Mechanical Miracles:

Automata in Ancient Greek Religion

Tatiana Bur

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Faculty of Arts, University of Sydney

Supervisor: Professor Eric Csapo

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Statement of Originality

This is to certify that to the best of my knowledge, the content of this thesis is my own work. This thesis has not been submitted for any degree or other purposes.

I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and sources have been acknowledged.

Tatiana Bur, March 2016.

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A Note to the Reader

The abbreviations of ancient authors follow *Liddell-Scott-Jones* conventions, or *Oxford Classical Dictionary* as the alternative on the rare occasion. Editions of Greek and Latin texts are as they appear in the *Thesaurus Linguae Graecae* and *Bibliotheca Teubneriana Latina* respectively. In the case of Philo of Byzantium's *Pneumatics*, I have prioritised Carra de Vaux's edition.

I refer to dates using BC and AD to avoid any confusion, and have opted for Latin forms of Greek names. Individual Greek words and very short phrases have been transliterated and I offer $\bar{e}$ and $\bar{o}$ for eta and omega respectively.

Figures 3-22 have been adapted from either Schmidt or Woodcroft except figures 9 and 18 which are from Carra de Vaux and have not been modified. All translations are my own unless otherwise stated.

Introduction

The broadcast of the Super Bowl XLIX is the most watched program in American television history to date. The 2015 game was viewed by an average of 114.4 million viewers in the United States, rising to 118.5 million during the much-anticipated halftime show.[1] The beginning of the entertainment was signalled by a chorus of performers crouching, holding illuminated baubles to form the logo of the sponsor: Pepsi. The first chords of Katy Perry's *Roar* blared throughout the stadium of 70 thousand spectators whose enthusiasm could barely be contained as Perry made her entrance perched atop a giant, golden automaton lion. The monstrous beast was ten meters long and five meters high, articulated at its neck, shoulders, hips, knees and ankles so as to move most convincingly before millions of watching eyes. Theatrically whipping the reins as she belted out her famous tune, Perry's entrance was slow and regal, the animal purposefully placing one giant paw before the other, looking around and flashing its red, LED eyes as it went.

Every year at the Super Bowl, the half-time show is a production in itself. It is a moment where private funds combine with public spectacle to enhance national identity and bolster the cult of popular personality. In formal terms, the Super Bowl is a sporting event, but in practise it has become an occasion for powerful public statements that both consolidate, and at times interrogate, the status quo.[2] Even in the modern age, in a world where technology is so omnipresent that one may dare suggest it has become normalised, the impact of Perry's automaton lion is but one

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[1] Statistics for the Super Bowl are always compiled by the global information and measurement company Nielsen. See Nielsen (2016) *Super Bowl 50 Draws 119 million TV Viewers and 16.9 Million Tweets.* Retrieved from http://www.nielsen.com/us/en/insights/news/2016/super-bowl-50-draws-111-9-million-tv-viewers-and-16-9-million-tweets.html.
See also: NBC (2015) *Super Bowl XLIX on NBC is most-watched Show in US Television History*. Retrieved from http://nbcsportsgrouppressbox.com/2015/02/02/super-bowl-xlix-on-nbc-is-most-watched-show-in-u-s-television-history/
[2] Beyoncé similarly manipulated the cultural potency of the Super Bowl half-time show in her 2016 performance controversially styling her costuming as an homage to the Black Panthers.

example that demonstrates the huge impact of impressive spectacle technology in a politicised and performative forum. The power of awe-inspiring automation technology has been used since antiquity.

The current study takes as its focus ancient machines of self-animation, and the modern anecdote brings into relief a number of issues pertinent to the thesis. What the example does first and foremost is offer a vivid context of deployment. This is worth stating quite explicitly because the context of use is more often than not entirely absent from discussions on ancient automata. Once we move beyond seeing ancient automata as arm-chair inventions, we are able to look at them much more productively as objects suspended in the webs of culture which man infuses with meaning.[3] Following such an approach, a starting point for the thesis was, therefore, compiling the evidence for the use of ancient automata in context. From here, it became obvious that animation technology held a special place in the religious realm, and this then became a natural limit of the project.

There is a great variety of factors that will shape how a viewer reacts to an automaton. Above all, a mechanistic conception of the world, or lack thereof, is likely to change the spectator's visualising of mechanical spectacle. That is to say that understanding the mechanics behind a self-animated machine, or at the very least having a certain amount of scientific knowledge, will make the individual more likely to rationalise the workings of a mechanical miracle. But this is only part of the exploration, and it is really too easily dismissive. More lenses of conceptualisation exist than the simple binary 'mechanistic' and 'non-mechanistic' when it comes to observing the world and its constituent parts. Even despite our supposed 'superior' mechanistic view of the world, the

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[3] An anthropological image which comes from Geertz 1973, 5 for which, conceptually, he leans on the works of Weber. The closest the latter comes to a raw definition of culture is in his essay on objectivity. See Weber 1904, especially 76, 81.

automaton clearly still holds sway in the modern day. It still impresses, it still provokes a reaction that can captivate hundreds of millions of people. So it becomes our task to ascertain what the defining quality of automata – artificial animation – provoked in its audience, and why? The answer that transcends historical periods, I believe, lies in the ability of automata to invoke 'the uncanny'.[4] Interpretation of the uncanny depends, of course, on the webs of culture within which the automaton is suspended at its moment of deployment and this, by essence, is rooted in time and place. In its moment of animation, the automaton becomes a way of fixing an affirmation of a worldview in perceptible form. Thus, the interpretation of 'the uncanny' will depend on the worldview in which it exists. In antiquity, the automaton machine harnesses the perfect point of ambiguity between *technē* and nature. The automaton hence becomes a tangible manifestation of mortal capabilities brushing against divine prerogative. Of course other forms of divine communication offer proof of supernatural involvement in human affairs too. Oracles, epiphany and dreams are some examples, but what the automaton does is bring in the human element, foregrounding the involvement of mortal *technē* to invoke the supernatural presence. In this, the study contributes in an entirely novel way to existing discussions on human-divine relations in ancient Greek religion.

If the power of the automaton resides in its ability to provoke the uncanny in its spectators, and in ancient Greece this notion of the uncanny toys with the threshold between human and divine realms, the sponsor of mechanical spectacle intentionally places himself at that delicate frontier. In the case of the Super Bowl as much as the Great Dionysia that Demetrius of Phalerum hosted in the fourth century BC, the imposing weight of the automaton lies at the heart of a peculiar gift economy established between the sponsor and the spectators. This is not just a practical concern, but an ideological one. The sponsor is essentially taking advantage of the potential not just of the occasion,

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[4] In psychology see Jentsch 1906 and Freud's response 1919.

but of the machine. Where can we isolate exactly what the 'advantage' really is? Their use in sacred spaces such as temples and sanctuaries allows us to understand that automata in antiquity had an ability to invoke a particular type of sacred awe. From there, we see that leaders then capitalised on the religious potential of the machine in the context of the festival.

Though these are the issues at the heart of the thesis, the modern anecdote serves as a tool for tangential explorations too. Perry's lion was made out of reflective gold surfaces and roared, reared on two legs and was accompanied by song, of course. How are aesthetics and sensory experience integrated into ancient automation technologies and to what effect? How does spectacle technology affect the overall mood of the event or space in which they are used? The ancient evidence for the use of automata in religious contexts urges us to think about the 'mood' of ancient Greek religion. Although it is often the starting point as a comparison with modern experiences, worship in antiquity did not have to be, and was not always, solemn. Automata as sacred icons help us access a mood of Greek religion inspired by ingenuity which in turn allows us to form a more complete picture of the divine experience in ancient Greece.

The intention of the thesis is twofold. First, to gather together the evidence which proves that automata were used in religious contexts, and second, to think about their particular appeal for such use. Part I (Chapters 1 and 2) contemplates the concept of automation, both in modern scholarship and in the ancient world. Chapter 1 presents an overview of the way in which ancient automata have been treated in modern scholarship. It points out the curious role that these machines have had since the mid-1980s in trying to move beyond a perceived incapability by Classical societies to produce technological developments – known as the technical *blocage* mentality - highlighting the way in which this has, ironically, merely served to recharacterise said 'blockage'. Chapter 2 then defines an automaton according to ancient ways of thinking. It examines the ways in which

automation of inanimate objects appears in ancient Greek myths and in the ancient Greek imagination more broadly to establish a coherent picture of what viably constitutes an automaton in the ancient mind.

Having undertaken this 'archaeology' of the automaton machine which comes to be manufactured in real life, Part II consists of two chapters which present the ancient evidence for the use of automata in ancient Greek religious contexts: Chapter 3 collects evidence from festival processions, and Chapter 4 considers smaller gadgets grouped together as temple miracles.

Like all projects, the thesis has imposed limits. Though passing mention is made to Roman examples, the study confines itself to religious contexts of the Greek world, and chronologically stops at the Antonines.[5] What the thesis does not attempt to claim is that automata are exclusively used in the religious realm in antiquity. A study is begging to be undertaken on spectacular sympotic vessels that make up portions of both Hero and Philo's treatises on pneumatics and which harness the wonder of spontaneity in a completely different way, for example. Technology used in theatrical performances, a topic already covered in scholarship, is also slightly different and consequently not touched upon here.[6] In the same way that no study on ancient cult statues claims to make statements necessarily transferable to honorific statues in the ancient world, so it is with the present study on automata. Technologies of automation were employed in other domains, but the material gathered together in the present work is unified by a particular interpretative framework. That interpretative framework, encouraged by religious space and occasion, makes the topic of interest here automata as cult objects.[7] The anthropological approach of the thesis means that I am far less concerned, therefore,

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[5] Hence the exclusion of Caesar's funeral automaton for which see App. *BC* 2.20.147.
[6] On the *mēchanē* in particular see Robkin 1979 and Fiorentini 2013. On stage machinery as part of ancient theatre as performance more generally see Taplin 1978; Csapo-Slater 1994 and Rehm 2002.
[7] On the *sacra* being sacred solely by virtue of their location see Smith 1987, 105-106; Iles Johnston 2008, 466-468.

with how the technologies of animation worked in terms of science and mathematics. The more interesting question instead becomes: given that automata are used in the religious contexts presented herein, why is this the case? What is their appeal? What does it tell us about the machine, and about the society which created it?

Part I: Thinking about Automation

Chapter 1/ Eliminating the *Blocage*: Ancient Automata in Modern

Scholarship

Ancient automata have been the subject of remarkably little detailed study. What has been written approaches these machines predominantly from the technological angle and removes the context of use almost entirely from the discussion. This chapter will offer an overview of how ancient automata have been treated in modern scholarship in order to better situate the aims and approaches of the current study.

Technical *blocage*, automata and the history of technology

Any topic which touches on ancient technology must address what has come to be termed the technical *blocage*.[1] This theory, which has now been confidently discredited by a new generation of scholars of ancient technology, rests on the premise that technological progress leads to economic progress.[2] The failure to develop technology on an industrial scale for the construction of labour-saving devices prompted scholars to conclude that something must have been blocking the route to technological development in antiquity and so began the search for what this might have been. In the 1920s, scholars such as Glotz and Louis, writing from an economic standpoint, saw slavery as what limited progress in the ancient world.[3] Jean-Pierre Vernant and then Moses Finley took up the debate from a different angle and explained the perceived technological stagnation through a cultural mindset.[4] Finley and Vernant focused on (predominantly literary) attitudes to technology and ascribed a lack of technological progress in the ancient world to an overwhelming disdain for manual labour.

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[1] The best places to go for discussions on the historiography of technology are: Greene 1990, 2008; Cuomo 2007; Devecka 2013.

[2] For a more detailed discussion of the mistaken premise of the technical *blocage* argument see Cuomo 2007, 4-5.

[3] Glotz 1926; Louis 1927.

[4] Vernant 1957, 1965; Finley 1973, 1984.

All of this supposed 'backwardness' of the ancient Greeks and Romans in regards to technology has now been put to rest. There is perhaps no better testament to this fact than the 2008 *Oxford Handbook of Engineering and Technology in the Classical World.* Peter Oleson states clearly in the introduction that the goal of the volume was to put an end to the myth of technological *blocage* in ancient cultures.[5] It is now the works of the volume's contributors including Cuomo, Greene, Oleson, White and Wikander who typify the current approaches to technology in the ancient world.[6] These scholars have been able not only to show through detailed histories of individual technologies that the ancient Greeks and Romans were far more advanced than previous scholars recognised, but to give nuance to anthropological debates concerning attitudes towards technology and technological determinism in antiquity.

What is most curious for the current project is the peculiar role that automata have played in this backlash against the *blocage* theory.[7] The backdrop of the technical *blocage* debate helps explain the ways in which automata have been variously omitted from or introduced into the discourse on ancient technology, progress and technical mentality. There have been three main approaches to the study of automata in post-*blocage* scholarship, or, better said, three interpretative frameworks through which they have been viewed. These are: i) automata as philosophical tools, ii) automata as toys and iii) automata as scientific tools. All are concerned first and foremost with the technological novelty of these machines; all are a response of some sort against the technical *blocage* mentality;

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[5] Oleson 2008, 6.

[6] Wikander 1984 (on Roman water mills); Oleson 1984 (on Greek and Roman water lifting devices); and White's *Greek and Roman Technology* 1984 (a thorough compilation of sources attesting to ancient technological abilities and innovation) all curiously published in the same year offered a shift away from Finley's prior assessment of technological stagnation in antiquity. Subsequently, Greene 1986; 1990 and Cuomo 2007 have been important.

[7] Lest it lose emphasis as the rest of the chapter unfolds, I must stress that in writing a thesis on spectacle technology in antiquity, I am very conscious that I am able to assume a certain level of technological sophistication as a starting point only thanks to fifty years of scholarship. I can only talk about technologies of entertainment in any serious manner because the discourse on ancient technology now accepts that ancient cultures were, firstly, capable of building these machines and, secondly, that they had an interest in doing so.

and none make any serious claims concerning the context of use of the machines. The three approaches are thematic rather than chronological, which reflects the way in which automata have been treated in parallel by scholars with different interests and different technophilic and technophobic tendencies. These competing claims on the value of technology (existing on occasion in the same chronological period) have marked the historiography of ancient automata more strongly than simply the passing of time.

Automata as philosophical tools

Interest in automata increased noticeably in various epochs in the modern age.[8] The Renaissance, when Hero's treatises were first edited and translated, saw a craze for building pneumatic and hydraulic models inspired by the ancient manuals. But it was the philosophers of the Enlightenment, and in particular their attitudes towards mechanistic physiology and animation, which underpinned a revived 'Golden Age' of automata. Metaphysicians and natural philosophers of the 17th century viewed animal and human bodies as entities constituted by material mechanisms governed by the laws of matter alone. As both Alfred Chapuis and Minsoo Kang rightly state, it was with the works of Francis Bacon and Descartes that automation entered modern philosophy.[9] Thus, automata were used as 'heuristic devices to illustrate the nature of the body, the state and even the entire universe constructed by an engineer-God functioning as the central emblem of the mechanistic cosmos of the classical Enlightenment.'[10] There arose, from then on and extending to the present day, a desire to imitate the natural world through mechanics. Automata suited this end perfectly.

And so, scholars anachronistically ascribed this modern philosophical interest onto the building of ancient automata. Largely repopularising the study of ancient automata in modern scholarship,

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[8] For a thorough treatment of automata in modernity see Kang 2004.
[9] Chapuis 1947, 46; Kang 2004, 175.
[10] Kang 2004, 175.

Derek de Solla Price in a 1964 article published in *Technology and Culture* wrote that 'it seems clear that any interpretation of the interaction between the histories of technology and philosophy must assign a special and nodal role to those peculiar mechanisms designed by ingenious artificers to simulate the natural universe.'[11] De Solla Price is emphatic in his conviction that the existence of automata offers proof that the natural universe was susceptible to mechanistic explication in the ancient mind.[12] From there, he is able to see in automata 'the progenitors of the Industrial Revolution'.[13] The reasoning that technologies involved in automata-making offered later inspiration for industrial progress, though irrelevant here, may well be true. It tells us very little, however, about antiquity.

Knowing the future use of certain technologies reveals nothing on the intent of the construction of ancient automata and it certainly does not take into account the critical consideration of the context of deployment of ancient automata. De Solla Price, and other scholars after him, are retrospectively ascribing an intention behind an invention which cannot be discerned in the way the products were made or used in antiquity. De Solla Price's argument can be seen as a voice against *blocage* theory, and a commendably early attempt to show a level of technological sophistication among ancient Greeks and Romans. His interpretation of automata still has a following. Hélène Fragaki, in a recent work on automata in Alexandria, for example, talks of the way in which automata reveal 'un besoin inné, profondément enraciné dans l'homme, de reproduire l'univers ou d'imiter la vie par des moyens mécaniques, domestiquant en quelque sorte les forces de la nature, comme s'il était l'unique souverain'.[14] The problem is, however, that these scholars are still prioritising technological understanding as the 'natural' understanding of the world. This premise, they share with the *blocagistes.* There is something highly anachronistic in the theological argument that god was a

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[11] De Solla Price 1964, 9.
[12] Contra: See Berryman 2003, 2009 and for more on the debate see *Chapter 2/ Inventing Automation*.
[13] De Solla Price 1964, 10. Cf. Bedini 1964, 24.
[14] Fragaki 2012, 30.

mechanic. A mechanistic view of the world suggests a remote (more Protestant) God who designs the world and then leaves it to run by himself without paying it any further thought. This is not a Greek view, and is inconsistent with the practices that make up Greek religious interactions. The Greeks saw their gods as taking a direct and present interest in their everyday lives, not this kind of 'remote control' from afar.

The viewing of automata as philosophical tools prompts the reflection that study of ancient gadgets in general, would benefit from a firmer separation between ancient automata and ancient simulacra. While debates concerning the ancient 'mechanistic' view of the world may well be applicable to models of the cosmos, and could be potentially applied to research on, for example, the antikythera mechanism or the Tower of the Winds, automata in ancient Greece were not designed as ways to understand the world.[15] Critically, they existed in very different situations. The best proof of this is that no biological models of automated humans are detailed in the technical treatises of antiquity. Instead, what we do get is details of how to make surprising, miraculous temple gadgets and large self-animated shrines. Automata were not meant to imitate life forms; they were meant to be larger than life. One of the best scholars on this point is Monica Pugliara whose monograph is unfortunately difficult to access and as a result is far too frequently omitted from discussions on ancient automata.[16] Pugliara notes that automata are not intended as replicas of reality but on the contrary, that self-animated technologies assist the exaltation of the artificial, the technical gimmick and celebrate the intervention of the human hand in producing wonder.[17]

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[15] See most recently Kaltsas 2012 and Kienast 2014 on the antikythera shipwreck and the Tower of the Winds respectively.
[16] Pugliara 2003.
[17] Pugliara 2003, xxii.

Automata as toys

Around the same time that de Solla Price was expounding a view on automata and ancient mechanistic conception, Robert Brumbaugh published a small book entitled *Ancient Greek Gadgets and Machines,* pleasurable above all the light-hearted curiosity that drives the work.[18] Brumbaugh openly confesses that the book is a work of self-indulgence that celebrates the inventive passion for gadgetry he professes to have shared with the ancient Greeks.[19] He gleefully notes the 'peevish discontent' among historians of technology that the most ingenious mechanical devices were not useful machines but trivial toys.[20] While this entertained Brumbaugh, others such as, recently, Martin Devecka, seem somewhat more displeased that a level of technical ingenuity that might have gone towards creating robots instead went towards orchestrating parade floats.[21] While Brumbaugh limits himself to outlining examples of the gadgetry that exposes the ingenious flare of the Greeks, Devecka goes further in his attempt to explain what can only be seen, once more, as a technological *blocage*. For Devecka, the priorities of Hellenistic kings were the limit to progress, and this progress could well have been the elimination of slaves. If a disdain for labour justified Vernant's argument, Hellenistic patronage forms the basis of Devecka's. In Devecka's history of automata, the machines go from being potential 'liberators of slaves to tools for monarchical rule'.[22] Devecka, however, falls short of demonstrating that mechanical invention ever had the labour-saving or utopia-creating function that he believes the Hellenistic kings were later able to 'pervert'.

The 'automata as toys' approach has the virtue of capturing the ingenious flare of the ancients. It does little, however, to move us beyond the technological *blocage* mentality, merely recharacterising the blockage. That the ancient Greeks had toys, that they were curious, creative and

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[18] Brumbaugh 1966.
[19] See in particular the first chapter 'A Gadget Admirer Abroad' 1-14.
[20] Brumbaugh 1966, 15.
[21] Devecka 2013, 64.
[22] Devecka 2013, 66.

clever are, by and large, things we already knew and for this reason, it is important now to go beyond automata as toys and to study the machines in context to better understand what motivated the creation and use of automation technologies in ancient Greece.

Automata as scientific tools

The last approach to automata, and one that has in fact only emerged relatively recently is perhaps the most anachronistic. That is, that automata were 'armchair inventions' designed merely as a way to demonstrate scientific principles.[23] In the most evident attempt to combat the view that the ancients had no engineering capabilities, automata became proof of a high level of physical theorising which rose above any sort of practical application. As a result, there has been a refusal by these scholars to allow automata to have spectacle as their sole function as if this would devalue the technological brilliance of these machines.[24] Instead, Ctesibius' water-clock and Philo's lamp were nothing but early instances of feedback control and Hero's automata were theoretical demonstration of programming and auto-propulsion.[25] This is very much an example of drawing a nice straight line from past minds to modern mechanics which completely omits the context of use of the inventions from their history. Though such a 'history of innovation' can productively be written,[26] I am less interested here in the impact of mechanical developments, and more concerned with really determining how automata were used in context and what this meant for both spectators and the machine.

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[23] The term is from Wikander 2008, 789.
[24] 'Mechanical automata were not mere toys' Wilson 2008, 361.
[25] Wilson 2008, 361.
[26] See Edgerton 1999 on the history of 'use' of technology versus the history of 'innovation'.

The author of the chapter on 'Gadgets and Scientific Instruments' in the *Oxford Handbook of Engineering and Technology,* is probably the biggest advocate of what we could term the 'hyper-serious' approach to automata. Örjan Wikander states that:

> '[Automata] have often been – and occasionally still are – dismissed as worthless toys or 'marvels' intended to evoke religious awe among the superstitious public. For some time, however, a more serious judgment of automata has prevailed, describing them as object lessons in mechanical and pneumatic principles, rather than as tricks intended to inspire wonder.'[27]

This refusal to acknowledge the place of the wondrous in automata production and deployment is particularly worrying if we consider the explicit purpose statement of Hero of Alexandria's treatise *On Automata Making* which is our only extant treatise on the construction of automata in the ancient world. Hero's text will be dealt with in detail later, and it suffices here to note that he opens his treatise with a declaration that automata are worth making specifically for the wonder they inspire in their viewers.[28] Even Wikander cannot hide from this evidence and he admits a handful of pages later that:

> 'Many automata were certainly intended to cause astonishment, but, as has been pointed out by various scholars, the ultimate intent of these miracles was doubtless to illustrate physical and mechanical principles.'[29]

In a handbook that is relentlessly dedicated to showing and justifying the level of technical ability of ancient cultures, there is a reluctance to acknowledge that automata were technologies for the sake of entertainment as if it devalues them. Ironically, then, the premise behind the notion of the *blocage* persists. Namely, that technology should be used for practical, labour-saving ends unless 'blocked' by some habit or defect. The majority of Wikander's chapter, after quickly dismissing any

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[27] Wikander 2008, 785.

[28] Hero, *Aut.* 1.1 cf. 1.7-8. For more on Hero see below *Chapter 2/ Inventing Automation* and **P5**.

[29] Wikander 2008, 790.

entertainment or spectacular purpose or context to automata, goes on to focus on 'practical applications of the physical principles' that automata illustrated, namely, water clocks, astronomical instruments, and hodometers.

This perception of entertainment technologies as worthless, 'lesser' technologies, or somehow a perversion of the 'proper' use of technology needs to be altered. I am inclined to say that the reverse can in fact be argued. We may look to the modern world for a parallel. Do our entertainment technologies devalue our mechanical abilities? Further, is there not incredible anthropological value in determining what constituted a technological miracle in antiquity? But here, battling against the *blocage* mentality, the handbook is so keen on showing how truly technological the ancients were that, perhaps without realising it, they are simply enriching in various ways the cultural presuppositions that gave rise to blockage theory in the first place.

Wikander goes on to say in his chapter that the inventors of automata were entirely dependent on the goodwill of the court and for this reason they 'masked' their scientific models as machines for entertainment.[30] That engineers and technicians relied on royal patronage in fact makes it more likely that these were technologies of wonder, not less, as these machines became tools used in political theatre.[31] The rhetoric of wonder that surrounds the use and construction of automata cannot be ignored, even by the most avid fans of the hyper-serious approach to automata. If ever there is an acknowledgment of the element of the wondrous and the fact that automata would have been more spectacle and less science, however, there is no consideration of what this means for the

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[30] Wikander 2008, 790.
[31] See below especially **P1-P3** and **P6**.

technologies of automation; both in their use and their spectatorship.[32] That is one of the gaps that this thesis aims to fill.

All three modern approaches to ancient automata, as philosophical tools, as toys and as scientific tools all assume a 'universal mind' that never reaches its full potential in relation to technology. They still ascribe the failure of technology to develop in antiquity as in the modern world (as if the latter were natural) to a mental shortcoming in the mechanicians themselves. Either they were metaphysicians, impractical jokers or feckless academics. All of these approaches are still making excuses for a failure to deploy technological know-how for industrialist purposes and in this, none of them have truly moved past the *blocage* mentality. To truly get rid of the *blocage* mentality, we must let go of the assumption that there is a natural, pre-destined evolution for technology. We must look more closely at the ancient evidence for how the ancients thought.

The question of context

Let us turn now to a few observations on what the relative absence of context of deployment has meant for the history of ancient automata.

To begin, in the historiography of technology in general, Hero of Alexandria, author of our only extant work on automata making, is treated as a reference, and very rarely as an author in his own right. This already limits what we allow ourselves to learn from his work. In using mechanical treatises like any other work of ancient literature, as a text with a literary tradition written by an author with a particular agenda, style and purpose, we are able to draw vastly more informed

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[32] Murphy 1995, 5-6; Chapuis 1947, 7; Berryman 2003, 347 all talk about wonder without further discussion of what this means. Zanker 2004, 117 comes the closest, noting (albeit briefly) that mechanical gadgets were used in the Hellenistic age to add to the impression of a divine presence in temples, shrines, and festival processions.

conclusions about technology and society.[33] As soon as we start to look at ancient technical treatises, not only by Hero, but what we can gather from Ctesibius, pseudo-Aristotle, Philo of Byzantium and Vitruvius we will start to gain a better understanding of the place of the technologies of pneumatics and automation in the ancient world. That is one aspect of historiography that this thesis hopes to address.

If, then, we begin to look at Hero as an author with an agenda who crafts his text in a particular way, the hyper-serious interpretation of automata is instantly discredited. We see very clearly from his texts that machines of automation are not presented to prove a physical property, but instead that the property is presented to explain a miracle. Hero's text forms a large part of the evidence for the thesis and we hope that it will serve to come to an accurate picture of Hero as an author writing in a literary tradition with a distinct purpose and audience.[34]

A notable exception to this trend is Karin Tybjerg's 2003 article 'Wonder Making in Heron of Alexandria'. The focus on 'wonder-making' technologies in this work is unique, and Tybjerg very much wants to point out that authors writing technical treatise were in rhetorical competition with philosophers. Thus, she argues, Hero aims to boost his *technē* by saying that the wondrous effects created by his machines are not to be regarded merely as entertainment but as a form of *metis.*[35] This novel exploration has the virtue of looking at the technical treatise as a piece written by an author with a particular agenda, something which far too often gets forgotten or marginalised for the scientific aspects of such works. [36] Yet Tybjerg does not make a distinction, and this could be

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[33] Serafina Cuomo, perceptive as ever, does note that technical texts are not just about transmitting information, but creating a certain identity for their authors, yet she regrettably does not elaborate further on the topic. See Cuomo 2007, 25.
[34] For more on Hero see *Chapter 2/ Inventing Automation* and **P5**.
[35] Tybjerg 2003, 458-9.
[36] McCourt 2012, 187, for example, who focuses on the mechanisms of movement in Hero's treatise makes clear that the context is outside the scope of his paper.

purely because it is not useful to her piece as it is in ours, between technological treatise and what actually comes into actuality. If it counts for little in rhetoric, as Tybjerg argues, 'mere entertainment' counts for something in history.

As well as contextualising mechanical treatise as a genre, therefore, it is equally important to place automata in their historical context of performance. This does not only serve to better characterise the machines themselves, but it also helps expand our concept of ancient Greek religion. Hugh Denard, for example, is almost alone in his discussion of para-theatrical forms of entertainment that made up ancient Greek festivals, giving us a more complete picture of the occasion.[37] If we consider the context of deployment of ancient automata, we can feed into and support discussions such as Denard's hence better characterising ancient festivals and sanctuaries, and in turn incorporating into discussions the 'ingenuous mood' of ancient Greek religion as a whole.

The last scholar who stands out in respect to a contextual approach to automata, and in fact to technology in general, is Astrid Schürmann. Schürmann's monograph of 1991 *Griechische Mechanik und Antike Gesellschaft: Studien zur Staatlichen Förderung einer Technischen Wissenschaft* focuses on the ways in which the state promoted technological developments, particularly in Hellenistic Alexandria. She thinks about think about the social function of technologies through analysis of the concepts of *technē* and *mēchanē* in Hellenistic antiquity. Schürmann's survey includes typical categories such as war machines, technologies of agriculture, timekeeping devices and other measuring devices, but she also discusses two types of technological uses that are often excluded from discussions on ancient technology: the private arena (the symposium), and the religious arena.[38] Among the religious technologies discussed, Schürmann makes special mention of automata

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[37] Denard 2007.
[38] Schürmann 1991 chapters 4 and 5 respectively.

in festival processions.[39] For this reason alone it is a shame that Schürmann's work, and approach in general, is not more often integrated into scholarship on the subject.[40] For Schürmann, automata were used above all to show the power of the sponsor (or tyrant, as she frames it), and advertise a positive approach to the sciences to gain political favour from the lower social classes who were the technicians. The main problem with Schürmann's thesis is that it overplays the technical mentality of the vast majority of the viewers, and ignores the thaumastic element of the machines. Nonetheless, if we follow a functionalist approach such as that expounded by Schürmann, we do in fact see that the ancient evidence offers proof for the way in which automata enabled certain social and psychological structures to be reinforced through the political use of spectacle machinery. Yet I believe a study of automata in context can take us further than this. The automaton situates the human vis à vis other constituents of the cosmos including the divine. Thus, the machine's contextual deployment allows us to look beyond the way that ritual validates human social structures and social roles, and instead look at a previously untouched aspect of part of Greek religion for what it tells us about religious patterns and religious thought in antiquity.

This Thesis

My aim is to integrate the contextual significance of self-animated machines into the discussion on automata. This will allow us in turn to understand how key the context of deployment is in the conceptualisation of self-animated objects as religious miracles. To do this as transparently as possible, the bulk of the thesis consists of a thoroughly assembled and easily searchable compilation of the ancient sources that attest to the use of automata in religious contexts. Accompanying each of these is a brief commentary pulling out the relevant themes and explaining anything obscure about the source. The testimonia have been subdivided into two sections: processional automata (**P1-P8**) and temple automata (**T1-T11**). I am not trying to claim that all festivals used automata in

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[39] Schürmann 1991, 235-249.
[40] Reference to Schürmann's monograph occurs only once in the *Oxford Handbook of Engineering and Technology in the Classical World.*

procession, or that every temple had self-opening doors. I am trying to show firstly, that the ancient Greeks had, and made avid use of, miracle-invoking technology and secondly, that spectators were sharing a certain reality when they watched these machines at work.

Since, like every history, modern scholarship on automata has been very much affected by our own technophobic and technophilic tendencies over time, this work cannot be an exception. Perhaps it is more useful, then, to anticipate, and acknowledge my own bias. I live in a context which revels in its overwhelming (and often self-professed) reliance on technology. I think in a manner that is affected by the fact that we value technological innovation most highly, at the same time palpably feeling the threat it poses (a post WWII anxiety that will likely never disappear). I write at a unique point in time when we can acknowledge, perhaps more pertinently than ever, that technologies of entertainment can hold huge sway over the masses, are used as political theatre, and when the allure and mystique of invention is tangible and sought-after as much as ever.

Chapter 2/ Inventing Automation: Automata in the Ancient Greek Imagination

Before automata began to be constructed in the ancient world, self-animated objects existed in the ancient imagination. Automation is an enigmatic yet common theme in Greek myth where divine power meets human *technē*; where the strictly miraculous flirts with the mechanical; and where childish wonder conflates with a more confronting type of religious awe. This chapter looks at various examples of self-animated animals, humans, objects, and even landscapes, as they feature in myth, literature and philosophy. This will allow us to refine our understanding of what constituted an automaton in the ancient mind, as well to explore how these machines interacted with ancient conceptions and theories of automation more generally. By examining spontaneous action outside of the historical examples of automata which will be presented later, we will be better equipped to understand the tradition that automata aimed to continue, or at least fit within, both in terms of their construction and deployment. This will in turn allow for a substantially less anachronistic analysis of how they would have been viewed and conceptualised by spectators.

There are a variety of ways one could approach this investigation which, it must be acknowledged, is at best a well-contemplated exploration through semantic space. I have chosen here to begin with linguistics and then extend the picture through an analysis of the semantics of manufactured automation more broadly as the phenomenon features in ancient literature. Interwoven within the exploration will be cases where we see spontaneous action combine with the typically inanimate without the vocabulary of automata necessarily being attached.

Etymology and Morphology

The term αὐτόματον (pl. αὐτόματα) itself is of course a substantive of the adjective αὐτόματος. The adverb αὐτομάτως (or, rarely, αὐτοματεί or αὐτοματί) and the verb αὐτοματίζω also appear in our corpus in related contexts. All these 'automat-' root words are formed from αὐτός (self) and the zero grade root of μέμονα, μέμαμεν (I have in mind, I intend) cognate with μένος (might, life, spirit, intention).[1] It is helpful to know that the second member -ματος is also cognate with the second element of the Latin *commentus* (devised, contrived)*.* The etymology of the word thus foregrounds the notion of independent thought connected to action, particularly in the way that intention precedes or instigates action. This is critical because it avoids thinking of these machines as simply self-moving which has been a pitfall of much modern scholarship dealing with automata. From de Solla Price's early definition of automata as 'devices that move by themselves'[2] and through to, most recently, Serafina Cuomo in the *Oxford Handbook of Engineering and Technology in the Classical World* who defines automata as 'things that move apparently by themselves …'[3] there has been a prioritisation of movement as the defining feature of ancient automata.[4] Though movement is very often the product of the perceived *menos* of the machines, it is more accurate to define automata as self-animated rather than self-moving. These were machines which acted of their own accord in terms of more than just movement, as they often included a range of sensory displays. Hero of Alexandria describes, for example, birds that whistle of their own accord (**T5**) and an organ that plays of its own accord (**T11**). The self-animated shrine of Dionysus (**P5**) combines movement with heat, sound and arguably smell too in its elaborate display. Athenaeus talks of miracle-makers (*thaumatopoioi*) who could make fires combust of their own accord.[5] We will also see in this chapter how landscape features that produce goods spontaneously were considered automata in the ancient

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[1] Beekes 2010 s.v. αὐτόματος.
[2] De Solla Price 1964, 9.
[3] Cuomo 2007, 24.
[4] Examples abound: see also Brumbaugh 1966, 3; Hillier 1976, 12; Humphrey, Oleson, Sherwood 1998, 61.
[5] Ath. 1.19e.

mind. The defining characteristic of an automaton, then, is that the source of animation is not human.

What the etymology of automata also helps foreground is the importance of the relationship between the initial and apparently unprompted intention (*menos*) and the perceptible effect(s) which follow. Ironically, the latter is the only way to guarantee the former, and thus to define an object categorically as an automaton. Aristotle twice uses comparisons to automata in his *Generation of Animals* both of which make a point precisely on this characteristic of the machines. In the first instance he compares automata to the formation of an embryo and in the second, to the movement of animals.[6] In both cases, it is the effect of a single trigger releasing a chain of reactions which is the reason behind choosing the simile as well as the *potentiality* for movement of the parts of the whole when at rest:

> ἐνδέχεται δὲ τόδε μὲν τόδε κινῆσαι, τόδε δὲ τόδε, καὶ εἶναι οἷον τὰ αὐτόματα τῶν θαυμάτων. ἔχοντα γάρ πως ὑπάρχει δύναμιν τὰ μόρια ἠρεμοῦντα· ὧν τὸ πρῶτον ὅταν τι κινήσῃ τῶν ἔξωθεν εὐθὺς τὸ ἐχόμενον γίγνεται ἐνεργείᾳ.

> And it is possible that this one should move that one, and that one the next, and that this should happen just like marvellous automata. For the parts somehow have potentiality while at rest and whenever some external agent should set into motion the first part, straight away the subsequent part will come into actuality.[7]

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[6] Arist. *GA* 734b9-15 and 741b7-10.
[7] Arist. *GA* 734b9-13. Translations of this passage typically replace 'automata' with 'puppets' or 'marionettes' but I see no reason why this should be the case and further, this fails to capture their self-intentioned nature. In the second simile the wording is 'ἐν τοῖς αὐτομάτοις θαύμασι' (741b8-9).

The 'miraculous' chain reaction instigated by an initial force is evidently an important feature in defining automata. It is pertinent to note here that automata were already common enough by the fourth century BC that Aristotle could use the simile easily and naturally in his work. Yet what the passage also betrays is an acknowledgment that despite the potential the parts hold, an external agent is needed for the potentiality to come into actuality. Already, then, when it comes to understanding the action of the machine, the spectator has an active role in speculation and interpretation. Aristotle is not clear about what he conceives this agent to be, but he certainly does not concede that it must involve human interference. We are drawn, then, to move beyond linguistics to ascertain what explanatory framework or frameworks are given to the machines, or perhaps better said to the animation of the machines, in the ancient Greek mind.

Automata in action

In this sense, we are now moving to looking at the semiotics of animation. As part of this transition, it is helpful to view the automaton as a cultural symbol. Adopting Clifford Geertz' sense of the term, 'symbol' here denotes any object, act, event, quality, or relation which serves as a vehicle for a conception. The conception is the symbol's 'meaning'.[8] What we are doing, then, is delving deep into a mindset, floating over an imaginative disposition to decode the meaning of the automaton in the ancient Greek mind. We are asking what 'ideas, attitudes, judgments, longings, or beliefs' underlie the existence of the automaton as an object.[9] For this reason, we will meander quite freely between prose and verse, myth and history. In all contexts and across all periods up to the modern day, animation of the inanimate provokes what in psychology is referred to as 'the uncanny'.[10] We are thus also mapping the topography of cognition and the boundaries of the credible as it relates to

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[8] Geertz 1973, 91.
[9] Geertz 1973, 91.
[10] Jentsch 1906; Freud 1919. On the uncanny and the automaton as a cultural symbol in European history see Kang 2011.

technology and religion for what it reveals about spectatorship and interpretation in ancient Greek culture.[11]

Beginning, as is so often the case, with the Homeric poems we notice perhaps with some surprise that automat- root words appear a mere four times in total in Homer's *Iliad* and not at all in the *Odyssey.* Of the four Iliadic uses, one refers to Menelaus coming unbidden (αὐτόματος) to Agamemnon's side and is thus less directly relevant to our purposes here.[12] Two of the three remaining uses appear in passages which are repeated verbatim and describe the automatically opening doors of Olympus:

αὐτόμαται δὲ πύλαι μύκον οὐρανοῦ ἃς ἔχον Ὧραι,

τῆς ἐπιτέτραπται μέγας οὐρανὸς Οὔλυμπός τε

ἠμὲν ἀνακλῖναι πυκινὸν νέφος ἠδ᾽ ἐπιθεῖναι.

And the automatic gates of heaven which the Horai possessed rang,

to whom great heaven and Olympus are entrusted

both to open the thick cloud and to shut it in.[13]

The fact that the first recorded use of the word *automatos* to describe a manufactured object occurs in a divine context is significant. Homer is explicit in stating that the gates are automatic (αὐτόμαται δὲ πύλαι) and further, he also explains the impetus behind the motion when he elaborates that the

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[11] For the boundaries of the credible as part of the technology of history and history as a genre see Johnson 2013.

[12] Hom. *Il.* 2.408. I say less relevant because there is human agency. But the metaphor relates to the fact that Menelaus came without Agamemnon actively summoning him (i.e. the intention came from within Menelaus himself) and the word is thus used as an analogy to an automaton machine.

[13] Hom. *Il.* 5.749- 51. The formulation is identical at 8.393-5.

doors were essentially possessed by the Horai: the keepers of these gates of Olympus. The illusion of the internally existing *menos* of the action is thus clarified through a divine framework. Doors or gates being thrust open automatically through the supernatural influence of the divine is an image which seems to have captured the ancient imagination more broadly. The first five lines of Callimachus' *Hymn to Apollo* offers a picture of various signs (*sēmeia*) which indicate the god's arrival, followed by an imperative command to the doors of the shrine:

αὐτοὶ νῦν κατοχῆες ἀνακλίνασθε πυλάων,

αὐταὶ δὲ κληῖδες· ὁ γὰρ θεὸς οὐκέτι μακρήν·

Of yourselves now, bolts of the doors, be thrown open,

Of yourselves, locks, for the god is no longer far.[14]

The hymn as a whole opens with a great sense of movement and agitation. Automation forms a particularly vivid part of this imagery, evidently enhanced by the repetition and word placement of the initial spondees αὐτοί and αὐταί.[15] The context of performance, real or imagined, for this mimetic hymn would be a religious festival in honour of Apollo, which induces the divinity to visit the temple.[16] It is no coincidence that this is precisely the sort of situation in which automated technology was later employed: inside temples, in sanctuaries more broadly, and as part of festival processions, all in order to help generate the manifest presence of the divine. Curiously, the agency or impetus behind the automation in Callimachus is not quite as overt as the Horai's control of the doors of Olympus in Homer. In the hymn, the doors thrust themselves open at the mere prospect of the approach of the god (ὁ γὰρ θεὸς οὐκέτι μακρήν). The poem thus offers an intriguing insight into

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[14] Call. *Hymn* 2.6-7.
[15] The first five lines are packed full of verbs of motion: *seiō* (I tremble); *arassō* (I beat); *epineuō* (I nod).
[16] I do not wish to enter the debate on the context of performance of Callimachus' hymns. On the topic see most recently Stephens 2015 especially 11-12 with further bibliography.

movement and supernatural involvement where, in this case, the automation is an augury prior to divine arrival. In most other cases we will see that automation signals divine influence or presence in the moment.

Callimachus' contemporary Apollonius also picked up on the Homeric image. In his *Argonautica,* Medea's incantations (*aoidai*) are powerful enough to have a similar effect on the doors of her house:

> τῇ δὲ καὶ αὐτόματοι θυρέων ὑπόειξαν ὀχῆες
>
> †ὠκείαις ἄψορροι ἀναθρῴσκοντες ἀοιδαῖς.

> And of their own accord the bolts of the doors yielded,
>
> Flinging backwards at her swift incantations.[17]

The examples are not limited to verse nor to the Hellenistic period. Temple doors are reported to open of their own accord as a religious revelation in Xenophon's *Hellenica*:

> ἀπηγγέλλετο δὲ καὶ ἐκ τῆς πόλεως αὐτοῖς ὡς οἵ τε νεῲ πάντες αὐτόματοι ἀνεῴγοντο, αἵ τε ἱέρειαι λέγοιεν ὡς νίκην οἱ θεοὶ φαίνοιεν

> Further, it was reported to them from the city that all the temples were opening of their own accord and that the priestesses said that the gods revealed victory. [18]

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[17] A.R. 4.41-42.
[18] Xen. *HG* 6.4.7.

Similarly, in Plutarch's *Life of Timoleon*, the people of Adanium report to Timoleon with amazement and wonder (μετὰ φρίκης καὶ θαύματος):

ὡς ἐνισταμένης τῆς μάχης οἱ μὲν ἱεροὶ τοῦ νεὼ πυλῶνες αὐτόματοι διανοιχθεῖεν, ὀφθείη δὲ τοῦ θεοῦ τὸ μὲν δόρυ σειόμενον ἐκ τῆς αἰχμῆς ἄκρας, τὸ δὲ πρόσωπον ἱδρῶτι πολλῷ ῥεόμενον.

That at the beginning of the battle, the sacred gates of their shrine flew open of their own accord, and the spear of the god was seen to be trembling from the tip of its point while lots of sweat trickled down his face.[19]

What unites these examples is that the automation is always a religious portent of some kind.[20] Further, it is a direct manifestation of divine will or intention. What makes these examples unique is that divinity is manifesting its influence through a man-made object rather than, for example, the natural world. Hero of Alexandria in his treatise on effects which can be produced through the use of pneumatic properties details the construction of self-opening temple doors (**T9**). This quite clearly looks back to this tradition of doors opening automatically as they link to divine will. When Hero devises two ways to have temple doors open of their own accord, we cannot be so ingenuous as to believe he was doing so merely to show the properties of heated air as argued by the advocates of the 'hyper-serious' approach to automata outlined in the previous chapter.[21] Why, then, would the author go out of his way to couch the pneumatic effect in a design that existed in the ancient imagination as a divine portent? Furthermore, Hero makes a point of cleverly obscuring the

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[19] Pl. *Ti.* 12.9

[20] Although not relating to the movement of manufactured objects, spontaneous apparitions of objects as a divine sign are frequent in the ancient corpus and also use the vocabulary of automation. See, for example, the weapons that appear of their own accord in Herodotus 8.37.9- 10 (Θῶμα μὲν γὰρ καὶ τοῦτο κάρτα ἐστί, ὅπλα ἀρήια αὐτόματα φανῆναι ἔξω προκείμενα τοῦ νηοῦ) or Artemis' warning sign to the hunter recorded in D.S. 4.22.3.

