

The Silver Triton: Suetonius Claud. 21.6.13-6

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Abstract

This article assesses the imperial Roman technological options and cultural impetus for constructing and displaying an automaton Triton. Suetonius reports that such a figure announced the commencement of a staged sea battle organised by Emperor Claudius to entertain the Roman citizens in 52 CE. This automaton, whose feasibility we assess, fits neatly as an application of the pneumatic techniques summarised by Heron of Alexandria, who was probably alive at the time. By drawing attention to this little discussed passage of Suetonius, our article corroborates the idea that these techniques were useful –here contributing to the “media-image” and audio-visual culture of Claudius’ imperial agenda– and that their wondrous effects provided an intellectual bridge between their practical utility and their ability to contribute to the philosophy of science and technology.

Keywords: pneumatic automata, Roman spectacle, Heron of Alexandria

Background

In his *Life of Claudius* Suetonius describes a *naumachia*, a spectacular mock naval battle, organised to attract the general public to the emperor’s attempted draining of the Fucine

lake in 52 CE. The tunnel through which the lake was to be drained required 30,000 men and 11 years of construction – a massive engineering project worthy of attention for its scope if nothing else.¹ Following the example of Hellenistic kings,² Roman generals during the late Republican period, and then Roman emperors, had enthusiastically adopted building feats as a means of showcasing Rome’s political prominence and their contribution to it.³ Still, the spectacle of a bloodthirsty, unscripted naval battle,⁴ which Coleman described as “the most ambitious *naumachia* recorded in antiquity,”⁵ was sure to pull a more substantial crowd to witness Claudius’ intended engineering triumph. Suetonius describes it as follows (*Claud.* 21.6.13-6):⁶

¹ However, Tacitus [*Ann.* 12.57.1-2 in Charles D. Fisher, *Cornelius Tacitus: Annales Ab Excessu Divi Augusti* (Oxford: Clarendon Press, 1906)] criticizes the “careless execution of the work” (*incuria operis*) which risked the lives of many spectators during a subsequent gladiatorial show. Claudius’ freedman Narcissus, who was in charge of the spectacle, and Agrippina, tried to blame each other for the embarrassing and dangerous incident. All Tacitus’ citations follow Fisher’s edition.

² Hellenistic kings typically embarked on large-scale building programs as part of their political agenda, in an effort to showcase their profile as royal benefactors (*euergetai*); see, for example, Graham Shipley, *The Greek World After Alexander 323-30 BC* (London and New York: Routledge, 2000), pp. 83-5.

³ See, for example, Penelope J.E. Davies, “Rome and her Neighbors: Greek Building Practices in Republican Rome,” in *A Companion to Roman Architecture*, edited by Roger B. Ulrich and Caroline K. Quenemoen (Malden, MA, Oxford, Chichester: Wiley-Blackwell, 2014), pp. 27-44, p. 42; also, see in the same volume, Inge Nielsen, “Creating Imperial Architecture,” pp. 45-62, pp. 47-50 and Caroline K. Quenemoen, “Columns and Concrete: Architecture from Nero to Hadrian,” pp. 63-81, p. 80.

⁴ The battle involved 19,000 convicts divided into two naval squadrons required to fight in reality in the hope that, if the spectacle was satisfactory, the emperor would spare them; see Tac. *Ann.* 12.56.3; cf. Thomas Wiedemann, *Emperors and Gladiators* (London and New York: Routledge, 2002), p. 90.

⁵ Kathleen M. Coleman, “Launching into History: Aquatic Displays in the Early Empire,” *Journal of Roman Studies*, 1993, 83: 48-74, p. 56.

⁶ Text and trans. John C. Rolfe, *Suetonius, Gaius Tranquillus: The Lives of the Caesars* (Cambridge, Mass.: Harvard University Press, 1914), vol.2, pp. 44-45. All Suetonius’ citations follow Rolfe unless otherwise specified.

hoc spectaculo classis Sicula et Rhodia concurrerunt, duodenarum triremium
singulae, exciente bucina⁷ Tritone argenteo, qui e medio lacu per machinam
emerserat.

At this performance a Sicilian and a Rhodian fleet engaged,⁸ each numbering
twelve triremes, and the signal was sounded on a horn by a silver Triton, which was
raised from the middle of the lake by a mechanical device.

⁷ The exact shape of the *bucina* has been a matter of debate; hence, in Ovid's *Metamorphoses* 1.335, 337 [in Frank J. Miller, *Ovid: Metamorphoses* (Cambridge, Mass.: Harvard University Press, 1984)] it is described as conch-shaped, a suitable instrument for the sea-god Triton; cf. Hyginus, *Astr.* 2.23 [in Mary Grant, *The Myths of Hyginus* (Lawrence: University of Kansas Press, 1960)]; both Wilhelm Kierdorf, *Sueton, Leben des Claudius und Nero: Textausgabe mit Einleitung, kritischem Apparat und Kommentar* (Paderborn, München, Wien, Zürich: Schöningh, 1992), p. 114 and Donna W. Hurley, *Suetonius. Divus Claudius* (Cambridge: Cambridge University Press, 2001), p. 158 agree that here Suetonius drew his inspiration from Ovid. Also, see Apuleius, *Met.* iv. 31. 6: "adsunt Nerei filiae chorum canentes ... iam passim maria persultantes Tritonum cateruae hie concha sonaci leniter bucinat," cited by Coleman (cit. note 5), p. 65 and translated as: "Nereus' daughters are there, singing in harmony ...troops of Tritons cavort over the sea, one blowing softly on his sounding conch." Yet, as John Ziolkowski, "The Roman Bucina: A Distinct Musical Instrument?," *Historic Brass Society Journal*, 2002, 14: 31-58, p. 57 n. 46 observes, "this poetic terminology seems to apply to the bore of the conch rather than to that of the musical instrument." At other times, however, the *bucina* is described as being similar to the Roman *tuba* (Greek *salpinx* / σάλπιγξ) – a "long and slender straight metal tube with a bell and a mouthpiece" (Ziolkowski *ibid.*, p. 31; also see fig. 1) or the *cornu* – animal horn which gave its name to a "G-shaped circular brass instrument" (again, Ziolkowski *ibid.*, p. 36). Given Suetonius' context, we take *bucina* to refer to a conch shell which may, in practice, have been the outward cover of a Roman *tuba*; cf. Margaret A.V. Gill, "Some Observations on Representations of Marine Animals in Minoan Art, and Their Identification," *Bulletin de correspondance hellénique Supplément*, 1985, 11: 63-81, p. 79 on the Mediterranean marine snail called Triton or "Triton's Trumpet" which had been used since Minoan times as a ceremonial horn and is "still used in places as a speaking tube." In the *Pneumatics*, Heron specifies a *salpinx* for his own Triton and another figure (Wilhelm Schmidt, *Hérons Von Alexandria, Druckwerke Und Automatentheater* (Leipzig: Teubner, 1899), *Pneum.*2.9 (pp. 224 and 226) and 2.35 (p. 320); Bennet Woodcroft, *Hero of Alexandria: The Pneumatics of Hero of Alexandria* (London: Taylor Walton and Maberly, 1851), sects. 49 and 75 on pp. 71 and 103). Note that Schmidt 1899 (*ibid.*), p. 323 n.1 and fig. 79 refers readers to Ovid (as above), noting the Triton's association with the conch. Also, see Gilbert Argoud and Jean-Yves Guillaumin (with Alain Cachard), *Les Pneumatiques d'Héron d'Alexandrie* (Saint-Étienne: Publications de l'Université de Saint-Étienne, 1997), pp. 139, 141 and 181.

