

DID THE GREEKS BELIEVE IN THEIR ROBOTS?

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This paper investigates the ‘prehistory’ of automata in fourth-century Greece. It argues, first, that automata appear more frequently in the philosophy and drama of this period than has usually been recognised; second, that robots function in classical Greek literature as a utopian substitute for slavery or other forms of bound labour; and, finally, that the failure of Hellenistic automata to realise this utopia illustrates some basic constraints on the power of technology to disturb social institutions in the ancient world.

The problem of technological stagnation in antiquity used to be a fruitful field for research, insofar as classicists felt compelled to apologise for what then looked, on the evidence and according to the models of technological development that were then current, like the idiocy of ancient civilisations when confronted with practical questions of engineering. If one were to rate civilisations on their capacity for coming up with ingenious ‘technological’ solutions to real world problems, as Marc Bloch realised, one would have to put Greece and Rome behind, not only those Near Eastern and Egyptian cultures that were then, and to some extent remain, on the margins of the modern study of the ‘classical’ past, but even behind the proverbially lightless Middle Ages, which saw a revolution in agrarian technology that fostered an explosion in the rural population of Europe.¹

For a long time, classical historians were productively engaged in writing apologetics for this perceived deficiency on the part of the civilisations they studied. The solutions proposed were manifold. They ranged from the indirect – for instance Wittfogel’s claim that highly technologised agriculture required despotic government and was therefore incompatible with that other great ‘invention of the Greeks’, democracy – to the specious – for instance the argument, which still has traction in some circles, that the Greeks and to a

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1 E.g. Landels (1978) 186–98. That author (p. 196) could still speak of ‘characteristic Greek shortcomings’ in the field of technological theory, by which he also meant ‘characteristic Roman shortcomings’ (cf. p. 186). Bloch (1969) 124–36 viewed the problem from a medievalist’s perspective, but still from the standpoint of ‘collective psychology’; his emphasis on the social and psychological dimensions of that psychology, however, makes his work on the subject valuable even today; for an elaboration of the Blochian perspective, see White (1963). For some framings of the problem of ‘technological stagnation’ that touch our approach here more closely, see Vernant (2006) 293–320 and De Ste Croix (1989) 38–9.

lesser extent the Romans were simply too obsessed with theory to care about the more practical aspects of mechanics. One wonders what a farmer in, say, fourth-century Corinth would have made of this suggestion; moreover, evidence can be, and has been, advanced that it does not hold true even for the writing classes with whom ancient history is usually concerned. Scholars like Serafina Cuomo have also begun to question whether it even makes sense to look for what we would call technological ‘progress’ in antiquity, given that so much craft innovation in that period took place in diverse locales, and so little of it was recorded as a written tradition on which subsequent craftsmen could try to build. But there is another way of approaching the supposed technological backwardness of antiquity, elaborated by (among others) Jean-Pierre Vernant, Moses Finley and Bloch himself, that does not attempt to explain ancient *blocage technique* in terms of élite attitudes alone. These investigators favoured an explanation that, for lack of a more specific term, we might call ‘social’: namely, that the availability of slave labour in antiquity made labour-saving innovations both unnecessary and unprofitable. I want to explore some implications of this thesis, taking ancient automata as my test case; and I hope, in the course of my explorations, to be able to give a convincing affirmative answer to the question that gives this paper its title.²

The evidence will show that automata, even before they were ‘invented’ by the new mechanics of the third century BCE, seemed plausible to Greeks living in Athens, who are the only ones for which we have much evidence on this point. This was so, I will suggest, because Greeks living in Athens had a model through which they could understand what robots might do; this model was the slave. A good deal of work has been done in recent years on Greek automata as instances of ancient ‘science fiction’. In the ancient world, as in the modern one, speculation about future technology had its roots in the problems of contemporary social life: in the popular television of the civil rights era (think of *The Jetsons*), robots replaced a racialised form of domestic labour that was coming to be seen as problematic. As an ‘imaginary technology’, robots were similarly useful for the Athenians precisely because they could use them to think through

2 For the core of Wittfogel’s theory of ‘hydraulic despotism’, see Wittfogel (1957) 101–36. Wittfogel concedes (p. 122) that ‘genuine elements of freedom’ are nevertheless present in technologically developed hydraulic civilisations, but these elements, which have a ‘democratic flavor,’ (p. 123) are restricted to narrow fields of village or confessional autonomy. Wittfogel’s rhetoric, which strikes us today as covering for a kind of intellectual deficit (e.g. p. 137: ‘Total Terror—Total Submission—Total Loneliness’, a chapter heading that almost demands an exclamation mark) could nonetheless be cited as authoritative by so level-headed a scholar as Eisenstadt (1963) 36, *inter alia*. Landels (1978) 186–7 and to some extent Vernant (2006) 293–8 stand as exponents of a ‘distraction by theory’ model. But compare Vernant (2006) 299–321, which proposes slavery as simultaneously an economic and a psychological explanation for the Greeks’ aversion to mechanical work and technological development. G. E. M. de Ste Croix (1989) 38ff. makes a similar observation, adding that other forms of bound labour (the client, the *colonus*, etc.) could do as much as slaves to impede the progress of technology. Bloch had already adopted a not dissimilar position. Finley’s (1973) 145–7 statement of the argument is one of the earliest, and it is also this version that, having once been canonised by Perry Anderson (1974) 25ff., has become a kind of Marxist dogma. My attempt to rescue what can be salvaged of the slavery/*blocage technique* nexus will be seen too, I hope, as an attempt to rescue lay Marxism from a historical myth that no longer wholly corresponds to the state of specialist scholarship in the classics (Horden and Purcell (2000) 287–97).

some of the conflicts implicit in a slave-based economy where the division of labour was regulated by the same legal precepts that controlled political participation and the distribution of goods, especially those, like land, that doubled as instruments of production. So, in a sense, and *pace* Vernant *et al.*, the slave economy works here like a kind of cultural incubator for a new technology that, in the third century BCE, did end up becoming real. But, I will conclude, the ways in which automata were realised during the Hellenistic period highlight the impossibility of a *certain* kind of technological innovation within the confines of a world of slave labour: a slave economy, like any economy, will never invent a piece of technology that overthrows it. To that extent, the explanation advanced by Vernant for the ‘technological stagnation’ of antiquity does hold true.³

This kind of interpretation is licensed, I think, at least in part because it was already current by the late fourth century BCE. In a passage of the *Politics* that has often been remarked upon – among others, by Marx, who saw it as representing the limit of ancient thought on industrial applications of technology – Aristotle notes that