[21] See above *Chapter 1/ Eliminating the Blocage* and Wikander 2008, 785-790.

mechanism which will serve to instigate the sign of divine manifestation by disguising it as part of ritual action.[22]

Moving Statues

Even with their obvious symbolism as thresholds, doors and gates are not exclusively associated with the divine, and they are not typically thought of as comprising part of the network of channels of human-divine communication. Something like a cult statue, however, is manufactured for this purpose so it is less surprising that we have prolific references to cult statues which are recorded as being miraculously animated in some way.[23] Being so intimately linked to the divinity (and in some epochs <u>being</u> the divinity), cult statues, and their construction in particular, prompt questions which the automated gates did not.[24] There is, for example, an extra layer of complexity attached to the human *technē* involved in creating them. Jan Bremmer usefully points out the use of terms such as *diopetēs* (fallen from Zeus) and *acheiropoiētos* (not made by hand) which were obviously used to navigate this anxiety and give the objects a tangible aetiological link with the divine realm.[25]

The very earliest possible reference to an animated cult-statue comes from book six of the *Iliad* when Hecuba offers a *peplos* to Athena who is said to have tossed back her head in refusal of the plea for mercy.[26] Though Aristarchus marked the line for deletion, Virgil, at least, took it to be a

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[22] More on mechanic and pneumatic miracles instigated by ritual action below see *Chapter 4/ Temple Automata*.
[23] Most of which are grouped together by Noëlle Icard-Gianolio in volume II of the *ThesCRA* for which I am grateful. *ThesCRA* vol ii pp 463-467. The reader may want to consult the full list as certain later Roman examples have been excluded from the present discussion. I exclude too cases where statues are seen in one place and then another for although this would similarly be seen as a sign of divine revelation through a statue, it departs significantly from a statue executing movements before the viewer.
[24] On statues being filled with what they represent see Gordon 1979; Faraone 1992; Scheer 2000; Steiner 2001; Iles Johnston 2008, 445; Eich 2011.
[25] Bremmer 2013, 11.
[26] Hom. *Il.* 6.311.

physical nodding.[27] In the ancient imagination, Athena was prone to giving animated signs through her statuary representations when she was upset. We hear, for example, of Athena's statue turning her head to the sky and the floor of her temple shaking when she witnesses the rape of Cassandra.[28] When Agrippa seized Aegina and Eretria, the Athenians are said to have attributed their woes to the statue of Athena who turned from East to West and spat blood.[29] Strabo recounts a story about the statue of Athena at Siris closing her eyes when suppliants were dragged from the sacred space.[30] He then adds that certain people continue to validate this marvel through claims that the statue could still be seen in his day.[31] Strabo's characteristic scepticism is useful in tracing the boundaries of the credible in the writing of history. For Strabo to be reacting emphatically, there must have existed a strong enough trend which subscribed to the miracle against which to argue.

In Euripides' *Iphigenia in Tauris,* Iphigenia lies to Thoas reporting that the statue of Artemis turned around and closed her eyes when the victims offered were impure. It is significant that Thoas subsequently asks whether this really happened of its own accord leading Iphigenia to affirm the automation:

Θο. αὐτόματον, ἤ νιν σεισμὸς ἔστρεψε χθονός; / *Ιφ.* αὐτόματον.

Th: By itself, or did an earthquake turn it? / *Iph:* By itself![32]

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[27] Verg. *Aen.* 1.482. For more see Graziosi and Haubold 2010, 165 who maintain that *ananeuō* covered the whole semantic spectrum from physical movement to mere refusal and that ancient readers would have understood the statue to have moved.

[28] Q.S. 13.425-429. cf. Lyc. 348-364; Serv. *Aen.* 1.41. Compare with Minerva who averts her eyes from Neptune dishonouring Medusa Ov. *Met.* 4.798.

[29] D.C. 46.33.3.

[30] Bronze statue fragments of eye-lids with serrated lashes come down to us from antiquity, notably from victor statues at Olympia. The curious 'tabs' at the top of the eye-lid combined with their strangely flat shape have lead me to speculate about whether they could have been hinged, allowing some movement in the eye-sockets. See De Ridder, 1896 nos. 632-633; Bol 1978, no. 428-f. and R. R. R. Smith 2007, 103-105 with fig. 8.

[31] Str. 6.1.14.

[32] Eur. *I.T.* 1165-1169 cf. Ath. 12.521f.

We agree entirely with Bremmer who notes that 'it seems reasonable to accept that the passage attests a belief in the agency of statues, as otherwise the lie would not have worked.'[33] These are the mythic precedents to the construction of mechanically moving statues in the ancient world. Just as Thoas is forced to accept that the automation was a sign of supernatural interference in the mortal realm, Ptolemy II surely knew that the mechanised statue of Nysa would encourage his spectators to feel the divine presence at his Grand Procession (**P2**). Similarly, the mechanised statue of Dionysus described in impressive detail by Hero of Alexandria (**P5**) was a spectacular display surely intended for religious and aesthetic satisfaction, and not to imitate life or attempt to understand it as is argued by those who want to see automata as philosophical tools.[34]

Statues do not only move as a form of divine approbation, warning or condemnation, but also sweat and cry. Diodorus Siculus records that three months before the arrival of Alexander in Thebes, sweat was seen on the statues in the agora.[35] Before leaving on an expedition against Persia, Alexander saw many favourable omens and among these, the wooden *xoanon* of Cyprian Orpheus at Leibethra was covered in sweat.[36] When the Spartans saw the statue of Heracles in his temple sweating before the battle of Leuctra, however, this was obviously a bad sign.[37] Various late sources relate that the statue of Apollo at Cumae cried for a number of days in 130 BC.[38] These stories of pan-sensory animation fit too with the types of automata which are deployed in history. As the reader turns to the testimonia, they will note that there are automation technologies of sound, texture, movement and even taste and olfaction. The recent 'sensory turn' in the Classics has made me particularly aware of the intentional pan-sensory experience of ancient automata, and it is clear that the focus

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[33] Bremmer 2013, 10.
[34] See above *Chapter 1/ Eliminating the blocage.*
[35] D.S. 17.10.4.
[36] Plu. *Alex.* 14.8.
[37] Cic. *Div.* 1.74. Cf. 1.98 for the statues of Apollo at Cumae and Nike at Capua dripping with sweat and A.R. 4.1284 for statues which sweat and trickle with blood.
[38] Jul. Obs., *De Prodigiis*, 28; August. *De civ. D.* 3.11; Liv. 43.13.

on a range of senses was intended to heighten the religious experience.[39] Indeed, ancient Greek festivals were hyper-sensory occasions. This is a point which scholarship perhaps has not sufficiently emphasised. In a recent volume dedicated to synaesthesia in antiquity, for example, there is no chapter dedicated to festivals though this was perhaps the most perfectly pan-sensorial occasion in the ancient Greek world.[40] I would like to suggest that we can in fact talk about the festival procession as explicitly using the pan-sensory experience to incite religious connection and that automata were working as part of this social phenomenon.

The discussion of statues being animated in moments of divine communication cannot be complete without looking at the case of Lucian's *On the Syrian Goddess.* In this passage, Lucian explains that though there are many oracles used in Greece, Egypt, Libya and Asia, the oracle of Apollo at Hierapolis is peculiar in a number of ways. Here, the image of the god is moved by its own impulse, and acts directly to complete the divination process (ὅδε δὲ αὐτός τε κινέεται καὶ τὴν μαντηίην ἐς τέλος αὐτουργέει).[41] This happens in the following way: when Apollo wants to deliver an oracle, he stirs in his seat as an indication that the priests should raise him up. If the priests fail to do so, he will sweat and move more violently. Once he has been raised, the god drives the priests around in a circle and upon questioning by the high priest, will use movement forwards and backwards to communicate approval or dissent. A final indication (*sēmeion*) of the god's presence (the most marvellous yet) is added as a coda to the story: the author himself witnessed an incident when the statue raised itself up off the shoulders of the priests and stayed aloft itself. [42]

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[39] Typified by works such as Butler and Purves 2013; Bradley 2009; 2015.
[40] Butler and Purves 2013.
[41] Luc. *Syr. D.* 36.7-8. On the text in general, see Lightfoot 2003.
[42] Luc. *Syr. D.* 36-37. Cf. D.S. 17.50.5-7 where the oracle of the god Ammon in Siwah offers his answers by controlling the movement of priests who carry the image of the god in a golden boat.

In Lucian, we have moved from receiving unsolicited signs from the gods, to actively seeking out a sign from which the divine will may be interpreted. This distinction is significant. Though here it is movement and perspiration that characterises divine communication with the mortal realm and not speech as is typical of an oracle,[43] we are in the territory of oracular responses rather than, for example, the unsought prophecies of a seer.[44] The distinction is also apparent when comparing acts of worship invoking epiphany to the sudden appearance of the god in a time of crisis.[45] Human responsibility or involvement in the ancient Greek religious experience is, however, taken to a whole other level with the inclusion of automata in the discourse precisely because of the technical aspect of these machines. In one sense, the mechanical highlights the construct of the object and its artificiality is thus one of its limits. At the same time, however, technological sophistication allows for a more impressive manifestation of divine authority giving it great religious potential. We cannot help but touch upon, here, the politicised aspect of these machines and the way in which they were actively harnessed as part of political theatre by leaders who wanted to bolster their own position and relation with the divine.[46]

The cult statue as an intermediary for communication with the mortal realm was already very much present in the ancient mindset from as early on as the Homeric poems. With the implementation of self-animated mechanisms there is a critical difference: the shift from an unsolicited *sēmeion*, *phasma* or *teras* to a humanly activated *thauma.* This is the novel contribution of automata to the discourse on divine manifestation in ancient Greek religion. If we needed any more direct evidence of the way in which mechanical devices could be used as religious portents, we can turn to Plutarch's *Life of Sulla.* There, Plutarch records for us that while in Pergamum, Mithridates was visited by many religious portents. One such occasion included an instance whereby a statue of Nike was crowning

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[43] A point which Lucian himself notes at 36.6-7.
[44] Though oracles did at times give visitors 'unsolicited' answers prior to any question being posed. I thank Julia Kindt for this insight.
[45] Platt 2011, 14, 55-56.
[46] See below **P1-P3** and **P6**.

Mithridates by a machine (*organon*) of some sort, but just before the crown touched Mithridates'
head, it dropped to the ground and shattered in the middle of the theatre.[47] This example is
particularly curious because it is a divine force (Nike) clearly expressing itself through man-made
mechanics but, unlike our testimonia to follow, it is less concerned with the automation of the
organon itself, and more with the fact that the mechanism was corrupted by divine will. Thus it is
still divine influence being manifested through the channel of human *technē* as a broader
phenomenon, but lies slightly outside the scope of the present study.

Automata and *Thauma*

With this in mind, let us move back to examining the final instance of automat- vocabulary in the
Iliad. Here we reach the most intriguing case in the corpus: Hephaestus' bronze tripods. The
tantalising reference comes from book 18 when Thetis asks Hephaestus to make armour for Achilles:

> τὸν δ᾽ εὗρ᾽ ἱδρώοντα ἑλισσόμενον περὶ φύσας
>
> σπεύδοντα: τρίποδας γὰρ ἐείκοσι πάντας ἔτευχεν
>
> ἑστάμεναι περὶ τοῖχον ἐϋσταθέος μεγάροιο,
>
> χρύσεα δέ σφ᾽ ὑπὸ κύκλα ἑκάστῳ πυθμένι θῆκεν,
>
> ὄφρά οἱ αὐτόματοι θεῖον δυσαίατ᾽ ἀγῶνα
>
> ἠδ᾽ αὖτις πρὸς δῶμα νεοίατο θαῦμα ἰδέσθαι.
>
> οἳ δ᾽ ἤτοι τόσσον μὲν ἔχον τέλος, οὔατα δ᾽ οὔ πω
>
> δαιδάλεα προσέκειτο: τά ῥ᾽ ἤρτυε, κόπτε δὲ δεσμούς.

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[47] Plu. *Sull.* 11 on which see Chaniotis 1997, 243-244.

She found him sweating, whirling about his bellows, hastening. For he was building tripods,

twenty in all, to stand around the walls of the well-built hall, and he put golden wheels

beneath the base of each so that they might automatically make their way to the divine

assembly for him and go back again to his house, a wonder to behold. And truly so greatly

were they being brought to completion, the handles were not yet cunningly placed on. These

he was making ready, and was forging the bindings.[48]

In a mere eight lines, we get an intense amount of information on conceptualising automation in the

ancient world and it is no surprise that this example has been at the heart of modern debates on

ancient mechanistic conception. As we have seen, de Solla Price first suggested in 1964 that there

had always existed in antiquity some strong, innate desire to explain the world mechanistically.[49] For

de Solla Price, this urge led to the construction of automata, and not the other way around. Sylvia

Berryman in an article in 2003, and expanded upon in her 2009 monograph, argues that mechanistic

thought and conception only emerged in late antiquity (with Hellenistic developments aiding this

along) and that we should not confuse mythic and philosophical allusions with actual mechanistic

development.[50] Most recently, Martin Devecka has argued that the ancient Greeks had a

mechanistic conception of the world as early as the fourth century BC. As discussed in the previous

chapter, Devecka insists that the ancient mind frame was capable of subscribing to the thought of

'robots' as described by Aristotle: that is, as replacements for slaves.[51] Even if there is a utopic vision

of a world without slavery suggested in Aristotle's text, this is a long stretch from what actual

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[48] Hom. *Il.* 18.373-379
[49] Fragaki 2012 also argues for this innate desire to explain the world via mechanics.
[50] Berryman 2003; 2009 esp. 21-53. Kang agrees with Berryman though for him, a mechanistic world view did not appear until the mid-17th century and then came into a crisis mid-18th century (Kang 2011, 27).
[51] The focus passage of Devecka's argument is Arist. *Pol.* 1253b33-1254a:
"εἰ γὰρ ἠδύνατο ἕκαστον τῶν ὀργάνων κελευσθὲν ἢ προαισθανόμενον ἀποτελεῖν τὸ αὑτοῦ ἔργον, <καὶ> ὥσπερ τὰ Δαιδάλου φασὶν ἢ τοὺς τοῦ Ἡφαίστου τρίποδας, οὕς φησιν ὁ ποιητὴς αὐτομάτους θεῖον δύεσθαι ἀγῶνα, οὕτως αἱ κερκίδες ἐκέρκιζον αὐταὶ καὶ τὰ πλῆκτρα ἐκιθάριζεν, οὐδὲν ἂν ἔδει οὔτε τοῖς ἀρχιτέκτοσιν ὑπηρετῶν οὔτε τοῖς δεσπόταις δούλων."

ancient mechanical innovators aimed to create. Devecka acknowledges this, disappointed as he by in the fact that technology was used 'only' for spectacle and political theatre.[52]

For these scholars debating the origins of mechanistic conception in the ancient world, what makes the tripods unique is that Homer is explicit when he says that Hephaestus is attaching wheels (*kykla*) to the tripods. In this detail, the mechanical is for the first time overtly introduced into the discourse on automata, as is the role and *technē* of the craftsman. While the doors of Olympus were made up of bolts and hinges, this was predetermined by their function; on the other hand, tripods do not need wheels. These are attached precisely so that the tripods might move to and from the divine assembly of their own accord (*automatoi*). This is for functionality rather than aesthetics, and from a spectator's point of view the combination of mechanics and movement make the tripods a wonder to behold (*thauma idesthai*).[53] Indeed, every time the formula *thauma idesthai* is used in the *Iliad* it relates to *technē* and the divine. Thus, what this tells us about the gaze of the spectator when they see such incredible craftsmanship is more relevant to the present discussion than the debate concerning mechanistic conception. Further, a mechanical explanation does not exclude a theological one given that the two are certainly not mutually exclusive. Once we move beyond Homer, the ancient source material leaves absolutely no doubt as to the fact that the miraculous and the marvellous was the aim of mechanical and pneumatic automation and is thus the lens through which we should assume they would have been viewed first and foremost. As I shall demonstrate, the mechanical and wondrous aspects were in fact inextricably entwined.

Our earliest extant work on mechanics, *Mechanical Problems* attributed to Aristotle, opens in the following way:

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[52] Devecka 2013 esp. 64-68.
[53] Hom. *Il.* 5.725; 10.439; 18.83.

Θαυμάζεται τῶν μὲν κατὰ φύσιν συμβαινόντων, ὅσων ἀγνοεῖται τὸ αἴτιον, τῶν δὲ παρὰ φύσιν, ὅσα γίνεται διὰ τέχνην πρὸς τὸ συμφέρον τοῖς ἀνθρώποις ... 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.

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 ... So whenever it is necessary to do something contrary to nature, it presents perplexity on account of the difficulty and required *technē*. We therefore call that part of *technē* solving such perplexity a *mēchanē*.[54]

There really could be no clearer statement explaining the interdependence and coexistence of machines and wonder. According to this text at least, the tantalising gap that exists between nature and art can be bridged by a specific part of *technē* termed mechanics.[55] There is, of course, a difference between the mechanic's understanding of the machine and the wonder it inspires, and that of the average spectator. This is something that the author makes quite explicit when he describes self-rotating wheels used in temples (**T1**):

οἱ δημιουργοὶ κατασκευάζουσιν ὄργανον κρύπτοντες τὴν ἀρχήν, ὅπως ᾖ τοῦ μηχανήματος φανερὸν μόνον τὸ θαυμαστόν, τὸ δ' αἴτιον ἄδηλον.

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[54] Arist. *Mech.* 847a11-13; 16-19.
[55] Arist. *Mech.* 847a23-24 '...and we call all these sorts of problems *mechanics*' (...καὶ πάντα σχεδὸν ὅσα τῶν προβλημάτων μηχανικὰ προσαγορεύομεν).

> Craftsmen construct a machine concealing the principle so that only the marvel of the mechanical device is visible, while the cause is unknown.[56]

At the heart of mechanics, then, is contradiction and the spectator <u>not</u> understanding. Further, there is a point at which understanding no longer matters, for even a mechanic is sometimes a spectator. As Berryman points out of the modern 'mechanical philosopher', it is not impossible that the mechanician might also, despite technical knowledge, attribute some of the wonder he has created to divinely inspired *technē*.[57] At the heart of the construction of the machine is the unfathomable and the marvellous. Or, better yet, the fathoming of something else. When the cause is unknown, the spectator is naturally inclined to wonder and in the same way that an irregularity in nature or the natural order is often considered to be the divine manifesting itself, a divine explanation is often sought for the animation of automata particularly given the religious nature of the performative contexts in which they were deployed.[58]

It is appropriate here to invoke the seminal work of Alfred Gell on the technology of enchantment and its reflex condition, the enchantment of technology.[59] For Gell, the more an individual struggles to comprehend the coming-into-being of an object qua construct via technology, the more they are forced to construe it as magic. The idea of magic is thus linked to uncertainty which Gell specifies does not make it opposed to knowledge:

> 'The problem of uncertainty is, therefore, not opposed to the notion of knowledge and the pursuit of rational technical solutions to technical problems, but is inherently a part of it. If we consider that the magical attitude is a by-product of uncertainty, we are thereby

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[56] Arist. *Mech.* 848a.37. See also **T1**.
[57] Berryman 2003, 349.
[58] On wonder in Herodotus and the divine manifesting itself through irregularities in nature see Munson 2001.
[59] Gell 1992.

committed also to the proposition that the magical attitude is a by-product of the rational pursuit of technical objectives using technical means.[60]

The ancient manual *Mechanical Problems* is incredibly useful for the insights it offers on the relationship between mechanics and wonder, spectatorship and the role of the mechanic already existent in antiquity. This is even more the case given its early date of composition during the late Classical period or early Hellenistic period.[61] We have no extant treatise devoted entirely to the construction of automata until Hero of Alexandria's *On Automata Making*. Composed in the first century AD*,* Hero's text is the closest we can come to understanding the mentality behind the construction and viewing of ancient automata specifically. In his text too, the vocabulary of wonder (*thauma*) abounds. For Hero, the psychological impression imparted to his viewers was his first priority; the principle motive driving the design and production of automata. In particular, the sense of the marvellous that automata aim to evoke is foregrounded repeatedly throughout Hero's work. *On Automata Making* begins with the following justification:

> Τῆς αὐτοματοποιητικῆς πραγματείας ὑπὸ τῶν πρότερον ἀποδοχῆς ἠξιωμένης διά τε τὸ ποικίλον τῆς ἐν αὐτῇ δημιουργίας καὶ διὰ τὸ ἔκπληκτον τῆς θεωρίας.

> The study of automaton-making has been considered by our predecessors worthy of acceptance both because of the ingenuity of the craftsmanship involved and because of the stunning nature of the public spectacle.[62]

Hero ends the proem with:

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[60] Gell 1992, 57.

[61] The exact date of the treatise is unknown and scholars argue from the late fifth to third centuries BC. For further issues of dating and authorship see Winter 2007.

[62] Hero, *Aut.* 1.1. I place a slight emphasis in my translation on the public nature of *theōria* which denotes publically participating in a festival, particularly when *thea* would have otherwise sufficed for a spectacle. On *theōria* as a cultural institution Nightingale 2004 esp.40-68 and Rutherford 2013.

ἐκάλουν δὲ οἱ παλαιοὶ τοὺς τὰ τοιαῦτα δημιουργοῦντας θαυματουργοὺς διὰ τὸ ἔκπληκτον τῆς θεωρίας.

Older generations call those who make these objects miracle-makers on account of the stunning nature of the public spectacle.[63]

Following the vocabulary of the text, then, these machines were designed and constructed to perform true miracles or *thaumata* and witnessing such a miracle was supposed to invoke an *ekplēktic* feeling in the viewer. We also know from Hero that it was imperative that spectators actually subscribed to the miracle because in detailing the construction he takes measures to avoid potential sources of scepticism in the viewers:

μειζόνων γὰρ γενηθέντων ὑπόνοιαν ἕξει τὸ ὅραμα ὡς ἐντός τινος ταῦτα δημιουργοῦντος. διὸ δὴ ἔν τε τοῖς ὑπάγουσι καὶ ἐν τοῖς στατοῖς αὐτομάτοις δεῖ φυλάσσεσθαι τὰ μεγέθη διὰ τὴν ἐσομένην ὑπόνοιαν.

For if the spectacle were bigger, it would arouse the suspicion that someone was fabricating these effects from the inside. Therefore, in both the moving and the stationary automata, one must be careful of the size on account of the scepticism generated.[64]

It is imperative that human intervention is not suspected and that in viewing these objects, the spectators feel that there is some higher power at work. Importantly, we are encouraged yet again to move beyond looking at these machines as toys or gadgets or as something made merely to

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[63] Hero, *Aut.* 1.7-8.
[64] Hero, *Aut.* 4.4-5.

illustrate mechanical principles. *Ekplēxis* has connotations not just of amazement but of awe, shock and surprise. It implies something that is so astonishing that, at least at first glance, it is rationally inexplicable.[65] Both visual and aural art typically invoke *ekplēxis* in the spectator.[66] Critically, the gods are not immune to *thauma* and *ekplēxis*.[67] This is crucial for us here because automata were used in sacred spaces and on sacred occasions where the main purpose was communication with the divine: both to make contact and to solicit a response.

This chapter has thus far focused on automation as an intimation of the divine but this largely ignores the fact that acts of worship in the ancient world were multi-directional. Athena Kavoulaki notes, for example, how a religious procession is always both a call and response; a call for the attention of the divine and a manifestation of divine authority at the same time.[68] Automata are the perfect ritual objects for these interconnected aims, and mechanical ingenuity the ideal manifestation of the symbiosis quite literally at work in a very public performative space. The divinity is, of course, thought to be present at a festival and their presence more tangible in temples.[69] Automata, self-animated machines, were a gift worthy of the gods but they were also thought to embody the (response of) the gods. The automaton is an acknowledgment and a manifestation of the deity's power, in turn intimately linked to the polis', or in certain instances the polis elite's, power. [70]

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[65]As a parallel, on the connotations of *ekplēxis* in the context of what a tragic *anagnōrisis* is supposed to invoke see Cave 1988, 44.

[66] For the power of music on the gods see Pi. *P.* 1.1-12. For the power of visual arts on the divine see D. Chr. 12.50-2. On the topic in general see O'Sullivan 2011, 137-154.

[67] To take one simple example, *thauma* grips both gods and mortals when they behold Pandora for the first time in Hesiod's *Theogony* 588.

[68] Kavoulaki 1999, 303. Platt similarly talks of the reciprocal acts of offering and epiphany: Platt 2011, 33.

[69] The messenger in Euripides' *Bacchae* refers to Dionysus as the *pompos theōrias* which we can translate as something like the 'sponsor of the procession for the spectacle/festival' (Csapo 1997, 281). On the icon of Dionysus being physically present in the theatre at Athens see Ar. *Eq.* 526-36, D.Chr. 31.21; Philostr. *VA* 4.22 and On the presence of the god being stronger in the temple see Rutherford 2013, 13.

[70] This two-way directionality of the power of technology and enchantment of course invokes, once more, the work of Gell 1992.

The viewers become participants of the spectacle or ritual, and this is integral to the spectacle being viewed and acknowledged by the god. Since the 1990s, scholars such as Jaś Elsner drawing on theoretical and art historical discourse have brought into classical scholarship the notion of 'modes of viewing'. Elsner in particular highlights a specifically ritually-centered way of gazing in the ancient world termed 'religious visuality'.[71] Religious visuality is not primarily concerned with the aesthetic quality of objects and artefacts, rather it is concerned with the function of objects and artefacts in religious ritual. Religious gazing applies whenever viewers finds themselves face to face with a material object that lends itself to becoming an entry point to religious and/or mythological reflection. This is the framework through which automata need to be analysed. Too often, these objects have been divorced from their performative context and in many ways, the plight of automata has been a modern scholarly obsession with what we could term 'technical visuality'.

Yet automata also bring out further subtleties to Elsner's thesis. There is something more forceful in the animation of the machine that bends the gaze to a certain understanding provoked by its context. Let us unpack this slightly. To begin, we can think of the difference between iconic and aniconic representations of statues. As is now well-understood in scholarship, the ancient Greeks created and maintained both iconic and aniconic representations of their gods simultaneously.[72] While aniconic representations served to highlight the gap between human and divine realms, iconic sculptural representations externalised precisely the divine essence that aniconic representations sought to conceal. In the words of Julia Kindt, iconic representations 'communicate the otherworldliness of the divine through a surplus of splendour and bodily perfection.'[73]Animation,

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[71] See Elsner 1995; 2007.
[72] Gordon 1979 esp. 11-13; Donohue 1988; Steiner 2001 esp. 80-104; Kindt 2012, esp. 42-47.
[73] Kindt 2012, 46.

then, as hyper-realism, becomes the absolute epitome of this and as such, represents a vastly understudied category of divine manifestation.

Daedalus' statues

At this point it is worth introducing to the discussions the statues of Daedalus, supposedly able to run away by themselves, which demonstrate two interesting points on automation. The first is that it was not outside the scope of the ancient imagination that human *technē* could make statues move. This is important for the diachronic development of the conceptualisation of automation and fits nicely alongside actual technical treatises such as those of pseudo-Aristotle, Philo of Byzantium, Hero of Alexandria and the lost works of Ctesibius before them.[74] The second point to be made is that the reaction to the myth and the way that Daedalus' statues are treated in the ancient corpus exemplify how there is in fact an important difference between 'types' of animation. Not all instances of animation inhabit the same space in the ancient imagination and we will see that despite what certain modern scholars argue, the Daedalian example did not inspire any actual historical automata.

Daedalus, an Athenian who spent a lot of time in Crete and later Sicily, is represented as living in the early heroic period, in the age of Minos and of Theseus. He was a very popular mythic figure in the ancient Greek imagination. We know that Aristophanes wrote a play entitled *Daedalus* which comes down to us in fragments and Platon, Eubulus (or Philippus) and Sophocles also wrote eponymous plays.[75] The fullest account of Daedalus' life and works comes from Diodorus Siculus who introduces the sculptor as gifted above others in the *technē* he possessed, particularly relating to building

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[74] For more on Ctesibius and his work see below, **P5**.
[75] Clem. Al. *Strom.* 6.26.5.

statues and stone-working.[76] Daedalus is also said to have invented many devices which helped his

art, and to have built works all around the Greek world which aroused wonder (*thauma*) in the

viewer.[77] Indeed Daedalus was such a gifted sculptor, Diodorus continues, that later generations

invented stories about his statues moving.[78] Through this incredulous statement, Diodorus is

expressing more than doubt about the anecdote. By drawing a link between the supposed stories

and Daedalus' talent as an artist, he is giving an alternate way of viewing and conceiving of these

self-animated statues. The point for Diodorus at least is that the statues trick the viewer into

thinking they are endowed with life in their artistic realism.[79] This is the function of any well-crafted

statue, at the very least according to Hellenistic epigram, and does not qualify them as automata.

Diodorus then goes on to explain that Daedalus was the first artist to carve statues in natural

poses.[80] Palaephatus gives a similar rationalising account of the myth of the movement of Daedalus'

statues explaining that the artist was the first to make statues with one foot forwards in a walking

pose and that it was on this account that people said his statues could walk.[81] To this tradition we

can also add a fragment of Aeschylus which alludes to Daedalus' images for their uncanny likeness to

a living form.[82] Philostratus the Elder also presents the statues from an art-history perspective. To

Philostratus, the statues 'give the promise of walking' which once again refers to the way in which

Daedalus was the first artist to depict statues with one foot in front of the other.[83] There is not a

single source in the ancient corpus that refers to the statues of Daedalus as automata. Nor, as noted

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[76] D.S. 4.76.1-2.

[77] D.S. 4.76.2.

[78] D.S. 4.76.1-3.

[79] This is precisely the point also of the Cretan Bull which Daedalus is said to have made for Minos' wife Pasiphae. The bull is created life-like enough to trick the bull into having intercourse with it, but cannot be considered an automaton in any way. In a similar way, just because spectators are tricked into thinking Daedalus' statues could run away does not make them automata.

[80] D.S. 4.76.3.

[81] Palaeph. 21. Palaephatus is equally unhappy about the supposed automation of stones to the sound of the kithara (Palaeph. 33). For more on Palaephatus and on rationalising myth in antiquity more generally see Hawes 2014.

[82] A. *Fr.* 78a.5-7 Radt.

[83] Philostr. *Im.* 1.16.

by Berryman, is there anything mechanical about the statues and without internal mechanisms, Daedalus' creations are not too different from Pygmalion's statue.[84]

In a fragment of Euripides' lost satyr play *Eurystheus* an unknown speaker tells an old man not to fear the moving statues he presumably has before him as they are not real:

τὰ Δαιδάλεια πάντα κινεῖσθαι δοκεῖ

λέγειν τ᾽ ἀγάλμαθ᾽· ὧδ᾽ ἀνὴρ κεῖνος σοφός.

All of the statues made by Daedalus seem to move and to speak, so clever is that man![85]

Importantly, it is above all Daedalus' abilities (here his *sophia,* elsewhere his *technē)* that are to be admired. These anecdotes are far less about the mechanisms of movement of the statues, and far more about the craftsman. We can compare the passage from Pindar's *Olympian* 7 where Zeus and Athena bestow upon the Rhodians extreme artisanal talent so that their roads bore works of art like living, moving creatures (ἔργα δὲ ζωοῖσιν ἑρπόντεσσί θ᾽ ὁμοῖα κέλευθοι φέρον). For this, the Rhodians' fame was profound (ἦν δὲ κλέος βαθύ).[86] While Hero, Philo and pseudo-Aristotle make an explicit point of hiding any suspected human intervention in their creations, Daedalus and the Rhodians revel in claiming authorship. Callistratus too was fascinated by Daedalus' artistic abilities talking of the way in which the sculptor's *technē* could make the viewer feel as though the figures of the artwork were dancing:

ἐμοὶ μὲν δὴ θεασαμένῳ τὴν τέχνην ἐπῄει πιστεύειν, ὅτι καὶ χορὸν ἤσκησε κινούμενον Δαίδαλος καὶ χρυσῷ παρεῖχεν αἰσθήσεις.

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[84] Berryman 2003, 353.
[85] E. *Fr.* 372 Kannicht.
[86] P. *O.* 7.49-53.

As I gazed at the art, the belief came over me that Daedalus had both wrought a moving

chorus and given the gold sensation.[87]

We notice in this passage that the figures are not actually dancing, but that the act of gazing

combined with the skill of Daedalus' *technē* is what makes it seem as though they are. In many ways,

this example thus fits much more comfortably into an ekphrastic tradition, similar to the sentiment

invoked by the shield of Achilles so skilfully wrought by Hephaestus in *Iliad* 18.[88] There too, figures

move 'like living men' and the movement of the gold is specified as the *thauma* of the work.[89]

Furthermore, both in the passage quoted above and in a second passage Callistratus talks of the way

in which upon looking at the artwork, it is apparent that Daedalus has made the gold feel human

sensation.[90] Aristotle indicates that the comic dramatist Philippus rationalised this through a

suggestion that the movement of Daedalus' statues came from mercury being poured in them.[91]

Though this exposes that to the ancient mind, statues of human manufacture could conceivably

move, it also serves to show that the ancient explanations of Daedalus' statues were certainly not

mechanical.

These sorts of statues, so life-like that they trick their viewers completely and almost become beings

in their own right, are not what later mechanics aim to replicate when automata come into fashion.

They do not aim to continue a conversation that started with Daedalus. Nowhere, in fact, do we get

'proto-robots' which were automated to imitate life flawlessly and 'preserved so well the

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[87] Callistr. *Stat.* 3.5.
[88] Hom. *Il.* 18.478-609.
[89] Hom. *Il.* 539-40 and 548-50 respectively.
[90] Cf. Callistr. *Stat.* 8.1 'to compel the gold to feel human sensations' (πρὸς ἀνθρωπίνην αἴσθησιν ἐκβιάζεσθαι τὸν χρυσόν).
[91] Arist. *de An.* 1.3, 406b17-22. On this point see Berryman 2003, 353.

characteristics of the entire body' (καθόλου τηρεῖν τὴν τοῦ ὅλου σώματος διάθεσιν) that they could be seen as following the tradition of Daedalus' statues.[92] Through the Daedalus myth, we learn more about attitudes towards sculpture and art and less about conceptions of automation. Daedalus and his statues exist in the ancient imagination not in conversation with technology and divine manifestation (the spheres within which automata sit), but with art and sculpture in particular.

Passages from the *Meno* and *Euthyphro* are often used as evidence for the early conception of the statues of Daedalus as automata.[93] Although, as we have seen with Aristotle's text, philosophers do at times look to automata as productive similes, the point of comparison with Daedalus in Plato has nothing to do with automation. In the *Meno,* Daedalus' statues are invoked as an extended metaphor for the way in which good opinion can 'run away' from the individual while knowledge remains permanently.[94] In the *Euthyphro,* Plato uses a simile comparing an argument 'running away' from the speaker to the way Daedalus' statues 'ran away' from him.[95] The point is precisely that you cannot control these figures: that the *technē* is so great that they move beyond their status as a pure construct and become animated figures in their own right. Daedalus' statues 'escaping' from the artist was a popular image in the ancient mind, but they resemble Pygmalion's woman of marble much more than any automaton.[96]

Two important points may be taken away from this exploration of the Daedalian tradition. First, that the construction of animated statues was not entirely divine prerogative; and second, that automata did not in fact seek to imitate life flawlessly, but to be larger than life: to shock and to cause *ekplēxis* and *thauma* through their status as a construct with *potential*.

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[92] D.S. 4.76.2.
[93] E.g. Brumbaugh 1966 25-26; Kang 2004, 15; Devecka 2013, 63.
[94] Pl. *Men.* 97d-98a.
[95] Pl. *Euthph.* 11c.
[96] See also Cratin. Fr 75 Kassel-Austin = 74 Kock.

The importance of the construct

When objects lose their status as a construct, manufactured though they may originally be, they lose their mechanised aspect and it seems, from the ancient evidence at least, that they are conceived of differently. One could compare the difference between a cyborg and a robot in the modern mind. Though very similar in definition and in action, the fact that the cyborg is composed of both organic and bio-mechanic parts allows it to occupy a different space in our imagination. It has different potential, different levels of threat, and its manufacture betrays different ideas on progress and technology. The tripods are not the only objects which Hephaestus manufactures and subsequently animates, yet they are the only ones with an obviously mechanical element and the only ones referred to as *automatoi*. Bronze, fire-breathing bulls were made by Hephaestus for Aeetes the king of Colchis, for example, and according to Nonnus, Hephaestus also made brass horses known as the 'Kabeiroi'.[97] Though our sources are not unanimous, certain traditions held that it was in fact Hephaestus who made the Caucasian Eagle that was subsequently animated and sent by Zeus daily to eat any liver Prometheus had regenerated overnight.[98] Despite being forged by the blacksmith and subsequently enhanced with the ability to move of their own accord, there is a point at which these creatures stop becoming products of superior *technē* and of the god's divine ability to animate things, and become mythical creatures in their own right. This is particularly tangible in the case of the bulls. The bulls' bronze hoofs and the bronze mouths from which fire bursts forth betray their manufactured nature. Yet when the bulls start fighting as they do in the *Argonautica,* it is no longer a question of automation because the 'apparently of its own accord' illusion disappears, and we simply have a mythical creature which is animate.[99]

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[97] Nonn. *D.* 29.193-205.
[98] Hyg. *Poet Ast.* 2.1.
[99] A.R. 3.1277 On this point see Berryman 2003, 352.

Though forged by a blacksmith, and a divine one at that, none of these creatures are referred to as *automata* nor are they described as moving *automatōs* in the Greek. I contend, therefore, that there is something fundamentally important in the automaton being and remaining a construct that is crucial to its conception. In other words, there is something to be said for the importance of the inanimate within the apparently animate creation itself. Beginning from and retreating back to the uninspired state is something that Homer emphasises about Hephaestus' tripods (θεῖον δυσαίατ' ἀγῶνα / ἠδ' αὖτις πρὸς δῶμα νεοίατο) and it will also become important for historical examples as in the Dionysus Shrine described by Hero of Alexandria (**P5**). It is also very much the point of the 'automatos bios' motif discussed below, and is further evident in the temple doors and other temple miracles.[100] This is in a sense one way of dealing with the problem of what 'happens' to the automaton outside of the religious context. Indeed, as we shall later see, when it comes to historical examples, processional automata will have their own ways of dealing with the construct of the machine outside the ritualised context of the festival.[101]

For Verity Platt, this conscious navigating between the recognition of the construct and the desire for a religious image to be 'real' is framed as 'absorption and erudition'.[102] For Gell, this oxymoron of the miracle of imitation qua imitation is expressed through an analysis of Peto's *Old Scraps* or *Old Time Letter Rack.* The painting's power, Gell argues, lies in the fact that the audience has great difficulty working out how coloured pigments can be applied so realistically.[103] It is then the creation of the work of art, its coming into being, that is the wonder. When it comes to ancient automata, there is a similar paradox inherent in that the greater the religious *thauma,* the greater the human *technē* and vice-versa. This tension is, in fact, exploited by rich leaders particularly in the Hellenistic period.

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[100] See coda to **P3** on miraculous springs and *Chapter 4/ Temple Automata*.
[101] For more on this see the introduction to *Chapter 3/ Processional Automata*.
[102] Platt 2011, 2.
[103] Gell 1992, 49.

Talos and the constraints of the mythic world

Another way to look at the issue of the construct of the machine is that myth, being by its very nature the world of the divine and semi-divine, is paradoxically one-dimensional in how animation can be interpreted. Mythic examples in many ways cannot be automata in that they are stuck in a world where the forces of the divine are constantly tangible, and this cannot be removed. Introducing the mechanical overtly, as with Hephaestus' tripods, is one way around this issue, but even then the boundary is fluid. The paradox is obvious in the case of Talos, who is also particularly interesting for what he reveals about automation of the human figure.

Talos was stationed on Crete to protect the island from invaders and was either created by Hephaestus or, more commonly, was the last descendant of a race of bronze demi-gods.[104] The source of Talos' animation is explained in detail in the *Argonautica*. He is permanently endowed with life through a blood-red vein that runs down to his ankle and held in place with a bronze nail.[105] Apart from this, Talos has a surprising number of human attributes. Physically, if the iconographic tradition is anything to go by, he was perceived to be a beautifully muscled young man, entirely human in figure and proportion.[106] He stands out on the Talos vase because of the bright white colour used for his body, but there is otherwise nothing technological about his presentation. The stories of his death which involve in one tradition Medea throwing him into a state of madness, and in another Medea tricking him and under the pretence of making him immortal pulling out the nail from his ankle, show that he had cognitive capabilities and desires of his own.[107] The question then

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[104] The two explanations are given in Apollodorus (Apollod. 1.140) while Apollonius will favour the latter version only (A.R 4.1638-1688).
[105] A.R. 4.1646-1647.
[106] The best representation of Talos comes from the so-called 'Talos vase' in Ruvo, Museo Jatta J 1501. See also the virtually identical fragment in Ferrara, Museo Archeologico Nazionale 3092.
[107] Apollod. 1.140.

arises: is Talos closer to a living being than a machine?[108] The fact that he has a nail in his ankle does suggest something slightly mechanical about him and it is tempting to the modern mind to see Talos as a proto-robot which fits with modern conceptions of automata. At the same time, however, the fact that Talos is never actually called an automaton, nor is the vocabulary of automation ever attached to him, makes his a slightly complicated case. If we imagine a sliding scale between *technē* and mortal construction on the one hand, and nature and divinely animated things on the other, the automaton revels in its ambiguous status between the two poles. The sense of the uncanny is provoked precisely because, in its moment of animation, the machine is perfectly, intentionally ambiguous. In the case of Talos, he seems to be leaning slightly too much towards the animate, though he is not quite as human as Pygmalion or Pandora. All things considered, it is rather reassuring to find blurring and overlapping categories when floating over the imaginative disposition of a complex and diverse culture.

The cases of Talos and of Daedalus' statues have thus brought a new layer of sophistication to the discussion. Rather than relying solely on linguistic exclusion in treating these cases as exceptional, we have also seen how semiotically, the objects and their animation represent something different. In one sense they are inseparable from the religious realm in that they exist in myth, but in another, that is their limitation when it comes to the real world. They lack the ability to move from inanimate to animate which, as we have seen, is so crucial to the automaton because of the way in which the movement is tied to divine presence, communication or other instances of supernatural intervention in the human realm. The wheels on Hephaestus' tripods are indications of a middle ground between the purely marvellous, entirely divine and the mechanically enhanced wonder that will characterise the creation of automata in history.

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[108] A similar case can be made for the golden handmaidens which help Hephaestus in his workshop who are describe as having *nous* (Hom. *Il.* 18.417-21).

Automatos Bios

The relation between the mechanical and the miraculous made Hephaestus' tripods an innovation by all accounts and we see that they captured the imagination of subsequent generations of ancient writers. Philostratus, for example, refers to the tripods, their Homeric precedent and their ability to move *automatōs* explicitly:[109]

προσδεξαμένου δ᾽αὐτοῦ καὶ τοῦτο μάλιστα ἀσμένως τρίποδες μὲν ἐξεπορεύθησαν Πυθικοὶ τέτταρες αὐτόματοι, καθάπερ οἱ Ὁμήρειοι προϊόντες, οἰνοχόοι δ᾽ ὑπ᾽ αὐτοῖς χαλκοῦ μέλανος, οἷοι παρ᾽ Ἕλλησιν οἱ Γανυμήδεις τε καὶ οἱ Πέλοπες. ἡ γῆ δὲ ὑπεστόρνυ πόας μαλακωτέρας ἢ αἱ εὐναί. τραγήματα δὲ καὶ ἄρτοι καὶ λάχανα καὶ τρωκτὰ ὡραῖα, πάντα ἐν κόσμῳ ἐφοίτα διακείμενα ἥδιον ἢ εἰ ὀψοποιοὶ αὐτὰ παρεσκεύαζον, τῶν δὲ τριπόδων οἱ μὲν δύο οἴνου ἐπέρρεον, τοῖν δυοῖν δὲ ὁ μὲν ὕδατος θερμοῦ κρήνην παρεῖχεν, ὁ δὲ αὖ ψυχροῦ.