Suetonius' description of the Triton's emerging from the lake deserves closer attention as it seems to indicate that the horn was blown after its emersion and therefore, probably during its subsequent immersion: the text contains a number of verbs in the perfect, describing Claudius' decision to stage the naval battle (21.6.5: *commisit*) and, then, his reaction to the apparent reluctance of the crews to fight: the emperor jumped off his seat (21.6.10: *prosiluit*) and partly with threats and partly with arguments urged (21.6.13: *compulit*) the crews to engage in battle (21.6.14: *concurrerunt*). The Triton's appearance, however, is expressed with the pluperfect *emerserat* (21.6.16) which implies that the Triton sounded its note after it emerged from the water. In order for the device to work, a cavity would need to be filling with water and driving air out of its trumpet into the atmosphere. The simplest way to achieve this is for the device to be sinking, and this is the process we have explored with our model described below (pp. 17-21).

The lake's draining to create arable land is a prime example of the scale of engineering feat that the Romans have come to be known for. It was unfortunate for Claudius that the success of his attempt was questionable, but a silver mechanical triton placed publically, theatrically and spectacularly at the emperor's service must also have made an impression to find its way into Suetonius' description. It is also evidence of the fascination with technology found at the highest levels of imperial Rome. Drawing on more recent scholarly trends in ancient technology which emphasize the practical utility,

⁸ Roger Dunkle, *Gladiators: Violence and Spectacle in Ancient Rome* (London and New York: Routledge, 2013), pp. 194-195 argues that the naval battle is most probably an unhistorical event. With regard to the historical context of aquatic spectacles in imperial Rome, Coleman 1993 (cit. note 5), pp. 69-74 argues that while it "lends plausibility to the narrative," it also allows the emperor to showcase his power by "re-writing" history. For contemporary Romans the Greek past was remote enough to be enveloped in a romantic aura, without running the risk of confusing myth and history. Thus, a number of the known *naumachiae* staged by Roman emperors, as much as well-known myths re-enacted on the arena, were represented contrary to their recorded historical outcomes. Yet, with regard to the *naumachia* on lake Fucine, Coleman (ibid., p. 69) writes that "Claudius staged an apparently fictitious battle between 'Sicilians' and 'Rhodians,' although this may reflect a simplification of the struggle for west Sicily c. 580-576 B.C. between colonists from Cnidos and Rhodes on the one hand and an alliance of Phoenicians and Elymians on the other."

as well as the philosophical and political implications, of ancient mechanics and engineering with specific references to Heron's contribution in the field,⁹ we argue that the device, like much other technology of the time, has the potential to heighten the empire's prestige and highlight the engineering capability at the emperor's personal disposal. Furthermore, we indicate how, by recording the involvement of the gods in the military endeavours of the Roman emperor, the mechanical Triton's participation supports the emperor's status as a deity who shapes decisively the course of history in the minds of the Roman citizens.

The silver Triton is not mentioned by Tacitus, nor Cassius Dio, in their own accounts of events leading up to the draining of the lake by Claudius.¹⁰ In one of several

⁹ Karin Tybjerg, "Wonder-making and philosophical wonder in Hero of Alexandria," *Studies in the History and Philosophy of Science*, 2003, 34.3: 443-466, pp. 460-2; cf. Giuseppe Cambiano, "Automaton," *Studi Storici*, 1994, 35.3: pp. 613-33, pp. 617-19; also, Karin Tybjerg, "Hero of Alexandria's Mechanical Treatises: between Theory and Practice," in *Physik/Mechanik. Geschichte der Mathematik und der Naturwissenschaften*, edited by Astrid Schürmann (Stuttgart: Steiner, 2005), pp. 204-226, p. 204 with n.2 (to which we may add Derek J. de Solla Price, "Automata and the Origins of Mechanism and Mechanistic Philosophy," *Technology and Culture*, 1964, 5: 9-23 as one of the earlier scholars to express doubt about the utility of Heron's mechanical inventions); Serafina Cuomo, *Technology and Culture in Greek and Roman Antiquity* (Cambridge: Cambridge University Press, 2007), p. 177; also, *ibid.*, *Pappus of Alexandria and the mathematics of late Antiquity* (Cambridge: Cambridge University Press), pp. 103-4. Lynne Lancaster, "Roman Engineering and Construction" in *The Oxford Handbook of Engineering and Technology in the Classical World*, edited by John Peter Oleson (Oxford: Oxford University Press, 2008), pp. 256-284, p. 263; cf. Matthew M. Mars, "The Repurposing and Legacy of innovation," in *A Cross-Disciplinary Primer on the Meaning of Principles of Innovation*, edited by Matthew M. Mars and Sherry Hoskinson (United Kingdom, North America, Japan, India, Malaysia, China: Emerald), pp. 51-64, esp. p. 56.