[i]f each instrument could do its own work, at the word of command or by intelligent anticipation, like the statues of Daedalus or the tripods made by Hephaestus, of

3 On third-century and later developments in Greek mechanics, see Wilson (2008) 337–42, and, for the pertinent applications in robotics, see Berryman (2003) 361–2. This era saw the theorisation of the lever, which had long been in use for construction and mining in Greece and elsewhere, as well as the ‘invention’ of gearing systems and pneumatics, at least one of which would have been indispensable as a means of power transmission for any automatic mechanism. The earliest text on the construction of automata, Philo of Byzantium’s appropriately-named *Automatopoïika*, dates from this period, and other sources (see p. 16 below) record a number of automata built by the Hellenistic monarchs. Cuomo (2007) 41–59 cautions us against reading ‘revolutions’ into what must generally have been an uneven and sometimes (from our prospective) retrograde development of technology in antiquity, but the balance of the evidence in this case weighs in favour of Berryman’s claims: there were no ‘automatic’ mechanisms before the third century, and there is much testimony for them after. The possibility of a ‘revolution’ in at least this subfield of mechanics seems to me to depend on two historical factors that were not operative in connection with the making of siege engines, which forms the basis of Cuomo’s analysis. First, the making of automata would have required a high degree of precision craftsmanship (for a detailed analysis, see Landels (1978) 204) that would have rendered empirical experimentation of the sort that probably played an important part in the building of siege engines (Cuomo (2007) 55) unfruitful. Second, the number of automata built, and thus the degree of ‘fiddling’ with their design, must have been much smaller than that of, for instance, ballistae. Accordingly, a narrower and perhaps even linear trajectory for the development of automata should probably be accepted.

For a treatment of Ancient Greek automata as ‘science fiction’, see Rogers and Stevens (2012) 141. It seems to me implausible to argue that the Homeric automata discussed there, and in Lively (2006) 275–81, would end up counting as science fiction by the standards of a definition that expects works within the genre to explore the epistemological and ethical implications of a technological innovation for individuals or societies (I paraphrase here Darko Suvin’s definition, discussed in Rogers and Stevens (2012) 136–9). On the other hand, it will appear that the Aristotelian and Athenian robots that shall take up the better part of my discussion below actually fit Suvin’s definition fairly well. So, when I use phrases like ‘imaginary technology’ here, and in the following pages, I mean it in a sense not too far from that of ‘speculative fiction’. My emphasis will fall, however, on the social conditions that go to produce such fiction, and not on the literary or ontological conundrums that may be implied by the fictions themselves. On these, see again Lively (2006) and, more exhaustively, Zunshine (2008) 73–130.

which the poet relates that ‘Of their own motion they entered the conclave of Gods on Olympus.’ A shuttle would then weave of itself, and a plectrum would do its own harp playing. In this situation managers would not need subordinates and masters would not need slaves.⁴

What Aristotle seems to be arguing here is that a toolkit of self-moving instruments – *automata organa*, to use his vocabulary – would eliminate the social need, not only for slave, but also for free labour. Only under these conditions can Aristotle conceive of an end to the conditions of domination that go hand in hand with Greek slavery, and that help to ensure the reproduction of whatever is materially essential for the Greek way of life.⁵

But this passage opens itself up, from the outset, to a pair of conflicting interpretations. We can read it, on the one hand, as a ‘*reductio ad absurdum*’, in which emancipation is conditioned upon a technological situation that Aristotle takes as clearly belonging to the realm of fantasy. Or, on the other hand, we can take it as describing what Aristotle takes to be a ‘really possible’ world, within the reach if not of present, then of future – or past – technological development. I will be arguing for a nuanced version of the second of these alternatives – that Aristotle did see automata as presenting a real possibility of liberation, that they counted for him as a kind of technology that was at least possible, if it was not yet real.⁶

The evidentiary value of this passage, and therefore of the interpretive work that I am going to perform on it, might be challenged on the grounds that whether Aristotle believed in robots, and whether ‘the Greeks’ did, are very different questions. So I should begin by explaining why I think such an elision is in this case permissible. What I take to be my *demonstrandum* is that Aristotle, in the passage I have cited, regarded robots as plausible – and I do not think that plausibility can be understood as an individual phenomenon. Plausibility happens at the level of culture, and it is a characteristic of what Paul Veyne has called ‘the constituent imagination’ – the field of collective beliefs that defines, in a given society and at a given point in time, what sort of things can happen. That is, the conditions that made robots plausible for Aristotle should have held for his contemporaries too. We should review these now, so that later on we can have a clear idea of what these Aristotelian, and Greek, robots were imagined to be like.⁷

4 εἰ γὰρ ἡδύνατο ἕκαστον τῶν ὀργάνων κελευσθὲν ἢ προαισθανόμενον ἀποτελεῖν τὸ αὐτοῦ ἔργον, καὶ ὡσπερ τὰ Δαιδάλου φασὶν ἢ τοὺς τοῦ Ἡφαιστοῦ τρίποδας, οὕς φησὶν ὁ ποιητῆς αὐτομάτους θεῖον δύνεσθαι ἀγῶνα, οὕτως αἱ κερκίδες ἐκέρκιζον αὐτοὶ καὶ τὰ πλῆκτρα ἐκισθάριζεν, οὐδὲν ἂν ἔδει οὔτε τοῖς ἀρχιτέκτοσιν ἰπρητῶν οὔτε τοῖς δεσπότηταις δοῦλων. (Arist. Pol. 1253b35)

Translations of Greek are my own unless otherwise noted.

5 For this reading, see Arist. Pol. 1253b15–1254a10 with Berryman (2009) 75 and, more fundamentally, Marx (1976) 532, a passage to which we shall be returning.

6 For some general conclusions regarding the ‘plausibility’ of mechanical hypotheses in ancient philosophy, see Berryman (2009) 201–2.

7 Veyne (1983) 60–68: ‘Ce principe [of probability] permettant également d’épurer le mythe de sa part de merveilleux, il devient possible de croire à toutes les légendes et c’est ce que les plus grands esprits de cette très grande époque [the classical period] ont fait’ (p. 63).

