INTRODUCTION

σῶτ̄ερίας παιδὸς
αὐτοῦ γυναικ[ός]

'(Of) the well-being of his child, himself, his wife' (1093A DVC)

[ν ἦ ἐ]ν τῶι δρυῖ σαμῆόν ἐστι

'[I]s there a sign in the oak' (2519B DVC)

αἰ νικασέω τᾶν δίκ[αν]

'If I will win the dispute' (2521A DVC)

Tantalisingly brief, puzzling in content, largely obscure in context, these inscriptions from the oracle to Zeus at Dodona presuppose various things about the ancient Greek gods.[1] By reaching out to the divine in hope for an answer, the worshipper takes at least four things for granted. First, there are gods. Second, gods and humans are inherently different: the divine is attributed a kind of omniscience which creatures on earth do not have. Third, by appealing to the divine in the hope of receiving an answer, there is an understanding that gods do things in the human world, that they involve themselves in human affairs. While the first and second claims are about divine *ontology*, the third claim centres around divine *manifestation* and is part of a conversation about gods engaging with and presenting themselves to humans. The fourth theological assumption which these ancient oracular inscriptions reveal is predicated on the first three: once ontologically distinct but accessible gods had been postulated, humans devised strategies to experience the sacred. These strategies allowed the supernatural

[1] *Dodona Online* (DOL) is working towards re-editing the Dodona oracular tablets open source and open access. The DVC edition is the combined efforts over decades of S. Dakaris, I. Vokotopoulou, A.-P. Christidis, and S. Tselikas published in 2013. See also Lhôte 2006 and Eidinow 2007.

to be authentically presented to the human worshipper, on the one hand, and offered confirmation to humans that the things they did were noticed by the gods, on the other. The inherent paradox of distance and connectedness between sacred and profane, coupled with the underlying model of reciprocity on which Greek religion was based, might be termed the 'problems of presence' in Greek religion. This book sheds light on how ancient technologies factored in solving ancient Greek problems of divine presence and how this, in turn, shaped religious experience.

Manifesting Solutions

The inscriptions from Dodona were part of a system of oracular consultation which bridged the human and supernatural worlds.[2] Oracular pronouncement was one of many ways of 'linking' the sacred to the human that together constitute the appropriately named 'religion'.[3] Since, for the most part, language is effective in creating and sustaining contact between humans, it is not surprising that it is also adopted to communicate with the divine. Partly because of a Judaeo-Christian bias towards the primacy of language as a means to connect with the sacred, and partly as a result of the 'cultural turn' privileging the immaterial (language, discourse, culture, and values), language has long been studied as a form of mediation between human and divine.[4] Scholars of ancient religion are happy to talk about different practices of human–divine communication in a way that prioritises language, speech, and cognition through examinations of the practices of prayer, divination, song, dreams, and, more recently, curses and magic, for example.[5] Broadly

[2] Precisely how the oracular consultation worked at Dodona is not entirely clear. See Parker 2015 for the compelling suggestion that cleromancy was employed. Chapinal-Heras 2021 in his book on Dodona agrees.

[3] The etymological link with *religare*, 'to bind', was already discussed in antiquity; compare Lewis and Short s.v. *religio*. See too the discussion in Beard, North, and Price 1998 (vol. I), 215–19.

[4] Indeed the 'problem of presence' was first coined by Webb Keane 1997 in relation to religious language. On the living presence of the gods in ancient Greece, see Osborne 2014.

[5] Prayer: Versnel 1981; Aubriot-Sévin 1992; Pulleyn 1997. Hymnody: Bremer 1981, 193–215; Furley 1995; Furley and Bremer 2001; Vamvouri Ruffy 2004; Language of dedications: Lazzarini 1976. Divination, dreams, oracles: Struck 2003; Johnston 2008, 2010; Stoneman 2011. Curse: Faraone 1985, 1991; Versnel 1991, 2002; Gager 1992;

speaking, in each of these cases religious language solves the 'problems of presence' by being markedly different to everyday language. The Dodona tablets offer a straightforward demonstration of the way that the intentional withholding of information through enigma and semantic poverty was effective in forging a connection with the omniscient but inscrutable supernatural. In other contexts, it was the polyvalence of religious language which marked it, or the form through which it was delivered, out as distinct.[6]

Unlike the prophecies of the Delphic Pythia – captured for us in ancient texts with their own discursive programmes – the lead tablets from Dodona are resolute in their *thingness*. The 'material turn' has, over the past twenty years, encouraged scholars of ancient religion to consider how visual and material strategies – from cult statues and votive dedications to processions and theatrical performance – worked to mediate between mortal and supernatural realms.[7] Together, these studies have been imperative for expanding our understanding of the range of options that existed in antiquity to forge and sustain divine presence as well as to understand the power of objects to exert agency over humans. Groundbreaking in this approach was Verity Platt's 2011 *Facing the Gods*, which examined, for the first time at monograph length, the visual dimension of divine epiphany in the Graeco-Roman world.[8] In one sense, this study is an extension of such work, introducing the technological as another 'mode' of visual epiphany in antiquity.[9] The end goal of sacred images – solving the 'problems of presence' – is not so different to the aims of the *deus ex machina* (Chapters 1–3), the processional automaton (Chapter 6), or an oracular autophone

Eidinow 2007. Magic: Graf 1997; Gordon 1999; Dickie 2001. See too the essays in Lardinois, Blok and Van der Poel 2011.

[6] For ambiguity in oracular language, see especially Manetti 1993, 14–35; Maurizio 1997; Kindt 2006.

[7] For a general review of the material turn in Classics, see Canevaro 2019. For theories of object agency and their application to the study, see pages 17–21. For further discussion specifically on the cult statue, see pages 57–63.

[8] Offering in-depth examination of issues noted in, for example, Gordon 1979; Gladigow 1985–6, 1990; Van Straten 1992; Platt 2002; Elsner 2007, 289–302; Gaifman 2008; Osborne 2011, 185–215. The epiphanic manifestation of Dionysus through the theatrical mask has held its own, and slightly earlier, scholarly trajectory especially thanks to works of Foley 1980; Vernant 1985, 1990; Frontisi-Ducroux 1991.

[9] On ancient epiphany see too Petridou 2015.

(Chapters 7–8) – but the latter are examples of a specific subset of religious objects which rely on *technical strategies* to achieve this goal. The cognitive challenges that viewing religious technologies entailed, and the epistemological problems that the constructions of these objects posed, are utterly unique.

The more ambitious claim that this book seeks to make, then, is that the relation between 'technical' and 'miraculous' epistemologies in the ancient Greek world was characterised by dialogue rather than conflict. This is to say that the phenomenon traced in this book is not just meant as an additional chapter in manuals on the functioning of ancient Greek religion and the variety of ancient religious media. Instead, I suggest a fundamental paradigm shift in how we think of the constructions of scientific and religious bodies of knowledge in antiquity, as well as the power of technical objects to reflect and to construct theological assumptions underpinning ancient Greek religion. I seek to broaden the focus from the historical usage of individual media to the way that media interact with larger processes of cultural production and with contemporary debates around the success of technological media in knowing, perceiving, and communicating with the divine. In a recent and highly stimulating volume dedicated to the place(s) and role(s) of media theory in Classics, Pantelis Michelakis helpfully defines media as 'concepts of the middle' which combine specific material and technical properties – the 'material hardware' of culture – with the recursive, often embodied practices of different systems of mediation – the 'discursive software' of culture.[10] Indeed, media-theoretical concepts will prove useful to come to grips with the way that religious technologies when understood as media take us beyond representation to a technically informed model of divine ontology that has implications for our understanding of ancient Greek religion.[11]

Technology as *Religio*

Technologies of the divine do more than manifest presence; they fundamentally condition religious experience too. Compare the

[10] Michelakis 2020, 3–4.