¹⁰See Tac. *Ann.* 12.56-7; Dio 60.11.5-6 [in Earnest Cary and Herbert B. Foster, *Cassius Dio Cocceianus: Dio's Roman History* (Cambridge, MA & London: Harvard University Press & William Heinemann, 1914)]. Note that Ronald Syme, *Tacitus* (Oxford: Clarendon Press, 1958) names among Dio's possible sources Cluvius Rufus (p. 287), Pliny the Elder (pp. 276, 698), Cremutus Cordus (p. 698), even possibly Tacitus, though this is doubtful (p. 690). All citations of Dio in the rest of the article follow Gary and Foster's edition.

epigrams mentioning staged sea battles,¹¹ Martial (b. 40 CE) praises the spectacles held in the Colosseum by comparing them to past events. In epigram 34(30, *prius* 28), lines 1-6 he references a number of past *naumachias*, starting with that of Augustus, a unique spectacle that amazed not only its Roman audience, but even sea deities such as Thetis, Galatea and Triton. Next, Martial also refers to the *naumachias* of Claudius (on Lake Fucine) and Nero (on the lake formerly at the site of the Colosseum), although no mention is made of Claudius' silver Triton. Based on Martial's text, we can argue by inference that Claudius' staged *naumachia* was still remembered when the epigram was published in 80 CE under Titus' reign. At the time of the Fucinian lake spectacle, Martial was only a boy who had not yet ventured to Rome.¹² His reference to the Claudian *naumachia* as a standard against which to compare Titus' event is an indication that the earlier spectacle had secured a prominent place in the literary *topos* of 'outdoing' previous emperors, here expressed by the injunction to the personified Fucinus to remain silent when confronted with the grander spectacle now offered by Titus' *naumachia* [*Spec.*34(30; *prius* 28), esp. line 11].¹³

¹¹ For instance, Martial's epigrams, *Liber de Spectaculis* 27(24), 28(25), 30(26), 34(30; 28) in David Roy Shackleton Bailey, *Martial: Epigrams, Volume I: Spectacles, Books 1-5*. (Cambridge, Mass.: Harvard University Press, 1993). All citations of Martial follow Bailey's edition unless otherwise specified. For a discussion of Augustus' staged sea-battle which emulated the battle of Salamis, see Coleman 1993 (cit. note 5), pp. 50-4.

¹² Martial arrived in Rome around 64 CE; see Oliver Taplin, *Literature in the Greek and Roman Worlds: A New Perspective* (Oxford: Oxford University Press, 2000), p. 49; Craig Williams, *A Martial Reader: Selections from the Epigrams. Mundelein, II: Bolcazy-Carducci* (Mundelein, IL: Bolcazy-Carducci, 2011), p. xi.

¹³ See Kathleen Coleman, *Martial: Liber Spectaculorum* (Oxford: Oxford University Press, 2006), pp. 257-9, s.v. 11 (*Fucinus et Teuceri taceantur stagna Neronis*); cf. Coleman 1993 (cit. note 5), p. 68 where she writes: "The occasion being celebrated in A.D. 80 was the inauguration of the Flavian Amphitheatre; hence this building should not be eclipsed by another site. At the same time, however, it was worth repeating some of the displays in the *Stagnum Augusti* for the scale and special effects that could be achieved, especially the paradox of chariots racing in water and the unique combination of a sea-battle with a landing." Coleman explains that, by holding aquatic displays in the Flavian Amphitheatre, Titus wished to compare the reign of the Flavians with that of Nero who had built a lavish, private pool opposite the site of the amphitheatre as part of his *Domus aurea* complex. Martial is not unobservant of the inference and spells out the comparison between the egotistical, tyrannical Nero and Titus who dedicates a splendid

Augusti labor hic fuerat committere classes
et freta navali sollicitare tuba.
Caesaris haec nostri pars est quota? vidit in undis
et Thetis ignotas et Galatea feras;
vidit in aequoreo ferventes pulvere currus
et domini Triton isse putavit equos:
dumque parat saevis ratibus fera proelia Nereus,
horruit in liquidis ire pedestris aquis.
quidquid et in Circo spectatur et Amphitheatro,
id dives, Caesar, praestitit unda tibi.
Fucinus et *tigri* taceantur stagna Neronis:
hanc norint unam saecula naumachiam

It had been Augustus' labor to pit fleets against each other here and rouse the waters with naval clarion. How small a part is this of our Caesar! Thetis and Galatea saw in the waves beasts they never knew. Triton saw chariots in hot career in the sea's dust and thought his master's horses had passed by. As Nereus prepared fierce battle for ferocious ships, he was startled to find himself walking on foot in the liquid expanse. Whatever is viewed in the Circus and the Amphitheatre, that, Caesar, the wealth of your water has afforded you. So no more of Fucinus and the lake of direful Nero; let this be the only sea fight known to posterity.¹⁴

Suetonius then, as far as we can currently establish, is our only source of information on the existence of this spectacular Triton. Still, the technology required for its construction, manual triggering, and subsequent autonomous operation was well within the gamut of the inventors of the time, possibly Heron of Alexandria who lived in the 1st century CE

amphitheatre in the same location for the enjoyment of the public in *Spec.* 2.5-6: *hie ubi conspicui venerabilis amphitheatri / erigitur moles, stagna Neronis erant* (here, where the distinctive amphitheatre raises its awesome bulk, Nero used to have his pools; text and translation reproduced from Coleman, *ibid.*).

¹⁴ Martial's Latin text quoted above and its translation is from Bailey 1993 (cit. note 11), pp. 36-7.

(see pp. 8-9 below on Heron's dates). Even if not Heron, another engineer, completely unknown, could have achieved the feat by applying techniques known at least since Ctesibius of Alexandria (fl. 270 BCE) and Philon of Byzantium (c. 280–220 BCE).¹⁵

Vitruvius, a key source on the importance of theatrical machinery under the Roman Empire, remarks upon the year-long efforts of the Roman praetors and aediles who prepared the machinery for the spectacles.¹⁶ Suetonius specifically refers to Claudius' predilection for such machines by noting that, in the event of operational failure, the emperor would punish the carpenters and other stage workers responsible for the impeccable function of the automatic devices commissioned for his spectacles, by forcing them to fight in the arena.¹⁷ Suetonius' reference is to be read as a sure indication of Claudius' cruelty and bloodthirstiness (*saevum et sanguinarium natura*; *Claud.* 34.1.1) which, according to him, manifested itself equally in small and great matters and, therefore, of his substandard performance as an emperor, which is in keeping with Suetonius' overall undermining of Claudius as the fool who scorned his own son, Britannicus, to allow Nero to become an emperor.¹⁸ His spectacle on the lake Fucine was clearly remembered, but most probably so was his failure to deliver the draining of the lake which then could imply that Suetonius' reference to the silver Triton is perhaps

¹⁵ *Vitr. Arch.* 5.7 [in Morris H. Morgan and Herbert L. Warren, *Marcus Vitruvius Pollio: The Ten Books on Architecture* (Cambridge: Harvard University Press, 1914)], and Pollux iv.126-7 and 130-132 [in Wilhelm Dindorf, *Iulii Pollucis Onomasticon: Cum Annotationibus Interpretum* (Leipzig: Kuehn, 1824)], refer to a number of Greek theatrical devices that were adopted by the Romans. All subsequent citations of Vitruvius and Pollux follow the editions detailed here.