Having also received this most gladly, out came four Pythian tripods of their own accord, advancing like the Homeric ones, and behind them cupbearers of dark bronze like Ganymede and Pelops among the Greeks. And the earth strewed beneath them grass softer than a bed, and dried fruits and bread and vegetables and seasonal treats all duly came in, served more pleasantly than if cooks had prepared them. Two of the tripods flowed with wine, while the other two gave forth, one a fountain of warm water, and the other a fountain of cold water.[110]

As well as picking up on the image of the automated tripods, Philostratus here integrates another important motif of automation in the ancient imagination: the spontaneous production of goods. Automat- root vocabulary is used extensively in this domain, and spectacle machinery later in history

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[109] See also Arist. *Pol.* 1253b35.
[110] Phil. *VA* 3.27.17-28.

will aim to reproduce it in various ways. To a certain degree, the 'automatic' or natural production of goods is simply synonymous with good crop growth or flora existing without human intervention, hence symbolising a life free from the anxiety of crop failures and famine.[111] But beyond the natural, there is something of an implied blessing in the images of automated abundance. The divine precedent for a world characterised by the spontaneous production of resources is, of course, the Golden Age of Kronos first described by Hesiod where men lived like gods and 'life-giving earth bared them fruit most spontaneously and plentifully' (καρπὸν δ᾽ ἔφερε ζείδωρος ἄρουρα /αὐτομάτη πολλόν τε καὶ ἄφθονον). [112] In the *Argonautica*, it is a divine sign from Rhea that trees shed abundant fruit; that the earth sprouts flowers *automatos;* and as another marvel (*teras*) that water gushes from what had been a dry peak.[113]

The float carrying an automaton that facilitates endless springs of milk and wine to spill forth from a cave as it rolled along in parade of Ptolemy II (**P3**) obviously draws upon this mythic tradition. We in fact have a number of curious examples which come down to us in ancient sources relating how on particular religious occasions, and thanks to the intervention of some god, natural springs miraculously and spontaneously produced wine instead of water (**P3:coda**). In all cases, we must note that the miracles were taken as evidence of the presence of the god on a specific religious occasion, and that the relationship with Dionysus is particularly strong, a point which will be revisited later.

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[111] This is particularly the case in Herodotus. The Nile rises *automatos,* waters the field and sinks again (Hdt. 2.14.13); cats can die *automatos* i.e. of natural causes (Hdt. 2.66.16); plants grow *automatos* in Greece (i.e. no human intervention is needed to make them grow as they grow naturally) (Hdt. 2.94.5; 3.100.5; 4.74.3; 8.138.11); Herodotus speaks too of 'naturally occurring' land formations (Hdt. 4.53.1).

[112] Hes. *Op.* 118. See also Pl. *Plt.* 271d-272a and Pl. *Lg.* 713c.

[113] A. R. 1.1142-1148.

Paola Ceccarelli, in an article on the image of spontaneously-occurring goods as they appear in fifth century BC comic fragments has termed this the *automatos bios* motif.[114] The term is useful, and I think we can push Ceccarelli's argument further in that this motif is not restricted to comic fragments, nor is it exclusively representative of a Periclean Golden Age. Eric Csapo has shown, for example, the relevance of the theme of plenitude in the Dionysiac festival context as a whole.[115] If we think of the *automatos bios* theme as it relates to the utopic world of the festival more broadly, we are led yet again to understand the way in which technological sophistication, operating without human intervention, was put to the service of religious zeal. As we have noted, it is of far less interest to the ancient mind to automate the human form in order to create proto-robots that might, for example, serve to replace slaves or exist as biological models for understanding the human body.[116]

The last point which automated landscapes and the *automatos bios* motif make particularly manifest is the paradox in the ancient mind of automata at once coming close to imitating nature yet, because of their artificiality, being very far from natural. This is a contradiction inherent in the use of human *technē* more generally which leads to ambivalent attitudes towards art, craft and technology in antiquity as is insightfully discussed by Cuomo in her monograph on the place of technology in Greek culture.[117] Automata offer a particularly interesting addition to this discussion given that in their very existence, there is a constant negotiation between something that appears natural or free from intervention, but at the same time is fundamentally mechanical in essence. This contradiction,

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[114] Ceccarelli 1996.

[115] Csapo 2013.

[116] Another example of the *automatos bios* motif as it relates to the carnival spectacle but in the Roman world is the mechanical distribution of items of largesse (known as *rhimmata* in Greek and *missilia* in Latin) attested to in both halves of the Mediterranean under the Roman Empire: Mart. 8.78 esp. lines 7-12; Stat. *Silv.* 1.6 esp. lines 10-27 and 65-67; Suet. *Dom.* 4.5 and Sen. *Ep.* 74.7-10 where the author draws an analogy between the goods distributed at festivals and the favours offered in life 'falling' into your hands. See Coleman 1996, 55 and Killeen 1959 on the *linea dives.*

[117] Cuomo 2007 esp. 8-40.

as we have noted above through an examination of the *Mechanical Problems,* is wondrous in the ancient mind.

Conclusion

This thesis looks at the use of self-animated machines of spectacle technology in ancient Greek religion. By examining the mythic narratives that were constructed around the theme of automation of manufactured objects this chapter has served to explore the space occupied by self-animated technology in the ancient Greek imagination. Combining this with the evidence from ancient mechanical treatises we have come to see that automata were constructed to produce wonder and awe in their spectators and that this was then put to use for religious zeal rather than, for example, industrialisation or to prove scientific hypotheses. The collection of sources that make up Part II of the thesis group together the historical evidence in the ancient corpus for the use of automata in Greek religious processions and sanctuaries. These examples highlight how at times, particularly when it came to huge processional equipment such as those commissioned by powerful leaders such as Demetrius of Phalerum, Ptolemy Philadelphus and Herodes Atticus, technologies of automation were clearly used as tools for political theatre. Yet in no instance was the religious element removed or marginalised from the context of deployment. A large part of this lies in the way in which gaze and spectatorship play a significant role in how automation was perceived and critically, the way in which automation technologies were part of multi-directional human-divine interactions in the ancient Greek religious experience.

Part II: Automata in Context

Chapter 3/ Processional Automata

The *pompē*

The first category of evidence gathers together the use of large machines of entertainment technology used in ancient Greek festival processions. Though an elusive subject at the best of times, work has been done to reconstruct the various events that typically made up an ancient festival.[1] The festival procession or *pompē* was just one part of various events, more or less well documented, that made up an ancient festival. The *pompē* was a grand affair. It traversed a significant area of the city, involved a huge number of people, culminated in public sacrifice, and, importantly for our purposes, included a variety of ritual objects and representations which were carried through the sacred spaces of the city. Each festival was unique in the exact items that were paraded and the ritual symbolism these possessed. Automata should be considered part of these ritual objects or the *pompeia* that made up the symbolic currency of the procession. The recent work of Didiers Viviers points out how city streets were often manicured in preparation for the celebration of a religious festival, and that the general trend for the development of the Greek festival *pompai* overtime shows evidence of increased theatricality.[2] To attend a festival and form part of its procession was not just walking from 'a' to 'b', it was engaging in the institution of theōria and was thus a fundamentally politico-religious act.[3] To be a spectator of ritual was to be a participant and vice-versa. For this reason, there exists an interpretative symbiosis between the automaton and the festival; between the machine and its performative context.

The festival as a sensory playground

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[1] With vastly differing views, of course, of what it all meant: Pickard-Cambridge 1968; Mansfield 1985; Goldhill 1987; Cole 1993; Sourvinou-Inwood 1994, 2003; Shear 2001 esp. 120-230; Parker 2005; Csapo 2013.
[2] Viviers 2014.
[3] On theōria as pilgrimage: Rutherford 2013.

We have already indicated how the festival was a highly sensorial occasion. Plato in his *Republic* pits

the philosopher directly against lovers of spectacle and it is the different sensory priorities of these

two groups which essentially distinguishes them. Plato's critique of the *philēkooi* (lovers of sound),

the *philotheamones* (lovers of spectacle) and the *philotechnoi* (lovers of crafts) is that they delight in

the sensorial experience without coming to a 'deeper' (i.e. philosophical) understanding of beauty.

That is to say, they engage only on a base sensory level with the sights, sounds, smells and tastes of

the spectacles that surround them and critically, it is by running from Dionysia to Dionysia that they

encounter these 'cheap thrills'. [4]

According to Plato at least, the sensory experience (and especially pleasure through sensory

experience) was something that was actively sought from festivals. Expanding on Elsner's thesis on

the religious gaze – and the viewing of objects as entry points for religious interactions – I would like

to suggest that we can in fact talk about the festival procession as explicitly using the pan-sensory

experience to incite religious connection and that automata were working as part of this social

phenomenon.[5] We need only to think of something such as transubstantiation in Catholicism as a

modern parallel.[6] A smell, for example, forges a connection between the people inhaling the odour

because they are united by a sensory experience and it is at the same time a way to connect with the

divine. Taste and music too act in this way as does, I would argue, witnessing a *thauma*, a miracle.

Further than a choral display or the burning of incense, automata combine the sensory with divine

awe and wonder in a way that other festival experiences do not in order to invoke the manifest

presence of the divine. As we make our way through the source material, therefore, there will be an

emphasis on this sensory aspect of the machines. The ancient Greek gods affected and were

affected by the visual (by art and dance, for example), the auditory (by song and music) and the

olfactory in turn. Automata, as larger-than-life, self-willed machines, formed part of negotiating

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[4] Pl. *R.* 5.475b-d

[5] Elsner 1995; 2007. And above *Chapter 2/ Inventing Automation* esp. pp 45-46.

[6] On the senses, and particularly olfaction, as triggers for category change see Howes 1991, 128-147.

human-divine interactions by combining the synaesthesia of the Greek festival with the awe and wonder invoked by miraculous, divinely inspired action.

The machine outside the religious arena

The religious framework for viewing ancient automata leads us to ask a series of poignant practical questions regarding the status of these machines as objects when viewed outside of the religious arena. What happened to automata after their use? Were these objects re-used year to year? How was the religious gaze secularised in between their use(s)? Were they destroyed? If so, to what extent was this part of a theatre of conspicuous waste on behalf of the leader? Some of the best evidence proving that the ancients bought into a religious reality projected by the machines is precisely in the anxiety attached with their use and reuse.

We unfortunately have hardly any evidence directly applicable to automata. We are forced instead to offer a tentative blueprint of possible answers according, mostly, to the evidence we have for other comparable ritual objects used in Greek religious procession. The issue is not as pertinent for Greek temple automata which, by virtue of their location, were affected by a palpable religious presence at all times.[7] Processional automata, however, rely on the religious utopia created by the festival occasion. Apollo's supposed disgust at the self-animated wagon paraded outside of its religious context recorded for us by a Socratic Epistle (**P7**) is indeed a good example of the perceived response when automation was not deemed to be divinely inspired.[8] Managing the highly performative and religiously significant object that was the processional automaton outside of the *pompē* is thus a tricky affair.

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[7] The Greek evidence suggests that many sanctuaries were regarded as places where the presence of the god was more tangible. See Rutherford 2013, 13.
[8] On which see below **P7.**

The first possibility is that automata were put on display after use. This would be a parallel situation to images of gods used in procession which were placed back in sanctuaries and temples after the festival had finished. This option makes logistical sense, and considering the cost of materials and production of the machines, leaders would surely want to capitalise on the impression these expensive and impressive objects left on spectators. The automaton on display in the city would not only remind passers-by of the animation it was capable of, and thus the festival sponsor's connection with the divine, but it would also serve in its inanimate state to reinforce the need for the divine connection to witness the *thauma* once more. There is some evidence, discussed further velow, that the automated ship of Herodes Atticus was put on display near the Areopagus after its use in the Panathenaea.[9]

If display was not always possible, practical, or ideologically reconcilable, another option would be to destroy the automata. As a parallel to this scenario, there is some indication that the phalloi used in the phallephoria in the Great Dionysia were burnt after use. In a comic fragment quoted by Dio Chrysostom, a man is supposedly burnt 'upon a heap of sixteen fig-wood phalloi' (ἐπὶ φαλήτων συκίνων ἑκκαίδεκα).[10] Though admittedly this is not conclusive evidence for the burning of phalloi after every use in procession, it is sufficient for us to think of it as a possibility. The fragment also implies that the phalloi were big enough for a pile of sixteen to support a grown man. This would make these phalloi comparable to automata in that they would be expensive to carve and bulky to store, more so than any other processional paraphernalia. Even better evidence for a disposal

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[9] See the discussion in **P6**.
[10] D.Chr. 33.63 = Ar. Fr 557 Kock. Excluded from the equivalent fragment in Kassel-Austin (568). For more on the fragment see also Cole 1993, 28.

procedure, burning or otherwise, is the epigraphic evidence showing that the phallos-icon of Dionysus at Delos was created anew for each Dionysia.[11]

We have another piece of ancient evidence that strengthens the possibility that automata were disposed of after use. Pausanias records for us the story of a local festival at Plataea known as the *Daedala* or *Little Daedala.*[12] This celebration was reportedly held every six years but in reality, Pausanias affirms, occurred slightly more frequently. The festival commemorated the reconciliation of Zeus and Hera after he tricked her into thinking he was marrying Plataea by wrapping a wooden image on a wagon. At the *Little Daedala,* the Plataeans walked in procession carrying wooden images to a grove of huge oaks in Alalcomenae. After a sacrificial ritual, the Plataeans cut down the trunk of a specific tree which had been marked out by a religious omen. According to Pausanias, both the tree trunk and the wooden images carried in the *pompē* are all called *daedala.* The author gives no further explanation for this curious part of the festival, but one cannot help but think of this as a ritualised demarcation of the trunk to be used for the next Daedala. The next passage which essentially describes a ritualised economy of construction and destruction of festival *pompeia* would support such a theory. As the account continues, Pausanias goes on to explain that every 59 years, once fourteen wooden images had been amassed (hence the author's initial suspicion that the *Little Daedala* must take place at smaller intervals than was reported to him), a festival known as the *Greater Daedala* was held. This larger-scale Boeotian-wide festival involved a more elaborate *pompē* with wooden images and a bridesmaid on wagons travelling from the river to the summit of Cithaeron. Here an altar had been prepared and after a sacrifice of a cow to Hera and a bull to Zeus, the victims along with wine, incense and the *daedala* were burnt.

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[11] *IG* XI 2, 144A ll. 33-6; *IG* XI 2, 154, ll. 43-4; *ID* 294, l. 7.
[12] The story is related in Paus. 9.3.2-9. We also get two versions in Plutarch's now fragmentary *Peri tōn en Plataiais Daidalōn = FGrH* 388 F 1. For an excellent reconstruction of the Daedala and its phases see Chaniotis, 2002.

Several interesting points can be drawn out from this account which are relevant to the present discussion. First, that there is possibly a ritualised way in which the material is 'chosen' for the next festival. This shows a concern for the sacred nature of the materials used in construction of ritual objects used in festival procession. We hear echoes again, then, of statues described as *diopetēs* (fallen from Zeus) and *acheiropoiētos* (not made by hand) and similar anxieties come through reconciling the object straddling the religious and secular spheres. The next point to note is the fact that the *daedala* (both trunk and/or statue) are stored for as long as would have been spatially and ideologically practical. Whether the *daedala* would have retained a religious significance on display in a religious setting, or whether they would have been stored out of sight and their significance thus 'secularised' until the next occasion is for us to imagine. What we do know is that the display or storage system is subsequently integrated into a performance of conspicuous waste when a collection of (by now) antique *daedala* are later burnt in a ritualised context which involved the whole community. What this burning also allows, then, is the destruction of essentially sacred representations to make room for the next generation of ritual objects.[13]

Preceding the testimonia, this discussion has served to bring into relief some tangible distinctions between automata in myth and the ancient imagination, and automata in history. There are different concerns and different ways in which automata need to be thought of when employed in history and the commentaries accompanying the testimonia will attempt to deal with these partly religious, partly socio-political questions to better understand the use of ancient Greek automata.

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[13] We might also allude to the refashioning of *pompeia* from the property of the Thirty after their overthrow in Athens in 403BC. For more on this see Kindt 2012, 83.

P1: The Snail of Demetrius of Phalerum

Polybius 12.13.9-11 = *FGrH* 75 F4 = *SOD* 89. Great Dionysia, 309/8 BC.

οὗ 'κεῖνος οὐ τὴν τυχοῦσαν πεποίηται κατηγορίαν ἐν ταῖς ἱστορίαις, φάσκων αὐτὸν γεγονέναι τοιοῦτον προστάτην τῆς πατρίδος καὶ ἐπὶ τούτοις σεμνύνεσθαι κατὰ τὴν πολιτείαν, ἐφ᾽ οἷς ἂν καὶ τελώνης σεμνυνθείη βάναυσος. ἐπὶ γὰρ τῷ πολλὰ καὶ λυσιτελῶς πωλεῖσθαι κατὰ τὴν πόλιν καὶ δαψιλῆ τὰ πρὸς τὸν βίον ὑπάρχειν πᾶσιν, ἐπὶ τούτοις φησὶ μεγαλαυχεῖν αὐτόν· καὶ διότι κοχλίας αὐτομάτως βαδίζων προηγεῖτο τῆς πομπῆς αὐτῷ, σίαλον ἀναπτύων, σὺν δὲ τούτοις ὄνοι[1] διεπέμποντο διὰ τοῦ θεάτρου,[2] διότι δὴ πάντων τῶν τῆς Ἑλλάδος καλῶν ἡ πατρὶς παρακεχωρηκυῖα τοῖς ἄλλοις ἐποίει Κασσάνδρῳ τὸ προσταττόμενον, ἐπὶ τούτοις αὐτὸν οὐκ αἰσχύνεσθαί φησιν.

καὶ δὴ ὅτι Toup; αὐτομάτος P.; ἀποπτύων Suid; ἄνοι P., ἄνθρωποι Jacoby; διότι δε Jacoby

That man (Demochares) made no ordinary accusations in his *Histories* saying that he (Demetrius) was such a governor of his country that he took pride in the political administration in the same way as a vulgar tax farmer might take pride. For he (Demochares) says that he (Demetrius) boasted that many goods were sold cheaply and that throughout the city abundant amenities of life existed for all. And indeed [he boasted] because a snail proceeding of its own accord led the procession for him, casting out slime, and with this, asses [men?] were paraded through the theatre presumably because Athens yielded all the good things of Greece to others and submitted herself to commands made by Cassander. He (Demochares) says that he (Demetrius) was not ashamed about all this.

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[1] The *communis lectio* now seems to be ὄνοι following the emendation by Toup. On the substitution of ἄνθρωπος for ὄνος in Aristotle's *Historia Animalium* as a whole see Thompson 1945, 54-55, and for the same issue in the Polybius passage at hand see, in the same volume, Walbank 1945, 122.

[2] Jacoby is alone in assuming a lacuna here after θεάτρου. This does possibly rehabilitate the otherwise strange causal link (διότι δὴ) between the *Pompē* of the Great Dionysia and the claim that Demetrius was yielding to others all the treasures of Greece and the commands of Cassander.

The automated snail of Demetrius of Phalerum is one of the earliest and most intriguing references to a processional automaton from the ancient world.[3] This impressive piece of spectacle technology is explicitly said to have moved of its own accord (*automatōs*) and was at the very head (*proēgeito*) of the procession of the Great Dionysia organised by Demetrius of Phalerum in his role as eponymous archon in 309/8 BC. The full Dionysian *Pompē* left from the Dipylon Gates, continued along to the Agora, stopped at the altar of the twelve gods for choral displays, passed along the Panathenaic way as far as the Eleusinium, followed down the 'Street of the Tripods' along the northern slope of the Acropolis before finally twisting right to arrive at the foot of the Acropolis at the Theatre of Dionysus.[4]

Politics and Spectacle

Demetrius of Phalerum was a peripatetic philosopher and was appointed to rule Athens by Cassander in 317 BC. Demetrius remained at the head of the Athenian *polis* until his expulsion in 307 BC. Very soon before he was expelled, as archon in 309/8 BC, Demetrius organised the Great Dionysia in which we find the snail. Felix Jacoby places Demetrius Poliorcetes' entry into Athens in the first month (Hecatombaeon) of 307/6 BC and 'presumably in the first third of that month'.[5] Thus Demetrius of Phalerum's expulsion was a mere four months after the grandiose celebrations he had organised for the Dionysia which would have taken place in Elaphebolion. The ousted leader then took refuge with Cassander in Thebes and upon his friend's death headed to the Ptolemaic court. It is in Egypt that he would later take part in the cultural projects of Ptolemy I and II such as the Library of Alexandria and the Museion. Alexandria under Ptolemy II is, perhaps not entirely coincidentally, the location of our next two testimonia (**P2-3**).

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[33] Though mechanics are obviously outside the scope of the present study it is worth flagging Rehm 1937, with the note that I personally take issue with his reconstruction.
[4] To date, the best maps of Athens are found in Ficuciello 2008.
[5] *FGrH* Commentary 328 F66.

To contextualise the fragment politically, it is important to note that at this point in his *Histories*, Polybius is trying to defend Demochares' reputation from the words of Timaeus. Thus, the account as we have it here is obviously slanted to favour Demochares, a democratic statesman and orator, son of the more famous orator Demosthenes' sister, and one of Demetrius of Phalerum's greatest political opponents. As a result, there is a strong element of political slander in the passage. Demochares lived from c. 350 to before 270/1 BC and was active at Athens from the expulsion of Demetrius of Phalerum in 307 BC, but subsequently exiled four years later under Demetrius Poliorcetes. He was politically opposed to Demetrius of Phalerum for the latter's oligarchic tendencies,[6] and embittered towards the democratic faction who came to power following Demetrius' expulsion for their sycophantic attitude towards their newfound 'liberator'.[7]

The implication of the passage is that Demetrius of Phalerum had boasted, most plausibly in some work of self-justification such as *On the Ten Years* (Περὶ τῆς δεκαετίας*) or *Of the Constitution* (Ὑπὲρ τῆς πολιτείας), about the prosperity which Athens enjoyed while it was under his rule.[8] Given the strain that the Lamian War (323-322 BC) would have recently put on the Athenian economy, coupled with the ever-present burden of the garrison at the Piraeus, the recovery and economic stability Athens enjoyed during the Phalerean decade does seem a commendable achievement by Demetrius. Yet the city's relative prosperity was nevertheless easily capable of being turned into slander against the leader, as is here done by Demochares. The low level of military activity that the Athenians were engaged in and the stability that the city enjoyed under Demetrius were perceptibly linked to her subordination to Macedonian power and her loss of independence.

The relevance of such politics to our present purpose is that Demochares criticises Demetrius' financial administration of the city by explicitly linking it to spectacle. What is more, the spectacle

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[6] For a thorough treatment of the perception of Demetrius' as 'tyrant' and 'oligarch' both in ancient and modern scholarship, see O'Sullivan 2009.

[7] We get a good glimpse of this attitude of Demochares in Ath. 6.62 252f-253b = *FGrH* 75 F 1-2.

[8] D.L. 5.80 = *FGrH* 228 T 1 = SOD 1.

apparatus of choice is an *automaton.* The rhetoric of pride and shame which runs through the

extract is grounded in the history of the period insofar as, at least according to his opponents,

Demetrius' ability to host such a marvellous Dionysia rested on the prosperity that had resulted from

Macedonian hegemony and the inescapable influence of Cassander.[9] The contrast between political

and military incapacity of the Athenian *demos* on the one hand, and prosperity and love of theatrical

display is a familiar rhetorical trope throughout Athenian history, and one that applies to the

Phalerean regime particularly well.[10] Demetrius evidently had a demagogic streak and did not shy

from using largesse to gain political favour.[11] The fact that he specifically did this through the

magnificent spectacle that was an automated machine in a religious festival is telling of the way in

which these machines were used as part of political theatre by rich leaders in the Hellenistic period.

From the point of view of his enemies, the sort of lavish pomp seen at the Dionysia of 309/8 BC was

contradictory to the character of the bulk of Demetrius' legislations largely geared towards enforcing

religious propriety. This sentiment is conveyed by Duris who notes that Demetrius was criticised for

laying down laws for other people and regulating their lives, but organising his own life with utter

freedom from law.[12] In fact, the Duris passage adds that during the *Pompē* of the same Dionysia

where Demetrius brought out the spectacular mechanical snail, he also arranged for a chorus to sing

verses of 'Siron of Soli' in his honour in which he was spoken of as 'shaped like the sun'.[13] The

festival as a whole, it would seem, was a tool of self-aggrandisement by the rich and powerful

leader. The use of an automaton in the procession was part of maximising on religious zeal during

the occasion to great effect, and we can see a similar trend at work with the extant examples of

Ptolemy II (**P2-3**) and Herodes Atticus (**P6**) too.

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[9] Indeed, with the entry of Poliorcetes, Athens would experience new hardships and Marasco goes as far as seeing Demochares' attack on Demetrius' economic success as an implicit apology for the period of deprivation suffered by Athens in the post-Phalerean period (Marasco 1984, 90).
[10] See especially Th. 3.38.4; Pl. *Grg.* 515e; D. 3.31; Plut. *Moralia* 818c-d.
[11] O'Sullivan sees Demetrius as Periclean in this aspect, a parallel already made by Plutarch, *Moralia* 818c-d.
[12] Ath. 12.60 542B-543A = SOD 43A.
[13] Ath. 12.60 542B-543A = SOD 43A.

Slow and steady?

The symbolic significance of the snail remains largely unclear. There are a couple of avenues of interpretation that we can definitely exclude. The first is that of the snail as a symbol of a luxury food product which appears to have been something of a Roman phenomenon and for which there is no strong evidence in the Greek material.[14] The second possibility, which would have nicely played into the trope of luxury and spectacle had there been sufficient evidence to support it, was the fact that the sea snail was used to create an exquisite purple dye often used to tint the expensive robes worn, for example, in festival processions. The crimson colour that was extracted from the sea snail was the colour of the tapestry laid out before Agamemnon by Clytemnestra upon his return; a colour only worthy of divinity at least in that context.[15] It was the colour of the robes worn by Alcibiades as he paraded pompously through the agora.[16] Aristotle indicates to us, however, that *kochlia* as we have in our text is a land-snail; *kochlos* a sea-snail; while the sea-snail used for dye appears to be referred to as a *porphyra*.[17]

The answer, if there must be one out of curiosity and not because it impacts the argument greatly, most likely lies in a combination of three factors. Pragmatics, firstly, could have played an important role: a giant shell in which to hide the mechanism must have helped as would the fact that snails characteristically moved very slowly. Secondly, there is possibly some agricultural symbolism at play since the Dionysia took place in early March, the beginning of the Greek Spring and thus the time when snails typically began to be seen actively among crops, coming out after the months of highest precipitation. Lastly, it is possible that the automaton snail is here is used as a literary trope by

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[14] There is a fragment of Alexis (Alex. Fr 175 Kassel-Austin = 170 Kock = Arnott 513) which mentions the trumpet snail (*kērux*) as an aphrodisiac and Galen says the Greeks ate snails, but there is no indication of the snail having any value related specifically to luxury in the Greek world.

[15] A. *Ag*. 910.

[16] Ath. 12.534c cf. Plu. *Alc*. 16.1. For more on the leader and visual spectacle in the context of the *chorēgos* see Wilson 1997, 102 and for elaborate costuming as indication of antidemocratic sentiment see Wohl 2002, 112-113.

[17] Arist. *HA* 4.4 = 538a.

Demochares to insult the 'idleness' of Demetrius as a ruler. This would in turn mean that automata in festival processions were common enough for such a trope to be used freely which is interesting in itself.

Something to do with Dionysus

The last, and possibly the most important, point to make in relation to Demetrius' snail is that there is something particularly Dionysian about spontaneous movement and, as noted by Csapo, about spontaneity more broadly.[18] Euripides' *Bacchae* gives us good evidence for this. With the arrival of Dionysus in Thebes, the chains are loosened *automatoi* from the feet of the Bacchant women, keys open doors with no mortal hand to turn them and other such marvels (*thaumata*) are witnessed.[19] Euripides spends a stanza describing how the Bacchants are also able to make goods produce spontaneously from the earth[20] and the motion that Dionysian influence provokes in earth and beast is summed up at the end of the stanza through 'the whole mountain and all beasts revelled too, and nothing was unmoved by their running' (πᾶν δὲ συνεβάκχευ᾽ ὄρος καὶ θῆρες, οὐδὲν δ᾽ ἦν ἀκίνητον δρόμῳ).[21] Dionysian rituals are intent on disturbing binaries: man and beast, male and female, for example. It would seem that automation is another avenue for the God's influence be felt as the division between animate and inanimate becomes mutable under Dionysius' auspices. All this is not to say, of course, that Dionysus had exclusive rights over spontaneous animation, but we will see throughout the course of the testimonia that he is frequently involved in cases of mechanised automation.

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[18] Csapo 2013, 25.
[19] E. *Ba.* 445-9.
[20] E. *Ba.* 704-11.
[21] E. *Ba.* 726-7.

P2: Nysa Pouring a Libation

Athenaeus, *Deipnosophistae,* 5.198F -199A = *FGrH* 627 F 2. Grand Procession of Ptolemy Philadelphus, c. 279-270 BC.

μετὰ δὲ ταύτας ἤγετο τετράκυκλος πηχῶν ὀκτὼ πλάτος ὑπὸ ἀνδρῶν ἑξήκοντα, ἐφ᾽ ἧς ἄγαλμα Νύσης ὀκτάπηχυ καθήμενον, ἐνδεδυκὸς μὲν θάψινον χιτῶνα χρυσοποίκιλον, ἱμάτιον δὲ ἠμφίεστο Λακωνικόν. ἀνίστατο δὲ τοῦτο μηχανικῶς οὐδενὸς τὰς χεῖρας προσάγοντος καὶ σπεῖσαν ἐκ χρυσῆς φιάλης γάλα πάλιν ἐκάθητο. εἶχε δὲ ἐν τῇ ἀριστερᾷ θύρσον ἐστεμμένον μίτραις. αὕτη δ᾽ ἐστεφάνωτο κισσίνῳ χρυσῷ καὶ βότρυσι διαλίθοις πολυτελέσιν. εἶχε δὲ σκιάδα καὶ ἐπὶ τῶν γωνιῶν τῆς τετρακύκλου κατεπεπήγεσαν λαμπάδες διάχρυσοι τέτταρες.

After these women, a four-wheeled cart eight cubits wide was led by sixty men. On it there was a seated statue of Nysa eight cubits high wearing a yellow tunic embroidered with gold, and with a Lakonian himation wrapped around her. This statue stood up mechanically with no one putting a hand on it, and after pouring a libation of milk from a golden *phialē*, it sat back down again. It was holding in its left hand a *thyrsos* bound with fillets, and was crowned with golden ivy leaves and with expensive bunches of grapes made of precious stones. It also was fitted with a canopy and at the corners of the four-wheeled cart were harnessed four torches interwoven with gold.

In book five of Athenaeus' *Deipnosophistae* we find an abbreviated portion of what was originally included in Callixenus of Rhodes' work *About Alexandria* written in the third century BC.[1] We possess four large fragments of *About Alexandria*, all preserved in book five of the *Deipnosophistae*, and

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[1] The date is anchored only by the accession of Ptolemy IV Philopator to the throne of Egypt 221 BC which furnishes a *terminus post quem* for the author's death. Rice 1983, 134.

Callixenus' text as it has come down to us appears to have been largely a catalogue of wonders, including the ostentatious displays of wealth by Ptolemy II that interest us here.[2] The first part of the fragment describes an ornamental pavilion in which it is assumed that a banquet would have been held as part of an elaborate festival. As the grand finale of Callixenus' ekphrastic description is a detailed account of the *pompē* of this same festival. Following Rice, it is worth putting a slight emphasis on the fact that the entire Callixenus fragment deserves to be taken together since it describes a single religious occasion.[3] Otherwise, in restricting discussion to the *pompē* alone, we omit some useful information in the broader reconstruction of the festival held by Ptolemy II, and thus of the real role of the multiple automata used by the King within their performative context.

Callixenus' account of the festival is ridiculously lengthy and the procession, we gather, was incredibly lavish. Of particular note is a statue of Nysa who stood up of her own accord, poured a libation, and sat back down, as well as a large float transported on a wagon which sported a cave with two springs continually gushing forth milk and wine. Although abridged from what Callixenus originally wrote, captured for us by Athenaeus are choruses of thousands of individuals, oversized chariots carrying various ritual objects, the processional display of both domesticated and exotic animals, as well as various self-consciously 'interactive' moments when spectators could, for example, splash about in puddles of wine as it ran from a cart throughout the streets; and even hold on to birds as if they were balloons, with long strings attached to their legs. We might compare this to the trend in the Roman period of distributing gifts of largesse among the spectators in the amphitheatre which, interestingly, was sometimes done mechanically.[4] Regrettably only the

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[2] For more on the author see Rice 1983, 134-149.
[3] Rice 1983, 32-33.
[4] See above *Chapter 2/ Inventing Automation* p. 57 n. 115.

Dionysian portion of Philadelphus' *pompē* has come down to us, though the text indicates there were similar sorts of processional displays to the other gods, Zeus in particular.[5]

The Context of the Parade

The occasion, date and purpose of the procession are not mentioned in the fragment and although these details are frustratingly difficult to pin down, they do deserve a brief investigation here to allow us to better contextualise the text. The only detail we can deduce with some certainty is that this festival organised by Ptolemy II was penteteric. Not only is the reader urged by Callixenus to consult the records of the Penteteric festivals should he wish to know more, but the presence of the personification of Penteteris early in the parade leaves us in no doubt that this was a four-yearly occurrence.[6]

Since the publication in 1890 of a decree from Amorgos regarding the Nesiotic League, the festival described by Callixenus has generally been associated with the Ptolemaea.[7] Although the epigraphic evidence for the Ptolemaea is fairly substantial, the inscriptions do little in helping date the festival in Athenaeus' text, nor in fact do they offer a definite link between the events described and the festival in honour of Ptolemy I.[8] We do know that games formed a part of the Ptolemaea as we have two epigraphic dedications commemorating sporting victories at the festival, but few other specifics on the festival can be concluded for certain.[9] Internally, the text itself gives little more information. The mention of 'the parents of the kings' (ἡ τοῖς τῶν βασιλέων γονεῦσι) at the beginning of the description of the procession has been the centre of much discussion as the plural is thought to

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[5] Ath. 5.197D; 202A.
[6] Ath. 5.197D and Ath. 5.198B respectively.
[7] *SIG*[3] 390 = Austin 218. The view is not unanimous. Contra see Fraser 1954.
[8] *SEG* 28.60 55 = Austin 44; 113 and *SEG* 1.366 = Austin 113.
[9] SIG[3] 1080 = IG 5.2 118 = Austin 122; *SEG* 27.1114 =Austin 217.

indicate that Ptolemy was married at the time of the celebration.[10] Yet this phrase aside, Rice notes that the absence of both Arisinoe I or II in the parade is strange given the cultic reverence shown for Alexander, Ptolemy I, Berenike and Ptolemy II in the *pompē*.[11] Rice persuasively argues that the reference to the 'kings' parents' refers to the parents of Ptolemy I and II, thus placing the festival in the period between Ptolemy's wives, c. 280-75.[12] Yet since the account of the procession as it comes down to us is not complete, we might err towards a slightly more cautious hypothesis. I would most comfortably place the festival somewhere in the decade between 280 and 270, where the latter date is anchored by the establishment of the cult of the *Theoi Sōteres*, a cult title not used in the fragment.

Though the year of the celebration is hard to pin down, the season is much easier and in many ways much more relevant to our purposes. In the description of the pavilion, Callixenus explains that precisely since the banquet was held in the middle of winter, guests were even more impressed at the floral profusion which appeared as a spectacular 'divine meadow' before them.[13] The theatricality of the decoration, heralding the way in which Ptolemy's Alexandria was wealthy to the point of being unhampered even by the powers of the season, and offering a taste of Dionysiac unrestrained abundance that will feature strongly in the parade, set the scene for the wonder and ingenuity that featured intensely in the entire festival with automata playing a key role within this.

The Route of the Parade

The route of the parade of Ptolemy II is far less certain than those of the Great Dionysia and the Panathenaea at Athens. The first limitation is the poor state of preservation of Alexandria largely

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[10] Ath. 5.197D. For a full discussion see Rice 1983, 38-42.
[11] Ath. 5.203A-B.
[12] Rice 1983, 42.
[13] Ath. 5.196D-E.

resulting from the inevitable subsidence of the land which has rendered much of the coastal region of the ancient city below sea-level. Knowledge of the topography of Ptolemaic Alexandria consequently depends almost entirely on the account given by Strabo who arrived in Egypt in 24 BC and stayed in Alexandria until c. 20 BC.[14] Fortunately, there are also various clues within Callixenus' text which allow us to make some general conclusions on the route of the parade, and on Ptolemaic Alexandria more generally, above and beyond what is given by Strabo's late text.

Callixenus begins his account of the procession by saying that the *pompē* was led through the stadium (ἤγετο γὰρ διὰ τοῦ κατὰ τὴν πόλιν σταδίου).[15] Whether or not the stadium was the starting place of the *pompē* is uncertain, but considering the amount of men, beasts and equipment involved, it seems more likely that there was another initial starting place akin to the Athenian Pompeion somewhere in Alexandria which could be used as an equivalent of a modern 'green room'. For an indication of the location of the Alexandrian stadium our best clue comes from Polybius who mentions a stadium at Alexandria near the open areas around the palace and the 'great square'.[16] As Strabo makes no mention of an agora at Alexandria, the reference to the 'great square' is rather elusive. The 'palace' in Polybius, however, probably refers to the larger palace area in the north of the Alexandria up to the harbour.

We might then conclude that the stadium was located slightly south of the palaces, probably fairly close to this region, but in the main area of the city. Either way, the stadium certainly formed an important part of the processional route as Callixenus mentions that it was in the stadium that wine and water were mixed, offering all those present a whiff of the sweet smell.[17] If the procession

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[14] Str. 17.1.8-10. On the buildings and topography of Ptolemaic Alexandria see Fraser 1972, 3-37.
[15] Ath. 5.197C.
[16] Plb. 15.30.
[17] Ath. 5.200B.

stopped to mix wine and water (and then possibly distribute it to the guests present), it is not impossible that this occurred within a longer moment of repose and demonstration within the elaborate *pompē,* similar to the way that the Dionysian *Pompē* at Athens stopped at the Altar of the Twelve Gods for choral display. The Callixenus fragment also mentions the Berenikeion which Strabo does not include in his text. The Berenikeion might either have been in the palace complex itself where many other shrines are known to have been located, or south of this in the centre of the city, possibly on the way to or from the stadium.[18] Berenike was obviously significant to the parade as her portrait-statue is mentioned later, too.[19]

According to Athenaeus' text, as part of the festival, a banquet was held in a grandiose pavilion inside the *akra* or citadel.[20] The *akra* is not mentioned by Strabo but by cross-referencing with other ancient testimonia, we can conclude that it was most likely located within the private 'inner palaces' of the city.[21] The general palace area in Alexandria made up between a quarter and a third of the entire city and hosted the 'inner palaces' which comprised the royal palace and various other buildings dedicated purely to royal entertainment.[22] This topographic and political exclusivity in Hellenistic Alexandria is reflected in the passage at hand as it was apparently only the more important guests who were permitted to indulge in the hyper-luxurious pavilion described before the *pompē* in Callixenus' text, while soldiers, craftsmen and foreign visitors were entertained elsewhere.[23]

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[18] Ath. 5.202B.
[19] Ath. 5.203A.
[20] Ath. 5.196A.
[21] Plb. 5.39.3 (where the whole episode occurs within the Palace area in the larger significance of the term); *Letter of Aristeas* (where the *akra* seems to have been associated with the royal palace as it was near where the translators of the Septuagint stayed when they came to Alexandria).
[22] Str. 17.1.8.
[23] On the exclusivity of the *akra* 5.196A-B.

Reconstructing as we can, therefore, the Grand Procession of Ptolemy II probably started north of the city and made its way southwards down the main thoroughfares of the city of Alexandria, passing the Berenikeion along the way. En route towards its final destination, the procession would have paused for a considerable time in the stadium, making this a definitive feature of the Alexandrian *Pompē*. The sacrificial feast which followed the parade seems to have then been held back in the prestigious 'inner palace' section for the most important guests and in a more communal area for the others.[24]

Nysa

The statue of Nysa which, placed on a cart led by 60 men, stood up, poured a libation and sat down again, is the first certain automaton mentioned in the parade.[25] Nysa could either refer to the nurse to whom baby Dionysus was entrusted, or to the personification of the birthplace of Dionysus. Olson and Rice lean towards the former interpretation, while Csapo and Canfora favour the latter.[26] Unpacking the story of Dionysus presented more broadly in the parade will allow us to form a more informed judgment on this issue. Throughout the *pompē*, different facets of Dionysus are presented. We see Dionysus as the patron of wine and theatre; Dionysus' return from India, and Dionysus fleeing to the altar of Rhea.[27] After the presentation of Nysa, a tableau is processed which shows the cave of Hermes (**P3**). This invokes the version of the Dionysus myth where he is entrusted to Hermes by Zeus as an infant to be taken to the cave of the nymphs at Mount Nysa. Assuming consistency in the mythic presentation of Dionysus throughout the festival, we might thus favour the interpretation of Nysa as a personification of the mountain rather than as the nurse. Rice also notes that this fits in terms of the political propaganda of the parade as the location of the rearing place of Dionysus

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[24] Viviers 2014, 32 on the ending place of the procession.
[25] There is nothing in the Greek to indicate that the statue of Dionysus which precedes the statue of Nysa and which 'poured a libation' (*spendon*) actually moved, or that there was a self-replenishing stream pouring from his *karchesion* since the liquid of the libation is not specified. Ath. 5.198C.
[26] Olson 2006, 459 n. 90; Rice 1983, 66; Csapo 2013, 27; Canfora 2001, 498.
[27] Ath. 5.199A; 198A-B; 200D and 201C respectively.

played an important part in the justification of the Indian campaign of Alexander, which itself is central to the *pompē*.[28]

This self-animated machine which impressively stood and poured a libation on loop as it passed throughout the streets of Alexandria inarguably relied on the wheels of the cart as its source of energy. This method of transferring circular energy to linear movement is something that we know both Vitruvius and Ctesibius were interested in and White adds that this application of the rack-and-pinion gear would have been particularly exciting since toothed gear wheels were a recent invention.[29] Exactly how recent an invention is hard to determine, but what we can note is that the technology employed to automate Nysa is certainly different to the technology used in Demetrius of Phalerum's snail decades earlier (**P1**), and again to the Panathenaic ship cart centuries later (**P7**).

Since Peter Fraser's conjecture in 1972 that Nysa was the work of Ctesibius, scholars have found this suggestion very attractive. Fraser, and Rice after him, point to the fact that Ctesibius was known to have been well-liked by the royal court. The evidence for this comes from a curious offering of a drinking cup (*rhyton*) in the form of the god Bes with an automatically operating trumpet dedicated in honour of Arsinoe Philadelphus by Ctesibius.[30] Attaching the name of a single mechanic's genius to the Nysa automaton is certainly a historiographic temptation but perhaps an oversimplification which clouds a more important conclusion. What the Bes *rhyton* and the Nysa statue do offer is evidence for the way in which advertisements of scientific achievements in the form of dedications characterised a particular class of objects in Ptolemaic Alexandria, and it is telling that self-mechanisation featured strongly within this, particularly in the Hellenistic period.[31] We must keep in

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[28] Rice 1983, 67.
[29] White 1993, 218.
[30] Ath. 11.497D-E = Hedyl. 1843-1852 = IV Gow and Page. See Fraser 1972 413, 426; Rice 1983, 63.
[31] On 'dedicated inventions' see Fraser 1972, 212-213.

mind that Ptolemy, as the Egyptian king is Osiris and thus, Dionysus. As with Demetrius' parade, there is a huge element of personal propaganda at work in this extravagant festival. The phenomenon that we are observing, then, is religion and political theatre residing close together, facilitated through the channels of mechanical ingenuity.

P3: Continuous Springs of Hermes

Athenaeus, *Deipnosophistae,* 200C = *FGrH* 627 F 2. Grand Procession of Ptolemy Philadelphus, c. 279-270 BC.

οὐκ ἄξιον δ᾽ ἦν παραλιπεῖν τήνδε τὴν τετράκυκλον, μῆκος οὖσαν πηχῶν εἴκοσι δύο, πλάτος δεκατεσσάρων, ὑπὸ ἀνδρῶν ἑλκομένην πεντακοσίων· ἐφ᾽ ἧς ἄντρον ἦν βαθὺ καθ᾽ ὑπερβολὴν κισσῷ καὶ μίλῳ. ἐκ τούτου περιστεραὶ καὶ φάσσαι καὶ τρυγόνες καθ᾽ ὅλην ἐξίπταντο τὴν ὁδόν, λημνίσκοις τοὺς πόδας δεδεμέναι πρὸς τὸ ῥᾳδίως ὑπὸ τῶν θεωμένων ἁρπάζεσθαι. ἀνέβλυζον δὲ ἐξ αὐτοῦ καὶ κρουνοὶ δύο, ὃ μὲν γάλακτος, ὃ δὲ οἴνου. πᾶσαι δ᾽ αἱ περὶ αὐτὸν Νύμφαι στεφάνους εἶχον χρυσοῦς, ὁ δὲ Ἑρμῆς καὶ κηρύκειον χρυσοῦν, ἐσθῆτας δὲ πολυτελεῖς.

It would not be right to pass over this four-wheeled cart, which was 22 cubits long and 14 cubits wide, drawn by 500 men, on which there was a cave extravagantly covered by ivy and smilax. Pigeons, ringdoves, and turtledoves flew out of this along the whole course of the procession, and their feet were tied with wool ribbons to make them easy for the spectators to catch. Two springs gushed forth from it: one of milk and the other of wine. All the nymphs around it wore gold garlands, and Hermes had a gold messenger's staff, and expensive clothing.