[11] Analogous to the way that Platt 2020 argues that understanding seals and their impressions as media has implications for understanding Graeco-Roman aesthetics.

following modern religious contexts: listening to an Islamic cassette sermon in a coffee shop in a lower-middle-class quarter of Cairo; participating in a North American megachurch with flashing lights, amplified music, and visual projections; holding in your hand a brightly coloured, mass-produced chromolithograph of Hindu deities Shiva and Vishnu; sitting in a small, candlelit church where the priest's unamplified voice delivers a sermon and hymns are accompanied by a small organ.[12] All these different occasions are packed full of 'religious technologies' that both shape and are shaped by theological concerns, and that shape religious experience.[13] In each case there are different underlying assumptions about how best to represent and contact the divine and what is appropriate or effective for a spiritual encounter. The snapshots also prioritise the senses in different ways and organise the worshippers' bodies in different ways.[14] In all cases *homo technologicus* has navigated these issues to make the gods present.

Instead of perceiving faith, belief, and spirituality as diametrically opposed to knowledge, reason, and technology, there has been a turn in religious anthropology over the past fifteen years to looking at how these latter factors condition experiences of the sacred. Technology – the quintessential product and tool of the enlightened, rational, modern human – has been shown to be deeply entrenched within religious communities, movements, institutions, and cultural forms. If *modern* technologies create and sustain links between believers and the transcendental, if they organise access to the supernatural, and authorise certain practices of mediation as truthful and valid, one of the basic motivating questions of this study is whether the same can be said of *antiquity*. This is not to fall into a simply instrumentalist – or, worse, technologically determinist – assumption, but it is to

[12] My snippets come from the ever-expanding literature on technology and religious mediation in anthropology. To begin, see Derrida 1996; Van der Veer 1999; De Vries 2001; Stolow 2005; Meyer 2006; Meyer and Moors 2006; Morgan 2008, 2018. The journal *Material Religion: The Journal of Objects, Art and Belief* gives a good representation of the direction of these studies, with the Classical world oddly almost absent from the contributions. On Islamic cassette sermons, see Hirschkind 2006; on Hindu chromolithographs, see Pinney 2004.

[13] On technology and/as/versus religion, see Stolow 2008: 194–5; 2013.

[14] On religious senses, see Harvey 2006; Promey 2014; Conybeare 2018; Laferrière 2019.

acknowledge that religious media affect religious experience. Mediating technologies must be understood not only as tools of transmission or 'intermediaries' but as themselves shaping the content which they transmit, and thus having social, cultural, and religious force in their own right. From a media theory perspective, the idea that religion and technology are fundamentally intertwined is not at all surprising: if media actively constitute culture, then they are also critical to (indeed actually *provide*) the very epistemological and ontological models that inform our relationship to the divine. The task of the historian then becomes to establish how certain material forms are vested with the capacity to render present divine power within a *specific* culture, society, or period. Accepting, inventing, or rejecting a religious medium is not just about representing the divine, but makes a statement about how the supernatural is thought to (be able to) communicate with the human sphere.

The modern occasions adumbrated here aptly demonstrate that every religious system has mechanisms to make its god(s) present to the worshipper. The implication that ancient divine presence is constructed should thus not be seen as impious, or as treating pagan religion as 'primitive' and its worshippers as naïve or credulous. Identifying religious technologies and understanding the discourses within which such technologies are authenticated helps us to understand the peculiarities of religious systems, characterise religious experience under these systems, ascertain shifts over time, and offer explanations for why these might have taken place given other historical factors at play. This study is an inquiry into ancient religion, ancient technology, and ancient history, and is an examination of how these worked together through tracing a single cultural phenomenon: that of technologically manifesting the marvellous.

Defining Ancient Technology

Technology and/as Technē

'Technology', as we use the term today, can refer to a physical object (it *is* a thing one can hold in hand), a process (it can be seen *in action*), and technical knowledge (it describes a specific type of scientific

know-how).[15] These three constituent components – objects, processes, and knowledge – will be drawn into constant conversation throughout the book in order to understand the unique material, discursive, and epistemic qualities of ancient technology. Like religion itself, technology is a social and cultural construct which responds to and within humanity's pursuits of existence.[16] These pursuits can relate as much to subsistence and production as to entertainment, imagination, and enchantment. This latter category – long ago identified and explored by anthropologist Alfred Gell – are the kinds of technologies to which the current work pays most attention.[17] It is in its intention of cognitive acquiescence that technology overlaps with art. Indeed, Gell sees technology *as* art and, thinking in emic terms, art and *technē* cannot be linguistically distinguished in Greek antiquity either. It is due to utterly modern categorisations – ones that take root in the Renaissance – that ancient art and ancient technology have been treated so differently by scholars of the ancient world. While art (and especially a sub-selection of Classical, naturalistic artwork) has been venerated, ancient technology has suffered from a mixture of being ignored, marginalised, and mischaracterised.[18] Yet the fact that artists in Classical antiquity are quite literally 'technicians' is important to demonstrate how much continuity there was between the realms of artistic production and technology, foremost in the context of ancient religion. Both works of art and mechanical objects at times chose to efface their own technical procedures (simple or complex), and at other times were self-conscious about how they came to exist.

As well as serving as a shorthand for the conjunction of objects, processes, and knowledge, another benefit to retaining the modern

[15] I take my lead from the definition in Bijker, Hughes, and Pinch 1987, 4.

[16] On the social constructions of technological systems (SCOT) see Bijker, Hughes, and Pinch 1987; Pfaffenberger 1992; Ingold 1997 (anthropology of technology). Though SCOT has been formative to how I approach technology, this book takes an anthropological approach to technological objects rather than a sociological approach to technological systems. This is in part due to the nature of the ancient evidence, which makes reconstructing the ancient technological system difficult, and in part because I am concerned, above all, with the effect of particular technologies on the viewer/worshipper in a close-grained manner.

[17] Gell 1992, 1998, discussed more fully on pages 17–21.

[18] For the historiography of ancient technology, see Greene 1990, 2008; Cuomo 2007; Devecka 2013. For ancient automata, in particular, see Bur 2016, 10–22.

'technology' is that the term implies a potential for continual advancement. There is a pitfall of anachronism here that must be avoided, and it is one that again points to the difference in treatment by modern scholars between ancient art and ancient technology. As Marcia-Anne Dobres has said, 'technology is an ongoing and unfinished process … through which people, society and materials together weave and re-weave the meaningful conditions of everyday life'.[19] Technology, then, is inherently bound up within an optimistic vision of its own development across time. This is also critical to the model of artistic progression employed in Pliny's *Natural History*, for example, which celebrates the artist as *prōtos heuretēs*, both first 'inventor' and 'discoverer'.[20] Yet this progressive vision is not, I stress, inexorably tied to economics or production. Ancient technicians were in an optimistic tradition of improving each other's technologies *because that is what technology entailed*, not because it would lead to our twenty-first-century notion of 'technological progress' (whatever that means!). Ancient technical writing in antiquity reveals that authors were very conscious of developments of knowledge and of models over time, and that they embraced being a part of this mission. In certain cases, 'progress' was aimed at shooting ballistics further or lifting heavier weights, for example, and there is no doubt that such advancements not just in war and construction technologies, but also in agriculture, transport, and manufacture, linked ancient technological progress with economic productivity.[21] In other cases, however, technological improvements were aimed at novelty in order to keep up the cognitive acquiescence, or 'enchantment', which they intended. This is particularly crucial when constructing a 'miracle'. Often, multiple goals were achieved in one: in the case of the miniature theatre described in Hero's *On Automata*, for example, the final *ex machina* epiphany of Athena was not only mechanically smoother, but also more visually arresting, and thus theologically compelling, than what

[19] Dobres 2000, 4.
[20] On which see Tanner 2006 and compare pages 143–48 on the pneumatically enhanced Bes *rhyton* of Ctesibius described as a *sophon heurēma*.
[21] For the economic effects of Roman innovation, see, most recently, the overview of Flohr 2021.

a predecessor had contrived some three hundred years prior.[22] By putting technology into conversation with religion, then, the book interrogates the character of Greek religion and its propensity for incorporating novelty, especially as it relates to the visual experience.[23] At the same time, another point is being made about the nature of innovation in ancient scientific enquiry: innovation and invention were sought after, but the ultimate goal was not always economic growth or efficiency. This is another way in which we do well to think about art and technology as analogous in the ancient world.