¹⁶ *Vitr. Arch.*, 10 Praef. 3.

¹⁷ *Suet. Claud.* 34.2.5-6.

¹⁸ It is not accidental that, according to Suetonius, "At any gladiatorial show, either his own or another's, he gave orders that even those who fell accidentally should be slain, in particular the net-fighters, so that he could watch their faces as they died" [*Claud.* 34.1.7-10, trans. Rolfe 1914 (cit. note 6), vol.2, p. 65] unlike Augustus, the unequivocal model of a worthy Roman emperor, whom Suetonius described precisely as banning gladiatorial contests if the defeated were forbidden to plead for mercy (*Aug.* 45.3.4-5). For Nero's role in the possible murder of Claudius, see *Suet. Ner.* 33 passim. Also, see Hurley 2001 (cit. note 7), p. 148 discussing *spectacula* as occasions which further established Claudius' reputation as a fool; also, see her pp. 125-6.

ironic. Importantly, Suetonius writes here *automatum*¹⁹ – automatic devices or machines (cf. Greek / English *automata*) – a subject that both Heron and Philon have detailed for posterity.²⁰

Heron may have been active around the period of Claudius although the evidence is circumstantial. After many years of previous scholarly debate over Heron's dates, in 1938 Neugebauer argued that Heron's reference to an eclipse of the moon in his work *Dioptra* (chapter 35) probably referred to a real event that took place on March 13, 62 CE and therefore, he concluded, Heron should be dated in the late first century CE.²¹ Sidoli

¹⁹ Apart from automata, Suetonius also refers to *pegma*, a kind of flying device mentioned by Juvenal; see *Juv. Sat.* 4.122 [in George G. Ramsay, *Juvenal and Persius* (London & Cambridge, MA: Heinemann & Harvard University Press, 1918)]; see Richard C. Beacham, *The Roman Theatre and Its Audience* (Cambridge, MA: Harvard University Press, 1991), pp. 180-181.

²⁰ See Susan Murphy, "Heron of Alexandria's on Automaton-Making," *History of Technology*, 1995, 17:1-44, p. 3 and 28 = *Hero. Autom.* 2.20; also see Heron's *Pneumatics* for which one should consult Marie Boas, "Heron's Pneumatica: A Study of Its Transmission and Influence," *Isis*, 1949, 40: 38-48: *passim*. On Philo, see Frank D. Prager, *Philo of Byzantium, Pneumatica, the First Treatise on Experimental Physics: Western Version and Eastern Version* (Wiesbaden: Dr. Ludwig Reichert Verlag, 1974).

²¹ Otto E. Neugebauer, "Über Eine Methode Zur Distanzbestimmung Alexandria – Rom Bei Heron," *Kongelige Danske Videnskabernes Selskabs Skrifter*, 1938, 26: 21-24; cf. Gilbert Argoud. "Héron d'Alexandrie et les 'Pneumatiques'" in *Sciences exactes et sciences appliquées à Alexandrie*, edited by Gilbert Argoud et Jean-Yves Guillaumin (Saint-Étienne: Publications de l'Université de Saint-Étienne, 1998), pp. 127-145, pp. 127-8. Nathan Sidoli, "Heron's Dioptra 35 and analemma methods: An astronomical Determination of the Distance between two Cities," *Centaurus*, 2011, 47: 236–258 where he eventually agrees with Neugebauer, having revised his own arguments against Neugebauer's association of the text of *Dioptra* 35 with the eclipse of 62 CE in "Heron of Alexandria's Date," *Centaurus*, 2011, 53: 55-61, esp. p. 57. Also, see Pierre Souffrin, "Remarques sur la datation de la "Dioptre" d'Héron par l'éclipse de lune de 62," in *Autour de LA DIOPTRE d'Héron d'Alexandrie*, edited by Gilbert Argoud, and Jean-Yves Guillaumin (Saint-Étienne: Publications de l'Université de Saint-Étienne), pp. 13-17 who remains sceptical about the evidence. Ramon Masià, "On Dating Hero of Alexandria" *Archive for History of Exact Sciences* 2015, 69.3: pp. 231-55, pp. 231-2 and 243-6 argues that the identification of the eclipse of 62 CE with the one mentioned in *Dioptra* 35 and used to date Heron is by no means secure (see his p. 52). Masià, who revises the arguments of both Sidoli and Souffrin (pp. 232-5 with nn. 2, 5 and 13), charges the latter with adopting a probabilistic approach. Cf. Dimitris Raïos, "La date d'Héron d'Alexandrie: témoignages internes et cadre historico-culturel," in *Autour de LA DIOPTRE d'Héron d'Alexandrie*, edited by Gilbert

has questioned this recently, preferring to treat the eclipse as a *terminus post quem* for Heron's work.²² Taking a different tack, Keyser provides useful discussion on dating Heron by reference to new kinds of *hydraulica* (water organs) mentioned in Suetonius' history that may well have been Heron's²³ (fig.1) – further evidence that pneumatics from Alexandria was known and of interest at the highest levels of Imperial Rome late in the 1st century CE.²⁴ Lewis has argued that Heron was still alive in 84 CE when the *cheiromballistra*, a Roman siege engine attributed to him, was first introduced.²⁵ Importantly, additional evidence suggesting that Heron was likely active during the 1st century CE is adduced from *Pneumatics* 1.21 where mention is made of a pentadrachm, a five drachms coin which was in circulation under Cleopatra VII (69-30 BCE) and then again under Nero (37-68 CE) and was apparently used to operate one of Heron's machines:²⁶

Argoud, and Jean-Yves Guillaumin, (Saint-Étienne: Publications de l'Université de Saint-Étienne), pp. 19–36, pp. 19 and 32-33.

²² Sidoli 2011 (cit. note 21) with Masià 2015 (cit. note 21), pp. 232-3 and Raïos 2000 (cit. note 21), pp. 32-3; cf. Tybjerg 2003 (cit. note 9), p. 444n.2 and *ibid.* 2005 (also, cit. note 9), p. 205.

²³ See Suet. *Ner.* 41.2.5-7 and Woodcroft 1851 (cit. note 7), sects. 76, 77 on pp. 105-9.