What complex of ideas might have made robots seem possible to Aristotle and, more generally, to ‘the Greeks’? We might begin by speaking of precedents, historical or otherwise. If we believe that a thing has happened before, then, it stands to reason, we might not be shocked to see it happen again. There were plenty of passages in earlier Greek literature that might have been read as describing automata. For instance, the animated guard-dog statues that stand outside Alcinous’ palace at Phaeacia:

On each side there were gold and silver hounds,
immortal and ageless for all time,
which Hephaestus had crafted with intelligent minds
to guard the house of great-hearted Alcinous.⁸

These have a parallel in the golden handmaidens of Hephaistos.⁹ Or, to cite from another author, the animals that Pindar’s Rhodians craft out of metal that has fallen from the heavens:

Owl-faced Athena gifted them with a craft
by which they could outdo all earth-dwellers with their well-labouring hands.
And the roads carried works that were like unto living creatures:
which was a great glory.¹⁰

These examples are not unproblematic. For one thing, they look in some ways more like ‘magical’ living statues than man-made automata; the Rhodians were mortals, sure enough, but they made their robots with a τέχνη that was divine. For another – and this is especially true of the Homeric instances – one is inclined to explain them with reference to a Near Eastern tradition of ‘animate’ guardian statues that was very old even by Homer’s day, and which obviously has nothing to do with ‘mechanical robots’.¹¹

8 χρύσειοι δ’ ἐκάτερθε καὶ ἀργύρεοι κύνες ἦσαν,
οὓς Ἥφαιστος ἔτευξεν ἰδυίησι πραπίδεσσι
δῶμα φυλασσέμεναι μεγάλητορος Ἀλκινόοιο,
ἀθανάτους ὄντας καὶ ἀγήρωσ ἡμᾶτα πάντα (Hom. Od. 7.91–4)

9 Hom. Il. 18.416ff.

10 αὐτὰ δὲ σφισιν ὅπασε τέχνην
πάσαν ἐπιχθονίων Γλαυκῶπις ἀριστοπόνοισι χερσὶ κρατεῖν.
ἔργα δὲ ζωοῖσιν ἐρπόντεσσι θ’ ὁμοῖα κέλευθοι φέρον
ἦν δὲ κλέος βαθύ. (Pind. Ol. 7.91–4)

11 Berryman (2009) 24–8, and compare Helmut Schneider’s remark on these automata: ‘Es existieren aber auch solche Werke des Hephaistos, die ihren göttlichen Ursprung nicht verleugnen können und sich völlig von den Schöpfungen der Menschen unterscheiden’ (Schneider (1989) 23). Cf. Pindar’s eighth paean, in which the divine or magical nature of the statues is clearer; and, on the Near Eastern sources for, and the magical character of, these archaic animated statues, see Faraone (1987). For an account that proceeds without making this distinction, see Hersey (2009).

Accordingly, Sylvia Berryman has argued forcefully in several recent publications on mechanical explanation in antiquity against seeing a prefiguration of later mechanical automata in such fictions. After all, there is nothing obviously mechanical about them, and a good deal, in each case, to suggest divine intervention. She sees an instructive parallel in Hesiod's account of the creation, and magical animation, of Pandora, whom no one has ever taken to be an automaton. Within certain limits, her argument carries conviction: it would be perversely anachronistic, for instance, to suggest that Homer had anticipated by several centuries the discoveries of ancient mechanics.¹²

How a fourth-century audience would have interpreted such passages is, however, a separate question, and it is the salient one for our discussion: was it possible for a Greek of the fifth or fourth century to read these archaic exempla as mechanical rather than magical? That 'mechanical explanations' of a certain sort were available to thinkers of the fourth century is clear from the texts. Aristotle himself stood on the cusp of the ancient 'invention' of mechanics, and, as de Groot has suggested, he may have seen mechanical operations as providing a good model for the workings of living creatures. A much-cited example of such modelling in Aristotle is his discussion of sperm and the embryo in *De generatione animalium*:

It is possible for this thing to move another thing, that thing to move yet another, and for this to be as in a self-moving puppet theatre. For the parts of this have a certain potential, even when deprived of motion; and at once, when one of them is moved from outside, the potential becomes motion. So, just as in the automata, a part moves in some way without being touched at all at present, but having been touched in the past, in this way too the source of the embryo or what made it causes it to move, having been touched by something in the past but not now being touched anymore; in some way the indwelling motion [does work,] just as house-building makes a house.¹³

Here, the supposed capacity of sperm to 'unfold' itself into a complete organism is understood by parallel with an 'automatic' puppet theatre that, once it has been set in motion, continues to operate in a mechanical fashion, without any further human input. Aristotle's word for such a device – *thauma* ('marvel'), a word that Plato also uses to describe a puppet theatre – suggests something of the newness of this invention and the

¹² Berryman (2009) 28 and Berryman (2007) 35–9.

¹³ Arist. *Gen. an.* 734b9–b17:

ἐνδέχεται δὲ τότε μὲν τότε κινήσει, τότε δὲ τότε, καὶ εἶναι οἷον τὰ αὐτόματα τῶν θαυμάτων. ἔχοντα γὰρ πῶς ὑπάρχει δύναμιν τὰ μόρια ἡρεμοῦντα· ὡς τὸ πρῶτον ὅταν τι κινήσῃ τῶν ἐξωθεν, εὐθὺς τὸ ἐχόμενον γίγνεται ἐνεργεῖα. ὥσπερ οὖν ἐν τοῖς αὐτομάτοις, τρόπον μὲν τινα ἐκεῖνο κινεῖ οὐχ ἀπτόμενον νῦν οὐθενός, ἀγόμενον μέντοι, ὁμοίως [δὲ] καὶ ἄφ' οὗ τὸ σπέρμα ἢ τὸ ποιήσαν τὸ σπέρμα, ἀγόμενον μέν τινος, οὐχ ἀπτόμενον δ' ἔτι· τρόπον δὲ τινα ἢ ἐνοῦσα κινήσις, ὥσπερ ἡ οἰκοδόμησις τὴν οἰκίαν.

On this passage see De Groot (2008) 58–62; and cf. MA 701b2–b7.

wonder it could provoke in its audience, a point to which I will return at the end of this article.¹⁴

Before Aristotle, Plato and the writers of the Hippocratic corpus had adumbrated some basic conceptions of mechanical advantage. A metaphor according to which weights ‘draw’ (*helkein*) something, and more weight draws more, appears not only in Aristotle but in Xenophon’s *Memorabilia*, where Socrates uses it in a casual way that suggests it would have been widely understood; such a metaphor seems to me to depend on a prior knowledge of pulleys or winches, both of which we know had long been used by the Athenians for construction and mining. In this intellectual context, it is at least conceivable that Homeric fictions of the sort we have been discussing could be taken as functioning, not by magic, but as the result of mechanistic craft.¹⁵

Aristotle himself would seem to have understood them along these lines, since he cites a pair of eminently mythological comparanda for the automata he describes. I want to look briefly at each of them, by way of suggesting that he did not select them at hazard. Each, in its own way, gestures towards a ‘natural’ robotics that might be produced, mechanically, by men.