Yet products of mechanical, mathematical, and scientific *technai* in antiquity have a unique relationship to the epistemic content they embody. Thus, in thinking about the complex and highly intriguing distinction between 'art and science' in antiquity, we should also put some emphasis on the fact that as 'epistemic things', technological objects are situated at the interface between the material and conceptual aspects of science.[24] The advent of the laboratory and the formal development of experimental procedure will change the nature of epistemic things dramatically, but even in the ancient scientific context, it is fair to say that, at least as they are represented in ancient technical texts, technological objects resemble reified theorems in a way that artworks do not. Technological objects and scientific instruments are hardware products of conceptual problems being worked through by experiment. This instrumental understanding frames technologies as *man-made* means to an end established *by man*.[25] In its essence, then, technology is both a problem and a solution, and this is what makes it ideal to solve problems of divine presence above all in a religious system which relies on a model of reciprocal call and

[22] Hero *Aut*. 20.2–3 discussed on pages 36–8. I have adopted Grillo's suggestion on the title of this work throughout. For controversies surrounding the title, see Grillo 2019, lxiv–lxxi.

[23] On religiosity and/of archaising style, see Osborne 1985; Elsner 2006; Hölscher 2010; Platt 2011, 115–20. On innovation and tradition in Greek scientific inquiry, see Lloyd 1987, 50–108. On novelty in ancient Greece, D'Angour 2011 demonstrates the delightful paradox of a society who were in some areas deathly conservative and resistant to change, and simultaneously obsessed with novelty and the human efforts and ingenuity that went with this. His model fits well onto an analysis of Greek religion.

[24] On the concept of epistemic things, see Rheinberger 1997, 2010.

[25] Compare Heidegger 1977, 3.

response between god and worshipper. Of course, this is not all that technology is. According to the ancient mechanical tradition, pneumatic objects, for example, are at one at the same time utterly 'frivolous' objects of ludic value, and 'serious' embodiments of pneumatic epistemologies.[26] The importance of play and the playful to both ancient religion and ancient technological epistemologies is a theme that runs through the book, on which more will be said very shortly.[27]

Overall, the similarities between art and technology are embraced and highlighted throughout the study as part of an effort to integrate the latter into explorations of ancient culture which extend beyond the history and philosophy of science. At the same time, acknowledging both how close art sits to technology and how it distinguishes itself helps to demonstrate how widespread the phenomenon at hand is: *technai* and religion is a topic that expands much further than the bounds of the current book. In this, it is my hope that the present discussion will speak to and perhaps even stimulate further work on how ancient religion interacted other branches of *technē*, such as medicine, weaving, music, and architecture, some of which are tangentially touched upon here. Yet what delineates the boundaries of this study are the particular epistemological properties and resultant aesthetic qualities of the technological, and especially mechanical, object and to access these, we are best served by turning to ancient mechanical texts.

Technology and/as Mēchanica

The term *technologia* (τεχνολογία) was not used in antiquity in the ways I have described thus far. A much closer term would be *mēchanica* (μηχανικά) 'the science of mechanics' which, to judge by the disparate testimony of surviving works, was subdivided into topics including ballistics, siege machinery, lifting devices, pneumatics, and automata. In the same way that (the modern term) 'technology' applies both to a branch of knowledge and to an application of such knowledge, the ancient discipline of mechanics was constantly and self-consciously negotiating its

[26] On which see Bur 2022. [27] See pages 23–7.

status between theory and practice.[28] The Peripatetic *Mechanica*, probably from the opening decades of the third century BCE and our earliest extant Greek mechanical text, defines the discipline as follows:[29]

Θαυμάζεται τῶν μὲν κατὰ φύσιν συμβαινόντων, ὅσων ἀγνοεῖται τὸ αἴτιον, τῶν δὲ παρὰ φύσιν, ὅσα γίνεται διὰ τέχνην πρὸς τὸ συμφέρον τοῖς ἀνθρώποις. ἐν πολλοῖς γὰρ ἡ φύσις ὑπεναντίον πρὸς τὸ χρήσιμον ἡμῖν ποιεῖ· ἡ μὲν γὰρ φύσις ἀεὶ τὸν αὐτὸν ἔχει τρόπον καὶ ἁπλῶς, τὸ δὲ χρήσιμον μεταβάλλει πολλαχῶς. ὅταν οὖν δέῃ τι παρὰ φύσιν πρᾶξαι, διὰ τὸ χαλεπὸν ἀπορίαν παρέχει καὶ δεῖται τέχνης. διὸ καὶ καλοῦμεν τῆς τέχνης τὸ πρὸς τὰς τοιαύτας ἀπορίας βοηθοῦν μέρος μηχανήν. καθάπερ γὰρ ἐποίησεν Ἀντιφῶν ὁ ποιητής, οὕτω καὶ ἔχει· τέχνῃ γὰρ κρατοῦμεν, ὧν φύσει νικώμεθα. τοιαῦτα δέ ἐστιν ἐν οἷς τά τε ἐλάττονα κρατεῖ τῶν μειζόνων, καὶ τὰ ῥοπὴν ἔχοντα μικρὰν κινεῖ βάρη μεγάλα, καὶ πάντα σχεδὸν ὅσα τῶν προβλημάτων μηχανικὰ προσαγορεύομεν. ἔστι δὲ ταῦτα τοῖς φυσικοῖς προβλήμασιν οὔτε ταὐτὰ πάμπαν οὔτε κεχωρισμένα λίαν, ἀλλὰ κοινὰ τῶν τε μαθηματικῶν θεωρημάτων καὶ τῶν φυσικῶν· τὸ μὲν γὰρ ὡς διὰ τῶν μαθηματικῶν δῆλον, τὸ δὲ περὶ ὃ διὰ τῶν φυσικῶν.