²⁴ Paul Keyser, "Suetonius 'Nero' 41. 2 and the Date of Heron Mechanicus of Alexandria," *Classical Philology*, 1988, 83:218-220, pp. 218-220; Keyser estimates that the *Pneumatics* was written in 65±3 CE. Note that the lake was drained in 52 CE and the *Dioptra* was written post 62 CE; Raïos 2000 (cit. note 21), pp. 19 and 36 [where he estimates the publication of the *Pneumatics* before 68 CE] and Markus Asper, "Dionysios (Heron.Def.14.3) und die Datierung Herons von Alexandria," *Hermes*, 2001, 129.1, 135-7, p. 136-7 both date Heron at the time of Nero, stressing (especially Raïos) the intense interest of the extravagant emperor in mechanical and engineering advances; cf. Manuela Rausch, *Heron von Alexandria: die Automatentheater und die Erfindung der ersten antiken Programmsteuerung* (Hamburg: Diplomica Verlag, 2012), pp. 12-14.

²⁵ Michael J.T. Lewis, *Surveying Instruments of Greece and Rome* (Cambridge: Cambridge University Press, 2001), p. 54.

²⁶ *Pneum.* 1.21 in Schmidt 1899 (cit. note 7), p. 110. See Olivier Picard, "À La Recherche Du Pentadrachme d'Héron d'Alexandrie," in *Aegyptiaca Serta in Soheir Bakhom Memoriam: Mélanges De Numismatique, D'iconographie et D'histoire*, edited by D. Gerin, A. Geissen, and M. Amandry (Milano: Ennerre, 2008), pp. 39-43; also, Gilbert Argoud 1998 (cit. note 21), p. 134; cf. Catharine C. Lorber, "The Coinage of the Ptolemies," in *The Oxford Handbook of Greek and Roman Coinage*, edited by William E. Metcalf (Oxford: Oxford University Press, 2012), pp. 211-251, pp. 224 and 22; Klaus Maresch, "Bronze

εἰς ἓνια σπονδεῖα, πενταδράχμου νομίσματος ἐμβληθέντος, ὕδωρ ἀπορρέει εἰς τὸ περιρραίνεσθαι.

In some libation vases, after a five-drachm coin has been inserted, water streams out and flows around.



Figure 1. Musicians playing the hydraulis (water organ) and the salpinx. 1st century BCE, Alexandria. H. 13 cm. Gréau collection, 1891. Department of Greek, Etruscan, and Roman Antiquities, Louvre, CA 426. The hydraulis was invented in the 3rd c. BCE by Ctesibius, a predecessor of Heron at Alexandria; see *Vitr. Arch.* 10.7. Image © Marie-Lan Nguyen / Wikimedia Commons. Used under license CC-BY 2.5.

Mechanical contraptions have been written explicitly into stage plays since the Greek theatrical works of the 5th century BCE.²⁷ Some early theatrical technology, for instance

Und Silber. Papyrologische Beiträge Zur Geschichte Der Währung Im Ptolemäischen Und Römischen Ägypten Bis Zum 2.," in *Jahrhunderts. n. Chr., Papyrologica Coloniensia XXV* (Opladen: Westdeutscher Verlag, 1996), pp. 96-97.

²⁷ See, for example, Graham Ley, "A Material World: Costume, Properties and Scenic Effects," in *Cambridge Companion to Greek and Roman Theatre*, edited by Marianne McDonald and Michael Walton (Cambridge: Cambridge University Press, 2007), pp. 268-285, pp. 273-28; Margarete Bieber, *The History*

the *mechane* (μηχανή, crane) was used to orchestrate the capricious arrivals and departures of the gods themselves. But, by Roman times, other characters could also claim impressive mechanically assisted stage arrivals and exits.²⁸ Technology was also employed for Roman theatrical spectacle to rapidly change sets, to create seemingly magical effects, or even to flood areas.²⁹ Consequently, the emergence from beneath the water of silver Triton, before thousands of enthusiastic onlookers waiting for a bloodbath, sits naturally within the eager adoption of technological advances by Roman emperors, as powerful symbols of their ability to surpass their predecessors, convince their subjects of their imperial command and silence their enemies.³⁰

Furthermore, Roman audiences, eager for ever more dramatic displays of political power, massed to the astonishing public events and immense spectacles organized by emperors and other public figures. These also employed technological wizardry for theatrical effect; for instance, Caligula rode a horse on a ship-borne bridge across the Bay of Naples.³¹ Technology contributed to imperial Roman architectural spectacle too; a

of the Greek and Roman Theater (Princeton, NJ: Princeton University Press, 1961), pp. 74-7; Peter Arnott, *Greek Scenic Conventions in the Fifth Century B.C.* (Oxford: Clarendon Press, 1962), pp. 72-90.

²⁸ Fritz Graf, "Religion and Drama," in *Cambridge Companion to Greek and Roman Theatre*, edited by Marianne McDonald and Michael Walton (Cambridge: Cambridge University Press, 2007), pp. 55-72, pp. 64-6; Donald J. Mastrorarde, *The Art of Euripides: Dramatic Technique and Social Context* (Cambridge: Cambridge University Press, 2010), pp. 181-184; also, see note 19 above.

²⁹ Cf. note 14 above; also, Beacham, *The Roman Theatre and Its Audience*, pp. 168-17; Richard C. Beacham, "Heron of Alexandria's 'Toy Theatre' Automaton: Reality, Allusion and Illusion," in *Theatre, Performance and Analogue Technology. Historical Interfaces and Intermedialities*, edited by Kara Reilly (New York: Palgrave Macmillan, 2013), pp. 15-39, pp. 30-3; Stephen di Benedetto, *An Introduction to Theatre Design* (New York: Routledge, 2013), pp. 27-28.

³⁰ Coleman 1993 (cit. note 5), esp. p. 49 refers to: "...an aspect of the Roman *mentalité* which is largely alien to our modern outlook: a passion for novel and elaborate ways of mounting spectacle, which in turn generates the notion of enhancing mortal combat by staging it in a theatrical setting." Also, see her pp. 68-9 where she discusses the integral role of aquatic displays in imperial ideology, especially in cases where the emperor is seen to perform what would be regarded as an impossibility (an *adynaton*). A sea-battle performed in a land-locked city would be exactly the kind of *adynaton* that would give the emperor an ideal opportunity to pose as a miracle-worker, a man who defies natural laws.

³¹ Suet. *Cal.* 19.1; Cary and Foster, Dio. 59.17.1, 3. For further examples see Dean Hammer, "Roman Spectacle Entertainments and the Technology of Reality," *Arethusa*, 2010, 43:63-86: *passim*.

slave-powered, or possibly water-powered, revolving ceiling was incorporated into the main banquet hall of Nero's *Domus Aurea*.³² The vault, mimicking the movement of the heavens, was designed and built for the emperor by architect/engineers Severus and Celer³³ and decorated by the artist Fabullus.³⁴ The abundance of this gimmickry in Rome supports the authenticity of the silver Triton described by Suetonius.