Nysa (**P2**) was not the only automaton in the grand procession of Ptolemy Philadelphus. Directly after the automated Nysa statue was a large tableau atop a cart which featured Hermes in elaborate clothing before a large cave surrounded by Nymphs. The narrative depicted by the tableau is that of the infancy of Dionysus who, having been entrusted to Hermes by Zeus, was then taken to the cave of the nymphs at Mount Nysa. Matching the narrative, the decoration of the float is distinctly Dionysian in flavour. Callixenus specifies that the cave was covered with ivy and smilax. Ivy was of

course a common cult symbol of Dionysus, used both as a wreath and to bind his *thyrsos*. The lesser known smilax is a vine with small white flowers which appear between August and November, and with fruit which ripen in autumn and stay intact until winter. At the time of Ptolemy's winter festival, the smilax would already have lost its flowers, but would still have had berries intact which would have matured from bright red to a darker purple colour.[1] The white flowers of the smilax plant are in fact far less noticeable than the berries which hang on the vine like clusters of grapes. Euripides makes particular mention of smilax berries in the *parodos* of the *Bacchae* when describing the ritual attire of the Bacchants.[2] We can imagine the striking impression left on the spectators as they saw, heard, and possibly even smelled, a cave richly covered with green flora interspersed with clusters of purple berries and housing two never-ending streams of wine and milk as it was paraded along the lengthy processional route during what should have been the most frugal time of the year. This was a clear statement of conspicuous consumption and a visual demonstration of the abundance of Dionysus and of Ptolemaic Alexandria.[3] In its magnificence, the parade was both an invocation of Dionysian presence and a manifestation of the deity's forces at work. The use of automata in the *pompē*, both the Nysa statue and the eternal springs, were particularly effective in visually manifesting this divine call and response.

The effect of three species of birds flying out of the cave with beating wings but with a long string attached from their legs so that spectators could catch them is yet another element which added to the theatricality of the float. Birds, and particularly doves, flying out of a cave quite possibly invoked a mantic setting, recalling the doves at Delphi, for example, thus increasing the religiosity of the tableau.[4] The float was one of the many 'interactive' moments that Ptolemy included in his parade.

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[1] Season of the festival is inferred from the description of the pavilion Ath. 196D-E.
[2] E. *Ba.* 107-108.
[3] D.S. 3.63.3 on the abundance of Dionysus even without cultivation.
[4] It is perhaps significant for the Dionysian connotations invoked that the doves in the *Ion* are referred to as a *kōmos peleiōn* E. *Ion* 1189. For more on the connection between doves, wine, Apollo and Dionysus see Elderkin 1940. Cf. also the doves of Dodona in Hdt 2.55, 57.

As well as the balloon-birds, grape-must ran onto the street from a wine press in which Satyrs were trampling as they sung, an *askos* with 3000 measures of wine released its liquid little by little along the course of the *pompē* so that wine would flow over the whole street as the procession advanced, and as we have seen, wine and water were mixed in the stadium releasing its sweet smell.[5] These moments characterise the festival more precisely for us, particularly with respect to the dynamic between spectacle and spectator, as the pan-sensory experience as a religious entry point. More than simply assisting as passive viewers, the participants in the Ptolemaic *pompē,* at least in the Dionysian portion, revelled in an interactive, highly sensorial manner in the perceived presence and physical manifestations of the god. This was the intention of the *pompē,* this was the experience that the self-animated machines served to enhance.

Never-ending springs

Now that we have thought about the tableau as a whole, let us turn to a detailed analysis of the perpetual springs of milk and wine inside Hermes' cave. This mechanical miracle is slightly different to the other festival automata treated thus far, but should still be considered part of the same trend in that it is a contrivance made to invoke a sense of the miraculous through mechanical ingenuity. The *thauma* that lies behind the endless springs can be broken down into two parts: the first is the perpetuity of the liquid flow. Though intuitively there should be nothing particularly miraculous about ever-flowing springs (given that this is how they appear in nature) a passage from the Odyssey suggests that even when the liquid at hand was simply water and the setting natural, springs were wondrous to the ancient mind. Furthermore, precisely because of their perpetuity, they were connected to idyllic and sacred spaces:

... ἐν δ᾽ ἱστοὶ λίθεοι περιμήκεες, ἔνθα τε νύμφαι

φάρε᾽ ὑφαίνουσιν ἁλιπόρφυρα, θαῦμα ἰδέσθαι:

[5] Ath. 5.199A-B.

ἐν δ᾽ ὕδατ᾽ ἀενάοντα.

...and in [the cave] are tall, stone looms where the nymphs weave purple webs, a wonder to

behold: in it also are ever-flowing springs.[6]

Flowing water was a luxury in the ancient Greek world, available only in particular natural settings, in

temples or in certain public spaces. It is likely that most ever-flowing springs in Greece were held to

be sacred sites – to the nymphs if to no one else. Thus, when it came to reproducing divinely

inspired miracles through mechanical means, the illusion of perpetual liquid flow was highly

desirable. Practically speaking this would have been possible through, for example, the use of an

Archimedes screw, an invention of the third century BC, powered by the wheels of the cart.[7] The

effect of the miracle would of course have been intensified by the fact that the springs in the

Dionysian cave produced milk and wine which were more precious than water, and did not come

straight from the earth.

The apparent inexhaustible flow of a perpetual spring meant that it was also constantly replenishing

and consequently, that there was something miraculous at its source. The passage from the *Odyssey*

implies that even natural water springs were considered wondrous in their inexhaustibility

(*aenaonta*) probably because the viewers were at a loss to explain how the liquid was continually

being produced. The *Bacchae* of Euripides is a useful place to turn to in order to conceptualise the

never-ending flow of precious liquids in the ancient mind-frame. The tragedy gives us a glimpse into

the role of the divine as it related to perpetual abundance. In Euripides' play the Bacchants, invested

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[6] Hom. *Od*. 13.106-109. The use of the formula *thauma idesthai* is once again seen in relation to divine *technē* (for more on this see *Chapter 2/ Inventing Automation*).
[7] The design of the screw is known to us through Vitr. 10.6.1-4. On the Archimedes screw more generally see White 1984, 15; Cuomo 2007, 45 n 15; Ulrich 2008, 42.

with Dionysian power, use their *thyrsoi* and even their bare fingers to draw springs of water, wine and milk from the earth.[8] This is used as manifest proof of the presence of Dionysus and his power.[9] Automation made what was typically 'Dionysian' perpetual abundance particularly tangible to the human imagination. In the case of milk and wine coming out of a cave – liquids which usually come from animal and plant sources respectively – the miracle was of course even more inexplicable. This was not just the divine inspiring or even controlling nature, but it was the divine manifesting its power in a way that was contrary to what the audience expected of nature. There is a difference between looking at a natural wonder and attributing it to the force of god, and seeing something which contradicts the conventions of nature and interpreting it as god's power at work. The second is a far stronger statement of divinity, and it is a statement that the technical gimmick allowed.

The miraculous 'sourcelessness' of the spring is particularly evident because of the portability of the float. When Herodes Atticus built an artificial cave on Olympia to which water was conducted by an aqueduct, he was making a similar but slightly different statement.[10] Set against the steep slope of the Kronian Hill in which the aqueduct was buried, the water of his exedra seemed to come out of the earth. The effect of the spectacle is subtly different to what we have in the case of Ptolemy's cave. Though the aqueduct betrays that the source of Herodes' spring is essentially human, he chose to integrate the exedra into the landscape to replicate something 'natural', while obviously tampering with its 'divine' essence. Ptolemy's cave, on the other hand, by virtue of its portability, is entirely unnatural and for that reason even more likely to be associated with divine power. Indeed, the rhetoric of objects being miraculous precisely for the way in which they are 'contrary to nature' (*para physin*) pervades Hero's *Pneumatics*.[11] The 'trick' vessels in Hero's treatise cause wonder

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[8] E. *Ba.* 704-711.
[9] E. *Ba.* 712-13.
[10] On the exedra of Herodes Atticus see Elderkin 1941, 132-134.
[11] Hero, *Pneum.* I.proem.74, 82, 98, 196, 241, 267, 327, 343; I.I; I.II; I.X; II.XIII.
Note: Though the Teubner edition in five volumes with German translation edited by Schmidt is still undoubtedly the best for Hero's works, the line numbering for the proem is unhelpfully not continuous. Line

precisely for the way in which they allow liquids to flow in what should be an impossible direction, according to the laws of nature. The distinction between imitating life through technology and engineering something that is intentionally contrary to the functioning of the natural world has already proved important in defining what characterises the ancient automaton, and in explaining why modern scholarship has been largely mistaken in its analysis of the machines.[12]

Coda: Miraculous Springs

There exists a number of curious examples in the ancient source material which relate how on particular religious occasions and thanks to the intervention of some god, springs of water miraculously produce wine instead. These can be thought of as replicating a similar *thauma* to Ptolemy's eternal springs. The earliest reference comes from Diodorus Sicilus who was writing in the first century BC. In a discussion regarding the competing claims of the people of Elis, Naxos, Eleutherae and Teos to being the birthplace of Dionysus, the Teans offer a particular piece of evidence:

> καὶ Τήιοι μὲν τεκμήριον φέρουσι τῆς παρ᾽ αὐτοῖς γενέσεως τοῦ θεοῦ τὸ μέχρι τοῦ νῦν τεταγμένοις χρόνοις ἐν τῇ πόλει πηγὴν αὐτομάτως ἐκ τῆς γῆς οἴνου ῥεῖν εὐωδίᾳ διαφέροντος·

> The Teans report as proof that the god was born among them the fact that up to the present day at fixed time in their city a spring of particularly sweet-smelling wine flows of its own accord from the earth.[13]

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numbers in the proem referred to here thus follow the digital version of the Teubner available on the *TLG* website. Subsequent chapters are referred to by their Roman numerals as in Schmidt, with Woodcroft's numbering offered too.

[12] See above *Part I: Thinking About Automation*.

[13] D.S. 3.66

This miracle is a sure sign (*tekmērion*) of the presence of the god. The competing claims from the other *poleis* are merely the consecration of a plot of land sacred to Dionysus, or shrines and sacred precincts dedicated to the god from ancient times. The *thauma* of wine flowing *automatōs* from the spring is taken to be the best proof of the intimate connection between Teos and Dionysus. Critically, the miracle happens only at a fixed time, presumably on an occasion of religious significance such as a festival, when the presence of the god was particularly strong. The smell of the wine is also emphasised in the passage, signalling the importance of the overall sensory experience of the miracle.

In the first century AD, Pliny talks of a spring at Andros which converts water to wine on the fifth day of January each year in honour of Dionysus. The passage comes as part of a broader discussion on remarkable springs. Pliny says that certain springs are particularly noteworthy for their temperature or the pattern of their flow but the spring at Andros appears to be in a league of its own:

> *andro in insula templo liberi patris fontem nonis ianuariis semper vini sapore fluere mucianus ter consul credit. dies* Θεοδοσία *vocatur.*

> On the island of Andros in the temple of Father Liber, Mucianus who was thrice consul asserts that there is a spring which on the *nones* of January always flows with the flavour of wine. The day is called θεοδοσία ('God's Gift Day').[14]

Various elements of the Andrian spring are very similar to the spring at Teos: this miracle occurs on a specific day only and has a clear relation to Dionysus. Pliny takes care to specify that the liquid has

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[14] Plin. *HN* 2.231

the flavour of wine, presumably to dispel belief that this was simply a wine-coloured liquid and in turn strengthen the claim of the miracle.

A century later Pausanias, as part of his description of Elis, records two strange stories. The first is that at a festival to Dionysus known as the Thyia, three empty pots were brought into a building by the priests and set down in the presence of citizens and visiting foreigners. The doors of the building were then sealed. The following morning, the Eleans found the pots filled with wine, but with the seals still intact. Pausanias says that this miracle is the first proof given by the people of Elis that Dionysus truly attended the Thyia. The second proof is as follows:

λέγουσι δὲ καὶ Ἄνδριοι παρὰ ἔτος σφίσιν ἐς τοῦ Διονύσου τὴν ἑορτὴν ῥεῖν οἶνον αὐτόματον ἐκ τοῦ ἱεροῦ.

The Andrians also say that every other year at their festival of Dionysus wine flows of its own accord from the sanctuary.[15]

Both of these wine-related miracles are used, in a similar fashion to the examples of Diodorus Siculus and Pliny, as evidence for the presence of Dionysus in the city and again, we see how this occurs specifically on a day of religious significance. All of these Dionysian examples are neatly tied together not only by the spring in the parade of Ptolemy II (**P3**), but also by material evidence at Corinth. The excavations from the site of ancient Corinth reveal a temple nestled close to a spring which has an underground tunnel connected to it, big enough for a man to crawl through. Access to the tunnel which ran under the shrine was possible thanks to a hidden door camouflaged as a *metope*.[16] Bonner

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[15] Paus. 6.26.2.
[16] For details on the architectural peculiarities that enabled the spring to work as a miracle for the credulous see Carpenter 1933, 57-61.

has convincingly shown how the structural peculiarities of this small fifth-century BC temple situated near the so-called 'Sacred Spring' in Corinth can be accounted for if we understand them as mechanisms built to allow for the reproduction of the Dionysian miracle of turning water to wine.[17] The evidence from Corinth encourages us to consider the way in which there could well have existed in antiquity priestly 'technical ruses' that share strong affinities with the logic of automata behind what would otherwise be dismissed as nothing more than fanciful stories.

We also have one mention of a deity turning water to wine which does not strictly fit the pattern of the examples so far. Philostratus talking of the powers of Apollo says:

> καίτοι ῥᾴδιόν γε ἦν αὐτῷ σεῖσαι μὲν τὸν Παρνασὸν πάντα, τὴν Κασταλίαν δὲ οἰνοχοῆσαι μεταβαλόντι τὰς πηγάς, Κηφισῷ δὲ μὴ ξυγχωρῆσαι ποταμῷ εἶναι, ὁ δὲ οὐδὲν τούτων ἐπικομπάσας ἀναφαίνει τἀληθὲς αὐτό.

> Though it was easy for him to shake all of Parnassus, to make Castalia flow with wine by changing its sources, or to forbid the Cephisus from being a river, he, without such boasting, plainly reveals the truth itself.[18]

This example is particularly interesting for the way in which a clear contrast is made between the sort of religious spectacles which we have seen to be typical of Dionysus, and the modest and measured oracular responses of Apollo. This is consistent with the presentation of the two divinities in Greek mythology more broadly for, as noted by Charles Segal, 'Apollo imposes limits and

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[17] Bonner 1929, 368-375. For the view that the temple held a dual priesthood to Dionysus and Apollo see Elderkin 1941, 125-137. The shrine is dated by masonry style and the use of dove-tail clamps. See Carpenter 1933, 56.
[18] Philostr. *VA* 6.10.4.

reinforces boundaries, Dionysus his opposite and complement dissolves them'.[19] The boundary between the animate and inanimate state is something that Dionysus is particularly inclined to manipulate. In contrast, Apollo's general disgruntled attitude towards automation will feature in another one of our examples to follow.[20]

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[19] Segal 1997, 12.
[20] See below **P7**.

P4: Dancing Baskets

Strabo, *Geography*, 13.4.5. Festival to Artemis at Gygaea, date unknown.

> ἐν δὲ σταδίοις τετταράκοντα ἀπὸ τῆς πόλεως ἔστιν ἡ Γυγαία μὲν ὑπὸ τοῦ ποιητοῦ λεγομένη
> [λίμνη], Κολόη δ᾽ ὕστερον μετονομασθεῖσα, ὅπου τὸ ἱερὸν τῆς Κολοηνῆς Ἀρτέμιδος μεγάλην
> ἁγιστείαν ἔχον. φασὶ δ᾽ ἐνταῦθα χορεύειν τοὺς καλάθους κατὰ τὰς ἑορτάς, οὐκ οἶδ᾽ ὅπως
> ποτὲ παραδοξολογοῦντες μᾶλλον ἢ ἀληθεύοντες.

> > [λίμνη]: Meineke καλάθους: *rw* καθόλου ; *mz* Ald., and Casaubon πιθήκους ; Lobeck conj.
> > πιθάκνας and certain others καλάμους

> Within forty *stades* from the city is Gygaea [a lake] mentioned by the poet (Homer), later
> called by a new name Coloē, where there is a temple of Coloēnian Artemis which has great
> ritual. They say that there, baskets danced around during the festivals, I don't know why on
> earth they rather tell marvels than tell the truth.

This passage from Strabo is more ambiguous than the sources presented thus far. Yet the curious
mention of 'dancing baskets' in relation to an eastern festival to Artemis deserves to be taken into
account for the way in which it yet again brings automation and the religious festival in close
contact.

Strabo and the boundaries of the credible

Strabo was born in Amasia on the Pontus around 64 BC, was educated in Nysa in Anatolia, spent a
considerable amount of his adult life in Rome, and died some time after 23 AD.[1] Limiting ourselves

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[1] For dating see Dueck, Lindsay and Pothecary 2005, 1.

to the fragment at hand, the origins and precise nature of this festival to Artemis Coloē are unclear, but if we assume that the use of the present tense indicates a contemporary event, we can at least estimate that the festival was still celebrated in the early Roman imperial period. The passage comes from one of the three books of Strabo's *Geography* dedicated to describing Asia Minor and Lake Gygaea was located in Lydia just north of Sardeis.[2] Geographically, then, as Strabo traversed Asia Minor to travel from Amasia to Nysa, he would certainly have passed very close to Gygaea and it is not outside the realm of possibility that Strabo visited the lake and its surroundings himself. Yet from the description of the festival, even if he had visited Gygaea, his intense scepticism towards the story of the dancing baskets seems to indicate that he never attended a festival there. Otherwise, Strabo would easily have been able to debunk through first-hand experience this story that he condemns as fanciful hearsay. Either that, or the miracle was so well performed that he could not omit it entirely from his narrative.

Lake Gygaea and its surroundings feature in earlier historical accounts and indeed, previous historiography on the area forms part of Strabo's fascination with the location. Homer's reference to the lake, though Strabo's starting point, is of little interest to our present purpose as the epic poet merely mentions a nymph of Gygaea as the mythical mother of two warriors; Mnesthles and Antiphus.[3] As Strabo continues his discussion, he refers to the tomb of Alyattes at Sardeis which he notes is also referred to by Herodotus.[4] This leads him to interact with a curious Herodotean tradition regarding the lake. According to Herodotus:

..λίμνη δὲ ἔχεται τοῦ σήματος μεγάλη, τὴν λέγουσι Λυδοὶ ἀείναον εἶναι:

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[2] For an excellent map see *Barrington Atlas of the Greek and Roman World* 2000, 56.
[3] Hom. *Il.* 2.864-865.
[4] Str. 13.4.7.

...and there is a great lake attached to the tomb which the Lydians say is ever-flowing.[5]

Strabo completely demystifies this miraculously 'ever-flowing' source, stating instead that:

χειροποίητον δὲ τὴν λίμνην ἔνιοι ἱστοροῦσι τὴν Κολόην πρὸς τὰς ἐκδοχὰς τῶν πλημμυρίδων, αἳ συμβαίνουσι τῶν ποταμῶν πληρουμένων.

Some report that Lake Coloē is an artificial lake, made to receive the overflows which take place when the rivers are full.[6]

Strabo's explanation is interesting for two reasons. Firstly, it brings ever-flowing springs back into contact with human engineering efforts continuing a theme discussed above (**P3** and **P3:coda**). Secondly, we should understand Strabo's rationalising as directly linked to the broader purpose of his work, which then leaves us ever more curious as to why he mentions the dancing baskets at all. Strabo wanted his work to be taken seriously (*spoudaios*) and to be considered worthy by philosophers.[7] He programmatically states that his text does not promote the virtue of marvelling.[8] The Stoic *athaumastia* that Strabo extols goes hand in hand with his claim that if *aisthesis* fails to explain something, *logos* will demonstrate it.[9] In touring the known world with him, Strabo's readers are to be free from any sort of astonishment, wonder or surprise; they are to be *athambos*, *atarachos* and *anekplēktos.*[10] All characteristics which are precisely linked to the types of emotions that automata seek to invoke in their spectators. We have seen, for example, Hero specify that the study of automaton-making is worthy because of the stunning nature of the public spectacle (διὰ τὸ

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[5] Hdt. 1.93.
[6] Str. 13.4.7.
[7] Str. 1.1.23.
[8] Str. 1.3.21. Cf. 6.2.10.
[9] Str. 1.1.18 Cf. 2.5.5; 2.5.11.
[10] Str. 1.1.23.

ἔκπληκτον τῆς θεωρίας).[11] Strabo's scepticism towards the dancing baskets should be seen through this framework. Given his agenda to banish *thauma* from his text, his incredulous tone should not prompt us to dismiss the idea that there may well have been some mechanism in place to feign a miracle at the festival in Gygaea precisely to incite inexplicable religious wonder of the sort which Strabo condemns. Herodotus makes no mention of a festival to Artemis at Gygaea, or of the dancing baskets, so this *thauma* does not have its roots in Herodotean narrative making it even more curious, then, that Strabo did not simply choose to omit this *thauma* from his work.[12] Strabo's scepticism is very useful as it helps trace the boundaries of the credible when it comes to technological marvels, and preserves the subtlety of the possible range of responses to automata in history. Strabo does not believe that the baskets danced *automatoi,* but is incapable of offering any explicable 'truth' he so wishes the Gygaeans had given him.

With an attitude not dissimilar to Strabo's himself, modern scholarship has sought to explain away the miracle of the dancing baskets. There is some uncertainty in the manuscript of the *Geography* at this point and modern conjectures betray a keen interest for rationalising the passage either by changing *kalathous* to a variety of more 'reasonable' possibilities, or by accepting *kalathous,* but rationalising the apparent miracle by supposing that these were in fact baskets carried on the heads of dancing maidens.[13] This interpretation is not easily reconcilable with our transmitted text unless we are to force χορεύειν τοὺς καλάθους to mean something like 'dance with respect to baskets'. I believe there is a simpler explanation that lies in the fact that there has been a conflation of two different ritual uses of the *kalathos:* one as a head-piece used in a dance, the other a key object of processional equipment*.* Ludolf Stephani in 1866 first brought together a corpus of relevant

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[11] Hero, *Aut.* 1.1.
[12] This could very loosely indicate that the origins of the festival post-date Herodotus' text.
[13] This is the explanation given in the translations of Falconer 1909 and Lloyd Jones 1917.

monuments concerning a dance called the *kalathiskos*.[14] The word *kalathos* in this context was

thought by Stephani to denote the name of a crown shaped similarly to the basket, much in the way

that *kalathos* might also be applied to a Corinthian capital.[15] Thus the *kalathos* head-piece could be

connected to the name of a dance that is found in Athenaeus and the lexicographers: *kalathiskos.*[16]

It by no means follows, however, that all references to a *kalathos* in procession must form part of

the *kalathiskos* dance, and the evidence suggests that what is being described here by Strabo is

something entirely different. According to the iconographical evidence at least, the *kalathiskos*

seems to have been very widespread and very popular, both geographically and temporally.[17] Why

would Strabo be concerned with the baskets and their movements if they were in the least respect

conventional? If these were baskets carried on the heads of maidens performing the *kalathiskos,*

there is no reason that Strabo would have been fazed enough to mention them. Nor, one imagines,

would the people of Gygaea from whom Strabo heard the story bother to relate the miracle were it

not something relatively unique to their festival. Further, there is no way that an author so

concerned with the rational would not have jumped at the opportunity to explain the movements

and demystify the anecdote.

Beyond its use in the *kalathiskos*, the *kalathos* is also attested as a ritual object particularly used in

the eastern part of the Greek world. These baskets, typically of narrow base and wide rim, were

involved in rituals attested in cults of Gaia, Artemis, Tyche and the Horae.[18] They were related to the

feminine sphere and were carried in procession as symbols of abundance and prosperous harvest.

The movement of a *kalathos* in a *pompē* to Demeter and the ritual behaviour of the women involved

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[14] For the *kalathos* as head-dress used in the dance see also Daremberg and Saglio 1881, 813-814; Ferrari 2008, 137-9 (particularly useful for the iconography).
[15] Ferrari 2008, 138-9.
[16] Ath. 11.467f. 14.629f.
[17] Ferrari 2008, 137.
[18] Daremberg and Saglio 1881, 812; Hopkinson 1984, 41.

in the festival is the focal point of Callimachus' *Hymn to Demeter.* The opening words of the hymn are:

Τῶ καλάθω κατιόντος ἐπιφθέγξασθε, γυναῖκες·

'Δάματερ, μέγα χαῖρε, πολυτρόφε πουλυμέδιμνε.'

τὸν κάλαθον κατιόντα χαμαὶ θασεῖσθε, βέβαλοι

As the basket returns, chant along, women:

'A great welcome, Demeter, who feeds many, who brings many bushels.'

As the basket returns you shall gaze up[19] from the ground, uninitiated[20]

Already we get a better idea of what an eastern festival involving a *kalathos* might look like; this is an all-female festival in which harvest, and the symbolic return of the basket, plays a central role.[21] There seems to be a single *kalathos* in this procession whose return marking the end of a fasting period is the main attraction of the *pompē.* This basket is personified, as in the Strabo passage, and it is clear that alongside its symbolism, the movement of this ritual object, the course it takes during the *pompē*, is quite integral to the religiosity of the festival. The poem closes with a vivid ritual image again involving the basket which this time betrays more about how it is being conveyed and the religious frame through which spectators would view it:

χὼς αἱ τὸν κάλαθον λευκότριχες ἵπποι ἄγοντι

τέσσαρες, ὣς ἁμὶν μεγάλα θεὸς εὐρυάνασσα

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[19] Stephens notes that *theaomai* in Homer often has the sense of 'gaze at with a sense of wonder', and in later prose and poetry comes to mean 'view as a spectator'. Both connotations are appropriate here. Stephens 2015, 276.
[20] Call. *Hymn* 6.1-3.
[21] Cf. Call. *Hymn* 6.134-138.

λευκὸν ἔαρ, λευκὸν δὲ θέρος καὶ χεῖμα φέροισα

ἥξει καὶ φθινόπωρον, ἔτος δ᾽ εἰς ἄλλο φυλαξεῖ.

As the four white horses lead the basket,

so will the great, wide-ruling goddess come to us bringing

a white spring, a white summer, winter and autumn,

and guard us until another year.[22]

The *kalathos* was carried through the city atop a cart or cart-like vehicle led by horses. This looks more like a parade float we would have seen in Ptolemy's Grand Procession. This picture is not unparalleled. Preserved for us from Alexandria is a Trajanic bronze coin showing an oversized *kalathos* on a cart pulled by four horses and followed by an Egyptian priest.[23] The resemblance with Callimachus' poem is striking and has already been noted in scholarship.[24] Unfortunately, there is no clue as to the occasion, but first fruits seem to be sticking out of the top of the basket suggesting a procession in honour of a deity associated with harvest and abundance, both Demeter and Artemis are likely candidates. On top of the numismatic evidence, a scholion on verse 1 of the *Hymn to Demeter* says that among the Athenian customs that Ptolemy Philadelphus imitated in Alexandria was the Procession of the Basket (τὴν τοῦ καλάθου πρόοδον) where a basket borne upon a carriage was paraded in procession in honour of Athena.[25] The details of the Athenian festival are unknown but of interest to us is the existence of such a festival, its importation to Alexandria and the prominence of the *kalathos* in the *pompē*. As the evidence comes together, it seems reasonable

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[22] Call. 6.119-123.
[23] Daremberg and Saglio 1181; 813 fig. 1002; Hopkinson 1984, 42; Stephens 2015, 276 fig. 3.
[24] Burkert 1985, 99; Daremberg and Saglio 813; Hopkinson 1984, 42; Stephens 2015, 276.
[25] Schol. Call. 6.2.

to conjecture that the explanation behind Strabo's mysterious dancing baskets lies in a similar processional use of the *kalathos* and that the particularly striking thing about the version at Gygaea (and possibly other places) was a mechanism to increase the theatricality of the movement of the baskets so as to make them appear to be dancing of their own impetus. The processional journey of the *kalathos* appeared to spectators to be spontaneously animated, or under the power of a deity; the same deity whose omnipotent influence would bring to the city successful harvest for the following year.

We know very little about cultic activity outside of Athens and the temptation to assume fiction should be resisted as much as possible. There evidently existed, at least in the Hellenistic period, in Athens across to Alexandria and possibly further East into Lydia a tradition of a ritualised and highly theatrical procession involving a basket known as the *kalathos.* We can easily imagine Hellenistic *pompai* using technologies of automation to enhance this personification of the *kalathos* dancing as the movement of the basket was clearly the main feature of the festival *pompē* symbolising to the return of harvest, and the end of famine thanks to the overwhelming generosity of the festival's patron goddess.

P5: The Automated Shrine of Dionysus

Hero of Alexandria, *On Automata,* 4.1-4. Treatise written first century AD.

Τούτων δὲ οὕτως ὑπαρχόντων ἐν ἀρχῇ τεθέντος τοῦ αὐτομάτου ἐπί τινα τόπον καὶ ἀποστάντων μετ᾽ οὐ πολὺν χρόνον ὑπάξει τὸ αὐτόματον ἐπί τινα ὡρισμένον τόπον. καὶ στάντος αὐτοῦ ἀνακαυθήσεται ὁ κατὰ πρόσθεν τοῦ Διονύσου βωμός. καὶ ἐκ μὲν τοῦ θύρσου τοῦ Διονύσου ἤτοι γάλα ἢ ὕδωρ ἐκπιτυσθήσεται, ἐκ δὲ τοῦ σκύφους οἶνος ἐκχυθήσεται ἐπὶ τὸν ὑποκείμενον πανθηρίσκον. στεφανωθήσεται δὲ πᾶς ὁ παρὰ τοὺς τέσσαρας κίονας τῆς βάσεως τόπος. αἱ δὲ περικύκλῳ Βάκχαι περιελεύσονται χορεύουσαι περὶ τὸν ναΐσκον. καὶ ἦχος ἔσται τυμπάνων καὶ κυμβάλων. καὶ μετὰ ταῦτα σταθέντων τῶν ἤχων ἀποστραφήσεται τὸ τοῦ Διονύσου ζῴδιον εἰς τὸ ἐκτὸς μέρος. ἅμα δὲ τούτῳ καὶ ἡ ἐπικειμένη τῷ πυργίῳ Νίκη συνεπιστραφήσεται. καὶ πάλιν ὁ ἔμπροσθεν γεγονὼς τῷ Διονύσῳ βωμός, πρότερον δὲ ὀπίσθιος ὑπάρχων ἀνακαυθήσεται. καὶ πάλιν ἐκ μὲν τοῦ θύρσου ὁ ἀναπιτυσμὸς ἔσται, ἐκ δὲ τοῦ σκύφους ἡ ἔκχυσις. καὶ πάλιν αἱ Βάκχαι χορεύουσι περιερχόμεναι τὸν ναΐσκον μετὰ ψόφου τυμπάνων καὶ κυμβάλων. καὶ πάλιν σταθεισῶν αὐτῶν τὸ αὐτόματον ἀναχωρήσει εἰς τὸν ἐξ ἀρχῆς τόπον. καὶ οὕτως τέλος ἔξει ἡ ἐπίδειξις.

Once these things have been prepared, having first placed the automaton in some spot and having stood away, a little while later the automaton will proceed forwards up to a certain delimited place. And having brought itself to a standstill, the altar down in front of Dionysus will blaze up. And truly from the *thyrsos* of Dionysus milk or water will spurt forth, and from his cup (*skyphos*) wine will pour forth onto the panther lying beneath it. The whole space beside the four pillars of the altar will be wreathed. The surrounding Bacchae will go around, dancing about, encircling the little shrine. And there will be the sound of drums and cymbals, and with this, when the noise has passed, the figure of Dionysus will rotate outwards in its turn. At the same time, the Nike standing on the little tower will turn with him. And once

more the altar before Dionysus, which earlier had been placed behind him, will blaze up. And again from the *thyrsos* there will be a jet, and from the *skyphos* a pouring. And again the Bacchae dance around, encircling the little shrine accompanied by the noise of drums and of cymbals. And once more, the automaton will go back to the place from which it began and in such a manner the display (*epideixis*) will reach its end.

Hero of Alexandria wrote the only extant treatise on ancient automata entitled *On Automaton Making* (*Peri Automatopoiētikēs*). Hero was interested in the practical applications of mathematics especially through mechanics and as a result, he prioritises utility over theory. Alongside his work *On Automata,* eleven of Hero's works survive dealing with a range of topics including pneumatics (*Pneumatika)*, catapults (*Belopoeika*), mirrors and optical illusions (*Catoptrika)*, geometrical terms and measures (*Metrika; Horoi; Dioptra; Geometrika; Stereometrika; Peri Metrōn*) and mechanical principals (*Mēchanika*). Lost works of Hero include a commentary on Euclid's *Elements;* a text describing a machine for lifting huge weights by means of a combination of gear wheels (*Baroulkos*); and a text concerning another type of artillery weapon (*Cheiroballistra*). In 1938, Neugebauer dated Hero's life and works which had up to then been the source of some contention to the first century AD by noting the lunar eclipse of AD 62 described in his *Dioptra.*[1]

The question of context

The treatise most relevant to the present study, *On Automata,* is divided into two parts. The first, from which the passage at hand has been extracted, describes a moving automaton (*hypagonton automaton*) which not only travels forwards and backwards of its own accord, but includes a charming scene of automated display. The second portion of the treatise describes a miniature

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[1] Neugebauer 1938, 21–24. This did not stop later authors from wrongly dating Hero's work. See, for example Bartholomew 1979.

automated theatre referred to by Hero as a static automaton (*staton automaton*) which presents a complete rendition of the Legend of Nauplius.[2] Although Hero does not mention the precise performative context of either type of automaton, the *hypagonton automaton* seems more relevant to our present purpose. While the minute and highly intricate detail in the construction of the *staton automaton* would be better suited to a more intimate, possibly sympotic or temple context, the imposing automated shrine to Dionysus is likely to have been employed as a paratheatrical form of entertainment at an ancient festival to Dionysus.

Victor Prou suggested in 1881 that the shrine would have been set upon the *logeion* on the stage in the theatre and performed before the spectators 'comme un véritable acteur'.[3] Not only does this misinterpret the symbolic significance of the automated shrine which was in no way a substitute or even a parallel for an actor, but this hypothesis does not sit comfortably with the choreography of the performance of the machine. Hero is quite explicit in his description of Dionysus' 'repeat performance' after a half turn upon himself, leaving us to imagine that the audience would have been encircling the shrine completely. The automated shrine was more likely employed in the *pompē* itself. Two possible options come to mind as to how exactly the shrine would have been paraded. First, it may have been placed upon a float, much as the statue of Nysa was in the parade of Ptolemy II (**P2**), and accompanied by many spectators on all sides as it made its way through the streets of the city. This hypothesis has the benefit of a historical parallel, though one cannot help but feel that the overall impact of the 'miracle' of the machine would likely have been more impressive in a slightly calmer situation where all the attention was focused on this spectacular piece of technology. For this reason, I would suggest that the automated shrine of Dionysus could have been brought out during the sacrificial feast. Alternatively, we can imagine the machine being employed

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[2] Of Hero's two automata, the miniature automated theatre has received much more scholarly attention. See, for example most recently, Beacham 2013. There is also a project underway at the University of Glasgow under the direction of Ian Ruffell entitled 'Hero of Alexandria and his Theatrical Automata'.
[3] Prou 1881, 35.

during one of the moments of repose during the *pompē* when the procession would typically stop for the performance of music, singing and dance in connection with other ritual acts such as sacrifice.[4] Both the procession of the Great Dionysia at Athens and the Grand Procession of Ptolemy II in Alexandria are known to have moments engineered as pauses in the parades.[5] One can imagine that an automated shrine in such a moment would have coincided very nicely with the religious mood of the event, combining movement, sound, heat and manifest religious presence through a veritable *thauma*.

The automaton

The *hypagonton automaton* is essentially made up of a statue of Dionysus inside a six-columned shrine which has been placed atop an architrave supported by four larger columns eight palms in height.[6] These columns then rest on a support whose height is given as three palms. The shrine of Dionysus is surrounded by dancing maenads, and there is a statue of Nike with her wings spread and a wreath in her right hand which stands atop the whole structure. The display of the automaton is set in motion by a system of counterweights which instigate a series of chain reactions by pulling cords variously wound around axles and attached to levers, each affecting an independent part of the machine in a pre-choreographed fashion. The remainder of Hero's treatise describes the mechanics involved in the machine. Above all, timing is essential in the set-up of the automaton, and Hero ensures that the ropes are pulled only when they need to be, and at the precise speed which the display requires.[7]

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[4] On which see Kavoulaki 1999, 295.
[5] See X. *Eq.* 3.2 for the Great Dionysia and above, **P2-3** for Ptolemy's parade.
[6] The description including heights are given Hero, *Aut.* 3.1-4.
[7] Using slack in the cords, with kinks in the slack and wax that sticks the ends to certain places in the base. Hero, *Aut.* 2.10-11.

After the machine slides forwards, the real display begins. A fire blazes up at Dionysus' feet, a group of maenads begin their circular frenzy around the shrine accompanied by the dramatic clang of drums and cymbals, and the figure of Dionysus comes to life as hidden pipes within the structure allow wine to pour from his wine cup and liquid to shoot up from the top of his wand. Both Dionysus and Nike then rotate 180 degrees on themselves to offer a repeat performance to spectators who had been facing the back of the machine. The display ends with the automaton retreating back to its starting position.[8]

Hero of Alexandria and the mechanical tradition

Since Hero's text is unique in terms of the insights into the practicalities of automation technology, we must ask ourselves how useful Hero's comparably late text is for the understanding of similar automated technologies from earlier centuries. By the first century AD when Hero was writing, there already existed an established tradition of mechanical writers and at various points throughout the text Hero alludes to the fact that he is writing in dialogue with his predecessors both on matters of mechanics and styling.[9] One such author to whom Hero of Alexandria was evidently indebted in many ways and to whom he makes direct reference is Philo of Byzantium (c. 280-220 BC). Philo wrote a compendium on a variety of mechanical subjects in nine books entitled *Mēchanikē Syntaxis*. Of this Hellenistic work, only the fourth book (*Belopoeika*), as well as parts of the seventh (*Paraskeuastika*) and eighth (*Poliorketika*) books are preserved in Greek, while book five (*Pneumatika*) is preserved in Arabic, with a partial Latin translation.[10] Yet we know that of the lost books, at least one must have dealt with the construction of automata. Not only does Philo mention

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[8] Note that the passage in the *Iliad* which describes Hephaestus and his automated tripods also stresses the importance of the tripods returning to their original position. Hom. *Il.* 18.373 – 379. For more on the automaton being defined by a departure from and return to the inanimate state see above *Chapter 2/ Inventing Automation.*

[9] Hero, *Aut.* 1.1; 1.7; 5.1; 20.1-5; 22.1-2.

[10] According to Drachmann, the Latin seems to be a translation and adaptation of the Arabic, not the original Greek. Drachmann 1948, 42-3.

such a work in his *Pneumatics,* but Hero also explicitly claims that of all his predecessors, Philo's work is the most useful for didactic purposes.[11] Indeed, Hero's own *staton automaton* is merely an improvement on the model put forward two hundred years earlier by Philo. The Alexandrian author aims to smooth out a few clumsy mechanical choices used in Philo's automated portrayal of the Legend of Nauplius, but otherwise bases his machine entirely on his predecessor's.[12] Even a generation earlier than Philo of Byzantium, Ctesibius (c. 300-230 BC) was concerned with applied mechanics in the same way as both Philo and Hero were after him.[13] Our chief sources for Ctesibius' works are Vitruvius (9.8.2-7; 10.7-8) and Athenaeus (4.174 and 11.497). Drachmann argues convincingly that we should accord a slight preference to Vitruvius as a source for Ctesibius as he seems to have had direct access to Ctesibius' works, which was not the case for Athenaeus.[14] Vitruvius is concerned only with Ctesibius' discussions on the pump, organ and water clock, but does leave a tantalising clue that Ctesibius did in fact write on entertainment technologies. In justifying his selective use of Ctesibius' works Vitruvius confines himself to what he considered useful:

> *reliqua, quae non sunt ad necessitatem sed ad deliciarum voluptatem, qui cupidiores erunt eius subtilitatis, ex ipsius Ctesibii commentariis poterunt invenire.*

> The rest, which is not suited to our needs, but to the pleasures of entertainment, can be found in the commentaries of Ctesibius himself by those who are interested in such refinements.[15]

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[11] Ph.Byz. *Pneum.* 3 and Hero, *Aut.* 20.1 respectively.

[12] Hero is particularly concerned with improving the apparition and disappearance of Athena which he says was 'unnecessarily difficult' (*ergōdesteron*) in Philo's model, as well as including the lightning bolt falling on Ajax with the accompanying sound of thunder which Philo seems to have omitted. Hero, *Aut.* 20.2-3.

[13] The debts the between all three authors, particularly through their approach to pneumatics, have been expertly traced by Drachmann 1948.

[14] Drachmann 1948, 1.

[15] Vitr. *De Arch.* 10.7.5.

Given that both Philo and Hero dedicated entire treatises to automata, it seems highly probably that Ctesibius' now lost writings on technologies that had as their purposes the 'pleasures of entertainment' would have included something on automata. If this hypothesis is correct, technical manuals on self-animated machines would have existed at least from the third century BC which sits comfortably with our early attested processional automata such as the snail of Demetrius of Phalerum at the Great Dionysia of 309/8 BC (**P1**), or the automata used in the Grand Procession of Ptolemy Philadelphus soon after (**P2-3**).

P6: The Panathenaic Ship of Herodes Atticus

Philostratus, *Vitae Sophistarum,* 2.550. Great Panathenaea, 143 AD.

κἀκεῖνα περὶ τῶν Παναθηναίων τούτων ἤκουον· πέπλον μὲν ἀνῆφθαι τῆς νεὼς ἡδίω γραφῆς ξὺν οὐρίῳ τῷ κόλπῳ, δραμεῖν δὲ τὴν ναῦν οὐχ ὑποζυγίων ἀγόντων, ἀλλ᾽ ὑπογείοις μηχαναῖς ἐπολισθάνουσαν, ἐκ Κεραμεικοῦ δὲ ἄρασαν χιλίᾳ κώπῃ ἀφεῖναι ἐπὶ τὸ Ἐλευσίνιον καὶ περιβαλοῦσαν αὐτὸ παραμεῖψαι τὸ Πελασγικὸν κομιζομένην τε παρὰ τὸ Πύθιον ἐλθεῖν, οἷ νῦν ὥρμισται.

Moreover, I heard the following concerning this Panathenaea: A *peplos* was fastened on the ship, more charming than a painting with the wind through its folds, [and I heard that] the ship travelled with no animals leading it, but gliding forwards by means of underground machinery. Beginning from the Cerameicus, with 1000 oars it went forth up to the Eleusinium and after circling it, passed by the Pelasgicum and thus being conveyed, passed by the Pythium where it is now moored.

Herodes Atticus (c. 101-177 AD) was a distinguished sophist and, at least according to Philostratus' text, a somewhat controversial public figure at Athens.[1] He is known to have been a lavish public benefactor throughout the Greek world, above all at Athens where he built an Odeon on the south-western slope of the acropolis as well as the renowned Panathenaic Stadium. In addition to constructing this impressive marbled monument, taking his role as *agōnothetēs* in 143 AD very

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[1] According to Philostratus, the Athenians resented Herodes' expenditures, particularly the construction of the Panathenaic stadium, viewing the funds used as money which was owed to the people. Herodes' father, it seems, had bequeathed to the people of Athens a *mina* annually per citizen but, seeing his inheritance dwindling, Herodes harassed the citizens with accusations of counter payments owed to him and to his family when the citizens came to collect their due. Philostr. *VS* 2.549.

seriously, Herodes also organised for the Panathenaic ship to process through the streets without the aid of draft animals, carrying the *peplos* of the Great Panathenaea.[2]

Peplos and Panathenaea

The Panathenaea was celebrated on the 28th day of Hecatombaeon, the first month of the Attic year and what would be roughly equivalent to our modern July or August. The festival celebrated Athena's victory in the Gigantomachy and every four years, at what was known as the 'Great' Panathenaea, a *peplos* decorated with a scene of Athena's victory was fastened as the sail of a ship and paraded through the streets of Athens as part of the procession of this elaborate Athenian festival of Panhellenic status.[3] Crucially, the *peplos* tapestry is not to be confused with the *peplos* robe which was woven annually by the *arrheporoi* and taken to the statue of Athena on the acropolis.[4] Unlike the robe, the *peplos* tapestry would have been very large so as to be seen clearly as it processed through the streets, proudly commemorating the victory of the Goddess to the spectators in Athens. John Mansfield estimates that the *peplos* tapestry would have measured between four and eight metres in length, with an area of between 16 and 64 square metres.[5] The great size of the *peplos* is also attested to by a fragment of the comic poet Strattis dating from the late fifth or early fourth century BC. Although the relation to a ship is implicit, the nautical terminology used by the author leaves no doubt as to the *peplos* being referred to:

τὸν πέπλον δὲ τοῦτον

ἕλκουσ' ὀνεύοντες τοπείοις ἄνδρες ἀναρίθμητοι

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[2] Although the passage at hand refers to the Panathenaea, it seems that Herodes was equally extravagant when it came to organising the Dionysia. Just prior to the mention of the automated ship and the Panathenaea, Philostratus makes reference to the way in which whenever the Dionysia came around, Herodes would not only organise a huge sacrificial feast, but would also furnish large quantities of wine for citizens and foreigner alike to drink as they lay in the Cerameicus on couches of ivy leaves. Philostr. *VS* 2.549.

[3] There has been some misunderstanding in modern scholarship as to what the Panathenaea celebrated, with certain handbooks suggesting it was a festival organised for Athena's birthday. Shear conclusively argues against such misguided interpretations. See Shear 2001, 3, 23 and throughout.

[4] On the confusion between the two *peploi* both in ancient and modern scholarship see Mansfield 1985, 2-18.