One marvels at things which happen according to nature insofar as the cause is unknown, and at things which happen contrary to nature, achieved through *technē* for the benefit of humanity. For in many cases nature produces effects against our advantage; for nature always acts consistently and simply, but our advantage changes in many ways. When, then, we have to produce an effect contrary to nature, we are at a loss, because of the difficulty, and require skill (*technē*). Therefore we call that part of skill which assists such difficulties, a *mēchanē*. For as the poet Antiphon wrote, this is true: 'We win through *technē* where we are beaten by nature.' Such is the case when the lesser overcomes the greater, and things possessing little weight move heavy weights, and all similar devices which we term mechanical problems. These are not altogether identical with physical problems, nor are they entirely separate from them, but they have a share in both mathematical and physical theorems, for the method is demonstrated by mathematics, but the practical application belongs to physics.[30]

Mechanics, according to this text, has certain key features: it is inherently man-made and requires ingenuity and skill; it enables acts contrary to the natural order which solve human predicaments; it is embodied in a device (*mēchanē*); it is often counter-intuitive in what it allows; it lies somewhere between theoretical mathematics and practical physics as a discipline. Many of these

[28] On ancient machines between words and acts, see Asper 2017.
[29] Issues of dating: Winter 2007; Wilson 2008, 338; Berryman 2009, 106–14.
[30] Arist. *Mech*. 847a.

qualities speak overtly to the definition of 'technology' proposed earlier, most conspicuously in the fact that it describes the application of human knowledge to the construction of an object (*mēchanē*) which *does* things (solves problems).

Mark Schiefsky has made a compelling case for understanding *para physin* in the *Mechanica* not strictly describing effects 'contrary to nature' (in the sense that they are magical or *super*natural, for example), but effects 'beyond nature' in the sense that they would not be possible without the intervention of art.[31] The idea that *technē* provides the necessary intervention to achieve something beyond what nature alone is capable of is very pertinent here. Communication with the supernatural is a clear example of such an *inter*vention. The *inter* prefix deserves stressing for the way it brings up, yet again, issues of communication and transmission between parties, particularly parties of different ontological statuses. This is at the very core of what media do: they 'filter the symbolic from the real, or messages from channels full of noise'.[32] The mechanical object does not *become* the supernatural, but it is a channel of transmission reliant on technical properties to achieve an end goal that lies outside the 'regular' sequence of cause and effect typically supported by nature.

In the centuries that followed the composition of the *Mechanica*, Hellenistic and Roman authors produced technical texts of many sorts which each had a stake in appropriating, expanding, delineating the discipline of mechanics.[33] In the early fourth century CE, Pappus of Alexandria usefully redefines the discipline in the opening of the eighth book of his *Synagoge*:[34]

[31] Schiefsky 2007. Compare the discussion in Berryman 2009, 3, 44–53, 236–49. I do not go quite as far as Schiefsky in seeing automata-building as a craft that seeks to imitate nature, however, as I would stress the ability of these objects both to aim at *mimesis* and to keep their status as a crafted construct. Relatedly, Schiefsky argues that once scientifically demystified, there is no wonder left in the mechanics and in the mechanical object, which for me assumes an erroneously binary understanding of viewing and viewership. For more on 'the importance of the construct' in religious technologies, see Bur 2024.

[32] Siegert 2015, 15.

[33] On the development of mechanics and/in philosophy, see Berryman 2009. On mechanics, philosophy, and wonder, see Tybjerg 2003.

[34] On Pappus and his context, see Cuomo 2000.

Ἡ μηχανικὴ θεωρία, τέκνον Ἑρμόδωρε, πρὸς πολλὰ καὶ μεγάλα τῶν ἐν τῷ βίῳ χρήσιμος ὑπάρχουσα πλείστης εἰκότως ἀποδοχῆς ἠξίωται πρὸς τῶν φιλοσόφων καὶ πᾶσι τοῖς ἀπὸ τῶν μαθημάτων περισπούδαστός ἐστιν, ἐπειδὴ σχεδὸν πρώτη τῆς περὶ τὴν ὕλην τῶν ἐν τῷ κόσμῳ στοιχείων φυσιολογίας ἅπτεται. στάσεως γὰρ καὶ φορᾶς σωμάτων καὶ τῆς κατὰ τόπον κινήσεως ἐν τοῖς ὅλοις θεωρηματικὴ τυγχάνουσα τὰ μὲν κινούμενα κατὰ φύσιν αἰτιολογεῖ, τὰ δ᾽ ἀναγκάζουσα παρὰ φύσιν ἔξω τῶν οἰκείων τόπων εἰς ἐναντίας κινήσεις μεθίστησιν ἐπιμηχανωμένη διὰ τῶν ἐξ αὐτῆς τῆς ὕλης ὑποπιπτόντων αὐτῇ θεωρημάτων.

The mechanical enquiry, Hermodorus my son, has many and important uses in practical life, is rightly held by philosophers to be worthy of the highest esteem, and is zealously studied by anybody interested in learning because it takes almost first place in dealing with the natural enquiry about the matter of the elements in the universe. For theoretical [mechanics] investigates the causes of rest and local motion of bodies, and their movement in space, in their generalities, and not only investigates the cause of whatever moves according to nature, but also moves what goes forcibly against nature from its own place towards a contrary motion; and it contrives to do this by means of enquiries originating from that matter and appropriate to it.[35]

Some six hundred years after the Peripatetic text, the field of mechanics as described by Pappus still ambiguously integrates practice and theory (both philosophy and mathematics). The discipline is still seen as beneficial for humans and is considered to deal with motions contrary to nature. Using examples of known texts from named predecessors, Pappus goes on to describe the branches subsumed within ancient mechanics through an explanation of who was considered a *mēchanikos*, a 'mechanician'. Presented in hierarchical order, we hear first of those who constructed weightlifting devices, then war engines (especially ballistics) and water-lifting machines. There follows an array of activities which fall under the purview of *thaumasiourgoi*, 'wonderworkers':

καλοῦσι δὲ μηχανικοὺς οἱ παλαιοὶ καὶ τοὺς θαυμασιουργούς, ὧν οἱ μὲν διὰ πνευμάτων φιλοτεχνοῦσιν, ὡς Ἥρων Πνευματικοῖς, οἱ δὲ διὰ νευρίων καὶ σπάρτων ἐμψύχων κινήσεις δοκοῦσι μιμεῖσθαι, ὡς Ἥρων Αὐτομάτοις καὶ Ζυγίοις, ἄλλοι δὲ διὰ τῶν ἐφ᾽ ὕδατος ὀχουμένων, ὡς Ἀρχιμήδης Ὀχουμένοις, ἢ τῶν δι᾽ ὕδατος ὡρολογίων, ὡς Ἥρων Ὑδρείοις, ἃ δὴ καὶ τῇ γνωμονικῇ θεωρίᾳ κοινωνοῦντα φαίνεται.

[35] Papp. 1022–3. Translation adapted from Cuomo 2000, 93.

The ancients also call mechanicians the wonder-workers, of whom some practice their art by means of air, as Hero in *Pneumatica*; some by means of strings and ropes, thinking to imitate the movements of living things, as Hero in *Automata* and *Balances*; others by means of floating bodies, as Archimedes in *On Floating Bodies*, or by using water to tell the time, as Hero in *Hydria*, which clearly has affinities with the science of sun-dials.[36]

Thanks to his overt absorption of the tradition which precedes him, Pappus' text thus offers a helpful bookend to understand the trajectory of ancient mechanics. Despite individual authors' takes on the relation between the theory and the practice in the intervening period, we can take Pappus as evidence first, that both proofs and applications were part of the ancient understanding of mechanics and, second, that technologies of enchantment constituted a very real, contemporary category of the ancient mechanical art.[37] While the first observation helps to formulate the boundary between art and mechanics, the second affirms their relatedness in spite of such differences.