Claudius' Triton, a representation of the fish-tailed, mythic son of Poseidon and Amphitrite, was made of silver.³⁵ Silver-white has been used to render sea-creatures in paintings and frescoes since Minoan times.³⁶ Since Triton was typically imagined as half-fish, his artistic representation in silver is sensible.³⁷ The silver Triton also calls to mind

³² Suet. *Ner.* 31.2.2-4; also, see Raños 2000 (cit. note 20), pp. 21-22.

³³ William Lloyd MacDonald, *The Architecture of the Roman Empire: An Introductory Study* (Yale: Yale University Press, 1982), pp. 126-129.

³⁴ Richard C. Beacham, *Spectacle Entertainments of Early Imperial Rome* (Yale: Yale University Press, 1999), p. 225 citing Plin. *N.H.* 35.120 Another public technological/architectural work, Andronicus of Cyrrhus' *horologium* (known colloquially as the Tower of the Winds) in the Roman Agora at Athens was also animated externally by a metal triton, this one a bronze weathervane (Vitr. *Arch.*, 1.6.4). The construction predates Nero and Claudius being from, at the latest, the middle of the first century BCE, possibly as early as the 2nd century BCE but was of interest to the Romans as indicated by Varro, *De Re Rustica* 3.5.17 (in William D. Hooper and Harrison B. Ash, *M. Porcius Cato and M. Terentius Varro on Agriculture* (London & Cambridge, MA: Heinemann & Harvard University Press, 1934)]. Also, see Hermann J. Kienast, "The Tower of the Winds in Athens: Hellenistic or Roman?," in *The Romanization of Athens*, edited by Michael C. Hoff and Susan I. Rotroff (Oxford: Oxford University Press, 1997), pp. 53-66, p. 56 and *ibid.* *Der Turm der Winde in Athen* (Wiesbaden: Verlag) pp. 6-7. According to Marcus Cetus Faventinus, *Liber Artis Architectonicae* 2 [in Hugh Plommer, *Vitruvius and Later Roman Building Manuals* (Cambridge: Cambridge University Press, 1973), p.2] a copy of this Triton-shaped vane existed somewhere in Rome.

³⁵ Our sources mention that Triton lived with his parents in a golden palace; see Hes. *Th.* 930 [in Hugh G. Evelyn-White, *Hesiod. The Homeric Hymns and Homeric. Theogony* (Cambridge, MA & London: Harvard University Press & William Heinemann Ltd., 1914); pseudo-Apollod. *Bibl.* 1.4.5 [in George Frazer, *Apollodorus: The Library in 2 Volumes.* (Cambridge, MA & London: Harvard University Press & William Heinemann Ltd., 1921)]. All references to pseudo-Apollodorus follow Frazer's edition.

³⁶ Gill 1985, *Marine Animals in Minoan Art*, pp. 65, 67, 71 (cit. note 7).

³⁷ In the course of discussing the Triton represented in the temple of Dionysus in Tanagra, Pausanias (9.21.1) is reminded of another Triton that he saw "among the wonders (*θαύμασι*) of Rome, less in size than the one at Tanagra." He then turns to a generic description of Tritons as follows: *ἔχουσιν ἐπὶ τῇ κεφαλῇ*

the golden handmaidens, workshop assistants at the beck-and-call of the god Hephaestus.³⁸ They are also reminiscent of king Minos' bronze giant, Talos, responsible for guarding Crete.³⁹ Each of these metallic beings we assume to be crafted by the labours of Hephaestus at his forge and anvil and to have similarly superhuman traits. Therefore, having such a creature as the Triton, a wonder of artistic craftsmanship perceived as partaking of divine skill (see n.37 below), heralding a public event, the emperor could effortlessly promote his exclusive access to the art of miracle working.⁴⁰

κόμην οἷα τὰ βατράχια τὰ ἐν ταῖς λίμναις χροάν τε καὶ ὅτι τῶν τριχῶν οὐκ ἂν ἀποκρίναις μίαν ἀπὸ τῶν ἄλλων, τὸ δὲ λοιπὸν σῶμα φολίδι λεπτῇ πέφρικέ σφισι κατὰ ἰχθὺν ῥίνην. βράγχια δὲ ὑπὸ τοῖς ὤσιν ἔχουσι καὶ ῥῖνα ἀνθρώπου, στόμα δὲ εὐρύτερον καὶ ὀδόντας θηρίου: τὰ δὲ ὄμματα ἐμοὶ δοκεῖν γλαυκὰ καὶ χεῖρες εἶσιν αὐτοῖς καὶ δάκτυλοι καὶ ὄνυχες τοῖς ἐπιθέμασιν ἐμφερεῖς τῶν κόχλων: ὑπὸ δὲ τὸ στέρνον καὶ τὴν γαστέρα οὐρά σφισιν ἀντὶ ποδῶν οἷα περ τοῖς δελφῖσιν ἐστίν. On their heads they grow hair like that of marsh frogs not only in color, but also in the impossibility of separating one hair from another. The rest of their body is rough with fine scales just as is the shark. Under their ears they have gills and a man's nose; but the mouth is broader and the teeth are those of a beast. Their eyes seem to me blue, and they have hands, fingers, and nails like the shells of the murex. Under the breast and belly is a tail like a dolphin's instead of feet. [for the text, see Friedrich Spiro, *Pausanias. Pausaniae Graeciae Descriptio in 3 Volumes*. (Leipzig: Teubner, 1903); trans. William H. S. Jones, *Pausanias. Pausanias Description of Greece with an English Translation, Vol. IV* (Cambridge, MA: Harvard University Press, 1935), p. 259. By the time of Pausanias Tritons are appreciated as wonders of nature which often inspire wonders of artistic craftsmanship and this is certainly the spirit in which the above extract is discussed; see Alexia Petsalis-Diomidis, *Truly Beyond Wonders: Aelius Aristides and the Cult of Asklepios* (Oxford: Oxford University Press, 2010), p. 166 who discusses Pausanias' text in light of ancient religious miracles; cf. *Orph. h.* 24.4 [in Apostolos Athanassakis and Benjamin M. Wolkow, *The Orphic Hymns* (Baltimore: John Hopkins University Press, 2013, pp. 23 and 115)] and Pliny, *H.N.* 36.4.7 [in John Bostock and Henry T. Riley, *Pliny the Elder: The Natural History* (London: Taylor and Francis, 1855)]. All Pausanias' references follow Spiro, cited above.