[5] Mansfield 1985, 7.

εἰς ἄκρον ὥσπερ ἱστίον τὸν ἱστόν.

Countless men hoist this robe to the top, hauling it up with ropes like sails on a mast.[6]

Combining this fragment with later sources, we can be certain that the *peplos* being referred to here by Strattis is indeed the same *peplos* that features in the Philostratus passage, and that both refer to the tapestry attached to the Panathenaic ship for use in the penteteric festival. A scholion on Aristophanes' *Knights*, for example, notes that by an idiosyncratic use of language of the Athenians (ἰδίᾳ παρὰ τοῖς Ἀθηναίοις) *peplos* can refer to the sail of the Panathenaic ship.[7] This comment appears almost *verbatim* in the Suda except for a shift in tense to the imperfect due to the tradition no longer being in custom.[8] We must imagine, therefore, that Herodes Atticus has taken one of the most distinctive features of the Great Panathenaea and has given it a spectacular twist by making the ship seem, through some hidden mechanics, to advance of its own accord. Whether Herodes was the first or the even the only ambitious *agōnothetēs* to do this we cannot know.[9]

By the second century AD, the Panathenaea already had a history of more than 600 years during which developments took place in almost every area of the festival.[10] The general trend which developed from the introduction of the *agōnothetai* onwards when the personal funds of wealthy individuals became the main source of finances for the festival was a greater general monumentalisation of processional route and increase in the theatricality of the *pompē* of the

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[6] Stratt. Fr 31 Kassel-Austin.
[7] Schol. Ar. *Eq* 556a.
[8] *Suda*, s.v. πέπλος (π 1006).
[9] There is some controversy surrounding the use and development of ship-carts and ships in Greek festival processions. See Csapo, 2012 esp. 28-29 with further references.
[10] On the history of the Panathenaea and a detailed analysis of its development over time see Shear 2001.

Panathenaea.[11] The case of Herodes Atticus is a perfect example of the way in which traditional Greek festivals came to be celebrated under the Roman Empire. The automated ship is included as part of Herodes' plans to aggrandise the festival through various breathtaking wonders. It is said that upon receiving the crowning honour of organising the Panathenaea, Herodes declared he would build a stadium of pure marble to receive the competing athletes. This stadium is referred to by Philostratus as a monument 'beyond all other marvels' (ὑπὲρ πάντα τὰ θαύματα) and immediately precedes the account of the automated Panathenaic ship. The vocabulary of *thauma,* as we have seen, is one that repeatedly surrounds automata. Religious awe tied with extravagant political display is at stake in the ancient evidence once more.

Deploying such marvels was not cheap, however, and the epigraphic evidence would suggest that Herodes was not the only individual to have spent ludicrous amounts of money on the festival and in particular, on the Panathenaic ship and its procession through Athens. Already in 299/8 BC it is a poignant and well-received political gesture that the Hellenistic King Lysimachus should replace precisely the yardarm and mast for the Panathenaic *peplos* which had broken at the previous Panathenaea.[12] A late fourth century AD Attic honorary inscription found on a statue base states that three times a certain Plutarch used his funds to draw the sacred ship near to the temple of Athena, but that he 'poured out all his wealth' in doing so.[13] It is worth emphasising that Plutarch's expenditure and the praise incurred refer specifically to the procession, and to conveying the ship towards the temple of Athena. Gifts which related specifically to the Panathenaic ship and the *peplos* tapestry which it bore were repeatedly used in Athenian history to represent the wealth and the piety of a powerful benefactor, and this is the tradition that Herodes is playing into with his automated ship.

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[11] Shear 2001, 932; For the argument for processions in general, and not just related to the Panathenaea, see Viviers 2014.
[12] IG II² 657.14-16.
[13] IG II² 3818.

Moving the ship

The marvel of Demetrius' ship has been met with a plethora of responses in modern scholarship. Pfuhl in 1900 suspected that horses were hidden inside the ship, concealed by the float.[14] J. Shear similarly remarks that draft animals may simply have been hidden by the ship.[15] T.L. Shear in 1978 was slightly vaguer simply saying that 'its wheels and means of locomotion were somehow concealed beneath the float'.[16] Schultess corrected Philostratus' mechanical understanding stating that in place of 'underground machinery', the ship would have concealed a locomotive machine inside it.[17] Graindor, ever a defender of Herodes' capabilities, says that we should take Philostratus' text at face value, though he does offer a hypothesis for a mechanical solution.[18] Leopold and Mansfield both imagine the ship as a proto-cable car, by far the most attractive solution.[19] As accurately noted by Leopold, the Athenians were used to hauling heavy ships onto the shore and had long ago invented rope systems to carry heavy blocks of stone on quarry roads.[20] Indeed, a good deal of knowledge on quarrying techniques would have been employed in the construction of Herodes' marble stadium!

An intriguing trail of clues regarding ropes used in the Panathenaea comes down to us in the epigraphic tradition which may help to further elucidate some of the mystery behind Philostratus' 'underground machinery'. In 282 BC an honorific decree was passed in honour of Kallias of Sphettos and inscribed his organisation and financial contribution to the festivals of the city. In particular, the decree records the way in which Kallias arranged for King Ptolemy II to organise for the Panathenaea

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[14] Pfuhl 1900, 9-11.
[15] Shear 2001, 148.
[16] T.L. Shear 1978, 43.
[17] Discussed in Graindor, 1930, 65.
[18] Graindor, 1930, 65.
[19] Leopold 1985, 125 and Mansfield 1985, 111 respectively.
[20] Leopold 1985, 125. On quarrying marble near Mt Pentelikon see Goette 2007.

'the ropes (ὅπλα) which it was necessary to provide for the *peplos'* ([… ὑπὲ]ρ τῶν ὅπλων ὧν εἰς τὸν πέπλον ἔδει παρασκευάσαι).[21] Shear says that these ropes were presumably used to secure the mast in position.[22] Yet a second inscription complicates the picture slightly. Some 140 years later, dating from 142/1 BC, another inscription similarly refers to the benefactions of a wealthy individual, this time a certain Miltiades of Marathon, who is particularly praised for giving 'the hemp ropes [and] the rest if the things lacking f[or the conveya]nce of the *peplos* (καὶ ὅπλα στύπ[πινα καὶ] τὰ λοιπὰ τὰ ἐλλείποντα πρ[ὸς τὴν κομιδ]ὴν τοῦ πέπλου)'.[23] If the reconstruction of the corrupt text is correct, these ropes were specific in their use: the conveyance of the *peplos.* Whether this means the conveyance up the mast pole, or more broadly its conveyance along the entire route remains a mystery but it is perhaps worth pointing out that the cognate verb κομίζεσθαι is used by Philostratus to refer to the transportation of the *peplos* along its processional route. One thing that we can certainly deduce from these inscriptions is that ropes were regularly used in the Panathenaic procession, and that they were presumably worn down and needing to be replaced by the next festival. If the 'conveyance' does refer to the motion of the ship along its route more generally, the other things lacking for the conveyance of the *peplos* could well refer to the wheels or 'many axles' that allowed the ship to move 'as if having waves underneath her', at least according to Himerius.[24] The most important point to take from untangling these mechanical clues, however, is how the ship would have been viewed as a marvel moving under the auspices of the goddess Athena, at a religious occasion facilitated by a leader whose divine connections would have felt very real to spectators.

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[21] *SEG* XXVIII 60.55-70.
[22] Shear 2001, 147.
[23] *IG* II[2] 968.37-55. (*Non-stoic.*)
[24] Him. *Or.* 47.13. Wheels can also be seen on the depiction of the Panathenaic ship on the calendar frieze on the church of Agios Eleutherios at Athens. For an illustration of the frieze see Simon 1983, 6 pll. 1-2.

Ropes, or in this case stern cables (*peismata*), are similarly mentioned in reference to a comparable procession to that of the Panathenaea at the Dionysia in Smyrna when a trireme is brought from the harbour to the agora. The point here seems to be that the stern cables are released allowing the ship to slide over land under the direction of the priest of Dionysus.[25]

The route of the parade

The route of Herodes' Panathenaic ship is described in great detail by Philostratus. This passage is in fact one of the most exhaustive descriptions of the *pompē* of the Panathenaea which has come down to us from antiquity. By all accounts, the Panathenaic procession started in the Cerameicus, at the north western walls of the city.[26] Beginning at the Dipylon Gates, the ship followed down what could be considered the main axis of the festival: the *dromos* which led to the Eleusinium along which *apobatic* races and torch races would also take place.[27] The ship then passed by the somewhat elusive Pelasgicum, also known as the Pelargicum. These ancient walls are mentioned in two sources, Thucydides and Strabo, however the two references are not reconcilable in terms of their location in the city of Athens.[28] Travlos has convincingly shown that Thucydides and Strabo in fact refer to two separate locations. The Pelargicum referred to by Thucydides is the one located near the Ilissos (termed the 'outer' Pelargicum by Travlos) located south of the Acropolis. Strabo's Pelargicum, on the other hand, is located on the north-western slope of the acropolis.[29] Given that the rest of the Panathenaic procession proceeded up the west side of the acropolis to the statue of Athena, Strabo's Pelargicum seems the most logical fit to the passage at hand. It makes little sense

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[25] Philostr. *VS* 1.25 (531).

[26] Thuc. 6.57.1; Philostr. *VS* 2.550; Plut. *Demetr.* 12.3; Him. *Or.* 47.12; Schol. Ar. *Eq.* 566a; *Suda* s.v. πέπλος (π 1006).

[27] On the other activities that were held on this course see Shear 2001, 670.

[28] Th. 2.17 and Str. 9.404 respectively.

[29] Travlos 1971, 91, 100 fig. 71 where both Pelargicum and 'outer' Pelargicum can be seen clearly and fig. 116 which shows the northwest slope of the Acropolis in detail. For updated maps of Athens see: Ficuciello 2008, 65; 211; 213.

to have had the ship continue its spectacle all the way around the Acropolis and down to the Ilissos in the south with no one watching.

Our ancient sources differ slightly in regards to the final destination of the ship which has inevitably caused some debate in modern scholarship. It is irrefutable that a huge structure such as the Panathenaic ship, self-propelled or not, would not have been able to manage the steep incline and steps that led directly up to the acropolis. Thus Himerius' description 'to the hill of Pallas' must either refer to the foot of the Acropolis, or to the entire procession's journey on foot up to the state of Athena once they had left the ship behind.[30] A scholion to Aristophanes as well as the entry in the Suda indicate that the Eleusinium was the final location of the ship in the procession.[31] Philostratus, as we have seen, has the ship arrive by the Pythium instead.[32] By the middle of the second century AD, Pausanias comments that he saw a ship used in the Panathenaic procession moored near the Areopagus.[33] The ancient evidence is then further complicated by the rather convincing hypothesis of Tobin who has shown that the ruins of a long, narrow building near Herodes' Panathenaic Stadium was not the tomb of Herodes as had been previously speculated, but a monument built to house the Panathenaic ship used in Herodes' Panathenaea of 143.[34]

My suggestion is that each year the ship, having completed its performative role in the *pompē,* was then put on permanent display in the city. We have too many sources stressing the final destination of the ship for it not to have had some significance. Pausanias' comment may then refer to where the Panathenaic ship used in the most recent festival had been put to rest. Philostratus' description of the automated ship 'now' moored at the Pythium, may more accurately refer to where the ship

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[30] Him. *Or.* 47.13.
[31] Schol. Ar. *Eq.* 566a; *Suda* s.v. πέπλος (π 1006).
[32] Philostr. *VS* 2.550.
[33] Paus. 1.29.1
[34] Tobin, 1993, 81-89.

was finally displayed, rather than where it ended the procession. While the general trend would have been to display the ship near the end of its processional route, somewhere at the foot of the west side of the acropolis between the Areopagus and the Eleusinium, Herodes' ship, which would have been particularly grandiose, had a purpose-built display room near the stadium which he also built for the occasion. What is most important about the route of the Panathenaic ship for our purposes is that the automaton undoubtedly travelled from the Cerameicus to the Eleusinium of its own accord, a distance of 760 metres with a 38.7 metre elevation.[35] This route was the core of the festival procession and in 143 AD, Herodes' automated Panathenaic ship with its exquisite tapestry blowing in the wind, would have stolen the show.[36]

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[35] Travlos 1971, 422

[36] It is worth noting that in the first half of the first century BC the Panathenaic Way up to the Eleusinium had been repaved and that later under Hadrian in the 120s AD, used blocks were employed to repave the section from the library of Pantainos (in the south-eastern corner of the Agora) up to the Eleusinium. Shear 2001, 922. The axis at hand was common to the *Pompē* of the Dionysia and it was obviously important to keep this route as clear and smooth as possible. With this in mind, we may recalibrate the picture of the typical festival *pompē* slightly to one which frequently involved large processional equipment.

P7: Automated Wagon

Socratic Epistle 35 (Hercher) = Köhler 33 = Malherbe 33. Delphi, date unknown.

πρῶτον μὲν οὖν συγχαίρω Συρακουσίοις ὅτι πέπαυνται τὸν χοῖρον ἴακχον καλοῦντες καὶ τὸν

βοῦν γαρόταν καὶ βαλλάντια τὰ ἀκόντια, καρποτόκον τε μῆνα, ὅτι καρπὸς ἐν αὐτῷ γίνεται.

καὶ τὰ εἰς Δελφοὺς πεμφθέντα ἀναγράψαι τὰ σοφά, ἐφ’ οἷς ἔοικεν ὁ Ἀπόλλων οὐχ ὡς πατὴρ

διατεθῆναι ἀκούσας καὶ τὸ ἀμάξιον ἰδὼν τὸ ἐν τῷ ἱπποδρόμῳ περιτρέχον αὐτόματον, ἀλλά

μοι δοκεῖ βουληθῆναι παῦσαι ἀφικνούμενον αὐτὸν τοιαῦτα θεωρήματα.

First then I congratulate the Syracusans because they have stopped calling the swine 'iacchus'

and the ox 'garotas', darts 'ballantia', and the moon 'fruit-bearing' because it produces fruit.

?And the business about inscribing the wise sayings sent from Delphi? it seemed that Apollo

was not disposed as a father when he heard of the clever words that the Delphians had been

sent to inscribe,[1] and when he saw the little wagon which raced around the hippodrome of its

own accord. But it seems to me that as he arrives, he wanted such spectacles to stop.

This next source relates an automated wagon moving around the hippodrome and comes down to

us in the corpus known as the 'Socratic Epistles'. These letters are preserved in a single manuscript

on which all the other manuscripts depend.[2] The broader collection known as the Cynic Epistles, of

which the Socratic Epistles form a small part, are highly under-studied not least because of the

limited accessibility of the texts. Abraham Malherbe offers the only English translation of the Cynic

Epistles but as his work does not aim to be a critical edition, readers still need to rely on Hercher's

Epistolographi Graeci of 1873 (with Latin translation) or Köhler's 1928 text (with German

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[1] The sense of the Greek at this point is difficult to make out.
[2] Malherbe 1977, 27.

translation).[3] Notably, Hercher and Köhler both leave the letter at hand untranslated, presumably because of the evident unintelligible nature of parts of the text. The translation above aims to make as much sense of the letter as possible and is indebted to Worley's translation in the Malherbe edition.

Though dating the letters with any precision is difficult, the consensus is that the Socratic Epistles were written after the earlier part of the second century AD.[4] This thus makes them too late for both Socrates and any first-generation Socratics. The 35 letters were not all written by the same person and can be divided into two main groups: those attributed to Socrates himself, and those attributed to his disciples. In letters 1-7, 'Socrates' sets out the principles that determined his actions. The notional author of the rest of the epistles, of which our letter forms part, is supposedly someone in the Socratic circle. The second group of epistles are less didactic and show greater interest in historical detail, relating how the students of Socrates followed his philosophical principles in their everyday lives.[5]

The implication of the passage is that the automated wagon was sent as a religious gift from Syracuse to Delphi.[6] It is likely that the wagon made up part of the *pompeia* brought by delegates such as the *theōroi* to the Pythian Games held every four years at Delphi. Schürmann suggests that the wagon was sent by Dionysius II to the Pythian games of 358 BC though this date is hard to secure firmly and is much earlier than the supposed composition of the letters.[7] Fortunately, the precise

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[3] These two editions differ slightly in the version of the text they offer and in the organisation and numbering of the Socratic Epistles. We have here followed Hercher in both.
[4] Malherbe 1977, 28-29.
[5] Malherbe 1977, 28.
[6] One imagines a similar situation to the *theōria* sent by Dionysius II of Syracuse to Olympia in the fourth century BC. For more see Rutherford 2013, 39.
[7] Schürmann 1991, 242; Schürmann 1999, 44.

date is not of huge concern for present purposes and we should prefer instead to use the source as evidence for attitudes towards automata and automation in context.

Apollo's supposed irritation at seeing a little automated wagon wheeling around the hippodrome is very interesting. Curiously, this is not the only reference to a disgruntled Apollo in relation to automation. We have already seen, for example, how Philostratus says that although Apollo could shake all of Parnassus, make Castalia flow with wine or forbid Cephisus from being a river, he preferred to reveal his oracles modestly without such boasting.[8] In direct contrast to Dionysian use of automation which strengthened the mortal sense of connection with the deity by invoking his presence, divinely inspired movement when associated to Apollo is portrayed as an unnecessary superfluity within human-divine relations. In the Socratic epistle, it is specifically the spectacle (*theōrēma*) that bothers Apollo.

It is critical to the interpretation of the passage at hand that the religious frame is absent. The fragment reveals how alongside sacred space, sacred time, was important to the deployment of the machine and the visualising of the miracle. The hippodrome perhaps formed part of the Pythian *pompē,* making it a religious arena at the time of a religious festival. The present participle (*aphiknoumenon*), however, betrays how when Apollo arrives, he struck upon mortals playing with the wagon in his absence, hence not during a religious occasion. In this we are reminded of the miraculous springs which change from water to wine only on specifically religious occasions.[9] It is evidently the lack of religious context for the display of the automaton which is deemed particularly problematic in this letter. In other words, it is the absence of any ritualised viewing induced by the

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[8] Philostr. *VA.* 6.10.4. Above **P3:coda.**
[9] See above **P3:coda**.

festival underpinning the deployment of this automata which resulted in Apollo's unhappy disposition.

We can do even more with this source if we treat it as the projection of elitist philosophers. As with Strabo's scepticism (see **P4**), this is useful in order to trace the range of responses to the use of automata. It seems that what this passage is showing is how self-animated machines came to be regarded by some as 'vulgar'. This would, first and foremost, indicate a certain level of popularity for the use of automata in religious contexts to entertain the masses. There is certainly evidence to suggest that particular types of entertainment were regarded as more lower-class than others in ancient Greece. Marionettes, for example, are seen as vulgar by both Athenaeus and Xenophon.[10] Dio Chrysostom recounts with disdain that miracle-makers (*thaumatopoioi*) performed in the street at the Isthmian games.[11] The feelings of disdain expressed in the Socratic Epistle towards the wagon moving *automatōs,* then, were ascribed haughtily by a group of high-brow philosopher to Apollo. For them, Apollo was a god whose muses stand in stark contrast to Dionysus and his revelling maenads; the prestige of Apollo's renown oracular utterances finding competition in the mantic powers of Dionysian ecstasy.[12]

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[10] X. *Smp.* 4.55; Ath. 1.19d-20a.
[11] D.Chr. 8.9.
[12] See Eur. *Ba.* 298-301. More on this dichotomy of Apollo and Dionysus above **P3:coda**.

P8: The Hippaphesis

Pausanias 6.20.10-14. The Olympia, c. 470 BC.

ὑπερβάλλοντι δὲ ἐκ τοῦ σταδίου, καθότι οἱ Ἑλλανοδίκαι καθέζονται, κατὰ τοῦτο [τὸ] χωρίον ἐς τῶν ἵππων ἀνειμένον τοὺς δρόμους καὶ ἡ ἄφεσίς ἐστι τῶν ἵππων. παρέχεται μὲν οὖν σχῆμα ἡ ἄφεσις κατὰ πρῷραν νεώς, τέτραπται δὲ αὐτῆς τὸ ἔμβολον ἐς τὸν δρόμον· καθότι δὲ τῇ Ἀγνάπτου στοᾷ προσεχής ἐστιν ἡ πρῷρα, κατὰ τοῦτο εὐρεῖα γίνεται, δελφὶς δὲ ἐπὶ κανόνος κατὰ ἄκρον μάλιστα τὸ ἔμβολον πεποίηται χαλκοῦς. ἑκατέρα μὲν δὴ πλευρὰ τῆς ἀφέσεως πλέον ἢ τετρακοσίους πόδας παρέχεται τοῦ μήκους, ᾠκοδόμηται δὲ ἐν αὐταῖς οἰκήματα· ταῦτα [τὰ] κλήρῳ τὰ οἰκήματα διαλαγχάνουσιν οἱ ἐσιόντες ἐς τὸν ἀγῶνα τῶν ἵππων. πρὸ δὲ τῶν ἁρμάτων ἢ καὶ ἵππων τῶν κελήτων, διήκει πρὸ αὐτῶν καλῴδιον ἀντὶ ὕσπληγος· βωμὸς δὲ ὠμῆς πλίνθου τὰ ἐκτὸς κεκονιαμένος ἐπὶ ἑκάστης ὀλυμπιάδος ποιεῖται κατὰ τὴν πρῷραν μάλιστά που μέσην, ἀετὸς δὲ ἐπὶ τῷ βωμῷ χαλκοῦς κεῖται τὰ πτερὰ ἐπὶ μήκιστον ἐκτείνων. ἀνακινεῖ μὲν δὴ τὸ ἐν τῷ βωμῷ μηχάνημα ὁ τεταγμένος ἐπὶ τῷ δρόμῳ· ἀνακινηθέντος δὲ ὁ μὲν ἐς τὸ ἄνω πεποίηται πηδᾶν ὁ ἀετός, ὡς τοῖς ἥκουσιν ἐπὶ τὴν θέαν γενέσθαι σύνοπτος, ὁ δελφὶς δὲ ἐς ἔδαφος πίπτει. πρῶται μὲν δὴ ἑκατέρωθεν αἱ πρὸς τῇ στοᾷ τῇ Ἀγνάπτου χαλῶσιν ὕσπληγες, καὶ οἱ κατὰ ταύτας ἑστηκότες ἐκθέουσιν ἵπποι πρῶτοι· θέοντές τε δὴ γίνονται κατὰ τοὺς εἰληχότας ἑστάναι τὴν δευτέραν τάξιν, καὶ τηνικαῦτα χαλῶσιν αἱ ὕσπληγες αἱ ἐν τῇ δευτέρᾳ τάξει· διὰ πάντων τε κατὰ τὸν αὐτὸν λόγον συμβαίνει τῶν ἵππων, ἔστ' ἂν ἐξισωθῶσιν ἀλλήλοις κατὰ τῆς πρῷρας τὸ ἔμβολον· τὸ ἀπὸ τούτου δὲ ἤδη καθέστηκεν ἐπίδειξις ἐπιστήμης τε ἡνιόχων καὶ ἵππων ὠκύτητος. τὸ μὲν δὴ ἐξ ἀρχῆς Κλεοίτας ἐστὶν ἄφεσιν μηχανησάμενος, καὶ φρονῆσαί γε <φαίνεται> ἐπὶ τῷ εὑρήματι, ὡς καὶ ἐπίγραμμα ἐπὶ ἀνδριάντι τῷ Ἀθήνῃσιν ἐπιγράψαι

ὃς τὴν ἱππάφεσιν <ἐν> Ὀλυμπίᾳ εὕρατο πρῶτος,

τεῦξέ με Κλεοίτας υἱὸς Ἀριστοκλέους·

Κλεοίτα δέ φασιν ὕστερον Ἀριστείδην σοφίαν τινὰ καὶ αὐτὸν ἐς τὸ μηχάνημα ἐσενέγκασθαι.

After passing beyond the stadium, in the place where the umpires sit, is a spot set apart for the races and the starting place (*aphesis*) for the horses. The starting place is constructed in the shape of the prow of a ship, and its ram is facing towards the track. In the place where the prow adjoins the portico of Agnaptus it becomes wider and a bronze dolphin has been made at the very tip of the ram. Each side of the starting place is more than four-hundred feet in length and stalls have been built in the sides. These stalls are assigned by lot to those who enter the horse contests. Before the chariots or the race-horses extends a small cord instead of the starting line (*hysplex*).[1] An altar of unburnt brick, plastered on the outside, is constructed at each festival as close as possible to the centre of the prow, and a bronze eagle is placed upon it with its wings outstretched to the fullest extent. The man appointed to start the race puts into motion the mechanism on the altar. Having been set into motion, the eagle is designed to leap upwards, so as to become visible to the spectators, while the dolphin falls to the ground. To begin, from both sides, the starting ropes by the portico of Agnaptus release, and the horses standing there run out first. As they run, they reach those who were arranged by lot in the second stations, and at that time the starting ropes of those in the second stations fall away. After this happens to all of the horses in the same manner, they are brought level with each other at the ram of the prow. Then it comes down to a display of the skills of the charioteers and the speed of the horses. It was Cleoetas who first contrived the starting mechanism, and he appears indeed to have been proud of his discovery, as on the statue at Athens he wrote the inscription:

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[1] This translation agrees with Broneer's analysis of the 'hysplex' as the regular race-starting mechanism and thus the 'small cord' referred to in our passage being detailed specifically because it forms part of a more complicated mechanism, here used in lieu of the regular hysplex. See Broneer 1973, 139-142 esp. 142. Gardiner on the other hand, would see the hysplex and the small rope as one and the same and would thus tend toward a translation such as 'a small cord extends as the starting line (*hysplex*)'. Gardiner 1903, 262-263.

He who first invented the mechanism to start the horse races at Olympia,

He made me, Cleoetas son of Aristocles.

They say that after Cleoetas, Aristeides introduced some clever device to the mechanism.

The *hippaphesis* described here by Pausanias was used at the Olympia, a festival held in honour of Olympian Zeus every four years in the city of Olympia in the western Peloponnese. This Panhellenic festival was held in the middle of summer during the first full moon after the summer solstice. Beginning in the eighth century BC, the festival existed for over 1000 years in its ancient form and has obviously had a long legacy in the modern era thereafter. The Olympic festival as a whole, and specifically the games which formed an integral part of the religious occasion, grew and developed a great deal during its ancient existence.[2] Because of these changes, the strict reconstruction of the sequence of events at the Olympic Games is contentious, but the general consensus is that after its introduction in the seventh century BC, the chariot-race was the opening athletic event. The games started with the race that offered the greatest opportunity for pomp and splendour and it should not surprise us that a sophisticated piece of technology was developed to accompany the grand opening of the religious games. The use of the *hippaphesis* not only marked the beginning of the chariot race, but it also signalled a break from the initial stages of the festival which involved preparation and preliminary religious rituals, bringing in activities of agonistic rivalry and athletic prowess.

Writing in the second half of the second century AD, Pausanias gives us a description of the starting mechanism used in the hippodrome at Olympia, a building which leaves no archaeological remains today. Instead of lining up in a single horizontal line, the starting stalls were constructed in the shape

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[2] For the development of the athletic events see Tselekas 2005, 73.

of an isosceles triangle with a portico along the base side.[3] At the tip of the triangle there was a dolphin harnessed high in the air in preparation for its 'fall' which would signify the start of the race. In the centre of the triangle there was an altar of unburnt brick made new each year which had an eagle placed on it. The eagle was attached to a mechanism which allowed it to soar upwards at the same time as the dolphin plunged towards the earth. Pausanias is clear that this self-propelled display existed for the benefit of the spectators, presumably as opposed to the contestants, so that they could all clearly see the start of the race even from the other end of the hippodrome. There was thus presumably some other way for the beginning of the race to be signalled to the contestants which leaves the leaping dolphin and soaring eagle as pure spectacle. We also note that there was a conscious decision to fashion these starting signallers as animals rather than, for example, inanimate objects such as blocks or balls. Pausanias explicitly states that the eagle had its wings outstretched to imitate flying, an aesthetic choice which would have increased the overall spectacle of the mechanism once the bird started moving.[4] The eagle in ancient Greece was intimately linked to victory as well as to Zeus, patron of the Olympic festival. Elean coinage often had an eagle on the obverse, sometimes holding prey in its talons.[5] The use of the eagle in the *hippaphesis* automaton reveals how mechanical ingenuity was used to signify the manifest presence of Elis' patron god at the most famous of their religious occasions as the audience was evidently meant to see the agency of the Zeus in the *thauma* they witnessed. The symbolism of the dolphin is slightly more elusive. Maddoli and Nafissi believe that the dolphin offers a parallel to the eagle for speed, the former being swiftest in the sea, the latter in the air.[6] Considering the context, this interpretation is certainly applicable though one wonders why a sea animal was chosen in place of a land animal. We might

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[3] For a good illustration of the *hippaphesis* see Miller 2004, 81.

[4] Levi aptly notes a modern Italian religious tradition which offers a nice parallel to the soaring eagle. To this day, during Easter at a festival called Scoppio del Carro, a large antique cart loaded with fireworks is paraded through the city of Florence in a way very reminiscent of an ancient *pompē*, accompanied by citizens, soldiers, priests and musicians. When the cart arrives at the Cathedral Square, a mechanical dove (the 'colombina') speeds along a wire to look like it is flying from the cart into the cathedral. This is the signal for the beginning of a complex firework show which explodes from the cart and lasts about 20 minutes. Levi 1971, 346.

[5] See Tselekas 2005.

[6] Maddoli and Nafissi 1999, 343.

therefore like to add the fact that dolphins were known leapers, a tactical virtue suited to starting a race. Together, the eagle and the dolphin that formed the *hippaphesis* would signal the start of the chariot race giving manifest evidence of the presence of the god watching over the events of the Olympic Games.

Arranged in this triangular starting position, the contestants began the race at intervals with the pair furthest towards the base of the triangle taking off first. The competitors knew when it was their turn to depart as the rope hanging in front of their stall would drop down automatically by means of some mechanical contraption.[7] The starting mechanism for the chariot race as whole was made up not only of the dolphin and the eagle propelled of their own accord in opposing directions, but of ropes falling away automatically from in front of the competitors too. When all the contestants had drawn up together in line with the tip of the triangle, the ropes of the last contestants were released and it was then up to the riders to display their skills, particularly when it came to manoeuvring around the notoriously difficult turning post. Stephen Miller says that the reason for the complicated stagger is not clear.[8] It is true that pragmatically, the staggered starts serve little purpose. The horses would still end up starting what constituted the 'true race' at the same time, and since the starting boxes could not functionally overlap, this arrangement did not save space horizontally either.[9] Yet in terms of pure performance, the staggered departures initiated by the soaring of the eagle and plunging of the dolphin made for a much more spectacular opening to the Olympic Games, allowing the wealthy charioteers to begin the race two by two with a bang - quite literally if we believe Bell

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[7] Though mechanically less advanced, an interesting parallel is offered by the archaeological evidence at Isthmia. In the ancient stadium excavated by Broneer in the 1950s are the remains of an ancient starting mechanism for the foot races. Broneer successfully reconstructed the device which is also based on ropes allowing the starting line to fall away from the starting stations signalling the beginning of the race. Precisely how and to what extent this system, which has been tested and found to function perfectly, differed from the use of ropes in the *hippaphesis* is hard to know, but it does give us a parallel example for the use of mechanics in athletic events which, it must be remembered, formed part of religious festivals. Broneer 1973, 49-50. See also Harris 1964, 64-77; Gardiner 1930, 128-143.

[8] Miller 2004, 81.

[9] Misguidedly implied by Maddoli and Nafissi 1999, 344.

who suspects that the energy for the contraption came from unwinding tightly wound ropes which would have been accompanied by a loud bang.[10]

Pausanias gives us absolutely no indication of the mechanics involved in the *hippaphesis*. He does say that both the dolphin and the eagle were made of bronze which would have made them expensive and heavy. For this reason, it is unlikely that the dolphin was simply released into free fall, or that the eagle was propelled in the air by torsion as the vivid verbs *piptō* and *pēdaō* poetically imply. Instead, I would conjecture that the animals were drawn automatically along masts of some sort. This type of mechanism would also have the advantage of a longer 'performance duration' which would mean that the animals could climactically reach their final destination at the same time as the last gates opened, coinciding with the 'true' beginning of the race: point at which all contestants would have taken off. The timing of both the animals' movement and the starting ropes falling away would likely have relied on an arrangement of pre-positioned ropes, comparable to that described in Hero's treatise on the construction of automata.[11] It makes the most sense to imagine the eagle and the dolphin as mechanically linked, using the movement of the plunging dolphin as a counterweight to help the eagle rise. It is perhaps worth nothing too that the eagle stood on an altar which Pausanias specifies was purpose built for each festival. This this may indicate that the altar had some relation to the installation of the mechanics of the *hippaphesis.* It was possibly used to hide parts of the mechanism such as ropes or pulleys. When the festival was not on, the heavy bronze dolphin and eagle would probably have been stored away awaiting the next festival.[12]

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[10] Bell 1990, 313-319.

[11] Hero, *Aut.* 2.10-11.

[12] On the issue of 'reusing' festival automata see the discussion above in the introduction to *Chapter 3/ Processional Automata.*

We are able to date the creation and consequently the use of this automaton far more precisely than many of our other examples. Pausanias makes plainly clear that the inventor of the *hippaphesis* was Cleoetas, the same man who also made the bronze statue of a warrior at Athens mentioned in book 1 of his work.[13] This Cleoetas is a known contemporary of Phidias and we can thus date the invention of the *hippaphesis* to beginning of the fifth century BC.[14] The early fifth century date coincides with other developments at Olympia. During the Persian invasion and in the period up to the Peloponnesian War, the sanctuary at Olympia became an important centre of Hellenism and of Hellenic identity. Then, contemporary with the establishment of a democratic regime in Elis in 472 BC and the process of synoecism in 471 BC, there were major reorganisations of both the Olympic sanctuary and the Olympic Games.[15] The stadium and hippodrome were reconstructed, for example, and it is likely that the *hippaphesis* was first put into place around this time. The mechanism underwent subsequent developments by a certain Aristeides whom we know nothing about.[16] The *hippaphesis* is thus our earliest example of technologies of self-animation in the festival context and it is a mechanism whose use may well have lasted until the second century AD if we assume Pausanias was an eye-witness.

The testimonia, it now is obvious, have not been presented in chronological order. Though the sources compound to elucidate a single point, I am wary of tracing an evolutionary teleology for automata in religious contexts. It would be a mistake, I think, to see the 'beginning' of a trend heading towards some perceived 'end' when it comes to the use of automated technologies in religious contexts. It would be even more mistaken to assume a 'betterment' of the machines with time. Thus, to avoid the temptation of seeing the *hippaphesis* as an earlier prototype of later

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[13] Paus. 1.24.3. Cleoetas, or rather his son, is also mentioned 5.24.5.
[14] Maddoli and Nafissi 1999, 345 are even more specific and date Cleoetas' activity to the first decade of the fifth century BC.
[15] Tselekas 2005, 69.
[16] Maddoli and Nafissi 1999, 345 tentatively suggest the fourth century as part of the renovations of 340-330 BC.

automata I held off presenting the *hippaphesis* first despite its early date. Rather, this example forms part of the same anthropological observation: that the ancient Greeks actively bought into a religious reality through using technologies of automation in the context of the ancient festival. We must not be tempted to view the employment of spectacle technology diachronically in a way that forces the machine realise some sort of mechanical 'potential'. This is a valid point in all history of technology and it is not new, though it is sometimes forgotten.[17] Then, like now, machines are built for a purpose, not to fulfil a mechanical potential. The common denominator that runs through all the testimonia is the specific type of automaton-gazing and subscribing to a religious miracle thanks to mechanical artifice in the context of the ancient festival.

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[17] Greene in 1992 drew attention to concept of the 'technology shelf' to help explain why technology did not advance on a single front and why less 'efficient' devices could co-exist with more efficient ones. For the same problems relating to a skewed perception of progress in Greek sculptural developments (which Herrmann termed 'Kunst-Darwinismus') see Herrmann 1975, 37-38 and Donohue 1988, 175-176.

Chapter 4/ Temple Automata

The testimonia in this chapter (**T1-T11**) gather together the evidence for what we have termed 'temple automata'. These are objects which use technologies of self-animation to present an inexplicable *thauma* to the eyes of the viewers and which we have fair reason to believe would have been used in temples, sanctuaries, or other similar religious spaces. Certain objects are specifically mentioned for set up or display in a temple, while in the case of others the vocabulary of ritual within the description betrays the context of use. Some of these temple automata might have been deployed specifically during a religious occasion such as a festival, while others appear to have been permanent instalments which helped to establish and maintain the strong presence of the god in the religious space of the temple. Others again may have been dedications serving as sanctuary 'wonders' on public display. Ian Rutherford notes that the major sanctuaries in the Greek world were laid out as spectacular attractions for the visitor, full of eye-catching buildings and dedications of which the following objects would have formed part.[1] Temple automata differ from the testimonia presented in the previous section in that they are not likely to have been used in procession. Ideologically, however, in their harnessing of mechanical ingenuity; their use in religious contexts; and in the way that they invoke a sense of the miraculous to inspire awe, they have a great deal in common with the larger processional automata (**P1-P8**).

Treatises on pneumatics

Two treatises on curious and wonderful objects that can be constructed by harnessing pneumatic principles come down to us from antiquity: Philo of Byzantium's work of the third century BC, and

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[1] Rutherford 2013, 142.

the treatise by Hero of Alexandria of the first century AD.[2] It is from these texts that much of the evidence for temple automata is found.

Both works open by noting that their collection of objects include discoveries handed down by earlier authors.[3] While Philo's text is dedicated to a certain Ariston who wished to know about wonderful objects, Hero is more generalising in the justification of his project:

> Τῆς πνευματικῆς πραγματείας σπουδῆς ἠξιωμένης πρὸς τῶν παλαιῶν φιλοσόφων τε καὶ μηχανικῶν, τῶν μὲν λογικῶς τὴν δύναμιν αὐτῆς ἀποδεδωκότων, τῶν δὲ καὶ δι' αὐτῆς τῆς τῶν αἰσθητῶν ἐνεργείας, ἀναγκαῖον ὑπάρχειν νομίζομεν καὶ αὐτοὶ τὰ παραδοθέντα ὑπὸ τῶν ἀρχαίων εἰς τάξιν ἀγαγεῖν, καὶ ἃ ἡμεῖς δὲ προσευρήκαμεν εἰσθέσθαι· οὕτως γὰρ τοὺς μετὰ ταῦτα ἐν τοῖς μαθήμασιν ἀναστρέφεσθαι βουλομένους ὠφελεῖσθαι συμβήσεται.

> The earnest study of pneumatics has been deemed worthy by both ancient philosophers and mechanicians: the former have given a logical account of its power, the latter also of the effects worked by pneumatics upon perceptible objects. We also believe it necessary to arrange in order what has been handed down by former writers, and to add to this our own discoveries. In this way, it will be of use to those who afterwards wish to study mathematics.[4]

The implication here is that the study of pneumatics was approached from two different angles in antiquity: the theoretical and practical. It also makes clear that similar technical manuals existed in

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[2] Linguistically, I rely more strongly on Hero's text due to the fact that Philo's treatise survives only in Arabic with a partial Latin translation based on the Arabic and not the original Greek. The Latin is available in Schmidt's Teubner edition of Hero's works. The Arabic was translated into French by Carra de Vaux in 1902 which remains the best translation of Philo's treatise for those, such as myself, with no Arabic. The only English translation available (produced in 1974 by Prager) is not entirely trustworthy, not least because it is based off the Latin in lieu of the Arabic. On this issue see Drachmann 1976, 116–119. Prager's monograph does, however, have the benefit of offering beautifully reproduced images from the Arabic manuscript.

[3] Hero, *Pneum.* I.proem.1-10; Ph.Byz. *Pneum.* 1.

[4] Hero, *Pneum.* I.proem.1-10.

the ancient world; that the trend of designing and building pneumatic-based 'miracles' had a history before the first century AD when Hero was writing; and that treatises were written down to serve as study books for the next generation of mechanics. It does not seem farfetched to make similar conjectures for treatises on automata construction.[5]

As the name implies, the objects described in Philo and Hero's treatises are unified by their use of the properties of air, along with the other elements, to create various wondrous effects. Hero gives the following programmatic statement in the proem of the text:

> διὰ γὰρ συμπλοκῆς ἀέρος καὶ πυρὸς καὶ ὕδατος καὶ γῆς καὶ τῶν τριῶν στοιχείων ἢ καὶ τῶν τεσσάρων συμπλεκομένων ποικίλαι διαθέσεις ἐνεργοῦνται, αἱ μὲν ἀναγκαιοτάτας τῷ βίῳ τούτῳ χρείας παρέχουσαι, αἱ δὲ ἐκπληκτικόν τινα θαυμασμὸν ἐπιδεικνύμεναι.

> For by the combination of air, fire, water and earth, and the combining of the three or the four elementary principles, various conditions are produced, some of which supply the most indispensable needs of life, while others produce a certain astonishment (*ekplēktikon*) and wonder (*thaumasmon*).[6]

Despite initially setting up this dual focus on both the useful and the awesome, when it comes to the content of the text, there is a strong preference for the marvellous. Indeed, by the end of the proem, Hero seems to have forgotten about utility reiterating only the way in which many diverse (*poikilas*) and wondrous (*thaumasias*) movements can be created by harnessing pneumatic properties.[7]

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[5] As argued above **P5**.
[6] Hero, *Pneum.* I.proem.15-20.
[7] Hero, *Pneum.* I.proem.346.

The objects described in both Hero and Philo's treatises can, for our purposes, be broken down into three distinct categories. A minority of objects are in fact 'useful'. These include the bent siphon to draw water out of a well; the syringe and medical 'cup'; and self-trimming and self-refilling lamps.[8] The next and most numerous category of objects can be considered 'playful' and consist of sympotic vessels made to trick or joke with (*empaizein*) spectators.[9] The trick vessels would likely have been considered objects of the newest technology which wealthy hosts could pull out to impress their guests possibly in sympotic contexts, or which could have been used by minor entertainers such as the elusive *thaumatopoioi*.[10] In many instances, the vessels rely on optical illusions and there is a focus on the flow of liquid being 'contrary to nature' (*para physin*), particularly by harnessing the ability of the siphon to make liquid travel upwards. These were essentially performative vessels where the audience's expectations of liquid flow were inverted. It is perhaps worth noting that these are described as *kraters,* further indicating a sympotic context, as opposed to the *spondeia* and *phialai* that make up the category of the 'wondrous'.

It is this third subcategory of objects that is of interest to us here. They are distinguished by their specifically religious context of use and by the fact that the effect of the items is miraculous rather than merely playful. The objects are often prefaced with a short sentence describing only the effect of the object, without any clue as to the technology behind the miracle. Without the rest of the explanation, it is likely that modern scholars would have deemed these objects impossible or fanciful which is why the treatises are so useful to us. At the same time, we must not allow the sometimes

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[8] Hero *Pneum.* I.I; II.XVII, II.XVIII, I.XXXIV and II.XXII-XIV Schmidt (=Woodcroft 1, 56, 57, 33 and 71-73 respectively). Cf. Ph.Byz. *Pneum.* 20 (eternal lamp) 64 and 65 (raising water from wells). Even in the case of the lamps, however, one wonders how much is intended for utility and how much would in actual fact qualify as a wonder, enabling the light to burn perpetually. Eternal fires were of course desirable features of temples, the most notable example being the eternal fire at Delphi.
[9] The term is used explicitly in Hero *Pneum.* I.VIII (= Woodcroft 8).
[10] Ath. 1.19e; D.Chr. 8.9.

overbearing mechanical explanations to detract from what would have been seen as truly miraculous by its ancient viewers.

There are a few items which fit into the category of the wondrous which have been excluded from the present collection on temple miracles. These miniature displays are closer to the *staton automaton* described in Hero's *On Automata Making* than anything else. They include, for example, a small model of Heracles shooting a dragon which then hisses (instigated by the viewer lifting the golden apple of Hesperides); an animal automaton whose head continues attached to its body after a knife has entered the neck at one side, passed completely through it and out at the other (the animal drinks immediately after the operation); and a statuette of a servant which intermittently pours water when a cup is placed in her left hand.[11]

Although the movements of these dioramas (which rely on rather complex chain reactions) would probably be considered *thaumata*, and the little display as a whole a *thauma*, it is not certain that the objects would have been viewed through a religious lens. This suspicion arises essentially from the fact that the display would have been initiated by human contact that lacked any ritual significance. The religiosity of objects resides at least in part in the human interaction with said objects. Rosary beads, to take a modern Catholic example, have a different religious significance to a regular beaded necklace. As ritual objects, rosary beads allow an entry point for divine communication which regular beads do not. Despite the apparent physical resemblance between the objects, the rosary chain takes on a religious importance facilitated through a ritualised engagement – a combination of touch (the worshipper's fingers passing along the chain) and sound (the recitation of the prayer). Similarly, there is a subtle difference between the heat of burning a

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[11] Hero, *Pneum.* I.XLI and II.XXXVII (= Woodcroft 40 and78) and Ph.Byz. *Pneum.* 30 respectively.

sacrifice or the touching of a purifying bronze wheel acting as the stimulus for a miracle, and an individual lifting up an apple to instigate a series of chain reactions.

T1: Rotating Wheels in Temples

Pseudo-Aristotle, *Mechanica,* 848a.19-37.