Two final observations remain. First, the Peripatetic *Mechanica* may be the earliest text *in* mechanics, but this does not make it the earliest *on* mechanics. Plato's apparent outrage at the corruption of pure geometry by the earliest mechanicians – Eudoxus and Archytas (both dated to the early fourth century BCE) – would indicate that discussion surrounding mechanics preceded its solidification as a discipline.[38] The disdain towards manual labour in certain ancient circles, a conversation within which mechanics was unfavourably embroiled, is less important for our present agenda of defining technology than it is for the way that ancient attitudes towards the *banausic* subsequently impacted secondary literature on ancient technology.[39] This leads to the second, related observation: that machines existed before the discipline of

[36] Papp. 1025–6. Translation adapted from Cuomo 2000, 93–4.
[37] On the importance of sensible perception in pneumatic epistemology, see Bur 2022.
[38] The sources relating this anecdote, however, are late: Diogenes Laertius, *Lives of the Philosophers* 8.83 and Plut. *Vit. Marc*. 14.3–5. For more on the development of the field of mechanics, see Schürmann 1991, especially 33–59; Berryman 2009; Cuomo 2018.
[39] A sample of ancient attitudes collected in Sherwood et al. 2019, 709–31. The modern 'technological *blocage*' mindset and subsequent explanations: Glotz 1926; Louis 1927 (slavery); Vernant 1957, 1965; Finley 1973, 1984 (cultural mindset). Cuomo 2007, 4–5 offers a detailed discussion of the mistaken premises of the technical *blocage* argument. For modern historiography on ancient automata, in particular, see Bur 2016, 10–19.

mechanics. Paradigmatic in demonstrating this fact is, for example, the case J. J. Coulton made in 1974 for the lifting mechanisms available in the absence of the compound pulley for the building of monumental architecture in the sixth century BCE.[40] In general, the work of archaeologists has been paramount to disproving the so-called technological *blocage*, a vision of antiquity as a technologically stagnant place erroneously based on privileging a limited range of literary sources.[41]

That machines existed before mechanics is the kind of claim that underlies the concept of 'cultural techniques' which will prove helpful in coming to grips with the diachronic progression of the phenomenon of manufacturing the marvellous.[42] In the words of Bernard Siegert, 'cultural techniques are conceived of as operative chains that precede the media concepts they generate'.[43] So people wrote before they conceptualised the alphabet and counted prior to formulating ideas about numbers, statues existed before the concept of the image, the act of singing does not depend on knowledge of musical notation, and so forth. Along these lines, I do not seek to trace the involvement of *mechanics* in ancient religion so much as the place of *mechanical technologies*.[44] Crucially, these operative chains of cultural techniques (such as counting or writing) 'always presuppose technical objects capable of performing – and to considerable extent, determining – these operations'.[45] So in the same way that an abacus allows for different calculations than do ten

[40] Coulton 1974.

[41] Wikander 1984 (on Roman water mills), Oleson 1984 (on Greek and Roman water-lifting devices), and White 1984 (a thorough compilation of sources attesting to ancient technological abilities and innovation), all perhaps not so incidentally published in the same year, offered a shift away from the prior assessment of technological stagnation in antiquity. Subsequently, Greene 1986, 1990; Wilson 2002; Cuomo 2007; and the chapters in Oleson 2008 have been important.

[42] Useful overviews of the concept of cultural techniques are offered by Winthrop-Young 2013. Geoghegan 2013 focuses on the debts to and distinctions from Kittlerian media theory.

[43] See Siegert 2015, 11, who leans here on the work of cultural historian Thomas Macho.

[44] In this I depart from the views of Gerolemou 2022 on ancient automation. One of the great virtues of that book is the breadth of conceptual work that Gerolemou allows 'automation' to do. This is in service to a diachronic explanation of a concept which shifts, especially, as the discipline of mechanics formalises. It does, however, risk reducing the story of automation (back) to a teleological one where the Archaic mind only conceptualises of automation as natural, the Hellenistic as mechanical, etcetera.

[45] Siegert 2015, 11.

fingers (than does a computer), the mechanical crane transmits theologies and constructs ideas of divine ontology in different ways than an automaton or an oracular autophone even if they are all technologies of religious media.[46] Each tunes the 'signal' in different ways. Cultural techniques are thus best thought of as a network comprising technological objects as well as the operative chains that they are part of, and that in turn configure or constitute them. Introducing a new media technology, then, does not mean simply inventing new hardware and software, but rather involves *refashioning* this network.[47]

Finding Ancient Technology

If technology denotes objects, processes, and knowledge, and if ancient technology's discursive and material trajectories tell complementary stories, it follows that we must look for traces of ancient technology in the material record, in prose and poetry that attest to and describe use, and in technical manuals concerned above all with construction. The *thingness*, contexts of use, and constructive programme of ancient technologies should be put into conversation if we are to write a cultural history of ancient enchantment technologies. In part this is because working with the full range of sources helps to fill lacunas. If we restricted ourselves to (extant) mechanical texts, for example, the historical picture would inevitably be skewed towards Hellenistic innovation, yet there are ways that intriguing realities can be fleshed out for earlier periods especially once we think of these machines using the framework of cultural techniques. That being said, the extent to which the solidification of the genre of mechanical writing reflects an important historical intensification in use is something that I seek to uncover.

Conversation between source types is also imperative because a single aspect of culture leaves different traces in different sources.[48] We understand ancient Greek catoptromancy differently,

[46] On ancient numeracy being tied to concrete objects such as counters, see Netz 2002.
[47] This is an idea crucial to concepts of *remediation*, first presented in McLuhan 1964 and expanded on by Bolter and Grusin 1999, on which see more on page 40.
[48] We might compare, for example, sacrifice as it appears distinctly in archaeology, epigraphy, and poetry, for which see Osborne 2016.

for example, by contemplating a bronze mirror, interpreting a catoptric manual, and reading about mirror divination as used in a sanctuary described by Pausanias. In all cases, however, the ability of reflection to create an ontological other helps to solve the problem of divine presence for the ancient Greeks.[49] The puzzling inscriptions from the Dodona corpus, with which we began, serve not only as entry points for the discussion of the problems of presence in ancient Greek religion, but also as an analogy for the way that this book approaches its source material on ancient technology when made to intersect with questions concerning ancient religion. It is often about uncovering what the sources presuppose about the divine and the way that human and divine relate to each other, rather than what they describe about the ancient Greek gods.

Accessing Technology's Agency: Gell and Beyond

In exploring technology's ability to manifest the numinous, this study is concerned with the potential of objects to exert agency on human actors, and this leads us to ask how we might access the agency of said technologies. Indeed, we are interested in the agency of a very specific *kind* of object, one which encodes technical knowledge for the purpose of cognitive acquiescence. Most helpful here, among the prolific theories on object agency, is the work of Alfred Gell, who offers an anthropological theory of art expressly concerned with the power of technological objects to enchant.[50] Gell's theory eschews style and aesthetics – traditional paradigms of art history – to prioritise the sense of enchantment that objects embodying technical knowledge and technical processes produced through other means such as function, context, and materiality. Gell's oeuvre as a whole, and especially *Art and Agency*, presented a then novel anthropological approach which treated objects as social agents. Gell looked at the invention, production, and circulation of art objects as sources of and targets for social interactions. In doing so, he shifted the focus from

[49] Further on catoptromancy, see Bur 2020 and pages 113–17.
[50] As opposed, for example, to actor network theory (ANT) and related object-orientated theories which look at the *sociological* agency of technology within a system.

aesthetic preoccupations, centred around what art 'means', to look instead at what art 'does'.[51]

Focusing on what art does is essential when dealing with ancient technologies for which we are almost always reliant on theoretical description or second-hand anecdotal evidence. It is simply the case that we know far more about the construction and/or use and/or perception of ancient enchantment technologies (*how* they worked) than we do about what they 'meant', or at times even what they looked like. This is as true of the tragic *mēchanē* discussed in Part I as it is of various religious technologies presented throughout the course of Part II. While the iconographic meaning (or indeed the precise aesthetic presentation) of Demetrius of Phalerum's automaton snail, used to lead the procession of the Great Dionysia in 309/8 BCE, is likely to be lost forever, for example, there are ways in which we can get at the object's agency, understand its religious impact, and draw conclusions on the concept of mechanical automation within Greek theology.[52] While there are various caveats, treated later in this book, to the blind application of Gell to objects of the ancient world, his model still proves useful for the topic at hand and, particularly in the face of the criticisms made since, I offer here a brief rehabilitation of Gell's theory of object agency as it applies to enchantment technologies.