³⁸ See Hom. *Il.* 18.410-20 [in Augustus T. Murray, *Homer. The Iliad in Two Volumes* (London & New York: William Heinemann & G.P. Putnam's Sons, 1925)].

³⁹ See Ap.Rhod. *Arg.* 4.1638ff. [in George W. Mooney, *Apollonius Rhodius: Argonautica* (London: Longmans, Green, 1912)]; pseudo-Apollod. *Bibl.* 1.40; Paus. 8.53.5.

⁴⁰ One need only remember how popular Homer remained under the Roman Empire when he was enveloped with the aura of an ancient sage; see Carles Miralles, "Memória I Ûs Dels Textos," in *Three Centuries of Greek Culture under the Roman Empire, Homo Romanus Graeca Oratione*, edited by Francesca Mestre and Pilar Gómez (Barcelona: University of Barcelona Publications, 2014), pp. 155-164, p. 16; Lawrence Kim, *Homer between History and Fiction in Imperial Greek Literature* (Cambridge:

The workings of a Triton *automaton*

A standard pose for Triton is repeatedly suggested by the art of imperial Rome. He is usually represented with his torso upright and his tail(s) flowing to either side. His conch, when it is depicted, is often held horizontally by one outstretched arm (fig. 2).⁴¹ This arrangement, as we show below, is well suited to a sounding automaton. We have no reason to imagine a non-standard pose for the figure. The figure would work best if it was sufficiently large to have been visible from shore – arguably, the bigger the better.

Among many devices he documents in the *Pneumatica*, Heron of Alexandria describes several components suitable for governing the Claudian Triton's performance. Heron specifically outlines many automated horn, pipe and whistle blowing devices, a trick that had been executed possibly even earlier than mid-fourth century BCE by Plato.⁴² Of particular interest is Heron's design for a Triton blowing a salpinx.⁴³ Unsurprising, the engineer had considered the theme. Arguably it was an obvious theme,

Cambridge University Press, 2010; Froma I. Zeitlin, "Visions and Revisions of Homer," in *Being Greek under Rome: Cultural Identity, the Second Sophistic and the Development of the Empire*, edited by Simon Goldhill (Cambridge: Cambridge University Press, 2003), pp. 195-268.

⁴¹ Examples include: a bronze Triton furniture applique, dated 1st century BCE/CE (Durand collection, 1825. Department of Greek, Etruscan, and Roman Antiquities. Br 518. Louvre, available at http://cartelen.louvre.fr/cartelen/visite?srv=car_not_frame&idNotice=9515&langue=en); a Triton with conch in Imperial Roman mosaic now in the Bardo National Museum, Tunis, Tunisia (www.theoi.com/Gallery/Z34.9.html; accessed 12/3/2017); a Triton in the mosaic of Neptune, Terme di Nettuno (II,IV,2) room 4, Ostia (fig. 2) detailed in Giovanni Becatti, *Scavi di Ostia IV: Mosaici e pavimenti marmorei* (Rome: Libreria dello Stato, 1961), Tav. CXXIV. Also, a Triton painting in Casa degli Amanti, Pompeii, in the north wall of cubiculum, detailed in Irene Bragantini, Mariette de Vos et Franca Parise Badoni, *Pitture e pavimenti di Pompei. Parte I. Regioni I, II, III* (Rome: ICCD, 1981), Pt. 1, p. 141, available at www.pompeiiinpictures.com/pompeiiinpictures/R1/1_2010_2011_20p6.htm (accessed 12/3/2017).

⁴² See Ath. *Deipn.* 4.174e-175b [in Charles Burton Gulick, *Athenaeus: The Deipnosophists. vol II, Books 3.106e-5* (Cambridge, Mass.: Harvard University Press, 2002)]. All references to Athenaeus follow this edition.

⁴³ Woodcroft 1851 (cit. note 7), sect. 75 on pp. 103-4; Schmidt 1899 (cit. note 7), *Pneum.* 2.9 on pp. 224, 226.

along with singing birds, human trumpeters, and hissing dragons, for the application of his pneumatics.⁴⁴

As mentioned above (p. 1 with n. 2), Hellenistic kings had a predilection for grand designs and the Ptolemies at Alexandria were certainly shaping Hellenistic aesthetics. One is reminded of Ptolemy IV Philopator's enormous galley, the "Forty" and of course, the famous Pharos. Much ingenuity was also channelled into divine representations such as the statue of Helios in the Serapeion, built by Ptolemy III Euergetes, which was reportedly suspended in mid-air using magnets, a spectacle that overwhelmed worshippers.⁴⁵ Ptolemy II Philadelphos also commissioned a four-metre-tall automaton representing Nysa, which Kallixeinos of Rhodes describes as part of the remarkable procession of 270 BC.⁴⁶ Drawn on a cart by sixty men and adorned with gold, it could rise to its feet, pour a libation, and sit down again unaided. Taking into account the Dionysian apparatus of the Nysa *automaton* and Heron's preoccupation with Dionysian themes in many of his inventions, Bosak-Schroeder argued that: "This *automaton* [i.e. that of Nysa] might not have been truly mechanical, but it is reasonable to think that Heron was both inspired by the form of this *automaton* and intended his treatises to contribute to the proliferation of *automata* in royal processions."⁴⁷ In addition,

⁴⁴ See Marylène Lebrère, "L'artificialisation des sons de la nature dans les sanctuaires à automates d'Alexandrie, du iii^e s. av. J.-C. au i^{er} s. apr. J.-C.," *Pallas*, 2015, 98: 31-53, pp. 38-43 describing a number of Heron's *automata*; cf. Gilbert Argoud 1998 (cit. note 21), pp. 130-7.

⁴⁵ Rufinus, *Historia Ecclesiastica* 2.23 [Latin text by Theodor Mommsen in Eduard Schwartz, *Eusebius, Werke 2, Die Kirchengeschichte Ant, Die Lateinische Übersetzung Des Rufinus* (Leipzig: Hinrichs, 1908)].

⁴⁶ Ath. *Deipn.* 5.198-9. Also, see Ellen E. Rice, *The Grand Procession of Ptolemy Philadelphus* (Oxford: Oxford University Press, 1983), pp. 62-8 (on the Nysa *automaton*) and 138-50 (where she argues that Athenaeus reproduced accurately Kallixeinos' text); Teun Koetsier and Handried Kerle, "The Automaton Nysa: Mechanism Design in Alexandria in the 3rd Century BCE," in *Essays on the History of Mechanical Engineering*, edited by Francesco Sorge and Giuseppe Genchi (Switzerland: Springer, 2015) pp. 347-366, pp. 348-9 where they emphasize the procession as an ideal opportunity for the Ptolemies to showcase their ability to achieve the impossible and thus, strengthen their claims to royalty; cf. Lebrère 2012 (cit. note 44), pp. 43 and Hélène Fragaki, "Automates et statues merveilleuses dans l'Alexandrie antique," *Journal des Savants*, 2012, 62.1: 29-67, p.62.

