering. In one, Apple created a software update that 'bricked' any iPhone that had been opened or repaired by a non-Apple technician (Brignall 2016). In the other, Apple is fighting the U.S. government through the courts against an order that they decrypt a secured iPhone belonging to a dead terrorist (McLaughlin 2016). Protecting against reverse engineering is good security and good business. In iPhone archaeology a democratizing approach to reverse engineering might involve 'jailbreaking' or 'rooting' the phone, opening it up to non-approved software and hardware additions, based on the idea that a phone you can't hack isn't truly yours. Archaeological hacking would add an ideological layer to reverse engineering: from understanding to openness as the basis of freedom and participatory democracy. Or we might reverse engineer Pandora's box and end up by opening it by accident. Either way, the historical archaeology of the iPhone will be a story worth telling one day.

Some of the harsher and most valuable critiques concern my criticisms of notions of modernity in the archaeology of the modern world. Both Dawdy and Müller note the over-simplicity of my models of modernity: Müller suggests rightly that there are far subtler conceptualisations outside of archaeology. This slightly misses the point, which is that the concept is treated simplistically within contemporary archaeology, but I pulled my punches, and what Dawdy noted as a straw-man is also the ghost of an *ad hominem*. Certainly this was one of the least well developed, unsubtle and grouchiest elements of my original paper.

Dawdy explores the organisation of technology and the notion that machines can 'enslave' their attendants, drawing a line from the mills at the birth of the Industrial Revolution through twentieth-century Fordism to Fritz Lang's "Metropolis," and sending me scurrying back to Marx's *Capital* to explore instruments of labour. The machines and assembly lines that wove human labour and technology so tightly together were expressions and drivers of new social relationships, and Dawdy uses the passive voice: "workers are deskilled" and their needs "subsumed to those of the machine" – but by whom? The view of the factory as dehumanised is the view from the head office: everything looks cleaner and simpler from a distance. I would slightly dispute Dawdy's suggestion that handmade technologies involve a qualitatively different human relation to the machinery of mass-production: my point is that all technologies, down to the microchips that Finn discusses, manifest quirks and oddities in their operation that become part of their attendants' tacit knowledge of their job, which is never as straightforwardly deskilled as it might appear. But Dawdy's principal point holds true: that an archaeology as reverse engineering could generate a more detailed and nuanced understanding of the 'species' of technology and the human-machine relations that they embody.

One of my enduring concerns in archaeology is the idea of outlining the unknowable: tracing the edges of darkness where the incompleteness of the record and the limits of our techniques force us to stop (or ought to). This theme of gaps – such as the inferred but unknowable human dimensions of technology – is taken up by Finn, who points out the ways in which archaeologists have filled material absences. Here perhaps is the chasm between reverse engineering the Antikythera mechanism on the one hand and the modern microchip on the other: in archaeology we are far more often reasoning backward from an incomplete material trace, an archive or object full of gaps. If archaeology is the art of reverse engineering from an incomplete artefact, we can perhaps revisit Piccini's criticism that it could produce 'an overly linear history'. Certainly the *chaîne opératoire* seems to imply linearity, but as Edgeworth points out, in archaeology we rarely deal with a straightforward human-material relation: "There are biological and geomorphological forces to take into account too, and the physical traces of these are intermeshed with those of human forces in complicated ways that are hard to disentangle." In summary, archaeological reverse engineering is amongst other things:

- A disentangling of fragments and layers, embracing non-linearity

- A process of human-material interaction, embracing play, performance and embodied reasoning

- A study of parts as well as wholes, embracing absences and gaps

Once again my deepest gratitude to the respondents and I look forward to future developments around the idea of reverse engineering in, as and of archaeology.

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