In an early, often overlooked article which probes the relationship between technology and magic, Gell defines technology as 'the pursuit of difficult-to-obtain objectives by roundabout means'.[53] Immediately, this disassociates technology from the notions of efficacy and economic priorities with which it is so often entangled in the modern mind. Gell then divides technology into three further subcategories: technologies of production, reproduction, and enchantment.[54] This third category groups together technologies which are concerned with human psychology and engineering ways to perceive of reality.[55] If we apply this

[51] Famously termed 'methodological philistinism' by Gell 1992, 42.
[52] Discussed further in Chapter 6 with pages 186–91 on the snail specifically.
[53] Gell 1988, 7.
[54] The technology of enchantment then formed the focus of his 1992 article.
[55] Gell 1988, 7.

definition to the present discussion, the 'difficult-to-obtain objective' is contact with the divine. This is difficult to obtain because it involves crossing metaphysical boundaries, and it must remain difficult to maintain the system's integrity. Gell goes on to describe magic as the symbolic commentary on technical strategies in production, reproduction, and psychological manipulation. 'Magical' ideas, according to Gell, provide the orientating framework within which technical activity takes place, and technological innovations thus occur in the course of attempts to realise technical feats previously considered 'magical'. Configured in this way, the trajectory of the miraculous orients practical technology, and not the other way around. Crucially, Gell points out, 'the defining feature of "magic" as an ideal technology is that it is "costless" in terms of the kind of drudgery, hazards and investments that actual technical activity inevitably requires. Production "by magic" is production minus the disadvantageous side-effects, such as struggle, effort'.[56] This is absolutely essential, for example, to interpret the presence of wheels on Hephaistos' automatic tripods, and specifically the toil involved in their construction.[57] Hephaistos' tripods are pertinently *not* magical, but – arguably – *the* earliest attested technological miracle. It takes a lot of sweaty, physical exertion for the divine blacksmith to forge these objects which are then able to dart around of their own accord. Gell's methodology is useful for the way in which it conclusively dismisses models which rely on primitivism to explain away 'magical' aspects of ancient or non-Western societies, and rethinks the relationship between technology and magic.

In 1992, extending the argument of this earlier piece, Gell explained that the 'enchanting' effects of technology are a direct result of objects as embodiments of technical systems.[58] According to this theory, it is the discrepancy between processes of production and the spectators' understanding of them which

[56] Gell 1988, 9.

[57] See Hom. *Il.* 18.372–9, discussed further on pages 158–9, 165–7. For an excellent synthesis and discussion of the various animated objects of Hephaistos in the *Iliad*, see Gerolemou 2022, 12–23.

[58] 'The technology of enchantment and the enchantment of technology'. See especially Gell 1992. Compare Gell 1998, 68–71.

produces enchantment: the spectator cannot follow the sequence of steps in the artist's 'performance' and as a result falls under the spell of the object.[59] Turning once more to the ancient world, and specifically to ancient technical manuals which present to us the 'invention, production and circulation' of ancient technologies, Gell's theory helps to explain how these object embodiments of technical knowledge exert power over the viewer, thanks to the way that they are construed as having come into the world, or, in Gell's words, their 'becoming rather than being'.[60]

Despite the lasting impact of Gell's work across art history, anthropology, sociology, and archaeology, historians have been eager to point out that Gell's anthropological methodology does not tell us how technical processes of art are conceived of diachronically.[61] Put bluntly, change is not possible under Gell's model of technology and enchantment. Further, there is a heavy focus on 'abduction' – the term Gell uses to designate 'the cognitive operation we bring to bear on indexes'[62] – with little specification of what this abduction actually consists of in relation to individual works of art.[63] In this we are reminded of the general shortcomings of the cognitive approaches to religion or religious anthropology.[64] The underlying notion that cognitive architecture of the brain materially affects the way in which humans learn, think, and behave need not be disregarded entirely, but we must acknowledge, as anthropologist James Laidlaw has convincingly argued, that this observation does not get us very far in constructing a complete or satisfying account of any particular practice, belief, or institution in any particular time and place.[65]

Further, the crucial role played by abduction in Gell's theory has led to criticisms regarding the overwhelming anthropocentricism of the model. Gell admits the agency of objects over a human subject who ultimately remains in charge of conception, production, and cognitive interpretation.[66] It is here that Gell's approach

[59] Gell 1998, 71. On the material culture of enchantment, see recently Morgan 2018.
[60] Gell 1998, 46. Compare pages 138–41.
[61] For the Classical world, see especially Osborne and Tanner 2007; Van Eck 2015. See too Miller 2005; Chua and Elliott 2013.
[62] Gell 1998, 14. [63] See especially Osborne 2007a.
[64] In relation to ancient Greek religion, see especially Larson 2016.
[65] Laidlaw 2007, 211–32. [66] See, for example, Knappett and Malafouris 2008.

diverges sharply from New Materialist models of object agency. The contemporaneous work of sociologists such as Bruno Latour, for example, ran precisely against this grain. Latour's model breaks down the subject–object dichotomy to take seriously the ways in which non-humans shape humans.[67] According to Latour's actor network theory (ANT), every component of the network – whether biological or technical, human or other, natural or artificial – plays a role in the overall functioning of a system. Within archaeology, ANT has been applied most influentially by Ian Hodder to formulate his theory of how things and humans are 'entangled' not just through social webs, but thanks to the very materiality of things.[68] Hodder's reintegration of the *body* of the human and the *thingness* of the non-human is most helpful when thinking about how religious technologies interact with human worshippers and vice versa. Particularly in dedicatory or processional contexts, where the worshipper's body is vital to the integration of the religious technology into the religious act, it proves productive to extend analysis beyond the Gellian framework – from aspects of Latourian ANT and Hodder's entanglements to the 'embodied object' which comfortably combines cognitive and phenomenological experiences under the sensible understanding that experience occurs at the level of both mind and body.[69]

Technology and Epistemology

As we have seen, insofar as this book is about (a specific subset of) objects that create religious aura, it is a book about object agency. Insofar as this book also concerns (a specific type of scientific) knowledge, it is also about epistemology. The supposed conflict between 'rational' and 'irrational' modes of thinking in Classical antiquity provoked intense scholarly debate, especially in the

[67] Latour 1999, 2005. Subsequently Brown 2001, 2003 (literature and culture) and Bennett 2010 (politics) have offered important, complementary angles.

[68] Hodder 2012. For ANT applied to Roman archaeology, see Van Oyen 2015, 2016. For ANT applied to technology and culture in Pharaonic Egypt, see Fitzenreiter 2023. In general, for a new cultural history of objects in antiquity and how these function within ancient culture, see the contributions in Osborne 2022.