Hephaestus’ tripods, in the first instance, stand out among all the archaic descriptions of robots as the only ones not to be cast mimetically in the image of a living creature. Instead, they are made in imitation of a piece of furniture that is itself the product of human art; and they function, ‘mechanically’ as we might say, by the interaction of multiple independently moving parts. Here is a fuller version of the Homeric passage from which Aristotle cites:

She [Thetis] found him sweating and shuttling with haste
about his bellows: for he was crafting twenty tripods
for standing around the wall of his well-built hall,
and he had set a golden wheel beneath the base
of each, so that they could enter ‘automatically’
the assemblage of the gods, then return home again –
a wonder to behold. So far, they were complete,
but he had not yet set marvellous ears on each:
he was joining these now, and cutting the rivets.

14 On the mechanism of the *thauma*, see De Groot (2008) 52ff. Thus Plato (*Lg.* 644d):

περὶ δὴ τούτων διανοηθῶμεν οὕτως. θαύματα μὲν ἕκαστον ἡμῶν ἡγησώμεθα τῶν ζώων θεῖον, εἴτε ὡς παίγιον ἐκείνων εἴτε ὡς σπουδῇ τινι συνεστηκός· οὐ γὰρ δὴ τοῦτο γε γινώσκομεν.

Regarding such things, let us think like this: that each of us living things is a divine *thauma*, made either as their toy or in some serious endeavour: this, we do not know.

It is by no means clear whether this passage carries mechanistic implications.

15 Arist. *Pol.* 1261a25–29; Xen. *Mem.* 6.14–16.

Why, we might ask, would Hephaestus bother to make automated tripods that operated in precisely this way, by composition with wheels? Why not simply enchant a tripod so that it could use its ‘feet’ as feet, and walk? The answer, I would suggest, is that Hephaestus is not envisioned here as ‘enchanting’ his tripods at all: they are machines, built by craft, and operating in an obscure but naturalistic way.¹⁶

The icons of Daedalus, Aristotle’s other exemplum, might seem atavistic by comparison, since they seem to belong to that category of ‘animated’, possibly magical statues of which Homer’s golden handmaidens were an example. They earn a place in Aristotle’s text, I think, because they have been designed and built by a human, and not a god. We might supplement this observation, however, by noting that Daedalan statues were almost a cultural commonplace in fourth-century Athenian literature. They appear twice in Plato (*Men.* 97e–98a and *Euthphr.* 11c); Philippus, a comedian, seems to have given a mechanical explanation of them involving quicksilver – a detail preserved by Aristotle himself, in the *De Anima* (406b17–22). And might we imagine that Aristotle, by citing these statues as comparanda, here enters into a polemic with his contemporary Palaiphatos, who gave a rationalising account of them in his *Peri Apiston*?

It is said regarding Daedalus that he constructed statues that moved by themselves; which strikes me as impossible, for a statue to walk by itself.

But the truth is this. The statue-makers and sculptors of that time sculpted the hands and the feet of their sculptures on one plane. Daedalus was the first to make one foot advance in a walking pose. On this account, men said that ‘Daedalus made this statue walking, rather than standing.’¹⁷

Palaiphatos regards the animation of these statues as incredible – adopting, as Paul Veyne says in his discussion of the passage, a criterion for the plausibility of myths that was generally accepted in the intellectual circles of Classical Athens. A myth was supposed to

16 Hom. *Il.* 18.372–9, with Edwards (1991) *ad loc.*:

τὸν δ’ εὐρ’ ἰδρώοντα ἔλισσόμενον περὶ φύσας
 σπεύδοντα· τρίποδας γὰρ ἑείκοσι πάντας ἔτευχεν
 ἐστάμεναι περὶ τοῖχον εὐσταθέος μεγάροιο,
 χρύσεια δέ σφ’ ὑπὸ κύκλα ἐκάστω πυθμένι θῆκεν,
 ὄφρα οἱ αὐτόματι θεῖον δυσίατα ἄγῶνα
 ἢ δ’ αὐτίς πρὸς δῶμα νεοῖατο θαῦμα ἰδέσθαι.
 οἱ δ’ ἦτοι τόσσον μὲν ἔχον τέλος, οὐατα δ’ οὐ πω
 δαίδαλα προσέκειτο· τά ρ’ ἦρτε, κόπτε δὲ δεσμούς.

17 Pal. *Peri Apist.* 21:

Λέγεται περὶ Δαιδάλου ὡς ἀγάλματα κατεσκεύαζε δι’ ἑαυτῶν πορευόμενα· ὅπερ ἔμοιγε ἀδύνατον εἶναι δοκεῖ, ἀνδριάντα δι’ ἑαυτοῦ βαδίζειν.

Τὸ δὲ ἀληθές τοιοῦτον. οἱ τότε ἀνδριαντοποιοὶ καὶ ἀγαλματοποιοὶ συμπεφυκότας ὁμοῦ τοὺς πόδας καὶ τὰς χεῖρας παρατεταμένους ἐποίουν. Δαίδαλος δὲ πρῶτος ἐποίησε διαβεβηκότα τὸν ἕνα πόδα. διὰ τοῦτο δὴ οἱ ἄνθρωποι ἔλεγον· “ὄδοιποροῦν τὸ ἄγαλμα τοῦτο εἰργάσατο Δαίδαλος, ἀλλ’ οὐχὶ ἐστηκός.”

be plausible, to travesty Veyne, if it recounted the kind of things that still happened; so giants and pegasi were out, but kings, of which there were plenty of contemporary examples, were in. And a myth that did not meet these criteria of plausibility would be rationalised until it did, as Palaiphatos has done to Daedalus' statues.¹⁸