διὰ δὲ τὸ τὰς ἐναντίας κινήσεις ἅμα κινεῖσθαι τὸν κύκλον, καὶ τὸ μὲν ἕτερον τῆς διαμέτρου τῶν ἄκρων, ἐφ' οὗ τὸ Α, εἰς τοὔμπροσθεν κινεῖσθαι, θάτερον δέ, ἐφ' οὗ τὸ Β, εἰς τοὔπισθεν, κατασκευάζουσί τινες ὥστ' ἀπὸ μιᾶς κινήσεως πολλοὺς ὑπεναντίους ἅμα κινεῖσθαι κύκλους, ὥσπερ οὓς ἀνατιθέασιν ἐν τοῖς ἱεροῖς ποιήσαντες τροχίσκους χαλκοῦς τε καὶ σιδηροῦς. εἰ γὰρ εἴη τοῦ ΑΒ κύκλου ἁπτόμενος ἕτερος κύκλος ἐφ' οὗ ΓΔ, τοῦ κύκλου τοῦ ἐφ' οὗ ΑΒ κινουμένης τῆς διαμέτρου εἰς τοὔμπροσθεν, κινηθήσεται ἡ ΓΔ εἰς τοὔπισθεν τοῦ κύκλου τοῦ ἐφ' οὗ Α, κινουμένης τῆς διαμέτρου περὶ τὸ αὐτό. εἰς τοὐναντίον ἄρα κινηθήσεται ὁ ἐφ' οὗ ΓΔ κύκλος τῷ ἐφ' οὗ τὸ ΑΒ· καὶ πάλιν αὐτὸς τὸν ἐφεξῆς, ἐφ' οὗ ΕΖ, εἰς τοὐναντίον αὐτῷ κινήσει διὰ τὴν αὐτὴν αἰτίαν. τὸν αὐτὸν δὲ τρόπον κἂν πλείους ὦσι, τοῦτο ποιήσουσιν ἑνὸς μόνου κινηθέντος. ταύτην οὖν λαβόντες ὑπάρχουσαν ἐν τῷ κύκλῳ τὴν φύσιν οἱ δημιουργοὶ κατασκευάζουσιν ὄργανον κρύπτοντες τὴν ἀρχήν, ὅπως ᾖ τοῦ μηχανήματος φανερὸν μόνον τὸ θαυμαστόν, τὸ δ' αἴτιον ἄδηλον.
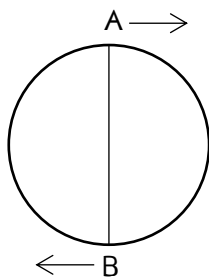
Figure 2: Single rotating wheel
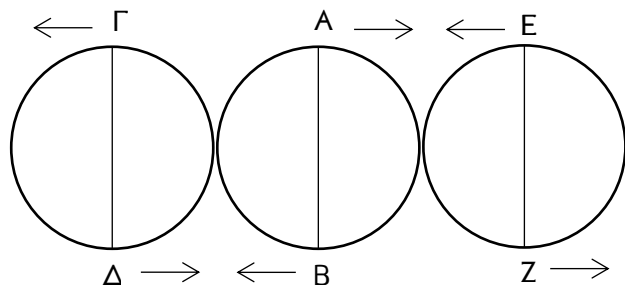
Figure 1: Mulitple rotating wheels

Because of the fact that opposed motions simultaneously put the circle in motion i.e. one end of the diameter A moving forwards and the other end B moving backwards (fig. 1), some have set up a construction so that from one movement, many circles move in opposite directions at the same time, just like they dedicate in temples, having made the little wheels out of bronze

and steel. For if circle AB were to touch circle ΓΔ, when the diameter of AB is moved forward, the diameter of ΓΔ will move backwards, so long as the diameter is moved on itself.[1] Consequently the circle AB is moved in opposition to ΓΔ and the same circle again will move the adjacent circle EZ in the opposite direction to itself due to the same principle (fig. 2). In the same way, if there were more [circles], they would all do this for the same reason. Taking this underlying nature of the circle, then, craftsmen construct a machine concealing the principle so that only the marvel of the mechanical device is visible, while the cause is unknown.

T1 Commentary

The *Mechanica* attributed to Aristotle is our earliest extant work on mechanics.[2] Though the doubt surrounding the Aristotelian corpus in general makes the treatise difficult to date with any precision, Andrew Wilson estimates that it was probably composed between 280 and 260 BC.[3] The treatise as a whole is dedicated to mechanically and geometrically explaining 'problems' or contradictions manifest in every-day life. Very few of these are purely theoretical problems; the majority in fact use very practical examples to explain mechanical systems (such as gear trains, windlasses, levers and slings) and even tiptoe around issues surrounding more complex physical principles (such as inertia, friction and centre of gravity): Why is a moving object easier to move than an object at rest? Why do objects that have been thrown eventually stop? How do pulleys pull great weights? Why is it that the longer a board is, the weaker it gets? At the same time, certain problems are hardly mechanical by our definition of the term but are still included in the treatise: Why are pebbles at the seashore rounded? Why is it necessary in order to stand up to first make an acute angle between calf and thigh, and between thigh and torso? The breadth of problems described in the treatise vividly

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[1] I.e. it does not roll forwards, but rather pivots around its centre point.
[2] I do not wish to enter into the debate on who is the true author of the text as it matters little to the topic at hand. On the issue see Winter 2007 with further references.
[3] Wilson 2008, 338.

demonstrate how far the power of *technē* extended in the ancient Greek mind, and the potential it

had to elucidate a variety of every-day complications – elucidate and subsequently, in most cases at

least, alleviate. This could be as simple as helping someone understand how to more effectively lift,

transport or break an object, or in other cases addresses problems related to the more

consequential activities of sailing or military affairs. Through this treatise, then, we get the picture of

the technician as someone with the capacity to access a vast field of knowledge and apply it where

he saw fit. In this sense, the mechanic for pseudo-Aristotle has (or is intentionally given, perhaps) a

role beyond the theoretical in a variety of areas, from mercantile and medical to the natural world

and the quotidian.[4] As the excerpt at hand makes clear, the mechanic's privileged knowledge and

practical skills were put to use to construct the seemingly inexplicable harnessed for religious effect.

As we have already noted, the introduction of the *Mechanica* invokes the vocabulary of *thauma*

many times most notably in its opening line.[5] The reference to rotating wheels in temples comes

from the end of the introduction. It is tied up within the author's initial proposition that the answer

to a lot of the marvellous 'problems' set out in the treatise are resolved by understanding the

geometry of the circle.[6] To make sense of this statement, we must first appreciate that ancient

geometry was kinetic, not static. Thus, 'a line is the sweep of a moving point; a plane is the sweep of

a line; a circle is the sweep of a line when one end is fixed; a solid is the sweep of plane.'[7] Even

through this simple insight into ancient conceptions of geometry we can see the way in which

movement was already tied into how the ancient conceived of shapes. Mechanics of automation

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[4] Using the numbering offered by Winter the problems can be divided up in the following categories, defined
by the topic they treat:
Mercantile: 1-2, 20; Nautical: 4-7, 13; Military: 12; Nature: 15, 30, 35; Medical: 21; Quotidian: 22 (nutcracker),
25 (construction of a bed), 28 (shadoofs); Theoretical: 23-24. The vast majority, however, are mere
observations relating size, shape and instrument to ease of action: 3, 8-11, 14, 16-19, 21, 26-27, 29, 31-34.
[5] See above *Chapter 2/ Inventing Automation*.
[6] The circle is for the author 'the first principle of all marvels' (οὐδὲν ἄτοπον τὸ πάντων εἶναι τῶν
θαυμάτων αὐτὸν ἀρχήν). Arist. *Mech.* 848a10-11
[7] Winter 2007, 2.

enabled this notion of kinetic geometry to become manifest very vividly before the eyes of the spectator. When it was put together in a way that caused a *trompe l'oeil*, it became a marvel.

The *Mechanica* is explicit in the location, material and use of the self-rotating wheels. These were dedications offered in temples made of bronze and steel. Yet the precise ritual they were involved in; the deity they were dedicated to; or the reason behind their rotation remains a mystery. One is, of course, inclined to think of the bronze wheels used in the automated pieces in the pneumatic treatises (**T6** and **T8.b-c**). If there is any parallel to be seen between the objects, we can perhaps offer some comparable use in purification rituals for the temple wheels described in the *Mechanica*. Leaving these uncertainties aside, what is clearly mentioned by the author is the fact that these wheels are considered marvellous for the way in which the source of animation of the subsequent wheels is unidentifiable, and that the wheels move alternately in opposite directions. The *thauma* is visible, the *aition* or *archē* unknown. In fact, it is specifically the *demiourgos* who hides the *archē*. The pre-Socratic language used by the author here is fairly striking. Determining exactly what constituted the *archē* of life was, of course, contested among these early philosophers and puts mechanical texts in an active intellectual discourse with philosophical thinkers. Of course as a mechanical treatise, the text makes a point of elevating the mechanic to a privileged position as someone who understands the *archē* of seemingly miraculous movement. Herein lies a distinction between mechanic and spectator. Caring little for explanations since 'only the marvel of the mechanical device is visible' (τοῦ μηχανήματος φανερὸν μόνον τὸ θαυμαστόν),[8] the spectator is left to revel in the manifest presence of the divine force within the temple.

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[8] Arist. *Mech.* 848a.19-37.

T2: Figurines which Pour Libations on an Altar

a. Hero, *Pneum*atics, I.XII Schmidt = Woodcroft 11.

Ἐπί τινων βωμῶν πυρὸς θυμιαθέντος τὰ παρακείμενα ζῴδια σπένδειν· κατασκευάζεται δὲ οὕτως.

Ἔστω βάσις, ἐφ' ἧς ἔστηκε τὰ ζῴδια, ἡ ΑΒΓΔ, ἐφ'ἧς ἐφεστάτω βωμὸς ὁ ΕΖ στεγνὸς πανταχόθεν· καὶ αὐτὴ δὲ ἡ βάσις στεγνὴ ἔστω συντετρημένη τῷ βωμῷ κατὰ τὸ Η· διὰ δὲ τῆς βάσεως σωλὴν διώσθω ὁ ΘΚΛ ἀπέχων μὲν ἀπὸ τοῦ πυθμένος τῆς βάσεως βραχὺ κατὰ τὸ Λ, συντετρημένος δὲ τῷ φιαλίῳ, ὃ κατέχει τὸ ζῴδιον κατὰ τὸ Θ· ἐγκεχύσθω δὲ εἰς τὴν βάσιν διά τινος τρυπήματος τοῦ Μ ὑγρόν, ὃ μετὰ τὴν ἔγχυσιν ἀπεστεγνώσθω. ἐὰν οὖν ἐπὶ τοῦ ΕΖΗ βωμοῦ πῦρ ἀνακαυθῇ, συμβήσεται τὸν ἐντὸς ἀέρα λεπτυνόμενον οἴχεσθαι εἰς τὴν βάσιν καὶ ἐκθλίβειν τὸ ἐν αὐτῇ ὑγρόν· τοῦτο δὲ μὴ ἔχον ἄλλην ἀντιπερίστασιν χωρήσει διὰ τοῦ ΘΚΛ σωλῆνος εἰς τὸ φιαλίδιον. καὶ οὕτως τὸ ζῴδιον σπείσει καὶ ἐπὶ τοσοῦτον, ἐφ' ὅσον καὶ τὸ πῦρ ἐπίκειται· σβεσθέντος δὲ τοῦ πυρὸς πάλιν παύεται σπένδον. καὶ τοῦτο ἔσται, ὁσάκις ἂν τὸ πῦρ ἀνακαίηται.

Ἔστω δὲ ὁ σωλήν, δι' οὗ ἡ θερμασία μέλλει εἰσέρχεσθαι, εὐρύτερος κατὰ τὸ μέσον· ἀναγκαῖον γὰρ τὴν θερμασίαν ἢ μᾶλλον τὸν ἀπὸ ταύτης ἀτμὸν εἰς εὐρυτέραν χωρισθέντα χώραν πλείονα γίγνεσθαι καὶ πλεῖον δύνασθαι ἐνεργεῖν.
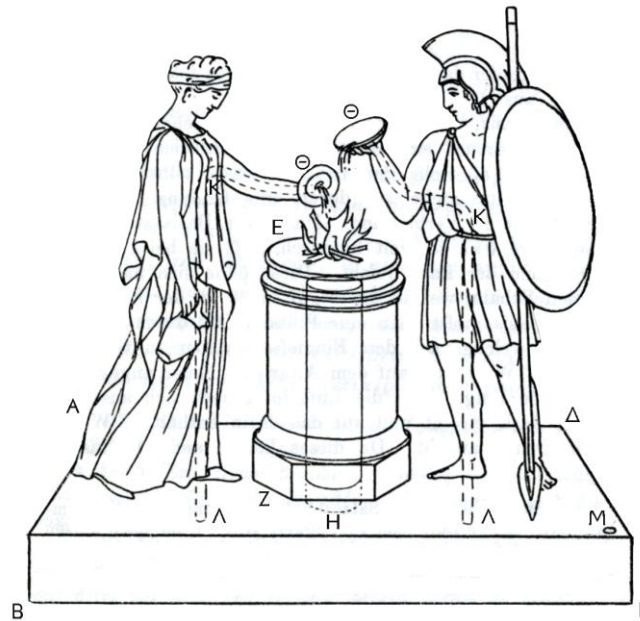
*Figure 3: **T2.α** Figurines pour libations on an altar*

After a fire has been set alight upon some altars, figurines at its side pour a libation. It is constructed as follows:

Let there be a pedestal ΑΒΓΔ upon which the figurines stand, and on which the altar ΕΖ also stands, completely watertight. Let the pedestal too be watertight and connected to the altar at Η. Insert a pipe ΘΚΛ through the pedestal at a small remove from the base of the pedestal down to Λ, and running all the way up to a little *phialē* which the figurine holds at Θ. Pour liquid into the pedestal through some hole Μ, which is to be sealed after the pouring. Now if on the altar ΕΖΗ a fire should be kindled, it will result that the rarefied air inside will go into the pedestal and will force out the liquid it contains which, compressed with nowhere else to go, will be forced through the pipe ΘΚΛ to the *phialē*. Thus the figurine will pour a libation and will continue for as long as the fire burns. When the fire is extinguished, then the libation will in turn stop, and as many times as the fire is kindled, the same will happen. Let the pipe through which the heat is going to pass be broader in the middle for it is necessary that the heat, or rather the steam, passing into a broader space be larger and act with greater force.

b. Hero, *Pneum*atics, II.XXI Schmidt = Woodcroft 60.

Βωμοῦ ἀναπτομένου τὰ μὲν παριδρυμένα ζῴδια σπένδειν, τὸν δὲ δράκοντα συρίζειν. Ἔστω τις βάσις κοίλη ἡ ΑΒ, ἐφ᾽ ἧς βωμὸς ὁ Γ ἔχων αὐλὸν μέσον ἐπὶ τὴν βάσιν καθιέμενον ἀπὸ τοῦ ἐπιπύρου τὸν ΔΕ, ὃς εἰς τρεῖς ἐσχίσθω σωλῆνας τὸν μὲν ΕΖ ἐπὶ τὸ στόμα τοῦ δράκοντος φέροντα, τὸν δὲ ΕΗΘ ἐπὶ οἰνοδόχον ἀγγεῖον τὸ ΚΛ, οὗ ὁ πυθμὴν ἀνωτέρω ἔστω τοῦ Μ ζῳδίου, προσηνωμένον τῷ ἐπιφράγματι τοῦ ΚΛ ἀγγείου χαρακοειδῶς· ἕτερος δὲ ὁ ΕΝΞ καὶ αὐτὸς ὁμοίως ἀνηκέτω εἰς ἕτερον οἰνοδόχον ἀγγεῖον τὸ ΟΠ καὶ αὐτὸς χαρακοειδῶς· συνεστεγνώσθωσαν δὲ καὶ ἀμφότεροι τοῖς πυθμέσι τῶν ἀγγείων. ἔστωσαν δὲ ἐν ἑκατέρῳ τῶν οἰνοδόχων <ἀγγείων> καμπύλοι σίφωνες ὅ τε ΡΣ καὶ ὁ ΤΥ, ὧν αἱ μὲν ἀρχαὶ ἔστωσαν ἐν τῷ οἴνῳ, τὰ δὲ τέλη διήκοντα πνικτῶς διὰ τοῦ περιφράγματος τῶν οἰνοδοχείων, καθ᾽ ὧν δεῖ γίνεσθαι τὰς σπενδούσας χεῖρας τῶν ζῳδίων. ὅταν οὖν μέλλῃς ἐξάπτειν, προεμβάλλων τοῖς σωλῆσιν ὑδάτιον βραχύ, ὥστε μὴ διαρραγῆναι τοὺς σωλῆνας ὑπὸ ξηροῦ τοῦ πυρός, ἀπόφραξον ἅπαντα, ὡς μὴ διαπνέειν. τὸ δὲ τοῦ πυρὸς πνεῦμα ἐγκαταμιγὲν τῷ ὕδατι διὰ τῶν σωλήνων ἀνελεύσεται ἐπὶ τοὺς χάρακας καὶ δι᾽ αὐτῶν θλῖψαν τὸν οἶνον ἀνοίσει ἐπὶ τοὺς καμπύλους σίφωνας τόν τε ΡΣ καὶ τὸν ΤΥ, ὥστε διὰ τῶν χειρῶν τῶν ζῳδίων ῥέοντα σπένδειν, ἐφ᾽ ὅσον ὁ βωμὸς καίεται ὁ δὲ ἕτερος σωλὴν τὸ πνεῦμα ἀνενεγκὼν ἐπὶ τὸ στόμιον τοῦ δράκοντος συρίζειν ποιήσει τὸν δράκοντα.
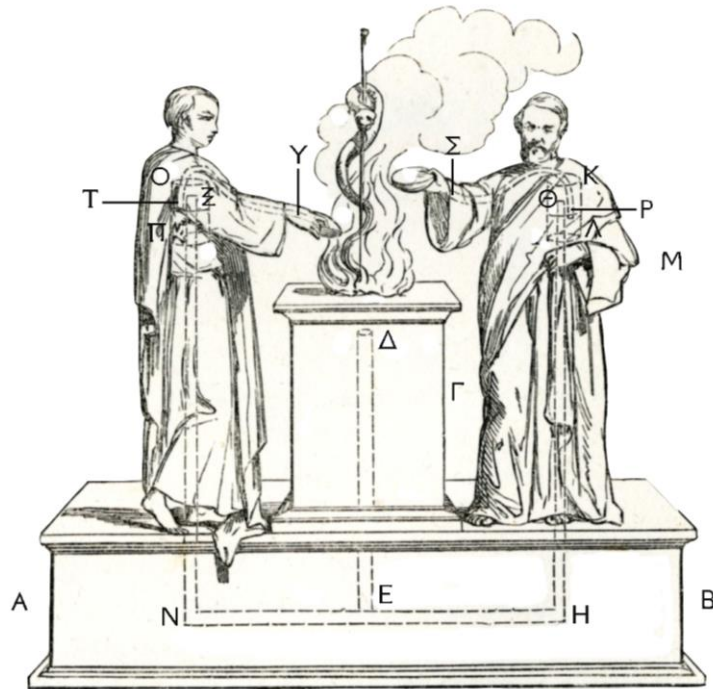
*Figure 4: **T2.b** Figurines pour a libation and a serpent hisses*

When a fire is kindled on an altar, figurines set up beside will pour a libation, and a serpent will hiss.

Let AB be some hollow pedestal upon which stands an altar Γ which has a pipe ΔE down the middle reaching from the hearth towards the pedestal. Let ΔE be divided into three tubes: EZ leading to the mouth of the serpent; EHΘ to a wine vessel KΛ the bottom of which must be higher than the figurine M and joined like a prop to the lid of the vessel KΛ; let the other tube ENƵ be joined in the same way to another wine vessel OΠ, also like a prop. Let both be soldered to the bottom of the vessels. In each of the wine vessels let there be a bent siphon, PΣ and TY, with one tip in the wine and the other extending, air-tight, through the sides of the wine vessel where there must be the hand of the figurine pouring the libation. Whenever you are about to light the fire, first pour a little water into the tubes so that they might not be broken by the heat of the fire, and block up everything so that no air passes through. The air

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of the fire, after mixing with the water, will ascend through the pipe towards the props and through them it will compress the wine and carry it to the bent siphons PΣ and ΤΥ. This results in the liquid that flows through the hands of the figurines pouring a libation as long as the [fire on the] altar is burning. The other tube, carrying the air up to the mouth of the serpent will make the serpent hiss.

T2 Commentary

The first two pneumatic automata (**T2.a-b**) are comprised of displays set into action through the heat of a fire kindled on an altar by a worshipper. Both items have figurines which then pour libations on the altar and **T2.b** has the additional hiss of a serpent included in the display.

The religious context for these two items is evident: the altars on which the displays reside are specifically mentioned, and the figurines are holding libation cups (*phialai*) from which wine is poured as an offering to a god. In a meta-ritualistic moment prompted by the worshiper kindling a fire on the altar, the figurines themselves engage in a ritual action which constitutes a vital aspect of Greek religious ritual, both in the public and private spheres.[1] We must remember that the libation was most likely accompanied by prayer, invocation or supplication by the worshipper and thus that the item here formed part of a more complete, pan-sensorial ritual of divine communication.

In both items, the figurines are referred to generally as *zōdia*. They are not specifically characterised as figures from myth nor, it seems, is there any imperative that they be representative of worshippers. Instead, the point that is worth drawing out here is that the aesthetics are malleable so as to be able to give the one mechanic set-up a variety of 'faces'. The same approach to design and

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[1] On the significance of libation in Greek religion see Burkert 1985, 70-73.

construction is seen in *On Automata Making.*[2] The exception to this, of course, is the serpent specified in **T2.b**. From this we see that sometimes it is in fact practicalities rather than symbolism that dictate the aesthetics of the machine, in this case the hissing sound being reminiscent of the serpent. This was surely relevant to our larger processional pieces too, and adds weight to the hypothesis that Demetrius' snail (**P1**) was chosen above all for practical reasons as a characteristically slow animal with a large shell in which to hide the mechanics.

Hero specifies that the display will work as many times as the fire is kindled. In this respect, we are in different territory to processional automata. Rather than a divine presence linked to a religious occasion such as the festival, here the divine presence is linked to religious space (the temple). While it is crucial that processional automata and the miraculous springs discussed in the previous chapter be tied to an occasion, it is precisely the constant presence of the god at the altar which allows the miracle to be re-performed.

The last point to note is the preoccupation with the smoothness of the display indicating, as with *On Automata Making,* that it is imperative that the viewer subscribe to the miracle so that no scepticism be aroused in the viewer.[3] A miracle which, in this case, this is brought about by seamless pneumatic technology.

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[2] Hero, *Aut.* 2.12; 21.2; 30.7.
[3] Hero, *Aut.* 4.4-5.

T3: Figurines Dance on an Altar

Hero, *Pneum*atics, II.III Schmidt = Woodcroft 70.

Ἐπί τινος βωμοῦ πυρὸς ἀνακαυθέντος ζῴδια καταφανήσεται χορεύοντα· οἱ γὰρ βωμοὶ διαφανεῖς, ἤτοι ὑάλινοι ἢ κεράτινοι, ἔσονται. Διὰ τοῦ ἐπιπύρου καθίεται σωλὴν πρὸς μὲν τὴν βάσιν τοῦ βωμοῦ ἐν κνώδακι στρεφόμενος, πρὸς δὲ τὸ ἄνω μέρος συριγγίῳ συμφυεῖ ὄντι τῷ ἐπιπύρῳ. ἐχέτω δὲ καὶ ἐπικεκαμμένα σωληνάρια ὁ σωλὴν συντετρημένα καὶ συμφυῆ ἑαυτῷ κατὰ διάμετρον κείμενα ἀλλήλοις καὶ τὰς <καμπὰς> καὶ ἐναλλὰξ ἔχοντα. ἐχέτω δὲ ὁ σωλὴν καὶ τύμπανον συμφυές, ᾧ ἐπίκειται τὰ χορεύοντα ζῴδια. ἐξαφθείσης οὖν τῆς θυσίας θερμαινόμενος ὁ ἀὴρ διὰ τοῦ συριγγίου χωρήσει εἰς τὸν σωλῆνα, ἐκ δὲ τούτου διὰ τῶν ἀνακεκαμμένων <σωληναρίων> ἐξωθούμενος καὶ ἀντερείδων τῷ τεύχει τοῦ βωμοῦ ἐπιστρέψει τὸν σωλῆνα καὶ τὰ χορεύοντα ζῴδια.
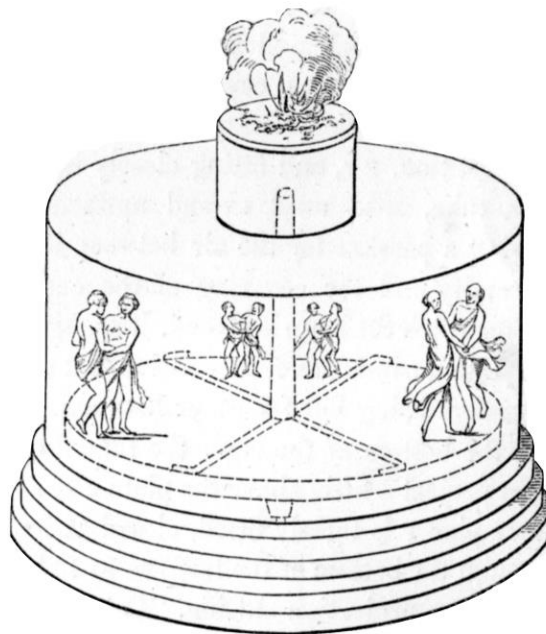
*Figure 5: **T3** Figurines dance on an altar*

After a fire has been set alight upon some altar, figurines will be seen dancing. The altars will be transparent, either of glass or horn. Through the hearth of the altar, let a pipe, rotating on a pivot extend downwards towards the base and at the top, be connected to a smaller tube

connected to the hearth. Additionally, let smaller tubes be attached to the pipe communicating with it and placed at right angles to each other, bent in alternating directions. Let there be a drum, on which the dancing figures are placed, also fastened to the pipe. Then, when the sacrifice is kindled, the heated air will go through the little tube into the pipe and be forced out of this into the small tubes. And exerting pressure on the casing of the altar, it will cause the pipe and the dancing figurines to revolve.

T3 Commentary

Similarly to **T2.a-b**, the source of energy for this object comes from the heat of a fire being kindled upon an altar: an essentially ritual action. Instead of pouring a libation, these figurines will be seen to dance, an act which we must also recognise as cultic activity.[1] As with pieces **T2.a-b** although the context of display is clearly religious, it is unfortunately difficult to say with any more precision where these objects would have resided. Perhaps we are to imagine them on display as sanctuary 'wonders' inside a temple, offered to the gods as a dedication.

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[1] On this, but in the context of music, see **T11**.

T4: Drinking Figurines

a. Hero, *Pneumatics*, I.XXIX Schmidt = Woodcroft 28.

Κατασκευάζεται δὲ ἔν τινι τόπῳ ὕδωρ ἐπίρρυτον ἔχοντι ζῷον εἴτε χαλκοῦν εἴτε ἐξ ἄλλης τινὸς ὕλης προσενεχθέντος δὲ αὐτῷ ποτηρίου πίνει μετὰ ψόφου καὶ βοῆς, ὥστε φαντασίαν ποιεῖν δίψης·ἔστι δὲ ἡ κατασκευὴ τοιαύτη.

Ἔστω τι ἀγγεῖον τὸ ΑΒ, ἐν ᾧ ἐπίρρυτόν ἐστι κρουνισμάτιον τὸ Γ·ἐν δὲ τῷ ΑΒ ἀγγείῳ καμπύλος σίφων ἔστω ἢ πνικτὸς διαβήτης ὁ ΔΕΖ, οὗ τὸ ἕτερον σκέλος ἐκτὸς ὑπερεχέτω τοῦ πυθμένος τοῦ ἀγγείου. ὑποκείσθω δὲ τούτῳ βάσις στεγνὴ ἡ ΗΘΚΛ ἔχουσα καὶ αὐτὴ ὁμοίως καμπύλον σίφωνα τὸν ΜΝΞ ὑποκείσθω δὲ τῷ Ζ στομίῳ χώνη ἡ ΟΠ, ἧς ὁ καυλὸς φερέτω εἰς τὴν ΗΘΚΛ βάσιν ἀπέχων ἀπὸ τοῦ πυθμένος ὅσον ὕδατι διάρρυσιν. τὸ δὲ τοῦ ζῳδίου στόμιον ἔστω πρὸς τῷ Ρ, δι' οὗ σωλὴν κείσθω φέρων δι' ἑνὸς τῶν ποδῶν ἢ δι' ἄλλου τινὸς μέρους τοῦ ζῳδίου κρυπτῶς εἰς τὴν βάσιν· ἔστω δὲ οὗτος ὁ ΡΣΤ. συμβήσεται οὖν πληρωθέντος τοῦ ΑΒ ἀγγείου ὑπερβλύσαν τὸ ὑγρὸν ἐνεχθῆναι εἰς τὴν ΠΟ χώνην καὶ πληρῶσαι μὲν τὴν ΗΘΚΛ βάσιν, κενῶσαι δὲ τὸ ΑΒ ἀγγεῖον. πάλιν δὴ πληρωθείσης τῆς βάσεως ὑπερβλύσαν τὸ ὕδωρ διὰ τοῦ ΜΝΞ σίφωνος κενώσει τὴν βάσιν, ἧς κενουμένης ὁ ἀὴρ διὰ τοῦ Ρ στομίου ἀναπληρώσει τὸν κενούμενον τόπον. ὅταν ἄρα προσενέγκωμεν τῷ Ρ τὸ ποτήριον, πίεται μετὰ βίας ἐπισπώμενον ἀντὶ τοῦ ἀέρος τὸ ὑγρόν, ἄχρις ἂν ἡ βάσις κενωθῇ ἐντός. οὕτω δὲ πάλιν τοῦ ΑΒ ἀγγείου πληρωθέντος κενοῦται, καὶ ταὐτὰ ἔσται τοῖς εἰρημένοις. ἵν' οὖν κατὰ τὸν δέοντα καιρόν, τουτέστι κενουμένης τῆς βάσεως, προσφέρηται τὸ ποτήριον, ἔστω διὰ τῆς ἐκρύσεως τῆς διὰ τοῦ ΜΝΞ διαβήτου κινούμενόν τι ἐπιπίπτοντος τοῦ ὕδατος αὐτῷ, ἐν ᾧ ἀποβλέποντες ὅταν κινῆται προσοίσομεν τὸ ποτήριον.
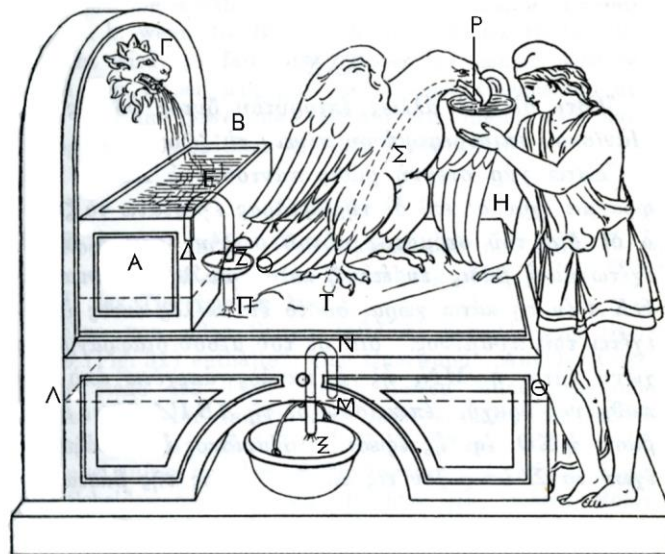
*Figure 6: **T4.a** Figure drinks thanks to running water*

In any place provided with running water, let a figurine be fashioned out of either bronze or some other material. When a drinking cup is presented to it, the animal drinks with a noise and a cry in order to give the appearance of thirst. The construction is as follows:

Let there be some vessel AB in which there is a flowing spout Γ. In the vessel AB let there be a bent siphon or an airtight *diabētēs* ΔEZ which has one leg that extends outside the bottom of the vessel.[1] Let there be an airtight pedestal HΘKΛ underneath this vessel which also has a bent siphon MNΞ. Under the opening Z let there be a funnel OΠ, the stem of which reaches towards the pedestal HΘKΛ, raised away from the bottom just far enough to leave a passage for water. Let the mouth of the figurine be at P, from which a pipe runs concealed, leading through one of the feet or through some other part of the figurine into the pedestal. Let this

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[1] I have chosen to leave the word *diabētēs* untranslated. According to the textual evidence, the *diabētēs* was an instrument which was roughly (but apparently not exactly) equated to a curved siphon (*kampylos siphōn*). **T4.a** and **T5.d** use the two terms somewhat interchangeably, while other items specify one or the other instrument. The *diabētēs* probably got its name from having its two ends outstretched in a U-shape, similar to a compass. Perhaps the difference between the *diabētēs* and the *kampylos siphōn* lay in the exact distance of separation between the legs, or the proportion between the length of the legs, with the *diabētēs* having slightly more even legs.

pipe be ΡΣΤ. It happens, then, that when the vessel ΑΒ is filled, the overflowing liquid will be carried into the funnel ΟΠ, filling the pedestal ΗΘΚΛ, and emptying the vessel ΑΒ. Similarly, when the pedestal has been filled, the liquid overflows through the siphon ΜΝΞ and empties the pedestal. As it empties, the air draws in through the mouth Ρ filling the void [that was left]. Whenever we present the drinking cup at Ρ, the liquid being sucked up vigorously will be drunk up in place of the air so long as the pedestal a vacuum is created within it. Thus the vessel ΑΒ is again filled and emptied, and this will happen as I have described. In order that the cup be presented at exactly the right time, that is to say when the pedestal is being emptied, let something move when struck by the discharge of water from the *diabētēs* ΜΝΞ. Paying attention, we will present the drinking cup whenever this moves.

b. Hero, *Pneumatics,* I.XXX Schmidt = Woodcroft 29.

Ἔστι δὲ καὶ ἄλλως ἐπιρρύτου ὄντος ὕδατος τοῦ Πανίσκου ἐπιστρεφομένου πίνειν τὸ ζῷον.

Ἔστω γὰρ στεγνὴ βάσις πάντοθεν ἡ ΑΒΓΔ διάφραγμα ἔχουσα· ἐπὶ δὲ τῆς ἐφέδρας ἐφεστάτω τὸ ζῷον· ὁ δὲ διὰ τοῦ στόματος αὐτοῦ σωλὴν ἔστω ὁ ΕΖΗ. ἐχέτω δὲ ἡ βάσις ἐν ἑαυτῇ καὶ καμπύλον σίφωνα τὸν ΘΚΛ ἐν τῇ κάτω χώρᾳ, οὗ τὸ ἓν σκέλος ἐκτὸς ὑπερεχέτω τοῦ πυθμένος. διὰ δὲ τοῦ μέσου διαφράγματος χώνη ἔστω ἡ ΜΝ, ἧς ὁ καυλὸς ἀπεχέτω ἀπὸ τοῦ πυθμένος βραχύ. ἐπικείσθω δὲ τῇ ΑΒΓΔ βάσει ἑτέρα βάσις ἡ ΖΟ, ἐφ᾽ ἧς ἐφεστάτω Πανίσκος ὁ ΠΡ ἀξόνιον ἔχων τὸ Σ ὑπερέχον εἰς τὸ ἄνω μέρος τῆς βάσεως, ᾧ συμφυὴς ἔστω σωλὴν ὁ ΤΥ ἔχων ἐκ τοῦ ἄκρου φιάλιον συμφυὲς καὶ συντετρημένον αὐτῷ τὸ ΥΦ· τηλικοῦτος δὲ ἔστω ὁ ΤΥ σωλήν, ὥστε ἐπιστραφέντος τοῦ Πανίσκου τὸ ΥΦ φιάλιον κεῖσθαι κατὰ τὴν ΜΝ χώνην ὑπεράνω βραχύ. κατὰ δὲ τὴν ΜΝ χώνην ἐπὶ τῆς βάσεως ἔστω φιάλιον τὸ ΧΨ συντετρημένον τῇ βάσει, ἐν ᾧ φερέσθω τὸ ἐπίρρυτον ὕδωρ τὸ Ω τοσοῦτον, ὥστε πλέον εἶναι τῆς διὰ τοῦ ΘΚΛ διαβήτου ἀπορρύσεως. ἐνεχθήσεται

ἄρα τὸ προειρημένον ὑγρὸν διὰ τῆς ΜΝ χώνης εἰς τὸ κάτω μέρος τῆς ΑΒΓΔ βάσεως, τοῦ ἐν αὐτῇ ἀέρος χωροῦντος διὰ τοῦ ΕΖΗ σωλῆνος. καὶ ἀεὶ ἔσται πλήρης ἡ βάσις τοῦ ὑγροῦ διὰ τὸ μείζονα εἶναι τὴν ἐπίρρυσιν τῆς ἀπορρύσεως. ὅταν ἄρα ἐπιστρέφωμεν τὸν Πανίσκον, τὸ ΥΦ φιάλιον ὑπὲρ τὴν χώνην γενόμενον δέξεται τὴν Ω ἐπίρρυσιν, ἥτις διὰ τοῦ ΤΥ σωλῆνος εἰς ἕτερον χωρήσει τόπον. μηκέτι οὖν ἐπιρρέοντος τοῦ ὑγροῦ εἰς τὸ κάτω μέρος τῆς ΑΒΓΔ βάσεως, ὁ ΘΚΛ διαβήτης κενώσει αὐτήν, τοῦ ἀέρος εἰσπίπτοντος διὰ τοῦ ΕΖΗ σωλῆνος, ὥστε προσενεχθέντος τοῦ ποτηρίου πάλιν πίεται τὸ ζῷον.
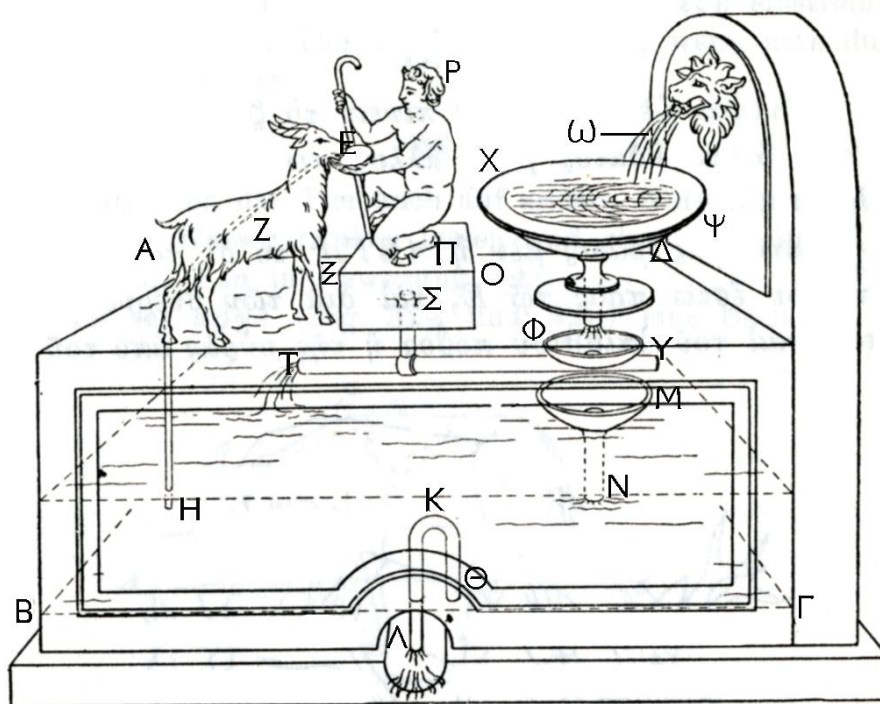
Figure 7: **T4.b** *A little Pan offers a figurine a drink*

There is also another way that the figurine will drink, with running water and the revolution of a little Pan.

Let there be a pedestal ΑΒΓΔ airtight on all sides and with a partition. Set the figurine on the surface and let the pipe ΕΖΗ pass through its mouth. Let the pedestal have a bent siphon ΘΚΛ within the lower partition, with the lower leg extending outside the base. Let a funnel

MN pass through the middle of the partition, its stem reaching a short way from the bottom. Upon the pedestal ΑΒΓΔ let another pedestal ΞΟ be placed upon which the little Pan ΠΡ stands attached to the axle Σ which extends down into the pedestal. To Σ let the pipe ΤΥ be attached having at its tip a drinking cup ΥΦ connected to and opening directly into the tube. Let the tube ΤΥ be of such a size that when the little Pan is rotated, the drinking cup ΥΦ will be in line with the funnel, a short distance above it. Upon the pedestal in line with the funnel MN let there be a drinking cup ΧΨ connected by a passage to the pedestal. Into the drinking cup let a stream of water Ω pour, greater than the discharge through the *diabētēs* ΘΚΛ. The aforementioned liquid will then pass through the funnel MN to the lower part of the pedestal ΑΒΓΔ, the air inside escaping through the pipe ΕΖΗ, and then the pedestal will be full of liquid because the influx is greater than the discharge. Thus whenever the little Pan is rotated, the drinking cup ΥΦ moving over the funnel will intercept the stream Ω, which will pass elsewhere through the tube ΤΥ. The liquid no longer running into the lower partition of the pedestal ΑΒΓΔ, the *diabētēs* ΘΚΛ will empty it, and since air will rush into the pipe ΕΖΗ, the figurine will drink once more when the cup is presented to it.

c.   Hero, *Pneumatics,* I.XXXI Schmidt = Woodcroft 30.

Δύναται δὲ καὶ ἄλλως πίνειν τὸ ζῷον μήτε ἐπιρρύτου ὄντος ὕδατος μήτε ἄλλου τινὸς κινοῦντος τὸν Πανίσκον.

Ἔστω γὰρ βάσις μὲν ἡ ΑΒΓΔ· τὸ δὲ τοῦ ζῳδίου στόμιον ἔστω πρὸς τῷ Ε, καὶ διὰ τῶν στέρνων τοῦ ζῴου καὶ τοῦ ὀπισθίου ποδὸς ἢ τῆς οὐρᾶς ἀπὸ τοῦ Ε στόματος διώσθω σωλὴν ὁ ΕΖΗ φέρων εἰς τὸ ἐντὸς τῆς βάσεως, καὶ τεθείσης ἀκινήτου τῆς βάσεως τετρυπήσθω ὁ ΕΖΗ σωλὴν ὁ διὰ τοῦ ζῴου λεπτῷ καὶ δυσθεωρήτῳ τρυπήματι †τῷ Ε κειμένῳ πρὸς διαβήτην τῷ Η στομίῳ. ἐὰν οὖν τις πληρώσῃ τὸν ΕΖΗ διαβήτην ὕδατος διά τινος μετεώρου σωλῆνος, οὗ τὸ ἄκρον πρόσκειται τῷ† Ε, μενεῖ πλήρης ὕδατος ὁ ΕΖΗ

διαβήτης διὰ τὸ ἐξ ἴσου κεῖσθαι τὰ στόμια αὐτοῦ. ὅταν οὖν προσενέγκωμεν τῷ Ε στομίῳ

τὸ ποτήριον καὶ βαπτισθῇ τι μέρος τοῦ στομίου, συμβήσεται τοῦ ΕΖΗ διαβήτου τὸ πρὸς

τῷ Η κῶλον μεῖζον γενέσθαι. καὶ διὰ τοῦτο ἐπισπάσεται τὸ ὑγρόν· τὸ δὲ ἐπισπώμενον

φέρεται εἰς τὴν ΑΒΓΔ βάσιν. οὐκ ἀνάγκη δὲ τὴν ΑΒΓΔ βάσιν στεγνοῦν ἐπὶ ταύτης τῆς
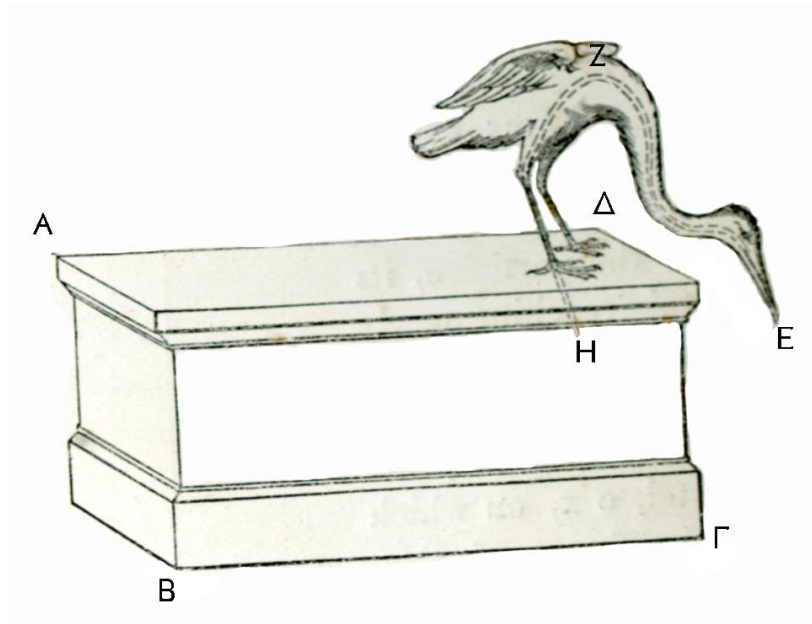
κατασκευῆς.

Figure 8: **T4.c** Simple drinking figurine

The figurine can also drink in another way, without running water or anyone moving the little

Pan.