[69] As elaborated in Gaifman and Platt 2018. See pages 127–50 and Bur 2022 for the embodied quality of ancient pneumatic epistemology.

turbulent wake of the World Wars.[70] Subsequent conversations problematising the apparent transition from *mythos* to *logos* extended beyond the psychologically inflected anthropology of E. R. Dodds, with explorations of tensions between 'tradition' and 'innovation' spilling over into examining Greek 'revolutions' not simply as a question of mindset, but as manifested across a wide array of cultural forms including politics, art, literature, religion, and philosophy.[71]

In relation specifically to the interactions between 'magic' and 'science', however, Dodds' 1951 *The Greeks and the Irrational* is still the starting point. Dodds' exposé of the Greek irrational mind present in every period of Greek history from Homer to the end of antiquity must now necessarily be tempered by the acknowledgements that while 'science' never supplanted 'magic' – nor 'reason' supplant 'myth' – inquiries recognisable as science and philosophy were developed in a sustained way in the ancient world. The work of Geoffrey Lloyd, in particular, has encouraged scholars to rethink the very categories of 'rational' and 'irrational' – or popular/traditional and philosophical/scientific – and the ways that these 'developed', rationally or otherwise.[72] Lloyd reconfigured what had been set up as an antithesis between 'magic' and 'science' by showing the ways in which, first, the categories were not in themselves unified, and, second, that the traditions in fact developed in analogous ways. On the one hand, traditional/popular/magical thought had its own trajectory based on the models of science and philosophy; on the other hand, Greek critical enquiry had plenty of mystique and mythical components. This allowed Lloyd, among other things, to demonstrate the utter fallacy that

[70] None more influential than Dodds 1951. Two excellent recent discussions from the same volume situate Dodds' work on the irrational within broader scholarly discourse: Parker 2019 deals with the more immediate conversations on ancient Greek religion while Gagné 2019 takes on the mammoth task of 'contextualizing Dodds' work within the broader debates of objects and methods in the field, and look more generally at some of the key currents that animated and divided the study of Greek religion across countries and languages' from 1920 to 1950. Compare the discussion in Tor 2017, 15–19. For an overview of scholarship on 'newness', see D'Angour 2011, 11–35.

[71] On the 'revolution' of ancient science, see Lloyd 1987. On myth and reason, see Vernant 1965; Veyne 1983; Buxton 1999. On Greek cultural revolutions, see Goldhill and Osborne 2006 especially relevant is the contribution of Harrison on pages 124–40; Osborne 2007b.

[72] Lloyd 1979, 1983.

'science' was equated with something clear and unambiguous, as well as to show that 'progress', as identified by the Greeks, could and often did include elaborations of traditional beliefs.

Lloyd's illustrations of the existence of parallel developments within different but contemporaneous epistemological traditions offers a solid basis for searching for a diachronic story of a phenomenon which might otherwise seem inherently paradoxical to the modern mind: the technological miracle. Lloyd's work is thus crucial for the current project which, by considering the interaction of 'technical' and 'miraculous' epistemologies, aims to break down any strict dichotomy between the two and instead to ascertain the ways in which they existed in a cultural dialogue. I am interested in understanding on what terms the technical and religious were made to speak in Classical antiquity. In order to do so, I look at what is expressed theoretically through ancient bodies of technical knowledge, but I also aim to bring these epistemologies to life, observing the ways in which they play out within Greek society and culture from the Athenian stage and the streets of Alexandria to the oracle to Trophonios and the receptive chamber of Lucianic dialogue.

Technology, Religion, and Play

A final theme and theoretical angle running throughout the book is that of play which proves relevant to the current study from two converging angles: the role of play and the playful in ancient Greek religion, on the one hand, and in ancient Greek technological objects and technical epistemology, on the other hand.

Following Louis Becq de Fouquières' 1869 *Les Jeux des Anciens* there was a long hiatus during which time the study of ancient ludic culture did not generate much interest.[73] Some time later, on the theoretical side, Roger Caillois' 1958 *Les Hommes et Les Jeux*, translated into English as *Man, Play and Games* (1961), was written as a very clear response to and expansion of the ideas presented in Johan Huizinga's 1938 *Homo Ludens*. Instead of

[73] For a fuller historiography of ancient ludic culture than I sketch here, see Dasen 2018; Dasen and Vespa 2021. See Hamayon 2016, chapter 1 for the broader anthropological picture.

seeing toys and games as meaningless residues of culture, Huizinga had presented the thesis that culture is derived from play. Caillois celebrated and nuanced this claim, arguing that the structures of play and reality are often identical, but that they always take place in incompatible temporal or spatial domains.[74] Play, according to Caillois, has some key characteristics: it is always free (in the sense that participation is not obligatory), separate (in terms of time and space), uncertain (in terms of result), unproductive (materially speaking), and either governed by rules or make-believe.[75] Given these characteristics, Caillois then formulated a taxonomy of play based around the attitudes and actions of the players. Caillois' four categories of play, *agōn* (competition), *alea* (chance), *mimicry* (make-believe), and *ilinx* (vertigo), have had a lasting imprint in ludic studies. Each category of play also has an internal axis conceived of as a continuum between the two poles of *paidia* (uncontrolled fantasy, carefree gaiety) and *ludus* (which involves effort, patience, ingenuity, or skill). If a kind of play exhibits more features of *paidia* it will have a spirit of improvisation and joy, while play that is more strongly aligned with *ludus* displays 'the taste for gratuitous difficulty'.[76] Even if we recognise that Caillois' study can be overly schematic in much of its categorisations, his explorations of the definitions and functionings of play offered a refreshing perspective which shed light on the complexity of the topic. The fine lines between playing, jesting, mocking, imitating, believing, and make-believing which are explored within *Man, Play and Games* are useful to keep in mind when we encounter ludic culture in antiquity that ranges vastly in character and spirit.

The cultural reach of play, games, and toys in the Graeco-Roman world has begun to receive fresh scholarly attention.[77] Understandably, there is a desire to go beyond Caillois' influential theory of play as expressed in *Man, Play and Games*, which is now some sixty years old and inevitably showing its age: girls play with dolls, boys play with toy planes, cultures aim towards 'civilisation', the Western perspective dominates discussion. The most

[74] Caillois 1961, especially chapter 5. [75] Caillois 1961, 9–10. [76] Caillois 1961, 27.
[77] Especially through the prolific content stimulated by the ERC-funded project *Locus Ludi* (2017–22) led by Véronique Dasen at the University of Fribourg.

problematic element of Caillois' thesis in my eyes is the supposed historical shift from societies dominated by *mimicry* and *ilinx* to those ruled by *agōn* and *alea* the latter of which, predictably, are governed by numbers and science. Certainly, there are ways in which material from the Classical world extends and reconfigures the picture presented in *Man, Play and Games*. Take, for example, Stephen Kidd's 'pleasure-model' of play which proposes that play in ancient Greece was a *state* rather than an *activity*.[78] Kidd reverses the relation between action and mood, suggesting that play activities did not lead to pleasure, but rather that joy and delight led to expression through play (including dance, song, and other delightful activities). Among other things, Kidd's semantic exploration is useful to stress just how broad the term *paizō* was and the equally expansive semantic range of *athurma* and *paignion* 'toys', as well as how often play in ancient Greece related to song, dance, and performance.[79] Still, Caillois' taxonomy is compelling (and, it must be said, does not claim to be comprehensive)[80] and his categories of play have proven to be highly stimulating for the material at hand. The ancient Athenian theatre, where the realms of *mimicry* and *agōn* meet artistic manipulation, forms the backdrop to the entire first part of the book. Further, spectacle and make-believe are as relevant to the deployment of automata in religious festivals discussed in Part II, as to Lucianic satire which forms the basis for the discussion of Part III. If *agōn* in the human realm is a common context for religious activity in antiquity, the figure of the *theomach* discussed at the end of the book offers a unique moment when the competition is against the divine, rather than part of hosting the divine. The aleatoric and combinatorial elements of play as they relate to the theological underlie the discussion of technologies of divination, especially in the manipulation of mathematical probability in astragalomancy. We must not forget, too, the polysemantic qualities of objects such as *astragaloi* and articulated figurines which are both religious technologies and toys. Given that *athurma* derives from the verb form *athurō*, which appears to be a sort of 'whirling', there is something inescapable for the study of Graeco-Roman play about

[78] Kidd 2019. [79] Kidd 2019; compare D'Angour 2013. [80] Caillois 1961, 12–13.