Veyne, as I have said, thinks of educated Greek belief in myth as conditioned by a bare level of 'everyday' experience. Consequently, as Veyne polemically concludes, this belief was entirely *unconditioned* by the social structures and patterns that lay behind that experience. For Veyne, the superstructures of culture go on by themselves, meanderingly, developing according to merely aleatory rules, and entirely independent of what we might loosely call 'infrastructural' relations: those of production, reproduction and distribution. Both these positions are obviously incompatible with my argument, but in any case Veyne gives only a very partial account of the cultural life of myths in Ancient Greece. The passive or neutral reception of myth that Veyne so masterfully describes was supplemented, at Athens and elsewhere in the ancient world, by a kind of *bricolage* through which new myths, or even not-quite-mythical beliefs of the sort that I have been discussing, could be built up. The materials that lay at hand for this *bricolage* were those that had been handed down by the mythic tradition, but also, and perhaps even in the first instance, the material base of social life: just those 'infrastructural' elements that Veyne rules out of court. On one level, these mental building blocks could take the form of material objects, assembled by thought to produce a functioning whole in a way that could be described as 'mechanical explanation'. On another level, too, they might appear as reified social relations, as ways of construing how an imaginary object might 'work' in a given social setting – for instance the thought, already apparent in Aristotle, that robots might take the place of slaves. I will treat both these levels in turn by way of showing how the Athenians invented a robot they could believe in.¹⁹

First, the *bricolage* of base materials, and the various forms of mechanical explanation to which it could give rise. We have already seen, in Philippus' description of Daedalus' statues as powered by quicksilver, one instance of how such a significant, interaction-based account of automata might have been given in fourth-century Greece. We can find a more detailed one, as I will argue, in a passage of the *Politics* from which we have already cited. In the paragraphs surrounding that citation, Aristotle sets forth a schema of manual labour in which *empsycha organa* – labourers or slaves – come together with *apsucha organa* – the means of production, to use an anachronistically Marxian term – to do useful work:

18 Veyne (1983) 60–75, and, on Palaiphatos, 77ff. For a good general treatment of Palaiphatos, see Osmun (1956). The debate surrounding these statues seems to have been decided by the second century CE: note its absence in the second-century 'book of implausibles' presented in Stern (2003).

19 Veyne (1983) 137–8; on *bricolage*, see Lévi-Strauss (1966) 16–21. For the persistence of 'naïve' *bricolage* in literate societies like Greece, see Goody (1977) 140–47. There, intriguingly, the modern mirror-concept of *bricolage* from which Goody does not think primitive *bricolage* can be disentangled is given, not as 'science' (Lévi-Strauss (1966) 16) or 'art' (ibid. p. 21) but as 'engineering' (Goody (1977) 147, fig. 2). Or mechanics?

Of these instruments, some are soulless, some ensouled. (so, to the steersman belong the soulless rudder and the ensouled watchman: for an assistant in the arts is by form a tool): thus the possession is an instrument for life, and property is an assemblage of instruments, and the slave is a kind of ensouled property, and any assistant is a tool in the place of tools.²⁰

His paradigmatic case is instructive: Aristotle describes the steering of a ship as resulting from the combined efforts of a steersman, his lookout man, who is an ‘ensouled instrument’, and his rudder, ‘the soulless instrument’. The instrumental status of these is with reference to the steersman, who, by Aristotle’s logic, would stand in the same relation of ‘ensouled instrumentality’ to the ship’s owner or captain as the lookout man stands to him. What justifies this hierarchy, as Aristotle makes clear elsewhere in his defence of slavery, is that each element in it lacks the deliberative faculty – *logos*, or participation therein – to conduct the *praxeis* of those that stand higher in the ‘chain of command’. Because there are some tasks, like those of the lookout and, implicitly, the steersman, that require a level of deliberative faculty higher than that of a ‘soulless instrument’, ‘ensouled instruments’ are a necessary part of the labouring process. On this model, labour, subordination and slavery appear as necessities.²¹

Aristotle is, evidently enough, building an explanatory model out of elements harvested from the material base of culture. The example of the steersman and the rudder is a favourite of Aristotle’s, who uses it elsewhere to show how a lever can transform a small movement into a large one – thereby generating what we would now call mechanical advantage. Here, too, he seems to want to emphasise the amplificatory effects of ‘organa’ on the directions of a deliberative faculty – in parallel, perhaps, to the body’s amplification of the mind’s intentions, as de Groot and others have argued.²²

How does this work as a ‘mechanistic’ – or even, to make the irresistible pun, a ‘cybernetic’ explanation? The sentence that follows those just quoted marks a key turn in Aristotle’s exposition. He says there that a servant is ‘an instrument in place of several instruments’ – the implication being, as I take it, that servants are to be regarded as

²⁰ Arist. Pol. 1253b4:

τῶν δ’ ὀργάνων τὰ μὲν ἄψυχα τὰ δὲ ἔμψυχα (οἷον τῷ κυβερνήτῃ ὁ μὲν οἰαζ ἄψυχον ὁ δὲ προφεύς ἐμψυχον· ὁ γὰρ ὑπηρετῆς ἐν ὀργάνου εἶδει ταῖς τέχναις ἐστίν·) οὕτω καὶ τὸ κτήμα ὄργανον πρὸς ζωὴν ἐστί, καὶ ἡ κτήσις πλήθους ὀργάνων ἐστί, καὶ ὁ δοῦλος κτήμά τι ἐμψυχον, καὶ ὡσπερ ὄργανον πρὸ ὀργάνων πάς ὑπηρετῆς.

²¹ Arist. Pol. 1254b21:

ἔστι γὰρ φύσει δοῦλος ὁ δυνάμενος ἄλλου εἶναι (διὸ καὶ ἄλλου ἐστίν) καὶ ὁ κοινῶν λόγου τοσοῦτον ὅσον αἰσθάνεσθαι ἀλλὰ μὴ ἔχειν.

He is a slave by nature who can belong to another – wherefore he actually belongs to another – and also he who partakes in *logos* sufficiently for understanding, but does not possess it fully.

Cf. Berryman (2009) 75ff.