Let there be a pedestal ΑΒΓΔ and let the mouth of the figurine be at E. From the mouth E let

a tube ΕΖΗ run through the chest of the figurine and through its back leg or tail, leading to the

inside of the pedestal. When the pedestal has been fixed so it cannot move, let the tube ΕΖΗ

which passes through the figurine be pierced through by a fine and scarcely visible hole †in a

line with the extremity H. If, then, someone should fill the siphon ΕΖΗ with water through

some raised pipe, the tip of which is attached to† E, the *diabētēs* ΕΖΗ will remain full of liquid

because the two extremities lie at the same level. Whenever we present a drinking cup to the

mouth E and some portion of the mouth is submerged, it happens that the leg of the *diabētēs* EZH is longer towards H. Because of this the liquid will be drawn up and the drawn-up liquid will be carried into the pedestal. It is not necessary that the pedestal ΑΒΓΔ be airtight in this construction.

d.   Philo of Byzantium, *Pneumatics,* 59.

Construction of a device, a vessel which is placed in temples. It must be close to a spring or running water from a cave or a steep location. One should place it in a temple: it is safer. The water must come out of some orifice or from a crack in the rock; near to which there is a dragon or a deer or some other figure suitable to a temple, or the location in which the device has been placed. This figure is turned towards the flow of water as if it wanted to drink. Opposite it, there is a figurine of either a little Pan or a little Hermes or someone else, arranged as if it were stopping the animal from drinking.[2] The figurine is placed on a mat and can be moved and rotated as one wishes. When you want the dragon to drink, you must rotate the little Pan, then as the water runs down, [the dragon] will drink and inhale with a loud breath and a snort as if it were very thirsty. If you want, you can place an elegant vessel underneath the weak flow of water. The animal will drink all the liquid which runs down, but when the little Pan is turned towards it, the animal will cease drinking, as if it were the figure which stopped it.

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[2] The French, from the Arabic, here is literally: '[a figurine] called in Greek Paniscos or Hermarion' which gives us some idea of translation issues at stake in this text.
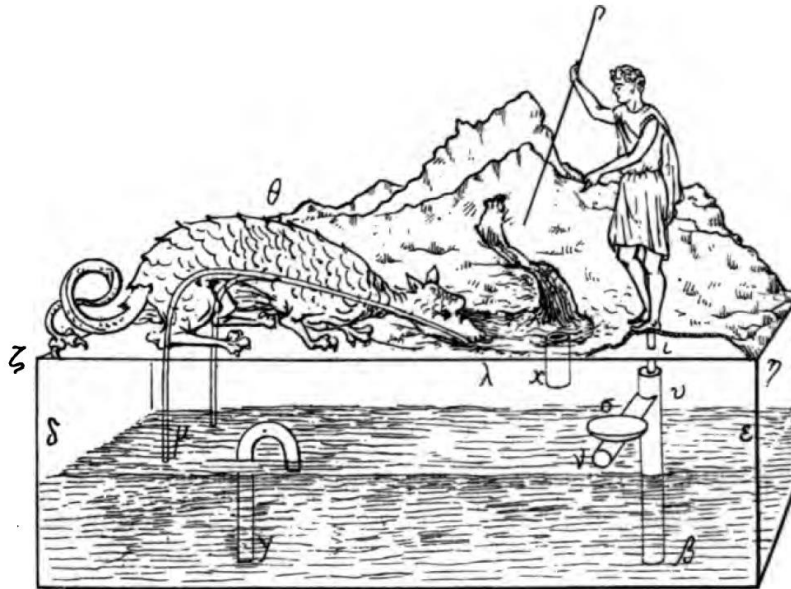
*Figure 9: **T4.d** Figurine drinks and a dragon hisses*

T4 Commentary

The human interaction with these four 'drinking figures' is not entirely straight-forward. The impetus for the self-animation does not result from ritual interaction as is the case for **T2-3** and **T6-8**, but at the same time we are not quite in the territory of the miniature self-moving displays which rely on more obvious chain reactions set in sequence by the human hand, and thus excluded from the present selection.

The access of flowing water is crucial to determining the context of use of **T4,** as well as certain objects of **T5** too. The *andrōn* of private houses did not have a running water source, while temples and other public spaces did.[3] Thus, as **T4.d** makes perfectly clear, these sorts of drinking figures, particularly if they relied on running water, would have been placed in temples.

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[3] Schürmann 1999, 41.

The drinking figurines are some of the most interesting items in terms of what they betray about conceptualising automation and the roles of the spectators and mechanicians respectively. By drinking the water as a 'reaction' to a cup being offered or a figure being rotated, the animal in these displays appears to have a soul or *psychē* of its own. These objects are not merely made to suck up water, but to drink 'as if they were thirsty', as is clearly stated in **T4.a** and **T4.d**. This interest in the figurines appearing to have desires of their own is quite striking and allows us to move beyond thinking of automata as machines which are created to superficially enact movements, but instead to view them as objects built to embody a spirit or soul more completely. In this, we are reminded of the supposedly golden handmaidens in the *Iliad* who help Hephaestus in his workshop and are said to have *nous*.[4] The believability of the *thauma* is of course increased by the drinking figurines being designed with the tubes cleverly concealed as is specified by at various points.

T4.a in particular makes clear that the extra dimension of complexity associated with the spectacle of these figures is that the cup must be presented at the right time for the animal to 'drink'. This brings into discussion the notion of the mechanician's privileged knowledge of the *thauma.* A number of times in his treatise on automata-making Hero similarly makes clear that the mechanic has a special sort of knowledge in his *technē,* and we have seen in **T1** how pseudo-Aristotle, too, makes comparable remarks*.* The complex interaction between the machine and the impetus for display also encourages us to question who would have 'operated' these automata and in what context. Schmidt in his figure imagines the little Pan to be holding a receptacle with liquid so that when it is rotated toward the mouth of the figurine, it is in fact the figurine which makes it drink (fig. 7). Though this is not explicitly mentioned in the Greek, it is still a wonderful thought which adds yet another level of complexity to the relationship between mechanician, viewer and miracle, and captures the flavour of Greek technological miracles very well. Given their use in temple contexts, a

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[4] Hom. *Il.* 18.417-21

priest (or possibly the elusive character of the *thaumatopoios*) could have been the one with the privileged knowledge of when to present the cup to the animal for the miracle to have the most striking effect.[5] It is possible, too, that these drinking figurines alongside the singing birds presented next (**T5**) had the potential to be used as divine signs of approbation or condemnation. This would sit comfortably with the presentation of animation of the inanimate in Greek myth and the imagination.[6] At the very least, the animation of the animals was clearly an indication of a divine presence and shows a point of intersection between religion, technological ingenuity and the miraculous.

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[5] On *thaumatopoioi* see Ath. 1.19e; D.Chr. 8.9 and for minor entertainers in general Milanezi 2004, 183-212.
[6] See above *Chapter 2/ Inventing Automation.*

T5: Singing Birds

a. Hero, *Pneumatics,* I.XV-XVI Schmidt = Woodcroft 14.

Εἰς ἔνια ἀγγεῖα ὕδατος ἐγχυθέντος μελαγκορύφου γίνεται φωνὴ ἢ συριγμός· κατασκευάζεται δὲ οὕτως.

Ἔστω βάσις στεγνὴ ἡ ΑΒΓΔ· καὶ διὰ τῆς στέγης τῆς ΑΔ διώσθω χώνη ἡ ΕΖ, ἧς ὁ καυλὸς ἀπεχέτω τοῦ πυθμένος ὅσον ὕδατι διάρρυσιν καὶ συνεστεγνώσθω τῇ στέγῃ. ἔστω δὲ καὶ συρίγγιον τὸ ΗΘΚ τῶν εἰθισμένων φθέγγεσθαι· συντετρήσθω δὲ τῇ βάσει καὶ συνεστεγνώσθω ὁμοίως τῇ ΑΔ στέγῃ· τὸ δὲ Κ στόμιον αὐτοῦ ἐπικεκάμφθω εἰς ὑδάτιον ἀγγειδίου παρακειμένου τοῦ Λ. συμβήσεται οὖν ἐγχυνομένου τοῦ ὕδατος διὰ τῆς ΕΖ χώνης τὸν ἐν τῇ βάσει ἀέρα ἐκθλιβόμενον χωρεῖν διὰ τοῦ ΗΘΚ συριγγίου καὶ τὸν ἦχον ἀποδιδόναι. ἐὰν μέντοι τοῦ συριγγίου τὸ ἄκρον ἐπικεκαμμένον ᾖ πρὸς τῷ ὕδατι, ἀνακαχλάζων εἴδεται ὁ ἦχος, ὥστε μελαγκορύφου γίγνεσθαι φωνήν· ἐὰν δὲ μὴ παρακέηται τὸ ὑδάτιον, συριγμὸς μόνος ἔσται. Αἱ μὲν οὖν φωναὶ γίνονται διὰ τῶν συρίγγων· διάφοροι δὲ τοῖς ἤχοις γίγνονται, τῶν συρίγγων ἤτοι λεπτοτέρων γινομένων ἤτοι καὶ παρεκτεινομένων εἰς μῆκος ἢ καὶ συστελλομένων καὶ τοῦ βαπτιζομένου μέρους εἰς τὸ ὕδωρ ἤτοι πλείονος ἢ ἐλάττονος γινομένου, ὥστε διὰ τοιούτου τρόπου ὀρνέων πλειόνων διαφόρους γίγνεσθαι φωνάς.
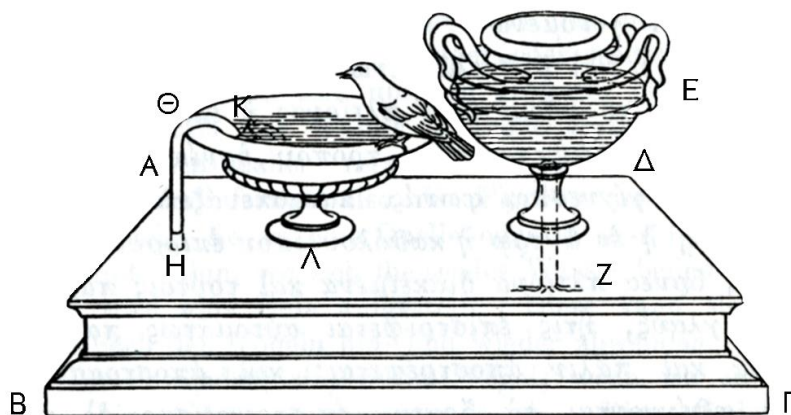
*Figure 10: **T5.a** Simple singing bird*

When liquid is poured into some vessels, the sound of a black-cap warbler or a whistling sound is made. The construction is as follows:

Let ΑΒΓΔ be a watertight pedestal. Through the top ΑΔ let the funnel ΕΖ be inserted. Let the stem be raised from the base just far enough to leave a passage for water and let it be soldered together to the top of the pedestal. Let ΗΘΚ be a little pipe of the sort that is used to make a sound, connecting to the pedestal and similarly soldered together to the top of the pedestal ΑΔ. Bend its mouth Κ into the water of a small vessel lying beside it at Λ. Then, if water is poured in through the funnel ΕΖ it will result that the air in the pedestal, being forced out, passes through the pipe ΗΘΚ and lets out a sound. If the tip of the pipe is bent to the surface of the water a bubbling sound is heard with the result that the note of the black-cap warbler is produced. If no water is nearby, there will only be whistling. These sounds, then, are made through the pipes, but the differences in the sounds are made if the pipes are thinner or wider; longer or shorter; and if a larger or small portion of the pipe is dipped into the water with the result that in this way, the different notes of many birds are produced.

b. Hero, *Pneumatics,* II.IV Schmidt = Woodcroft 43.

Ἐκ διαλειμμάτων φωναὶ γίνονται ὀρνιθαρίων οὕτως.

Ἀγγεῖον ἔσται στεγνόν, δι' οὗ χώνη διεῖται, ἧς ὁ καυλὸς ἀπέχει ἀπὸ τοῦ πυθμένος ὅσον ὕδατι διάρρυσιν. ὑπέρκειται δὲ τῆς χώνης ἀγγεῖον κοῖλον ἐν κνώδαξι στρεφόμενον τὰ βάρη εἰς τὸ ἄνω μέρος ἔχον, εἰς ὃ φέρεται ἀεὶ ἐπίρρυτον ὕδωρ. συμβαίνει οὖν κενοῦ ὄντος τοῦ ἐκνωδακισμένου ἀγγείου ὀρθὸν αὐτὸ διαμένειν· βαρύλλιον γὰρ ἔχει προσκείμενον τῷ πυθμένι. πληρωθέντος δὲ καταστρέφεται τὸ ὕδωρ εἰς τὸ στεγνὸν ἀγγεῖον. ὁ δὲ ἐν τούτῳ ἀὴρ ἐκθλιβόμενος διά τινος συριγγίου τὸν ἦχον ἀποτελεῖ. κενοῦται δὲ τὸ ἀγγεῖον διά τινος καμπύλου σίφωνος. ἐν ὅσῳ δὲ ἡ κένωσις γίνεται, πάλιν τὸ ἐκνωδακισμένον ἀγγεῖον

πληρωθὲν καταστρέφεται. δεήσει δὲ τὴν ἐπίρρυσιν μὴ κατὰ μέσον φέρεσθαι τοῦ ἐκνωδακισμένου, ὥστε πληρωθὲν ταχέως καταστρέφεσθαι.

*Figure 11: **T5.b** A bird which sings at intervals*

Sounds of birds are produced at intervals as follows:

There will be a watertight vessel through which a funnel is inserted whose stem sits above the base of the vessel just far enough to leave a passage for water. Placed above the funnel is a hollow container, rotating in sockets and having a weight placed below, into which running water is continuously carried. It happens, then, that while the container on the pivots is empty it will remain upright for a weight is fastened to the bottom, but after it has been filled with water, it tips upside down into the watertight vessel. The air in this vessel being pushed out through some tube will produce a sound. The vessel is emptied by means of some bent siphon and while it is being emptied, the container pivots on its axis and is filled once more. There will be a need for the stream not to fall into the centre of the container on pivots so that when filled it may be inverted swiftly.

c. Hero, *Pneumatics,* II.V Schmidt = Woodcroft 44.

Καὶ ἄλλως δὲ ἐκ διαλειμμάτων ἦχοι γίνονται τόνδε τὸν τρόπον.

Ἀγγεῖόν ἐστι πλείονα ἔχον διαφράγματα πλάγια· ἐν δὲ ταῖς χώραις διαβῆταί εἰσι φέροντες εἰς τὰς ὑποκειμένας χώρας ἄνισοι ταῖς ἐπιρρύσεσιν· ἐν δὲ τῷ ὑποκάτω ἀγγείῳ πρόσκειται τὸ συρίγγιον τὸ καὶ τὸν ἦχον ποιοῦν· εἰς δὲ τὸ ἄνω ἀγγεῖον φέρεται ἡ ῥύσις. καὶ συμβαίνει πληρωθέντος τοῦ ἄνω ἀγγείου μεταχωρεῖν διὰ τοῦ ἐν αὐτῷ διαβήτου εἰς τὸ ὑποκείμενον, ἄχρις ἂν ἐπὶ τὸ τελευταῖον παραγένηται τὸ ὑγρὸν στεγνοῦ αὐτοῦ ὄντος· ὁ δ' ἐν τούτῳ ἀὴρ ἐκθλιβόμενος διὰ τοῦ συριγγίου τὸν ἦχον ἀποτελεῖ.
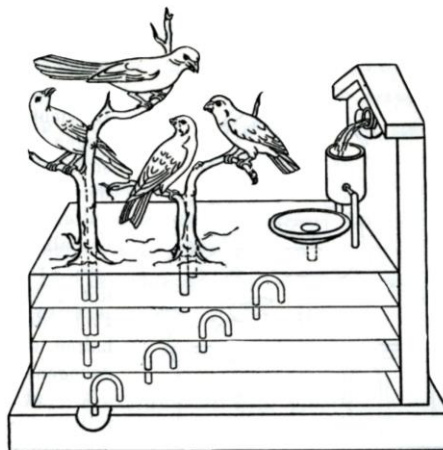
Figure 12: **T5.c** *Birds sing at intervals thanks to multiple compartments*

Sounds are also produced at intervals in this other way:

There is a vessel which has a number of horizontal partitions. In the chambers *diabētēs* are placed to the chambers below, the channels being uneven. In the lower compartment is the pipe which produces the sound; and the water stream falls into the upper compartment. It will happen that as the upper compartment is filled, the liquid moves through the *diabētēs* into the compartment below, until it arrives at the lowest one and since it is airtight, the air inside it being forced out through the pipe, produces the sound.

d. Hero, *Pneumatics,* I.XVI Schmidt = Woodcroft 15.

κατασκευάζεται οὖν ἤτοι ἐν κρήνῃ ἢ ἐν ἄντρῳ ἢ καθόλου ὅπου ἐπίρρυτον ὕδωρ ἐστίν, ὄρνεα πλείονα διακείμενα καὶ τούτοις παρακειμένη γλαύξ, ἥτις ἐπιστρέφεται αὐτομάτως παρὰ τὰ ὄρνεα καὶ πάλιν ἀποστρέφεται· καὶ ἀποστραφείσης μὲν φθέγγονται τὰ ὄρνεα, ἐπιστραφείσης δὲ πρὸς αὐτὰ οὐκέτι φθέγγονται. καὶ τοῦτο πλεονάκις γίνεται. κατασκευάζεται δὲ τὸν τρόπον τοῦτον.

Ἔστω κρουνισμάτιον ἀεὶ ῥέον τὸ Α· τούτῳ δὲ ὑποκείσθω στεγνὸν ἀγγεῖον τὸ ΒΓΔΕ ἔχον πνικτὸν διαβήτην ἢ καμπύλον σίφωνα τὸν ΖΗ καὶ καθιεμένην χώνην τὴν ΘΚ, ἧς ὁ καυλὸς ἀπεχέτω ἀπὸ τοῦ πυθμένος τοῦ ἀγγείου ὅσον ὕδατι διάρρυσιν. ἐχέτω δὲ καὶ πλείονα συριγγίδια, οἷα εἴρηται, ὄντα τὰ Λ. συμβήσεται οὖν πληρουμένου μὲν τοῦ ΒΓΔΕ ἀγγείου τὸν ἀέρα τὸν ἐν αὐτῷ ἐκθλιβόμενον καὶ τὰς τῶν ὀρνέων ποιεῖν φωνάς, κενουμένου δὲ μετὰ τὴν πλήρωσιν διὰ τοῦ ΗΖ διαβήτου μηκέτι φθέγγεσθαι. ἵνα οὖν ἡ γλαὺξ ἐπιστρέφηται καὶ ἀποστρέφηται, ὡς προείρηται, προκατασκευάζεται τὰ μέλλοντα λέγεσθαι· ἔστω γὰρ ἐπί τινος βάσεως τῆς Μ ἄξων βεβηκὼς ὁ ΝΞ ἀπὸ τόρνου εἰργασμένος, περὶ ὃν περικείσθω ἁρμοστὴ σύριγξ ἡ ΟΠ εὐλύτως δυναμένη περὶ αὐτὸν στρέφεσθαι· ταύτῃ δὲ συμφυὲς ἔστω τυμπάνιον τὸ ΡΣ, ἐφ᾽ ᾧ ἐπιβήσεται ἡ γλαὺξ συμφυὴς αὐτῷ ὑπάρχουσα· περὶ δὲ τὴν ΟΠ σύριγγα δύο ἁλύσεις ἐπὶ τἀναντία ἐπειληθεῖσαι αἱ ΤΥ, ΦΧ διὰ τροχίων δύο ἀποδεδέσθωσαν ἡ μὲν ΤΥ εἰς βάρος ἐκκρεμάμενον τὸ Ψ, ἡ δὲ ΦΧ εἰς κοῖλον ἀγγεῖον τὸ Ω ὑποκείμενον τῷ ΖΗ σίφωνι ἢ πνικτῷ διαβήτῃ. συμβήσεται οὖν κενουμένου τοῦ ΒΓΔΕ ἀγγείου τὸ ὑγρὸν φέρεσθαι εἰς τὸ Ω ἀγγεῖον καὶ ἐπιστρέφεσθαι τήν τε ΟΠ σύριγγα καὶ τὴν γλαῦκα, ὥστε βλέπειν πρὸς τὰ ὀρνιθάρια, κενωθέντος δὲ τοῦ ΒΓΔΕ ἀγγείου κενοῦσθαι καὶ τὸ Ω διά τινος ἐν αὐτῷ πνικτοῦ διαβήτου ἢ καμπύλου σίφωνος, ὥστε πάλιν καταβαρῆσαν τὸ Ψ βάρος ἀποστρέψαι τὴν γλαῦκα κατὰ τὸν καιρὸν ἐκεῖνον, ὅτε πληροῦται τὸ ΒΓΔΕ ἀγγεῖον καὶ πάλιν αἱ τῶν ὀρνέων γίνονται φωναί.

Καὶ οἱ τῶν σαλπίγγων δὲ ἦχοι διὰ τοῦ παραπλησίου γίνονται τρόπου τῷ προειρημένῳ· ὅταν γὰρ εἰς στεγνὸν ἀγγεῖον κατατεθῇ τῆς χώνης ὁ καυλὸς ἀπέχων ἀπὸ τοῦ πυθμένος

βραχὺ καὶ συνεστεγνωμένος τῷ τεύχει τοῦ ἀγγείου, εἶτα ἡ σάλπιγξ ἔχουσα τόν τε

κώδωνα καὶ τὴν γλωσσίδα συντετρημένην τῷ ἀγγείῳ κατὰ τὸ ἄνω μέρος αὐτοῦ,

συμβήσεται διὰ τῆς χώνης ἐγχυνομένου τοῦ ὑγροῦ ἐκθλιβόμενον τὸν ἐν τῷ ἀγγείῳ ἀέρα
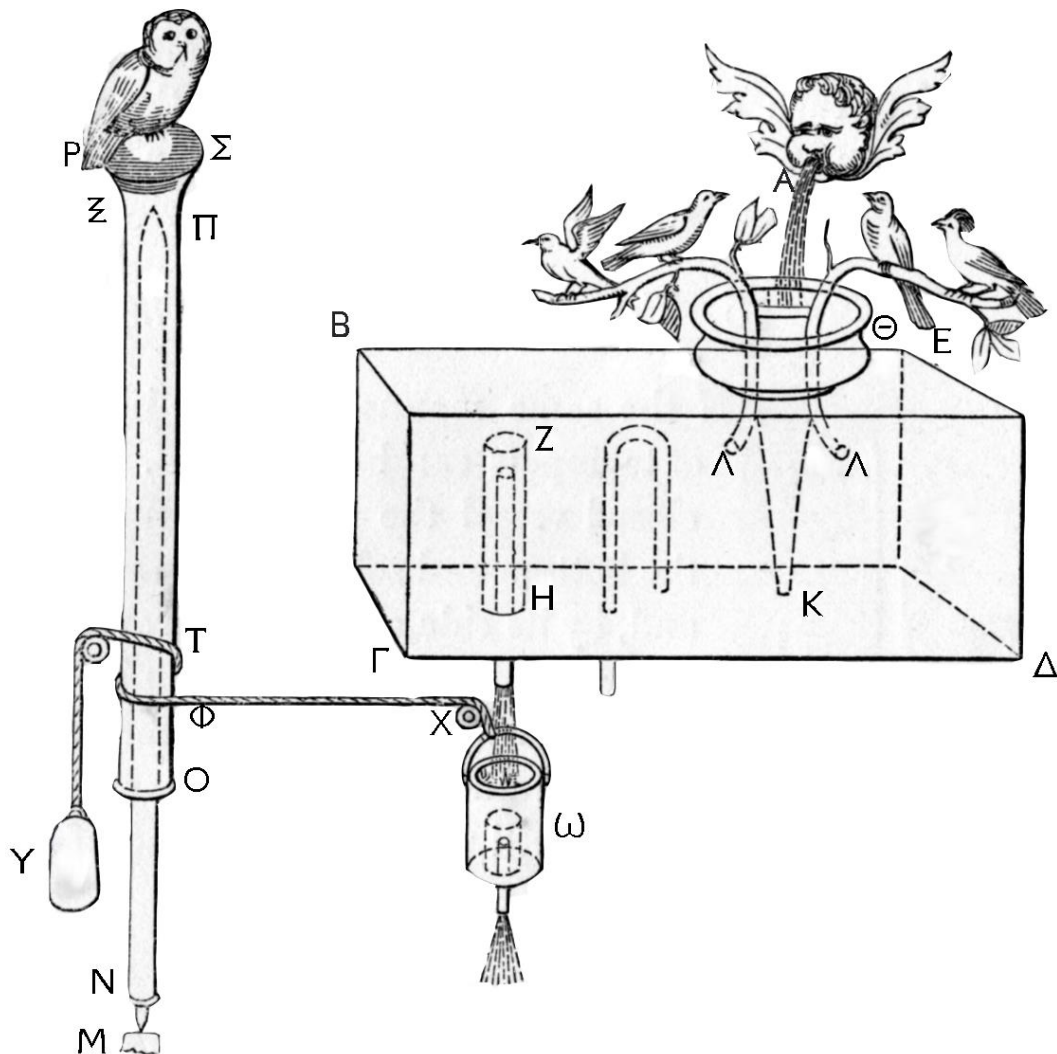
διὰ τῆς γλωσσίδος τὸν ἦχον ἀποτελεῖν.

*Figure 13: **T5.d** Coordinated rotation of an owl and singing of birds*

Many different birds are built, arranged either in a spring or in a cave or in general wherever

there is running water. Beside them lies a little owl which turns around of its own accord

towards the birds and then back again. And when the owl turns away the birds sing, but when

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it turns towards them, they no longer sing. And this happens a number of times. It is constructed in this way:

Let A be a perpetually flowing spout. Place underneath this spout a watertight pedestal ΒΓΔΕ holding an airtight *diabētēs* or curved siphon ZH and having inserted in it a funnel ΘΚ whose stem is raised above the base of the vessel just far enough to leave a passage for water. Additionally, let [the funnel] have many little pipes, such as were mentioned before, at Λ. It will happen that when the vessel ΒΓΔΕ is filled with water, the air inside being forced out will produce the sounds of the birds; and when [the water] pours out through the *diabētēs* HZ after [the vessel] has been filled, [the birds] no longer make a sound. In order that the owl may turn one way and the other, as was described before, the following are prepared in advance: Let an axle NΞ built in a lathe stand upon some pedestal M. Let a suitable pipe ΟΠ be placed around [the axle] so it can turn loosely around it and let it be joined to a cylinder PΣ upon which the aforementioned owl sits affixed. Around the tube ΟΠ let two chains TY and ΦΧ, having been wound up in opposite directions, be tied up around two pulleys: the one TY to a weight hanging at Ψ; the other ΦΧ to an empty container ω which lies beneath the siphon or airtight *diabētēs* ZH. It will happen that as the vessel ΒΓΔΕ is being emptied, the liquid is carried into the container ω and both the pipe ΟΠ and the owl turn so as to face towards the birds, but once the vessel ΒΓΔΕ is empty, the container ω will likewise be emptied by means of some airtight *diabētēs* or bent siphon within it with the result that the weight Ψ again overloaded turns the owl away at that exact moment when the vessel ΒΓΔΕ is being filled again and the sounds of the birds are produced.

The sounds of trumpets can equally be produced in the manner previously described. For whenever the stem of a funnel is placed into a watertight vessel reaching a short distance away from the base of the vessel and soldered into the surface of the vessel; and then the trumpet, having both a bell and a mouthpiece, has been connected by a passage to the vessel

below its extremity, it happens that if liquid is poured into the funnel, the air inside the vessel being forced out through the mouthpiece will produce the sound of a trumpet.

e. Philo of Byzantium, *Pneumatics,* 60.

Construction of another very beautiful device of a similar type to the first.[1] We must prepare another device such as that one, which works by water coming from a cave or a spring or a source where it is flowing. You make well-constructed little birds, placed on little rocks or little trees. Their structure is such that they sing with different sounds according to the whistles which have been placed in their throats. This lasts while the water flows, their singing is uninterrupted. When you want them to sing continuously, a well-constructed owl should be made and placed in a spot prepared for it facing the birds. This spot where the owl sits can move and shift. When you want the birds to sing, the owl should not look at them, but should turn its back. The birds sing until the owl is turned once more.

T5 Commentary

The objects collected under **T5.a-e** are a variety of singing birds. Above all, by virtue of their focus on the auditory, these items bring to the fore the way in which automata did more than move of their own accord. All the singing birds harness the effect of the displacement of air provided by a flow of water which, when passed through a pipe, will make a sound.[2] It is worth emphasising, as noted above, that the access to flowing water makes a temple a likely place for these miracles to have been deployed.

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[1] I.e. Similar to Ph.Byz. *Pneum.* 59 (**T4.d**).
[2] Philo of Byzantium has a singing bird which works by the steam rising off boiling water. Though it is an object worth knowing about, there is no explicit mention of the fire being lit as a sacrifice. Ph.Byz. *Pneum.* 58.

The specificity of the birds is something to be noted in **T5.a** (as well as in **T6**, below). The black-cap warbler is a small, wide-spread bird which is resident all year round in Europe and particularly in the Mediterranean.[3] The male warbler in particular is distinctive for its thin, high-pitched and fairly squeaky-sounding song. With the ancients being more attuned to the sounds of nature than most of us today, and probably as keener ornithologists too, it is not unlikely that the song was identifiable by passers-by and that it would have blended with the surroundings. At the same time, it seems probable that Hero retrospectively attributed the sound made by the pipe to the warbler's call, as with the hiss of the snake in **T2.b**. The choice of the owl in **T5.d-e**, on the hand, as the bird which 'controls' the whistling and silence of the other birds was probably more deliberate. It fits with the prominence of the owl in the Greek imagination particularly for the auspices it carries, and thus the close relationship it holds with the divine.

The two different ways to make birds sing at unpredictable intervals (**T5.b-c**) shows an interest in randomising miracle technology. This is obviously a technique to increase the believability of the *thauma* given that the more random and thus assimilated to the natural and divine realms the automata are, the less likely it is that spectators suspect human intervention. Despite seeing the constant water flow from a spout, the connection with the bird sounds produced would seem more obscure if there existed a delay and unpredictability in sound.

T5.d combines sound and movement by coordinating the rotation of a little owl and the whistling of many different birds arranged either in a spring or cave or in another place with running water. The location of this automaton is clearer than many others, and the link with caves and springs fits with what we have come to expect of automata thus far. Apart from the practicalities of offering running water, we have already seen the cave feature in processional automata in the parade of Ptolemy II

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[3] Constantine 2006, 97, 123.

(**P3**), and springs too serve as the source for miracles at various sacred sites in the Greek world on festival days (**P3:coda**). The sensorial intensity of these locations has already been foregrounded, as well as the way in which both caves and springs would likely have been considered sacred spaces by their very natures, making this an obviously religious automaton.

The next three temple miracles (**T6-T8**) are unified in that the animation of the objects is initiated by a worshipper engaging in a ritualised act. We have already seen this logic at work in pieces **T2-T3** where the heat of a fire was used to supply the energy for the automation. Those fires, however, were quite directly located on the altar on which the miracle would take place while in the following cases the relation between worshipper and miracle is slightly more removed. Precisely because the action which instigates the miracle has an independent existence, the miracle seems unprovoked and thus more divinely inspired. This is particularly the case in **T7**, for example, where merely entrance into a sacred space triggers a trumpet to miraculously sound of its own accord.

T6: A Self-Animated Bird atop a Shrine

Hero, *Pneumatics,* II.XXXII Schmidt = Woodcroft 68.

Θησαυροῦ κατασκευὴ τροχὸν ἔχοντος στρεφόμενον χάλκεον, ὃς καλεῖται ἁγνιστήριον· τοῦτο γὰρ εἰώθασιν οἱ εἰς τὰ ἱερὰ εἰσιόντες στρέφειν. ἔστω οὖν τοῦ τροχοῦ στραφέντος μελαγκορύφου γίνεσθαι φωνήν, καὶ αὐτὸ δὲ τὸ ὀρνύφιον ἐφεστὼς στρέφεσθαι, σταθέντος δὲ τοῦ τροχοῦ μηκέτι φθέγγεσθαι τὸν μελαγκόρυφον μήτε στρέφεσθαι.

Ἔστω θησαυρὸς μὲν ὁ ΑΒΓΔ, ἄξων δὲ διακείμενος ἐν αὐτῷ ὁ ΕΖ εὐλύτως δυνάμενος στρέφεσθαι, ᾧ συμφυὴς ἔστω ὁ ΘΚ τροχός, ὃν δεῖ στρέφειν. ἔστωσαν δὲ τῷ ἄξονι δύο τροχοὶ συμφυεῖς ἐντὸς οἱ Λ, Μ, ὧν ὁ μὲν Λ ἐξελίκτραν ἐχέτω, ὁ δὲ Μ ἀκτινωτὸς ἔστω. περὶ δὲ τὴν ἐξελίκτραν σπάρτος ἐπειλήσθω, ἧς ἀπὸ τοῦ ἄκρου ἐκκρεμάσθω πνιγεὺς ὁ Ν σωλῆνα ἔχων τὸν ΖΟ καὶ συρίγγιον ἔχων ἐπ᾽ ἄκρου μελαγκορυφίζον. ὑποκείσθω δὲ τῷ πνιγεῖ ὕδατος ἀγγεῖον τὸ ΠΡ. καθείσθω δὲ καὶ ἀξονίσκος ὁ ΣΤ ἀπὸ τῆς κορυφῆς τοῦ θησαυροῦ εὐλύτως δυνάμενος στρέφεσθαι, πρὸς μὲν τῷ Σ ἔχων τὸν μελαγκόρυφον, πρὸς δὲ τῷ Τ ἀκτινωτὸν τύμπανον ἐμπεπλεγμένον τῷ Μ τυμπάνῳ. συμβήσεται οὖν ἐπιστραφέντος τοῦ ΘΚ τροχοῦ ἐπειλεῖσθαι τὴν σπάρτον περὶ τὴν ἐξελίκτραν καὶ ἀνέχειν τὸν πνιγέα, ἀφεθέντος δὲ τοῦ τροχοῦ τῷ βάρει καταφερόμενον τὸν πνιγέα εἰς τὸ ὕδωρ

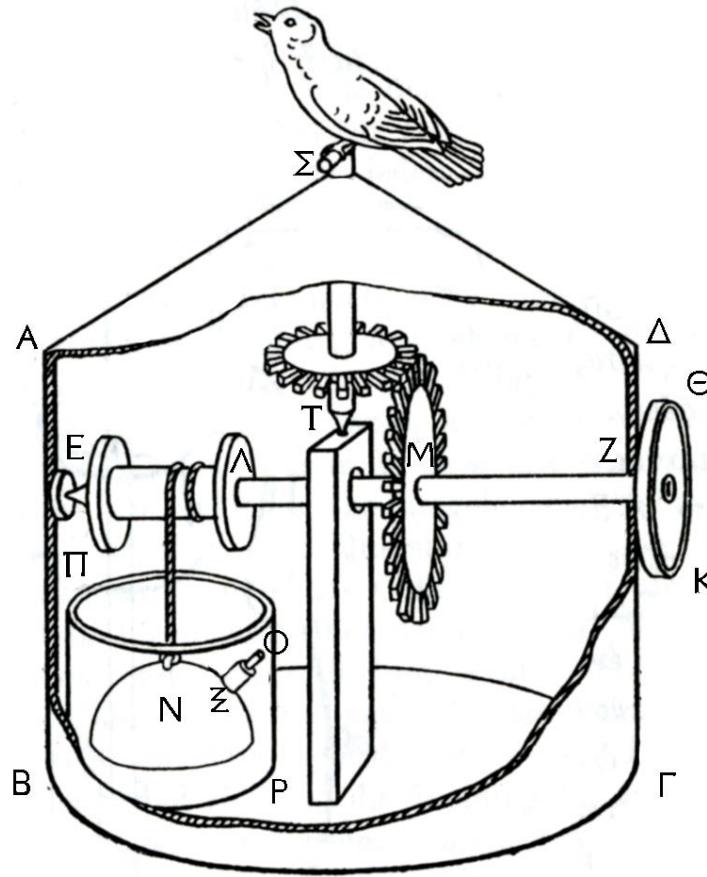τὸν ἦχον ἀποτελεῖν τοῦ ἀέρος ἐκθλιβομένου, ἅμα δὲ καὶ τὸν μελαγκόρυφον ἐπιστρέφεσθαι διὰ τῆς τῶν τυμπάνων ἐπιστροφῆς.

*Figure 14: **T6** Ritual purification causes a bird to turn and sing*

The construction of a sacred receptacle with a revolving wheel of bronze, termed a ritual purifier, which visitors to the temple are accustomed to spin. Let it be, then, that when the wheel is turned, the sound of a black-cap warbler will be produced, and that this bird set atop the shrine will rotate too. If, however, the wheel is still, the black-cap warbler will neither make a sound, nor rotate.

Let there be a sacred receptacle ΑΒΓΔ and let ΕΖ be an axle fixed inside it, able to revolve freely, to which the wheel ΘΚ, which must be spun, is attached. Let two wheels Λ and Μ also be attached to the axle. Of these, let Λ have a pulley and let Μ be a cogwheel. Let a cord be

wound around the pulley, from the end of which is suspended a *pnigeus* N which has a tube

ƵO and is provided with a little pipe which produces the sound of a black-cap warbler.[1] Let

there be a vessel of water ΠΡ placed under the *pnigeus.* Let there also be a small axle ΣΤ

dropping down from the top of the receptacle capable of revolving freely: Σ having a black-

cap warbler attached, and Τ a cogwheel, interlocking with the cogs of Μ. It will happen, then,

that when the wheel ΘΚ is spun, the cord is wound around the pulley and raises up the

pnigeus, but when the wheel is released, the *pnigeus* lowers thanks to its own weight into the

water and produces a sound by the expulsion of air. At the same time, it happens too that the

black-cap warbler rotates, on account of the revolution of the wheels.

T6 Commentary

The construction of this automaton involves an explicitly sacred vessel (*thēsauros*)[2] equipped with a

wheel used in ritual purification here termed an *agnistērion*. The miracle engages at least three

senses, combining sound, touch and sight.

The text of **T6** explicitly mentions that visitors to temples are accustomed to spin such a wheel upon

entering a temple. **T8.b** clarifies the intention behind such action for us, adding that this was

because of the belief that bronze purifies. Since the ritual touching of the wheel exists regardless of

this automaton, the sound and movement of the bird would be even more unexpected. The miracle

is innately linked with the interaction of the worshipper as the warbler is still and silent when there

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[1] I have chosen to leave *pnigeus* untranslated throughout as this term remains somewhat obscure to me. In cooking, a *pnigeus* is a kind of dome put on coals to trap the heat for baking (see Ar. *Nu.* 96 and Sparkes and Talcott 1958 no. 36). Fragaki 2012, 61 defines the *pnigeus* as 'une sorte de cloche, surmontée d'une fente par ou l'air s'échappe en sifflant lorsque l'objet est immergé dans l'eau'. It is defined in **T7**, below, as 'a vessel with a narrow mouth' and combined with the obvious etymological link to the verb *pnigō* I am led to imagine a type of funnel. How it differs from a *chōnē* is unfortunately lost in translation.

[2] I have intentionally translated *thēsauros* as neutrally as possible. LSJ give the meaning 'offertory box' as well as 'slot-machine' (Hero, *Spir.* 1.21). We are probably meant to imagine a sort of donatism box, increasing the contact between worshipper and god in a gift-exchange transaction.

is no interaction. The sense of connection between the worshipper, ritual action and the presence of

the divine would thus be heightened through technical ingenuity.

T7: Trumpet Sounds on Opening of Temple Door

Hero, *Pneumatics,* I.XVII Schmidt = Woodcroft 17.

Θυρῶν ἀνοιγομένων ναοῦ σάλπιγγος ἦχος γίνεται τόνδε τὸν τρόπον.

Ὄπισθεν τῆς θύρας ἀγγεῖον ἔστω τὸ ΑΒΓΔ ὕδωρ ἔχον· πνιγεὺς δὲ ἔστω ἐν τούτῳ, τουτέστι σύστομον ἀγγεῖον κατεστραμμένον τὸ Ζ· τῷ δὲ πυθμένι αὐτοῦ συντετρήσθω ἡ ΘΚ σάλπιγξ ἔχουσα τόν τεκώδωνα καὶ τὴν γλωσσίδα· τῷ δὲ σωλῆνι τῆς σάλπιγγος παρακείσθω κανὼν ὁ ΛΜ συμφυὴς μὲν ὢν τῷ πνιγεῖ, συνδεδεμένος δὲ τῷ τῆς σάλπιγγος σωλῆνι καὶ ἔχων ἐκ τοῦ ἄκρου κωλυμάτιον τὸ Μ, τουτέστι χελωνάριον· τῷ δὲ κωλυματίῳ ὑποκείσθω κανὼν ὁ ΝΖ ἀνέχων τὸν Ζ πνιγέα ἀπέχοντα ἀπὸ τοῦ ὕδατος ἱκανόν. ὁ δὲ ΝΖ κανὼν κινείσθω περὶ περόνην τὴν Ο ἐκ δὲ τοῦ Ζ ἄκρου τοῦ κανόνος ἅλυσις ἢ σπάρτος ἐκδεθεῖσα ἀποδεδέσθω διὰ τροχίλου τοῦ Π εἰς τὸ ὄπισθεν τῆς θύρας. συμβήσεται οὖν τῆς θύρας ἀνοιγομένης τεινομένην τὴν σπάρτον ἐπισπᾶσθαι τὸ Ζ ἄκρον τοῦ κανόνος, ὥστε μηκέτι ὑποπεπτωκέναι τὸν ΝΖ κανόνα τῷ Μ κωλυματίῳ· τούτου δὲ παραλλάξαντος φερόμενος ὁ πνιγεὺς εἰς τὸ ὕδωρ τὸν τῆς σάλπιγγος ἦχον ἀποτελέσει διὰ τὸ τὸν ἐν αὐτῷ ἀέρα διὰ τῆς γλωσσίδος καὶ τοῦ κώδωνος ἐκθλίβεσθαι.
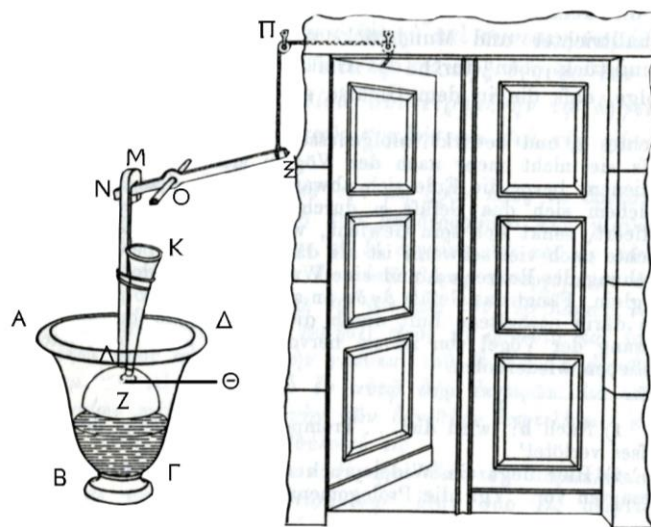

*Figure 15: **T7** Walking into a temple triggers a trumpet sound*

When the doors of a temple are opened, the sound of a trumpet is produced in the following way:

Behind the doors let there be a vessel ΑΒΓΔ holding water. Let there be a *pnigeus* inside the vessel, that is to say a vessel with a narrow mouth inverted at Ζ. The trumpet ΘΚ, which has both a bell and mouthpiece, connects by a passage to the bottom of the pnigeus. The rod ΛΜ attached to the *pnigeus* is adjacent to the pipe of the trumpet. [The rod] is tied to the pipe of the trumpet and has a clasp at the tip Μ, that is to say a little lip. Let a rod ΝΞ, which supports the *pnigeus* hovering above water adequately at Ζ, extend beside the clasp. Let the rod ΝΞ move around the pivot Ο and let a chain or cord attached to the tip Ξ be fastened by means of a pulley Π to the rear of the doors. It happens that when the doors are opened, the cord, being stretched, will draw up the tip of the rod at Ξ with the result that the rod ΝΞ no longer supports the clasp Μ. When the clasp moves, the *pnigeus* is drawn into the water and the sound of the trumpet will be produced by the air inside [the *pnigeus*] being pushed out through the mouthpiece and the bell.

T7 Commentary

Technological knowledge is here employed to signal the transition of the worshipper into a sacred space. It would be an indication to the worshipper themselves, as well as to any priests and other people already inside the temple. Of course, from the worshipper's point of view, the unexpected sound would feel like an acknowledgment of their entrance into divine space by the god. Unlike certain other temple miracles which may have been dedications, or which were obviously dismountable, this mechanism would have been permanently installed in the temple. It is interesting that unlike the automatically opening temple doors (**T9**), the trumpet seems to be attached to full-sized temple doors.

T8: Automated Dispensing of Sacred Water

a. Hero, *Pneumatics,* I.XXI Schmidt = Woodcroft 21.