Caillois' *ilinx*. It cannot be coincidence that so many of the toys that trick baby Dionysus are characterised by their spinning quality: ball, spinning top (*kōnos*), bull-roarer (*rhombos*). The wonder that mechanical technologies can induce relies precisely on the kind of instability of perception that forms the core of *ilinx* which exacts disorientating alarm, or what the Greeks termed *ekplēxis*, in the once-lucid mind. It follows that the ludic elements of the phenomenon of manufacturing the marvellous are not frivolous by any means, but form part of its serious theological persuasiveness.

Yet it is not just the overlap of the content and contexts of play and religion that are pertinent, but the fundamental similarities in the *functioning* of play and religion. Roberte Hamayon's observations on the parallels between the player's and the believer's attitudes leads to the conclusion that the effectiveness of play and the persuasiveness of theology are not all that distinct.[81] For that reason, theories of play as make-believe can shed light on the inherently difficult issue of ancient religious belief in which the viewing of religious technologies are inherently bound up. Huizinga already explained how both playing and religious belief imply being 'aware and duped'.[82] Hamayon dissects this idea further and suggests that:

> doubt – a core part of the attitude of belief – plays a part similar to indeterminacy in a game, which explains the variations in a player's commitment. Doubt stretches out in a continuum from a pole of compliance to a pole of detachment. Sliding from one pole to the other, both the believer's doubt and the player's variable involvement become, in a way, the driving forces of a speculative movement that pushes them forward.[83]

This analogous functioning of religious doubt and indeterminacy in games, of belief and play more broadly, will be particularly relevant when, in Part III, we turn to looking at instances where the same technologies that are put to the service of constructing divine presence are presented as potential tools for religious forgery and fraud. It is also a theme that lingers less explicitly throughout the book as a whole given that the unfixed nature play speaks quite

[81] Hamayon 2006. On ritual, play, and belief in early societies, see the contributions in Renfrew, Morley, and Boyd 2017.
[82] Huizinga 1951, 51 'conscient et dupe'.
[83] Hamayon 2016, 6. Compare Hamayon 2006, 446.

directly to the theological adaptability of the religious system of the ancient Greeks.

The ludic is also a driving force in the creation and deployment of many ancient *technai* from music to mathematics and mechanics.[84] We have seen Pappus explain that mechanicians (*mēchanikoi*) in antiquity are synonymous with wonder-workers (*thaumasiourgoi*) when they occupy themselves with mechanical crafts including pneumatics and automata-making, for example. Indeed, in both his text on automata as well as in his text on pneumatics Hero of Alexandria explains that the objects described will cause wonder (*thauma*) and alarm (*ekplēxis*) in the viewer.[85] These qualities speak quite explicitly to two of Caillois' categories of play: vertigo and make-believe. Both pneumatics and automata-making as genres of ancient technical texts describe objects with obvious ludic and especially theatrical qualities. This goes from being as overt as the case of mechanical theatres or pneumatically animated scenes of worshippers engaging in ritual action, to more subtle cases of 'trick vessels' which 'prank' (*empaizein*) unsuspected guests.[86] There is a ludic quality to the descriptions themselves in the sense that the reader 'puzzles' through and it becomes a game to figure out in the mind's eye how the components described fit together. Ultimately, however, if we acknowledge, as I am certain we must, that the objects described were meant for construction, there is a conscious choice being made here about how best to materially demonstrate forms of mechanical knowledge, and the decision falls in the realm of the ludic.

[84] Music and play: D'Angour 2011, 166–70; 2013; see Moseley 2016 for music as a ludic medium 'from Apollo to Nintendo'. Netz 2009 is key on the ludic nature of Hellenistic mathematical proofs. On the playful and embodied qualities of ancient pneumatics, see Bur 2022.

[85] Hero *Aut*. 1.1, 1.7–8; Hero *Pneum*. pr.15–17.

[86] Hero *Pneum*, I.IX Schmidt = 8 Woodcroft. The mechanical theatre was seemingly a typical component of automata-making. We have only the treatise of Hero extant on the topic (where book 2 is dedicated to the mechanical theatre) but can deduce from the text that Philo of Byzantium described a very similar piece in his text some two hundred years earlier. For pneumatically animated scenes which are religious in character: Libations at an altar: Hero *Pneum.* I.XII Schmidt = 11 Woodcroft, II.XXI Schmidt = 60 Woodcroft. Water for ablution: Hero *Pneum.* I.XXI Schmidt = 21 Woodcroft, I. XXXII Schmidt = 31 Woodcroft, compare Philo *Pneum*. 36, 63. Self-opening temple doors: Hero *Pneum*. XXXVIII–XXXIX Schmidt = 37–8 Woodcroft. Figurines dance on an altar: Hero *Pneum*. II.III Schmidt = 70 Woodcroft. For more on pneumatics in manufacturing the marvellous, see pages 127–55.

The Book

To bring all these various strands together, the book is structured in three parts. The first part, 'Greek Tragedy and Mechanical Epiphany' (Chapters 1–3), is based around a single, well-known technological object from Classical antiquity: the theatrical crane or *mēchanē*. Stemming from the paradox that the crane was at one and the same time the paradigmatic divine solution to ancient tragedy and a visually invasive piece of mechanical scenery, I re-evaluate the role of this object on a contextual level, as a part of the religious festival of the Dionysia and as part of theatrical performance, as well as on a discursive level, in individual plays to understand how mechanical epiphany is deployed and manipulated. I see in the tragic *mēchanē* a formative early model of the interaction between technology and religion which, importantly, predates the Hellenistic period and the formal development of the discipline of mechanics. The innate visibility of the *mēchanē* is shown to be integral to the theological work that this cultural technique performs.

Many of the themes and conclusions presented in Part I offer firm anchoring from which to look forwards and backwards as the book progresses and the story unfolds. Part II, 'Technologies and Ritual Experience' (Chapters 4–6), thus takes up two challenges: to demonstrate the use of religious technologies in ancient Greek ritual contexts, and to historicise the phenomenon at hand. Ancient evidence in Part II spans archaic votive objects, technical manuals, historical anecdotes, and Hellenistic epigram and in its breadth attests to a consistency in the sorts of mechanisms used to enhance divine presence over an impressive range of time and space in the ancient Greek world. Equally, the evidence also points to an increase in the degree of independent interest in the mechanisms qua mechanism as time goes by and, crucially, in the theological and political potential of the mechanism.

The third and final part of the book, 'Faking the Gods' (Chapters 7–8), is grounded in an Imperial Greek context and shows how the role of the technological in religious experience is deployed both to resolve and to complicate conflicts of world views so pertinent to the period. Two dialogues of Lucian,

Alexander and *Icaromenippus*, are used as springboards to further explore what happens when technology is no longer put to the service of religion, but instead, the phenomenon of technologically manufacturing the marvellous holds potential to threaten the religious order by falsifying, fabricating and imitating the gods.