²² On Aristotle’s use of steersman metaphors, see De Groot (2008) 53–66 and cf. Arist. *De motu an.* 701b24–27.

composites of all the other *organa* – soulless or otherwise – over which they exercise their deliberative control. So the metaphor of the ship, which in one sense explains the relationship between master and servant, is in another sense wholly internal to the servant himself, who is a whole that consists of predictably interacting parts – an important criterion that Berryman, among others, has advanced for deciding whether an explanation counts as mechanical or not. And it is this assemblage, the deliberative faculty in combination with the several instruments it controls, that Aristotle then, in the very next sentence, uses automata to explain.²³

Such a mechanical conception of labour and subordination, he concludes, can in fact be extended to cover the whole of a household:

But the possession is said to be as a part. For the part is not only the part of something else, but entirely belongs to it: likewise with property. Therefore the master is only the master of the slave, and not his possession; while the slave is not only the slave of the master, but entirely belongs to him.²⁴

The way to understand how a human can ‘belong’ to someone in the same way that, say, a shovel can is to see them both as functioning parts in the whole that constitutes the master. This is what modern philosophers would call a mereological argument, which explains how things exist with reference to the mode of their composition out of parts. The line of mechanistic reasoning in which Aristotle’s robots play a role thus helps raise a culturally specific form of labour relations to the level of metaphysics.²⁵

Aristotle’s argumentation, as I have reconstructed it above, already points us toward that other level of imaginative *bricolage*, the one that constructs imaginary objects not out of ‘material’ objects, but out of reified social relations. Robots, says Aristotle, are a reasonable substitute for slaves; reciprocally, they help Aristotle to explain how slavery works, and why it is necessary. He takes the master–slave relationship – infrastructural in a strong sense for Classical Athens, as Maurice Godelier has argued – and crafting an imaginary object out of it, a substitute slave, the sort of thing that could replace a slave, the sort of thing that a slave therefore is.²⁶

It is worth dilating a little bit more on this point. In Aristotle’s analysis, the slave is an *organon* in the same sense as a spinning wheel or a ship’s rudder: an *empsychon organon*, to be

23 Berryman (2009) 15–20, and cf. n. 24 below.

24 Arist. Pol. 1254a6:

τὸ δὲ κτήμα λέγεται ὡσπερ καὶ τὸ μόριον. τὸ γὰρ μόριον οὐ μόνον ἄλλου ἐστὶ μόριον, ἀλλὰ καὶ ἀπλῶς ἄλλου· ὁμοίως δὲ καὶ τὸ κτήμα. διὸ ὁ μὲν δεσπότης τοῦ δούλου δεσπότης μόνον, ἐκείνου δ’ οὐκ ἔστιν· ὁ δὲ δούλος οὐ μόνον δεσπότητος δούλος ἐστίν, ἀλλὰ καὶ ὅλων ἐκείνου.

25 For a definition, see Howda (2009) 55–63.

26 Lévi-Strauss (1966) 20–21; on the infrastructural relations between slavery and politics in Ancient Athens, see Godelier (2011) 198–206, and Godelier (1977) *passim*. See Fisher (1993) 41–55 and 86–98 for the reasoning behind my ‘maximalist’ approach to Athenian slavery.

sure, but then the emphasis falls on a slave's 'instrumental' quality. The force of the comparison is simply to make a slave's soul appear to be a thing of no importance – and as to a slave's 'humanity', his robotic replacements dispense with that altogether. That the slave's most important qualities are not his human ones is a claim Aristotle stakes explicitly elsewhere in the *Politics*. The substitutability of slaves and robots helps to elucidate a thing generally apparent in Greek philosophical accounts of slavery: namely, that slaves had somehow 'fallen out' of human society and even out of human nature. Replaceability by robots looks, from this perspective, like a special case of the general phenomenon Orlando Patterson, in his broad comparative study of slaveholding societies, calls 'social death'. As Patterson points out, much of the 'cultural' production surrounding practices of enslavement around the globe has been dedicated to making this social fact look like a natural one.²⁷

So for Aristotle, a motivating element in the construction of imaginary robots was precisely that fact of Greek social life that they were meant to elucidate and explain – chattel slavery. Moreover, it is on precisely this point that Aristotle's depiction of automata agrees most closely with those of his contemporaries and predecessors. Plato, as we have said, makes mention of Daedalus' statues in a couple of places; in the *Meno*, where he describes them most extensively, he compares them to 'drapetoi anthropoi', which is to say, runaway slaves. Not insignificantly, he is using them as a simile for *doxa* without understanding, a state of knowledge not dissimilar to the 'participation in logos without understanding' that characterises a natural slave on Aristotle's definition.²⁸

Crates, a comic playwright of the mid- to late-fifth century, deployed the same constellation of ideas in a passage of his *Therioi* that might well have inspired Aristotle's excursus:

A: So, no one shall have a man or a lady slave, but every old man shall serve himself himself?

B: No, not at all. I shall make everything walk by itself.

A: What good will that do them?

27 For the non- or quasi-human status of slaves in the Aristotelian tradition, see *Pol.* 1254a17–1255a2 and *Ec.* 1341a23–1341b21; after having defined the 'human part' of the household, the text begins its discourse on the 'property component' by discussing chattel slaves. But cf *Pol.* 1260a31–1260b7 for some remarks of another tenor that are, as Nicholas Smith has recognised, difficult to reconcile with Aristotle's general argument regarding natural slavery: Smith (1983) 121–2. On the concept 'social death', and for some of the cultural practices it could generate, see Patterson (1982) 38–76.

28 *Plat. Meno* 97e–98a:

Have you not reflected upon the statues of Daedalus? To acquire one of his masterworks when it is not bound is of no great value, like a runaway slave – for it will not stay in place – but to acquire a bound one is valuable indeed: for the work is exceptionally lovely. To what intent do I say these things? With regard to true opinions. For true opinions, for as long as they stay in place, are a beautiful possession and work all to the good.

cf. *Euthyph.* 11c and see, for Aristotle's discussion of a slave's relation to logos, n. 21 above.

B: Each article of furniture will come when he calls it. Place yourself here, table! You there, get yourself ready! Knead, oh kneading trough. Fill up, ladle! Where's the cup? Go wash yourself.²⁹

In the section of the *Deipnosophistai* that preserves this passage, Athenaeus gives a number of parallels from the fifth and fourth centuries that make the obviation of slavery by automation look almost like a trope of Greek comedy; they extend it, indeed, not only to furniture but even to fish, sausages and barley-cakes. In this context, automata seem not just plausible, but deeply attractive. They seem to show a way out of the major structuring conflict of urban Greek political life.³⁰

I conclude, then, that the Greeks *did* believe in their robots. Automata had mythic precedents and the rudiments of a mechanical explanation working in their favour; finally, they answered serious questions of a political and economic order. They were the kind of objects that a culture could invent to explain itself to itself, and that it could use to express its utopian wishes. Why, then, did these wishes come true in a way that jarred utterly with what a reader of Aristotle, or indeed anyone who had seen the *Therioi*, would have expected?