Εἰς ἔνια σπονδεῖα πενταδράχμου νομίσματος ἐμβληθέντος, ὕδωρ ἀπορρέει εἰς τὸ περιρραίνεσθαι. Ἔστω σπονδεῖον ἢ θησαυρὸς ὁ ΑΒΓΔ, οὗ στόμιον ἔστω τὸ Α ἀνεστομωμένον, ἐν δὲ τῷ θησαυρῷ ἀγγεῖον ἔστω τὸ ΖΗΘΚ ἔχον ὕδωρ καὶ πυξίδα τὴν Λ, ἐξ ἧς κρουνὸς ἔξω φερέτω ὁ ΛΜ. παρακείσθω δὲ τῷ ἀγγείῳ ὄρθιος κανὼν ὁ ΝΖ, περὶ ὃν ἕτερος κηλωνευέσθω ὁ ΟΠ ἔχων πρὸς μὲν τῷ Ο πλατυσμάτιον τὸ Ρ παράλληλον τῷ πυθμένι τοῦ ἀγγείου, πρὸς δὲ τῷ <Π κανόνιον τὸ> ΠΣ ἔχον πρὸς τῷ Σ ἁρμοστὸν πῶμα τῇ Λ πυξίδι, ὥστε μὴ ῥεῖν τὸ ὕδωρ διὰ τοῦ ΛΜ σωλῆνος. ἔστω δὲ τὸ πῶμα τῆς πυξίδος βαρύτερον τοῦ Ρ πλατυσματίου, κουφότερον δὲ συναμφοτέρων τοῦ τε νομίσματος καὶ τοῦ πλατυσματίου. ὅταν οὖν ἐμβληθῇ διὰ τοῦ Α στομίου τὸ νόμισμα, ἐπιπεσεῖται τῷ Ρ πλατυσματίῳ καὶ καταβαρῆσαν ἐγκλινεῖ μὲν τὸ ΟΠ κανόνιον, ἐπαρεῖ δὲ τὸ πῶμα τῆς πυξίδος, ὥστε ῥεῦσαι τὸ ὕδωρ· ἀποπεσόντος δὲ τοῦ νομίσματος πάλιν τὸ πῶμα ἐπιπεσὸν ἀποκλείσει τὴν πυξίδα, ὥστε μηκέτι ῥέειν τὸ ὕδωρ.
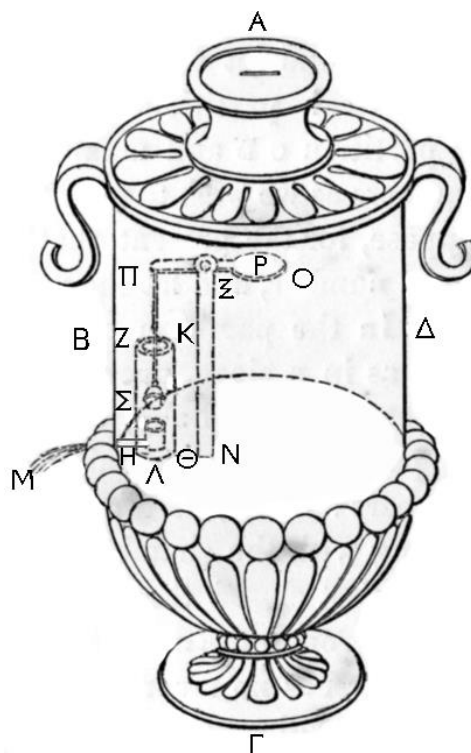

*Figure 16: **T8.a** A coin donation releases sacred water*

When a five-drachma coin is inserted into a certain sacrificial vessel, holy water will flow out.
Let ΑΒΓΔ be a sacrificial vessel or sacred receptacle which has an opening A in its lid. In the
sacred receptacle let there be a vessel ZHΘK containing water and a small cylinder Λ from
which a nozzle ΛΜ extends outside the receptacle. Beside the vessel (ZHΘK), let there be a
vertical rod ΝΞ, on which pivots ΟΠ which has on the one side O a little flat tab P parallel to
the base of the vessel; on the other side Π, a rod ΠΣ with the lid Σ fitting on the cylinder Λ so
that water does not flow through the tube ΛΜ. Let the lid of the cylinder be heavier than the
flat tab P, but lighter than the coin and the tab combined. Thus, when the coin is inserted into
the opening A, it will fall onto the flat tab P and, weighing it down, it will cause the rod ΟΠ to
tilt and lift the lid of the cylinder, so that the water flows out. When the coin has fallen off, the
lid will descend and close the cylinder so that the water no longer flows.

b. Hero, *Pneumatics,* I.XXXII Schmidt = Woodcroft 31.

Ἐν τοῖς Αἰγυπτίων ἱεροῖς πρὸς ταῖς παραστάσι τροχοὶ χάλκεοι ἐπιστρεπτοὶ γίνονται
πρὸς τὸ τοὺς εἰσερχομένους ἐπιστρέφειν αὐτοὺς διὰ τὸ δοκεῖν τὸν χαλκὸν ἁγνίζειν· ἔστι δὲ
καὶ εριρραντήρια πρὸς τὸ τοὺς εἰσερχομένους περιρραίνεσθαι. δέον οὖν ἔστω ποιῆσαι,
ὥστε ἐπιστραφέντος τοῦ τροχοῦ ὕδωρ ἐξ αὐτοῦ ἐπιρρέειν εἰς τὸ ὡς εἴρηται
περιρραίνεσθαι.

Ἔστω ὄπισθεν τῆς παραστάδος κρυπτὸν ἀγγεῖον ὕδατος τὸ ΑΒΓΔ τετρημένον τὸν
πυθμένα τῷ Ε τρήματι. ὑποκεκολλήσθω ὑπὸ τὸν πυθμένα αὐλίσκος ὁ ZHΘK ἔχων καὶ
αὐτὸς τρύπημα κατὰ τὸ ἐν τῷ πυθμένι τρῆμα· ἐντὸς δὲ τούτου ἕτερος αὐλίσκος ὁ ΛΜ
κατὰ μὲν τὸ Λ μέρος προσκεκολλημένος τῷ ZHΘK, κατὰ δὲ τὸ Ε τρῆμα καὶ αὐτὸς τρῆμα
ἔχων τὸ Π· μεταξὺ δὲ τῶν εἰρημένων δύο αὐλίσκων ἕτερός ἐστιν ὁ ΝΞΟΡ
συνεσμηρισμένος ἀμφοτέροις καὶ ἔχων τρῆμα κατὰ τὸ Ε τρῆμα τὸ Σ. καταλλήλων οὖν
τούτων τῶν τρημάτων ὄντων, ἐὰν ἐγχέῃ τις εἰς τὸ ΑΒΓΔ ἀγγεῖον ὕδωρ, ἔξω ῥεύσει διὰ
τοῦ ΛΜ αὐλίσκου· ἐὰν δὲ ἐπιστρέφωμεν τὸν ΝΞΟΡ αὐλίσκον, ὡς παραλλάξαι τὸ Σ

τρῆμα, οὐκέτι ῥεύσει. γεγονέτω οὖν ὁ τροχὸς συμφυὴς τῷ ΝΞΟΡ αὐλίσκῳ, ὥστε ἐπιστρεφομένου αὐτοῦ πλεονάκις τὸ ὕδωρ ῥεύσει.
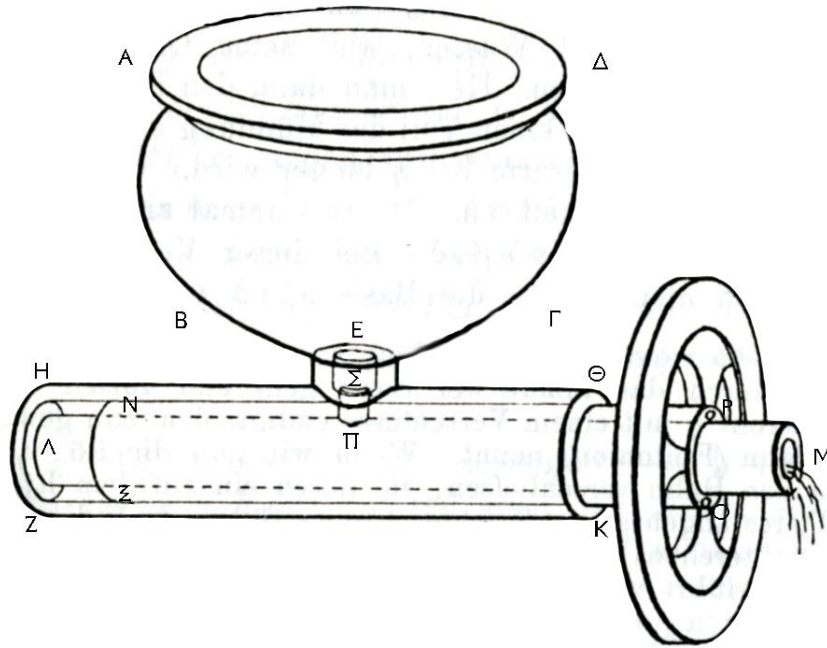

Figure 17: **T8.b** *Bronze purification wheel releases sacred water*

In Egyptian temples beside the entrance, rotatable bronze wheels exist for visitors to spin because of the belief that bronze purifies. There are also vessels for lustral water for visitors to sprinkle themselves. Let there then be a need for a construction so that upon rotating the wheel, water flows from it to be sprinkled on the visitors as has been described.

Let there be at the back of the entrance a hidden vessel of water ΑΒΓΔ having a hole Ε perforated in its base. Below the base let there be fastened a small pipe ΖΗΘΚ also with a perforation in line with the hole in the base. Within this let there be another little pipe ΛΜ soldered to ΖΗΘΚ at Λ, also in line with the hole Ε and with its own similar perforation at Π. Between the two aforementioned pipes another pipe ΝΞΟΡ is positioned which also has a perforation Σ in line with the hole Ε. Therefore, if all these orifices are in line and some water

is poured into the vessel ΑΒΓΔ, it will flow out through the pipe ΛΜ. But if we rotate the pipe ΝΖΟΡ so that the perforation Σ is displaced, it will no longer flow. Let the wheel, then, be joined to the pipe ΝΖΟΡ so that when it is rotated several times, water will flow.

c.   Philo of Byzantium, *Pneumatics,* 63.

Another device. A hydraulic wheel for ablution and purification, placed in the vicinity of a mosque or a temple.[1] This device is similar to the one previously described, but the wheel is out of bronze. The ancients used many wheels of this kind. Upon entering a temple, they sprinkled their clothes with water which was carried by this wheel, then they moved it with their hands because they believed that by touching the bronze, they were purified. And the wheel turned with a regular rotation and continues and whistles: this is what marked it out to those entering the temple. It stopped when one touched it with their hand, and, upon releasing it once more, it started its movement and turned like before.
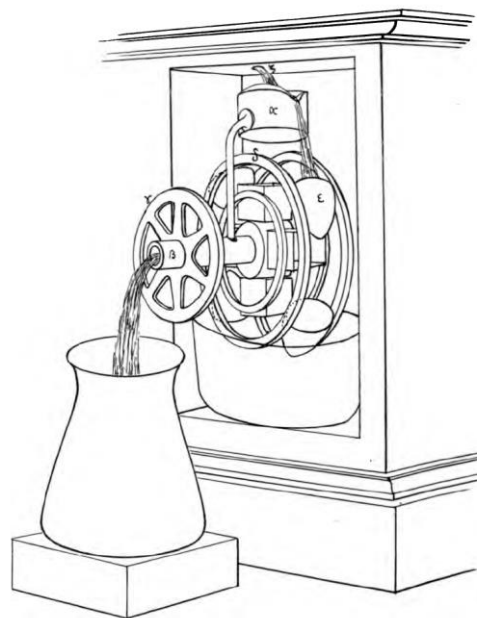

*Figure 18: **T8.c** Purification wheel rotates and whistles*

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[1] The mosque obviously being a later interpolation to the Arabic text.

T8 Commentary

Of all of Hero's inventions, **T8.a** is one of the more popular ones among historians. Often referred to as the 'coin-slot machine', this gadget for the automated dispensing of sacred water has been of higher interest than the rest because of the way in which it brings religion and financial profit into close contact. Having said this, it is not by any means the first contact between religion and finance as for hundreds of years already revenue had flowed into sanctuaries through different avenues and was regarded simply as the capital of the temple. Despite how cynical the modern reader can be about the five-drachma fee for sacred water, the religious context of this contraption is undeniable and should not be marginalised. The vessel is specified as a *spondeion* (libation vessel) or *thēsauros* (sacred receptacle) and the water is intended for sprinkling in sacred rites (*perirrainein*).[2]

We get an unusual amount of information regarding the context of use of automaton **T8.b**. Firstly we know it would be hidden away near the entrance which again shows how important it was that visitors actually subscribed to the miracle. Secondly, Hero specifies that the bronze wheel is modelled on similar items erected in Egyptian temples. This is a fascinating comment in terms of what it allows us to deduce on technological and religious influences between states in the Roman and possibly also Hellenistic and even Classical periods. The author also mentions in the first line that the worshipper would touch the bronze upon entry because of the belief that bronze purifies. As with **T6**, this would mean that the impact of the miracle would be heightened since it was unexpected. The last point of interest of **T8.b** is that it seems to imply that the holy water does not flow on every rotation of the bronze wheel. If this is the case, there is a slightly haphazard relation between cause and effect chain created by this machine. As with **T5.b-c**, the randomness helps increase the religiosity of the miracle and appear to be a more direct sign from the gods.

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[2] On the *thēsauros* see above commentary to **T6.**

The statement in **T8.c** that 'the ancients used many wheels of this kind' implies that the use of hydraulic energy to make continuously rotating wheels was perhaps more frequent in antiquity than has otherwise been recognised. The fact that this was to be perceived as miraculous is evident in Philo detailing a little later in the chapter that the hydraulics should be hidden so that spectators cannot perceive what makes the wheel turn.

T9: Automatically Opening Temple Doors

a. Hero, *Pneumatics*, I.XXXVIII Schmidt = Woodcroft 37.

Ναΐσκου κατασκευή, ὥστε θυσίας γινομένης τὰς θύρας αὐτομάτως ἀνοίγεσθαι, σβεσθείσης δὲ τῆς θυσίας πάλιν κλείεσθαι.

Ἔστω ὁ προειρημένος ναΐσκος ἐπὶ βάσεως τῆς ΑΒΓΔ, ἐφ' ἧς ἐπικείσθω βωμίσκος ὁ ΕΔ· διὰ δὲ τοῦ βωμίσκου διώσθω σωλὴν ὁ ΗΖ, οὗ τὸ μὲν Ζ στόμιον ἐντὸς ἔστω τοῦ βωμίσκου, τὸ δὲ Η ἐν σφαίρᾳ τινὶ περιειλήφθω τῇ Θ ἀπέχον ἀπὸ τοῦ κέντρου αὐτῆς βραχύ· συνεστεγνώσθω δὲ καὶ ἡ σφαῖρα τῷ ΗΖ σωλῆνι. ἔστω δὲ καὶ ἐν τῇ σφαίρᾳ καμπύλος σίφων ὁ ΚΛΜ. οἱ δὲ στροφεῖς τῶν θυρῶν παρεκτετάσθωσαν εἰς τὸ κάτω μέρος καὶ στρεφέσθωσαν ἐν κνωδακίοις οὖσιν ἐν τῇ ΑΒΓΔ βάσει εὐλύτως. ἐκ δὲ τῶν στροφέων ἁλυσείδια εἰς ἓν ἀποδεθέντα διὰ τροχίλου ἀποδεδέσθω εἰς ἀγγεῖον κοῖλον τὸ ΝΞ κρεμάμενον· ἕτερα δὲ ἁλυσείδια ἐπειληθέντα πρὸς τοὺς στροφεῖς τὰ ἐναντία τοῖς πρότερον εἰς ἓν ἀποδεθέντα διὰ τροχίλου εἰς βάρος μολιβοῦν ἀποδεδέσθω, δι' οὗ καταρρέποντος ἀποκεκλεισμέναι ἔσονται αἱ θύραι. ὁ δὲ ΚΛΜ σίφων τὸ ἐκτὸς σκέλος ἐχέτω φέρον εἰς τὸ κρεμαστὸν ἀγγεῖον. ἐμβεβλήσθω δὲ διά τινος τρυπήματος τοῦ Π ὕδωρ εἰς τὴν σφαῖραν, ὥστε δι' ἡμίσους γενέσθαι, ὃ μετὰ τὴν ἔγχυσιν ἐστεγνώσθω. συμβήσεται οὖν τοῦ πυρὸς θυμιαθέντος θερμαινόμενον τὸν ἐν τῷ βωμίσκῳ ἀέρα χεῖσθαι εἰς πλείονα τόπον· οὗτος δὲ διὰ τοῦ ΗΖ σωλῆνος εἰς τὴν σφαῖραν χωρῶν ἐκθλίψει τὸ ἐν αὐτῇ ὑγρὸν διὰ τοῦ ΚΛΜ σίφωνος εἰς τὸ κρεμαστὸν ἀγγεῖον, ὃ δὴ καταβαρῆσαν ἐπισπάσεται τὰ ἁλυσείδια καὶ ἀνοίξει τὰς θύρας. πάλιν δὴ σβεσθέντος τοῦ πυρὸς ὁ μὲν λεπτυνθεὶς ἀὴρ ἐκχωρήσει διὰ τῶν ἀραιωμάτων τοῦ τεύχους τῆς σφαίρας. ὁ δὲ καμπύλος σίφων ἐπισπάσεται τὸ ὑγρὸν τὸ ἐκ τοῦ κρεμαστοῦ ἀγγείου, ὥστε ἀναπληρῶσαι τὸν τῶν ἐκκριθέντων ἀραιωμάτων τόπον· ἔσται γὰρ αὐτοῦ τὸ ἄκρον βαπτιζόμενον εἰς τὸ ἐν τῷ κρεμαστῷ ἀγγείῳ ὕδωρ. κουφισθέντος δὲ τοῦ ἀγγείου πάλιν τὸ ἐκκρεμάμενον βάρος καταρρέψαν κλείσει τὰς θύρας. ἔνιοι δὲ ἀντὶ ὕδατος ὑδραργύρῳ χρῶνται, ἐπειδήπερ βαρύτερός ἐστι τοῦ ὕδατος καὶ εὐκόπως ὑπὸ τῆς θερμότητος λύεται.
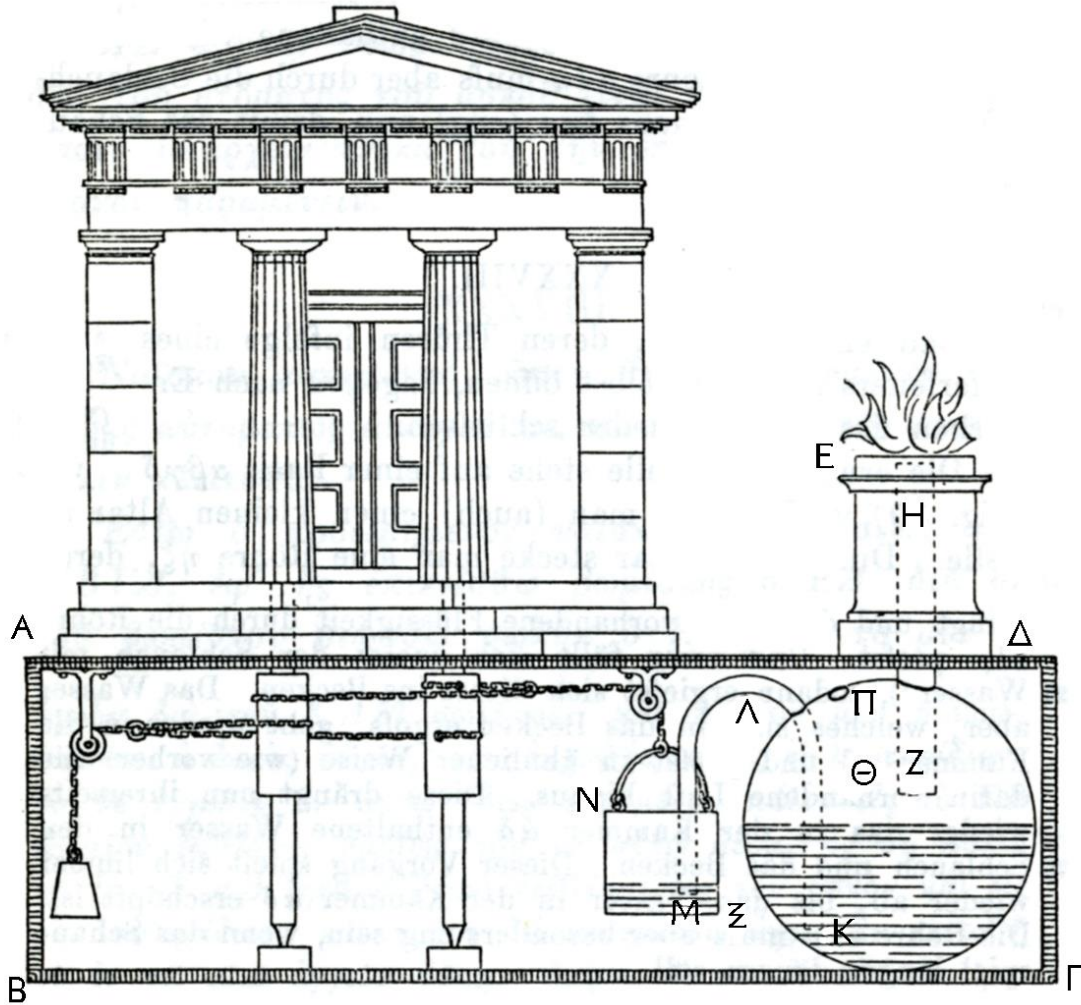
*Figure 19: **T9.α** Temple doors open automatically*

The construction of a small temple so that while an offering is being burnt, the doors open of their own accord and shut again when the offering is extinguished:

Let the aforementioned temple stand upon a pedestal ΑΒΓΔ on which lies a small altar ΕΔ. Let the tube ΗΖ be inserted through the altar, with the end Η inside the altar and the end Ζ enclosed within some globe Θ, reaching a short way from the centre. Additionally, let the globe be soldered to the tube ΗΖ and inside the globe let there be a bent siphon ΚΛΜ. Let the hinges of the doors extend downwards and rotate freely in pivots on the base ΑΒΓΔ. From the hinges let two chains running into one be tied up by means of a pulley to a hollow

suspended vessel NΞ. Let other chains be wound around the hinges in the opposite direction to the former and, running into one and tied up by means of a pulley, let them be attached to a lead weight whose descent will cause the doors to shut. Let the outer leg of the siphon KΛM extend to the suspended vessel. Through some hole Π let water be poured into the globe so that it is half-filled and after the pouring, let the hole be closed-up completely. It will happen, then, that when the fire has been set alight, the air in the altar becoming heated expands into a larger space, and thus passing through the tube HZ into the globe, it will drive out the liquid contained there through the siphon KΛM into the suspended vessel which, descending, will pull on the chains and open the doors. When the fire has been extinguished, the rarefied air will escape through the pores in the fabric of the globe. The bent siphon will draw up the liquid from the suspended vessel filling up the space of the particles removed for the tip will be immersed in the water in the suspended vessel. When the vessel becomes light again, the hanging weight will sink and the doors will shut. Some use mercury in the place of water since it is heavier than water and easily dislodged by heat.

b.   Hero, *Pneumatics*, I.XXXIX Schmidt = Woodcroft 38.

Ἔστι δὲ καὶ ἄλλως θυσίας γινομένης τὰς θύρας ἀνοίγεσθαι.

Ἔστω πάλιν ναΐσκος ἐπί τινος βάσεως τῆς ΑΒΓΔ, ἐφ' ἧς ἔστω βωμὸς ὁ Ε. διὰ δὲ τοῦ βωμοῦ σωλὴν ἔστω ὁ ΖΗΘ· ἀποδεδόσθω δὲ εἰς ἀσκωμάτιον τὸ Κ στεγνὸν πάντοθεν, ᾧ ἐπικείσθω βαρύλλιον τὸ Λ, ἐξ οὗ ἀλυσείδιον διὰ τροχίλου ἀποδεδέσθω εἰς τὰ περὶ τοὺς στροφεῖς ἀλυσείδια, ὥστε ἐπτυγμένου τοῦ ἀσκώματος κατακρατεῖν τὸ Λ βάρος καὶ κλείειν τὰς θύρας, ἐπιτεθέντος δὲ τοῦ πυρὸς ἀνοίγειν· πάλιν γὰρ θερμαινόμενος ὁ ἐν τῷ βωμίσκῳ ἀὴρ χεθεὶς χωρήσει διὰ τοῦ ΖΗΘ σωλῆνος εἰς τὸ ἀσκωμάτιον καὶ ἐπαρεῖ αὐτὸ σὺν τῷ Λ βάρει, καὶ ἀνοιχθήσονται αἱ θύραι· ἤτοι γὰρ αὗται δι' ἑαυτῶν αὐτομάτως ἀνοιχθήσονται, καθάπερ καὶ αἱ τῶν βαλανείων θύραι αὐτομάτως κλείονται, ἢ ἕξουσί τι ἀντισηκοῦν βάρος τὸ ἀνοῖγον αὐτάς. σβεσθείσης δὲ τῆς θυσίας καὶ ἐκχωροῦντος τοῦ ἐν

τῷ ἀσκωματίῳ εἰσελθόντος ἀέρος, τὸ Λ βάρος καταφερόμενον σὺν τῷ ἀσκώματι ἐπισπάσεται καὶ κλείσει τὰς θύρας.
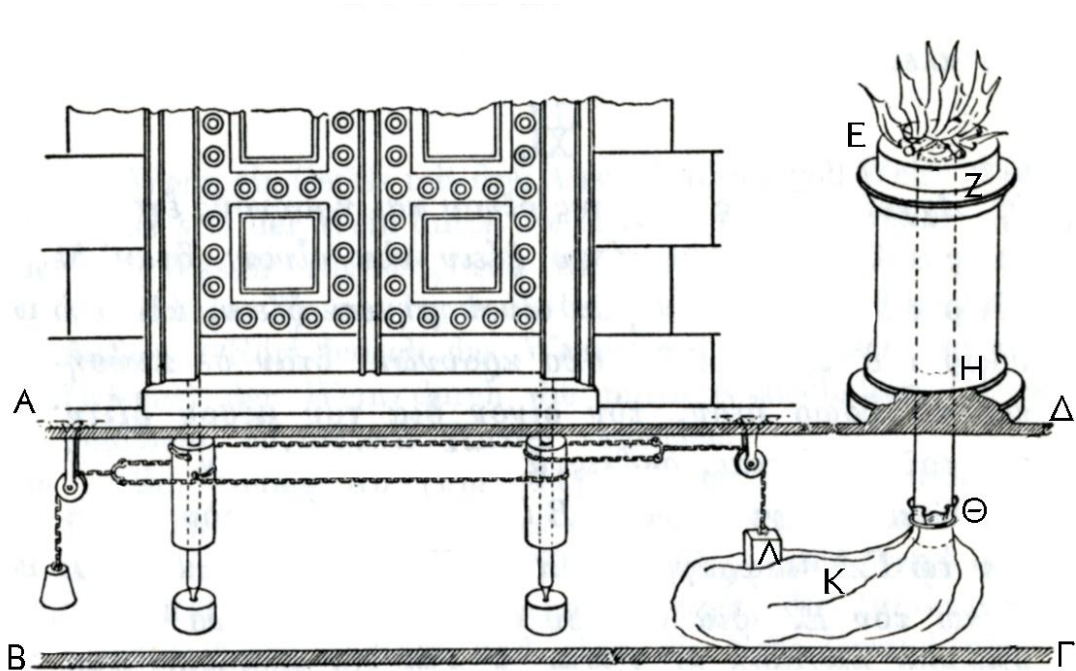

*Figure 20: **T9.b** Alternate set up for temple doors to open automatically*

Additionally, there is another way so that when an offering is burnt, the doors will open.

Once more, let there be a temple upon some pedestal ΑΒΓΔ upon which there is an altar Ε. Let the tube ΖΗΘ pass through the altar and be fastened to a perfectly water-tight, leather bag Κ, to which a little weight Λ is attached. To this in turn let there be a chain attached around a pulley to the chains around the hinges so that when the leather bag is folded, the weight Λ preponderates and shuts the doors, but when a fire is set up, they are opened. For once again, when the air in the little altar becomes heated and expands, it will travel through the tube ΖΗΘ into the bag and raise it up with the weight Λ, and the doors will be opened. The doors will either open automatically of their own accord, just as the doors of baths shut of their own accord, or they will have some counter-weight to open them. When the sacrifice

has been extinguished, and the air which had entered the bag has left it, the weight Λ, descending with the bag will pull on the chains and close the doors.

T9 Commentary

As discussed in detail in Chapter 2 above, there is a strong mythic precedent for self-opening temple doors. It is a religious miracle which by its very nature implies a religious presence, here harnessed and made technically possible by Hero's mechanical knowledge.

The use of heat to enact these miracles is similar to what we have in **T2-3** though it is worth noting that here it is specifically the burning of an offering which provides the heat. As tempting as it would be to see impressive automated mechanisms attached to the doors of temples around the Graeco-Roman world, it is important to remember that as Hero has it here, these are actually miniature reconstructions of temples with self-opening doors. Thus we must imagine that they would sit within a life-sized temple, probably as a dedication. The reference to baths which have self-closing doors in **T9.b** is very intriguing, however, and shows that there is a possibility of similar life-sized technologies existing in the Graeco-Roman world.

T10: A Fountain Trickles by the Sun's Rays

Hero, *Pneumatics,* II.XIII Schmidt = Woodcroft 47.

Ἡ καλουμένη λιβὰς στάξει, ἡλίου ἐπιβαλόντος αὐτῇ.

Ἔστω βάσις στεγνὴ ἡ ΑΒΓΔ, δι' ἧς χώνη διώσθω, ἧς ὁ καυλὸς ἀπεχέτω ἀπὸ τοῦ πυθμένος βραχὺ λίαν. ἔστω δὲ καὶ σφαιρίον τὸ ΕΖ, ἀφ' οὗ σωλὴν φερέτω εἰς τὴν βάσιν ἀπέχων ἀπὸ τοῦ πυθμένος τοῦ ἀγγείου καὶ τοῦ τεύχους τοῦ σφαιρίου βραχύ. καμπύλος δὲ σίφων ἐναρμοσθεὶς εἰς τὸ σφαιρίον φερέτω εἰς τὴν χώνην, καὶ ἐμβεβλήσθω εἰς τὸ σφαιρίον ὕδωρ. ὅταν οὖν ὁ ἥλιος ἐπιβάλῃ τῷ σφαιρίῳ, θερμανθεὶς ὁ ἐν αὐτῷ ἀὴρ ἐκθλίψει τὸ ὑγρόν, ὃ δὴ διὰ τοῦ Η σίφωνος ἔξω ἐνεχθήσεται καὶ διὰ τῆς χώνης εἰς τὴν βάσιν χωρήσει. ὅταν δὲ ἐπισκιασθῇ, ἐκχωρήσαντος τοῦ ἀέρος διὰ τοῦ σφαιρίου ὁ σωλὴν ἀναλήψεται τὸ ὑγρὸν καὶ ἀναπληρώσει τὸν κενωθέντα τόπον· καὶ τοῦτο ἔσται, ὁσάκις ἂν ὁ ἥλιος ἐπιβάλῃ.
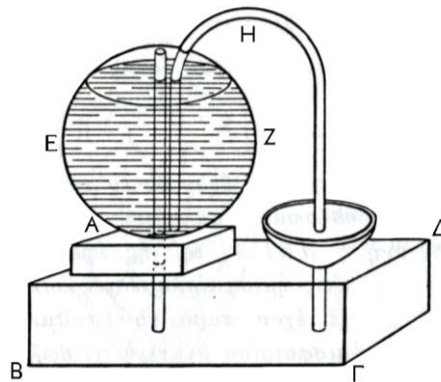

*Figure 21: **T10** Sunlight makes a fountain trickle*

The so-called 'fountain' will trickle when the sun falls upon it.

Let there be a water-tight pedestal ΑΒΓΔ through which a funnel is inserted, the tube of which extends a short distance away from the bottom. Let there also be a globe ΕΖ out of which a tube leads to the pedestal extending a short distance from the bottom of the pedestal and

from the casing of the globe. Let a bent siphon which has been inserted into the globe lead into the funnel. Then, whenever the sun falls upon the globe, the air inside being heated will force out the liquid which in turn will be carried through the siphon H and go through the funnel into the pedestal. But on the other hand, whenever it is in the shade, when the air has withdrawn through the globe, the tube will draw up the liquid and fill up the void. This will occur as many times as the sun falls upon it.

T10 Commentary

This 'fountain' is quite unique. Contrary to many of the objects so far which we can imagine to have been located inside the temple, this item must have been placed in an outdoor area of a sanctuary where the sun could hit it. Both this object and the next (**T11**) are quite striking in their use of the pan-sensory experience.

The fountain which trickles when the sun's rays hits it reminds one of a curious reference in Pausanias:

> ἐμοὶ δὲ παρέσχε μὲν καὶ τοῦτο θαυμάσαι, παρέσχε δὲ πολλῷ μάλιστα Αἰγυπτίων ὁ κολοσσός. ἐν Θήβαις ταῖς Αἰγυπτίαις, διαβᾶσι τὸν Νεῖλον πρὸς τὰς Σύριγγας καλουμένας, εἶδον ἔτι καθήμενον ἄγαλμα ἠχοῦν … ὃ Καμβύσης διέκοψε· καὶ νῦν ὁπόσον ἐκ κεφαλῆς ἐς μέσον σῶμά ἐστιν ἀπερριμμένον, τὸ δὲ λοιπὸν κάθηταί τε καὶ ἀνὰ πᾶσαν ἡμέραν ἀνίσχοντος ἡλίου βοᾷ, καὶ τὸν ἦχον μάλιστα εἰκάσει τις κιθάρας ἢ λύρας ῥαγείσης χορδῆς.

> This made me marvel, but the colossus in Egypt made me marvel far more than anything else. In Egyptian Thebes, on crossing the Nile to the so called Pipes, I saw a statue, still

sitting, which gave out a sound … This statue was broken in two by Cambyses, and at the present day from the head to middle it has been cast away; but the rest is still seated, and every day at the rising of the sun it makes a noise. The sound one could best liken it to is that of a harp or lyre when a string has been broken.[1]

The notion that the sun (Helios) brings not only light and heat, but that these two elements can be accompanied also by sound or liquid is a fascinating idea which betrays an interest in manufacturing a pan-sensory religious experience. This is an automaton of a different sort to the ones we have seen thus far. It is far less mechanic or even pneumatic than all the other examples, but the source of animation is certainly not human and in sourcing energy from the sun itself, it is perhaps the most awe-invoking object.

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[1] Paus. 1.42.3.

T11: Self-Playing Organ

Hero, *Pneumatics,* I.XLIII Schmidt = Woodcroft 77.

Ὀργάνου κατασκευή, ὥστε ἀνέμου συρίζοντος ἦχον ἀποτελεῖσθαι αὐλοῦ.

Ἔστωσαν αὐλοὶ μὲν οἱ Α, ὁ δὲ συντετρημένος αὐτοῖς πλάγιος σωλὴν ὁ ΒΓ, ὁ δὲ ὄρθιος ὁ ΔΕ, ἐκ δὲ τούτου πλάγιος ἕτερος ὁ ΕΖ φέρων εἰς πυξίδα τὴν ΗΘ ἔχουσαν τὴν ἐντὸς ἐπιφάνειαν πρὸς ἐμβολέα ἀπωρθωμένην. ταύτῃ δὲ ἁρμοζέτω ἐμβολεὺς ὁ ΚΛ εὐλύτως δυνάμενος εἰς αὐτὴν κατέρχεσθαι· τούτῳ δὲ συμφυὲς ἔστω κανόνιον τὸ ΜΝ προσκείμενον ἑτέρῳ κανονίῳ τῷ ΝΞ κηλωνευομένῳ περὶ ἄξονα τὸν ΡΠ· καὶ πρὸς μὲν τῷ Ν περόνιον ἔστω εὔλυτον· πρὸς δὲ τῷ Ξ πλατυσμάτιον προσκείσθω συμφυὲς τὸ ΞΟ, τῷ δὲ ΞΟ παρακείσθω ἄξων ὁ Σ καὶ ἔστω κινούμενος περὶ κνώδακας σιδηροῦς ἐν πήγματι δυναμένῳ μετάγεσθαι. τῷ δὲ Σ ἄξονι συμφυῆ ἔστω τυμπάνια δύο τὰ Υ, Φ, ὧν τὸ μὲν Υ σκυτάλια ἐχέτω ἐπικείμενα τῷ ΞΟ πλατυσματίῳ· τὸ δὲ Φ πλάτας ἐχέτω καθάπερ τὰ καλούμενα ἀνεμούρια. ὅταν οὖν ὑπὸ τοῦ ἀνέμου τυπτόμεναι ἐπείγωνται πᾶσαι καὶ ἐπιστρέφωσι τὸ Φ τυμπάνιον, ἐπιστραφήσεται καὶ ὁ ἄξων, ὥστε καὶ τὸ Υ τυμπάνιον καὶ τὰ ἐν αὐτῷ σκυτάλια ἐκ διαλείμματος τύπτοντα τὸ ΞΟ πλατυσμάτιον ἐπαίρει τὸν ΚΛ ἐμβολέα· καὶ ἀποστάντος τοῦ σκυταλίου κατενεχθήσεται ὁ ἐμβολεὺς καὶ ἐκθλίψει τὸν ἐν τῇ ΗΘ πυξίδι ἀέρα εἰς τὰς σύριγγας καὶ τοὺς αὐλοὺς καὶ τὸν ἦχον ἀποτελέσει. ἔξεστι δὲ τὸ πῆγμα τὸ ἔχον τὸν ἄξονα ἐπιστρέφειν ἀεὶ πρὸς τὸν πνέοντα ἄνεμον, ὡς ἂν βιαιοτέρα καὶ συνεχεστέρα ἡ ἐπιστροφὴ γίνηται.
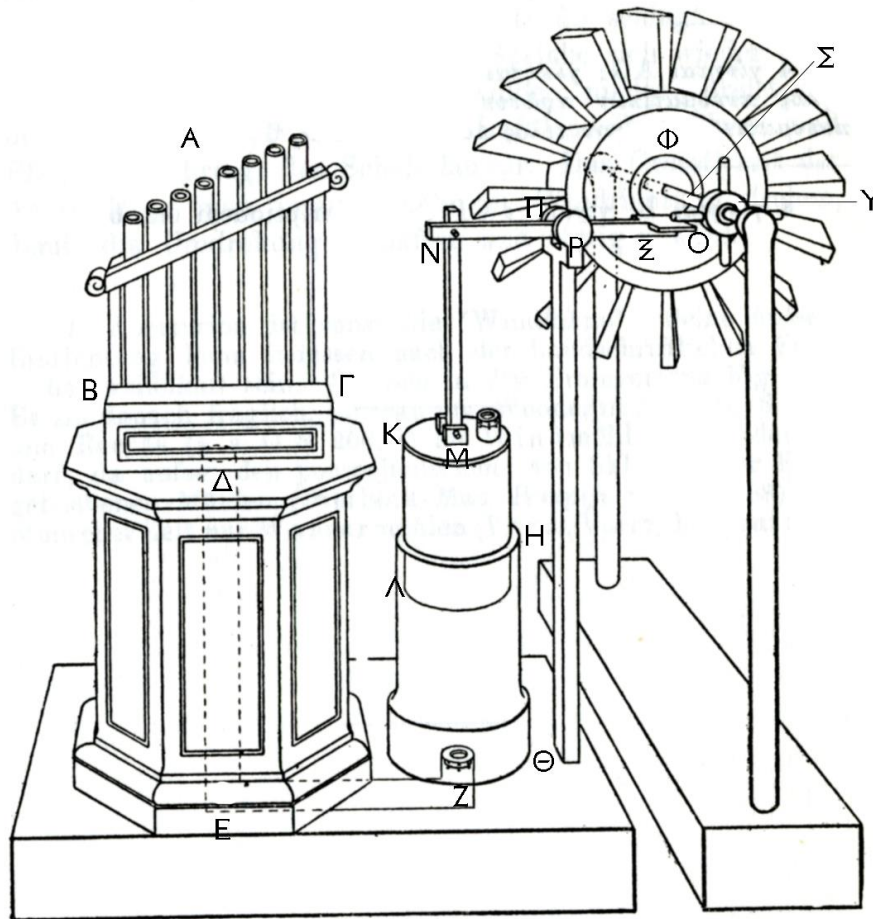
*Figure 22: **T11** Magical Organ*

The construction of an organ so that when the wind blows, the sound of a flute will be produced:

Let there be pipes A and let the tube BΓ be connected to them horizontally, let ΔE be vertical, and EZ another horizontal leading out of ΔE into a box HΘ whose inside is made level to fit a piston. Let the piston KΛ be fitted in this box, able to descend into it freely. To the piston let there be a rod MN connected and to this another, NΞ, pivoting on the axle PΠ. At N let there be a loose pin and let there be a little flat tab ΞO attached at Ξ. Beside the tab ΞO let there be an axle Σ attached which moves in an iron socket in a dismountable frame. To the axle Σ let there be two small rollers Y and Φ of which let Y have small rods on the side of the little flat tab ΞO; and let Φ have flat blades just like a wind-mill attached. Whenever, then,

all the blades are pushed having been struck by the wind, the axle will rotate with the result that both the roller Υ and the small rods attached will strike the little flat tab ΖΟ at intervals and raise the piston ΚΛ. When the little rods are out of contact, the piston will be lowered and the air in the box ΗΘ will be pushed out into the pipes and the flutes and will produce a sound. It is possible for the frame which has the axle to always be turned towards the prevailing wind, so that the revolution is both forceful and continuous.

T11 Commentary

This is another item obviously meant for set-up outdoors in a sacred place such as a sanctuary. The dismountable frame indicates that this miracle is intended to be deployed at particular times, not simply left to 'play' whenever the wind strikes it in the right direction. Controlling the *thauma* is of course a constant preoccupation of Hero's as the artist and craftsman. All the same, this item, as with the previous, is always bound to be slightly out of human control given its reliance on natural elements for energy. This adds a nice touch of unpredictability to what is already a complex and slightly uneasy relation between mortal *technē* and divine manifestation.

The fact that the wind would cause tuned notes to come out of the pipes of the organ must be recognised as creating music without visible human agency. Music in itself was a cultic activity in ancient Greek religion and, as noted in Chapter 2, the gods both play music themselves, and receive music as dedications from mortals. Thus, the artifice of automation here creates a tangible link between human and divine, being at the same time a humanly produced *thauma* worthy of the gods, and embodying the (response of) the gods too.

Conclusion

'Sacred symbols thus relate an ontology and a cosmology to an aesthetics and a morality.'

Geertz (1973) *The Interpretation of Cultures* 127.

This study has looked at ancient automata as objects with a cultural life. Self-animated machines were imagined, engineered, created and deployed by and within a pulsating society whose characteristics in turn affected the way in which these machines were viewed and conceptualised.

In ancient Greece, automata were used in religious contexts because they had the particular appeal of toying with the perceived division between nature and culture. This division should not be seen as a sharply distinguishable frontier between two opposite realms, but rather as a sliding scale where ambiguity of status becomes an important feature. The defining quality of automata – artificial animation – suspended the machines at the perfect point of ambiguity between the prerogatives of the divine and the capabilities of mortals. This fragile place of suspension was where their status as a manifestation of the uncanny became most evident, allowing them to be seen as tangible proof of supernatural involvement in human affairs. On the one hand, this is seen in religious space and on the other, it is exploited on religious occasion. In both cases, there is a common religious visuality which automata are subject to which makes them function as sacred symbols.

Though both categories are products of the same phenomenon (namely, the use of automation technologies to manifest divine presence), the prestige as it relates to social display is much stronger in the case of festival processions. The sponsor of the festival harnesses the uncanny that the

machine inspires to bolster personality cult. In his deployment of the machine, the sponsor is effectively able to reproduce the effects of nature through *technē* and to show his mastery over the natural realm as a virtue of his proximity to divine status. Yet the leader himself did not build the automaton that causes *ekplēxis* in the viewer, he simply orchestrated the occasion at which the spectacle could take place. This is important and should be seen as an ideological camouflage for the fact that there was human skill which mediated the relation between the rulers and the ruled; between the divine and the mortal realms.[1] This *technē* was hidden in the artisan or technician whose machines caused a strong enough feeling of inexplicable awe (*ekplēxis*) in their spectators that it prompted a supernatural explanation. The leader could not be the *demiourgos* (or worse, the *banausos*), he merely facilitated contexts for the socially beneficially fiction which the *thaumastic* experience promoted to unfold.[2] The miracles of mechanical *thaumata* were particularly useful in maintaining this fiction and the present study groups together the ancient evidence for such a phenomenon on the religious occasion of the festival (Chapter 3) and in the divine space of the temple (Chapter 4).

Apart from collecting the ancient source material, the thesis set out to determine the particular appeal of automata in the religious realm. It thus started with an examination of the broader notion of ancient automation in order to contextualise and problematise the topic. This took the form of ascertaining how ancient technologies of automation had been viewed in modern scholarship to date (Chapter 1), as well as exploring the space that automation occupied in the ancient Greek mind to ascertain what sort of imaginative precedents existed for the construction of ancient automata (Chapter 2). The thesis demonstrates how automata were used in ancient Greek religious contexts to inspire a particular type of '*thaumastic*' awe which has in turn served to introduce technologies of automation into existing scholarly discourse on human-divine interactions in ancient Greek religion.

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[1] On the delicate position of the artisan see Gell 1992, 52.
[2] On *ekplēxis* as a 'socially beneficial fiction' see O'Sullivan 2011, 154. On the negative connotations of the *banausos* in ancient Greece see Cuomo 2007, 9.

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