In the Hellenistic period and after, when the science of mechanics had developed a working knowledge of gearing, pneumatics and leverage that permitted the construction of working automata, the technical know-how that might have gone towards creating Aristotle's animated tools appears to have gone instead towards orchestrating impressive parade floats. Here is one early instance, from the reign of Ptolemy II:

There followed a statue of Nysa . . . that stood up by a mechanism, without anyone touching her, and, having poured out milk from a golden phial, sat down again. In

²⁹ Athen. *Deip.* 6.267e:

{A.} Ἐπειτα δούλον οὐδὲ εἷς κεκτήσεται οὐδὲ δούλην,

ἀλλ' αὐτὸς αὐτῷ δῆτ' ἀνὴρ γέρον διακονήσσει;

{B.} Οὐ δῆθ' ὀδοιποροῦντα γὰρ τὰ πάντα ἐγὼ ποιήσω.

{A.} Τί δῆτα τοῦτ' αὐτοῖς πλέον; {B.} Πρόσεισιν αὐθ' ἕκαστον

τῶν σκευαρίων, ὅταν καλῆ τι παρατίθου τράπεζα:

αὕτη παρασκευάζει σαυτήν. Μάττε θυλακίσκει.

Ἐγγχει κύαθε. Ποῦσθ' ἠ κύλιξ; Διάνιζ' ἰούσα σαυτήν.

³⁰ cf. Athen. *Deip.* 6.268a and, intriguingly, Arist. *De An.* 406b16:

ἐνιοὶ δὲ καὶ κινεῖν φασὶ τὴν ψυχὴν τὸ σῶμα ἐν ᾧ ἐστίν, ὡς αὐτὴ κινεῖται, οἷον Δημόκριτος, παραπλησίως λέγων Φιλίππῳ τῷ κομφοδοδιδασκάλῳ φησὶ γὰρ τὸν Δαίδαλον κινουμένην ποιῆσαι τὴν ξυλίην Ἀφροδίτην, ἐγγέαντ' ἄργυρον χυτόν:

Some say that the soul moves the body in which it is just as it itself moves about: for example Democritus, speaking more or less as Philippus the comic playwright does. For he says that Daedalus made his wooden Aphrodite move by pouring in quicksilver.

On the 'liberating' power of cyborgs to de-structure social divides, see Lively (2006) 283–7.

her left hand it held a thyrsus adorned with ribbons. And she was crowned with ivy made of gold and with grape clusters made from gemstones.³¹

If a robot like this could do useful symbolic work, it hardly fulfilled the revolutionary promise of the automata envisioned by Crates and Aristotle. Automata were to become, instead, a standard element in the apparatus of Hellenistic rule. These were *thaumata* indeed, designed, like their predecessors the puppet theatres, solely to impress. Another Veynian concept, this time one with which I have no quibbles: these automata were part of the *apparatus* of Hellenistic kingship, one of those trappings of power that *did* nothing, that only communicated the cold ‘facts’ of power relations.³²

In this narrative, everything happens as if the ‘realisation’ of robotics had thrown cold water on a tradition of wild speculation about the possibilities embodied in a technological advance that had been conceptualised but not yet achieved. I am sceptical of such an explanation for many reasons, but chiefly because it does not account for what we have seen was a decisive change in the political and class valence of automata – from liberators of slaves to tools for monarchical rule. What iron law of progress guarantees that a ‘disappointing’ but real technology should become the property of kings, while the radical hopes expressed in science fiction should belong to the masses?

Actually, the reasons for this disappointment are exactly the ones that Marx foregrounded in his commentary on the Aristotle passage with which I began this article. Anyone can own an imaginary robot – or, I suppose, in Marx’s day, an imaginary steam-powered loom – but, when it comes to building the real thing, technology follows capital, or power, to use a less anachronistic and more general term. Machines that could liberate if they were common property become, in the hands of a few, new tools for subjection. The Greeks’ faith in their robots was betrayed by this iron law of economics: technological development tends

31 Athen. *Deip.* 5.198f:

ἐφ’ ἧς ἄγαλμα Νύσης ὀκτάπηχου καθήμενον, ... Ἀνίστατο δὲ τοῦτο μηχανικῶς οὐδενὸς τὰς χεῖρας προσάγοντος καὶ σπείσαν ἐκ χρυσῆς φιάλης γάλα πάλιν ἐκάθητο. Εἶχε δὲ ἐν τῇ ἀριστερᾷ θύρσον ἐστεμμένον μίτραϊς. Αὕτη δ’ ἐστεφάνωτο κισσίνῳ χρυσῷ καὶ βότρυσι διαλίθοις πολυτελέσιν.

32 On the *apparatus*, see Veyne (2002) 5–12. For another amusing example of Hellenistic robotics, see Polyb. 13.7:

He built a kind of machine – if it is right to call this a machine. For it was in the form of a woman, all dressed up, and in appearance it was not unlike Nabis’ wife. Whenever he called out some of the citizens from whom he wished to squeeze some cash, he began by setting forth his request in long and friendly speeches ... if anyone, shaking his head, refused the command, then he [Nabis] said something like this: ‘Perhaps I cannot convince you, but I think that this Apega shall convince you.’ For this was the name of Nabis’ wife. And when he said this, the aforementioned statue was standing by. And when he had taken her by the hand, after he had got the woman up from her seat and embraced her with his hands, he drew her gradually to his chest. Now she had iron hooks all over her hands and breast underneath her clothing, and when he put his hands on her back, then she drew closer and pressed on the one who had been drawn in by certain *organa*, and by this means [Nabis] forced the crushed man to to say all kinds of things.

This robot tax-collector should almost certainly be understood as an imaginary reflection of the many real, but useless, robots that appear in the Hellenistic record; it is almost too allegorical to be true. For a Hellenistic robot that was surely imaginary, see classically Ap. Rhod. *Argon.* 4.1638–86 on Talos.

to magnify, rather than repair, the structural inequalities inherent in a given mode of production. Then, as in Marx's day and now, there were no magic – or mechanistic – bullets for fixing problems of a social order. To say, as Aristotle said, that the only escape from slavery was technological was just the same as claiming – which Aristotle did, notoriously, elsewhere – that slavery was natural, and bound to endure forever.³³

So the explanation advanced by Vernant, Finley and all the rest for classical antiquity's 'technological stagnation' can be reframed, and repostulated, in a way that brings it closer to the truth. In this instance, the social relations produced by an economy based on slavery provided the raw materials for the development in the Athenian cultural imaginary of a piece of technology, the automaton. But this technological advance could only be realised with the help of capital that had been accumulated precisely by individuals and groups exploiting social relations of enslavement. It was, then, necessarily going to be realised in a 'disappointing' form – certainly not in a form that could radically disrupt those social relations, as Aristotle had imagined it doing. The easy availability of slave labour was not what blocked technological development along such lines. The interest of a slave-based economy in its own preservation simply dictated that technologies as expensive and craft-intensive as automation were not going to be used in a revolutionary way.

The implications of this argument extend beyond the field of robotics. In recent years, something of a reaction has set in on the margins of classical studies against the idea of an ancient *bloccage technique*: scholars like Kenneth Greene have argued that the pace of technological advance in antiquity was quite as fast as one could have wanted, all things considered. In support of this contention, they have cited a wealth of newly discovered archaeological evidence that points to extensive Roman use of water mills, to frequent innovations in the design of wine- and oil-presses, and to the institutionalised mass-production of mold-formed pottery after the first century CE. Now, these were technologies to intensify labour, not to replace it. But Greene also presents convincing evidence that, by the end of the second century CE, 'automatic' technology had been

33 Marx (1976) 532–3. For Aristotle's views on natural slavery, see Arist. Pol. 1254a7–1255b23. His first framing of the issue is worth quoting in full, because it deploys a vocabulary to describe 'synthetic' slavery that Aristotle (or one of his followers) elsewhere uses in discussing mechanical devices:

τοὺς μὲν γὰρ δοκεῖ ἐπιστήμη τέ τις εἶναι ἢ δεσποτεία, καὶ ἡ αὐτὴ οἰκονομία καὶ δεσποτεία καὶ πολιτικὴ καὶ βασιλική, καθάπερ εἴπομεν ἀρχόμενοι: τοὺς δὲ **παρὰ φύσιν** τὸ δεσπόζειν (νόμῳ γὰρ τὸν μὲν δούλον εἶναι τὸν δ' ἐλευθέρου, φύσει δ' οὐθὲν διαφέρειν): διόπερ οὐδὲ δίκαιον: **βίαον γάρ.**

To some, mastery seems to be a kind of knowledge, and that, as we mentioned at the outset, home economics and mastery and politics and kingship are all the same thing; but to others it seems that mastery is *para* (against, in addition to, beyond) nature (since slave and free are by convention, but do not differ at all by nature). On which account it is not just; for it is *biaion* (by force, synthetic).

For the use of the bolded terms in the pseudo-Aristotelian *Mechanica*, see Berryman (2009) 44–8. On the narrow orientation of the ancient economy toward increasing surplus extraction rather than overall production, which would have had a decisive influence on the use of technological innovations, see Ste Croix (1981) 39ff. and, from a less statist or elitist perspective, Horden and Purcell (2000) 269–70.

deployed in the mines of Spain: curiously regular impressions on an ore-crushing stone that seem rather more likely to have been made by a repeating mechanical hammer than by the imprecise action of human hands.³⁴

This raises a question. Are the robots that I have been discussing no more than a ‘special case’ of missed opportunity to automate against the background of an ancient technology that could, in fact, deploy complex machines when called upon to do so? I think not. That automation could find an economic niche in (late) antique mining operations only goes to demonstrate my point: it should hardly come as a surprise, in light of the preceding arguments, that expensive and intricate technologies for labour replacement should *only* be deployed in a location that was distant from the main sources of Roman slaves, at a time when the supply of these was shrinking, and in an industry both capital-intensive and notoriously deleterious to the health of its labourers. This was the hard extractive margin of the ancient economy; automation in other sectors, where slaves could be used more efficiently, remained unlikely. Not only robots, but indeed no ancient technology may have been used in a way that would tend to undermine existing relations of production: as the history of nineteenth-century industry also suggests, technology gets deployed to spare the labourers only when cheap labour is in short supply.³⁵

But arguments like those advanced by Greene have not been the only or even the main reason why the question of antiquity’s *blocage technologique* has ceased to interest most historians. Here, I take Horden and Purcell’s curt dismissal of the old debate as exemplary. In a long chapter of *The Corrupting Sea* devoted to questions of technological development, they point out, first, that the distribution and reception of new techniques was a much more important dimension of the history of technology than was a linear sequence of inventions; second, that advances in agricultural technique took place, for the most part, in rural settings where the traces they have left will probably be archaeological rather than literary. So the ancient world was a patchwork of different stages of technological development, and we would be wrong to expect from antiquity the sort of grand narrative of inventors and inventions that was, for the most part, an invention of the Enlightenment. They conclude their discussion by quoting someone else: ‘there is now no place for “antiquisants qui continuent à être frappés du syndrome finleyen de ‘blocage technologique’ du monde Greco-romain,”’ says Raepsaet, a pioneer in the new *histoire des techniques*.³⁶

34 Greene (2000) 30–31 and 35–7. On the use of machines for pace intensification rather than labour replacement, see Greene (2000) 42 and Wilson (2002) 5–6. The question of whether technological development of the sort suggested by Greene would really increase overall economic output is tangential to my claims in this paper, but cf. on this point Zelener (2006), who uses a ‘pipeline’ model of production to show that technologically-mediated windfalls at one point in the production process may produce, not overall growth, but simply bottlenecks further downstream.

35 On slavery and other forms of dependent labour as ‘substitute’ forms of technological innovation on a region-by-region basis, see Horden and Purcell (2000) 274–8 and 294–5, an account that I prefer in detail to the less flexible narrative of G. E. M. de Ste Croix (1989) 38–40. On the nineteenth century, see fundamentally Marx (1976) 592–625 alongside Harvey (2010) 213–25.

36 Horden and Purcell (2000) 288–90; Raepsaet (1979) *passim* and Raepsaet (1994) 325–6.

It should be clear from the foregoing pages that, while I accept Horden and Purcell's arguments here, I have reservations regarding their conclusions. A certain kind of technological innovation (or better, development) was going on all through antiquity, far from the gaze of the urban, literate writers from whom I have been drawing my evidence. What I have been trying to suggest is that there were limits to this development, avenues down which 'classical' technology could not advance for reasons that, as I have detailed, were intensely 'social', but which are likely to escape the grasp of social history as it is currently practised. From my point of view, then, the *blocage technique* of the Greco-Roman world remains a very striking problem indeed. It is not, however, a problem of technological history *stricto sensu*. It poses, in an introductory way, what I take to be a broader question: why those cultures of classical antiquity that seem to have been so able to think past themselves failed to realise these imaginings on a technological, or indeed on any other, plane.

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