⁴⁷ Clara Boysak-Schroeder, "The Religious Life of Greek *automata*," *Archiv für Religionsgeschichte*, 2016, 17.1: 123-136, p. 126. Other automata in Hellenistic and later processions include Demetrios of Phaleron's

several devices described by Heron are explicitly lowered into water to generate their sound. Accordingly, here is our proposal outlining how the Triton described by Suetonius could work by applying only principles detailed in Heron's treatises.

(i) Triton's emergence

The Triton's appearance from beneath the water's surface could have been achieved by a theatrical *mechane*⁴⁸ mounted on shore or a barge. Alternatively, the Triton might have been raised from below, or, if properly sealed prior to its release it might have been sufficiently buoyant to rise of its own accord.⁴⁹ Of these options, the *mechane* has the benefit of simplicity, is in keeping with the theatrical conventions of the period, and fits Suetonius' description literally. Although possible designs and dynamics of a complex *mechane* have been discussed recently in scholarship,⁵⁰ very little manoeuvrability would be required for Claudius' application since the Triton needed only to be lifted directly from beneath the water surface. This is quite different to the usual situation in which

mechanical snail, which trailed slime as it moved [Polyb. 12.13.2 in William Roger Paton and revised by Frank William Walbank, *Polybius. The Histories*, Vol. 4 (Cambridge, Mass.: Harvard University Press, 2010)], the bloodied wax statue of Julius Caesar, rotating mechanically above his bier [Polyb. 2.20.147 in William Roger Paton and revised by Frank William Walbank and Christian Habicht, *Polybius. The Histories*, Vol. 1-2 (Cambridge, Mass.: Harvard University Press, 2010)] and the self-propelled ship carrying Athena's *peplos* in Herodes Atticus' Panathenaic procession [Philostr. *VS* 550 in Wilmer, C. Wright, *Philostratus, Lives of the Sophists. Eunapius, Lives of the Philosophers and Sophists* (Cambridge, Mass.: Harvard University Press, 1921), pp. 146, 148.

⁴⁸ See Vitruvius *Arch.*, 10.1.1; Hdt.2.125 [in Karl Hude, *Herodoti Historiae* (Oxford: Clarendon Press, 1927)]; Pollux, *Onom.* iv.126-7 and 130-132; *Cra.* 425d [in Harold N. Fowler, *Plato in Twelve Volumes* (Cambridge, MA & London: Harvard University Press & W. Heinemann Ltd., 1921)]; Arist. *Poet.* 1454b1-4 [vol.23 in William H. Fyfe, *Aristotle in 23 Volumes* (Cambridge, MA & London: Harvard University Press & W. Heinemann Ltd., 1932)].

⁴⁹ To keep the Triton submerged until required it could be anchored via a pin-released cord. Heron used such pins in miniature to (for instance) unhitch stage backdrops and a lightning bolt in his mechanical theatres [Murphy 1995, Heron. *Autom.*, bk. 2, sects. 29.1, 30.5 (cit. note 20)]. To prevent the Triton from capsizing it could easily have been fitted with a counterbalance or keel.

⁵⁰See Thomas G. Chondros, Kypros Milidonis, George Vitzilaios, John Vaitsis, "'Deus-Ex-Machina' Reconstruction in the Athens Theater of Dionysus," *Mechanism and Machine Theory*, 2013, 67: 172–191, pp. 180-9.

human actors on a theatrical stage needed to be raised, moved, and lowered sufficiently carefully to avoid injury and conduct a play. A rope mounted over pulleys and attached to a counterweight would have been sufficient for the Triton. Once the automaton had been raised, the counterweight could be freed to enable Triton to sink of his own accord.



Figure 2. A Triton in the mosaic of Neptune (detail, with keystone correction), rm. 4, Regio II, Insula IV, Terme di Nettuno (II,IV,2) Ostia, Italy. Image © Alan Dorin, 2015.

(ii) Generating the sound of Triton's conch

The principle of Heron's trumpeting Triton is common to many of the devices he describes. Air is forced from a vessel through the only available exit within which is mounted either a whistle, a trumpet with mouthpiece and bell or an organ-pipe.⁵¹ As discussed above (note 7), the salpinx dressed as a conch is the most likely candidate for Triton to sound the call to battle. It is worth remarking on the fact that this instrument requires the human player to vibrate their lips to generate sound. Since Heron's salpinx-blowing devices are often sounded by air forced from a vessel by the entry of water through another orifice, a true salpinx would not suffice for the purpose as there is nothing in the instrument to generate the required oscillations. In the case of Heron's own Triton, pressurised steam is used instead of air, but this does not solve the problem. The

⁵¹ E.g., See: whistle in Woodcroft 1851 (cit. note 7), sects. 14, 48 on pp. 29-30 and 70; trumpet *ibid.*, sect. 16 on p. 32; organ-pipe *ibid.*, sect. 76, 77 on pp. 105-9.

clue to the operation of the device by an automaton is in the type of mouthpiece, a *γλωσσίδα* [*Pneum.*2.35.10, 11 in Schmidt 1899 (cit. note 7), p. 320] which contained a reed (Liddell-Scott, s.v. *γλωττ-ίς, ἴδος* citing specifically Hero *Spir.*1.16 for the mouthpiece of a trumpet). With this in mind, Heron's simple design for *A thyrsus made to whistle by being submerged in water*, is, with only cosmetic modification and a reeded mouthpiece, sufficient as a solution for the Claudian Triton:⁵²

A Thyrsus made to whistle by being submerged in Water. By immersing a thyrsus in water to produce the sound either of a pipe or of any bird. Let A B C D (fig.3), be a thyrsus; and at the extremity of its head, which must be hollow and shaped like a fir-cone, let there be an orifice D. Close the shaft a little below the mouth by the partition A E, and place near it a small pipe, F, just beneath the mouth of the tube, and passing through an orifice in the partition. If we insert the thyrsus in water and force it downwards, the air contained in it being driven out by the water will produce a sound. If there is nothing but the pipe we shall have a whistle only; but if there is any quantity of water under the partition there will be a gurgling sound.

If built in mimicry of this thyrsus, or Heron's door trumpet,⁵³ the air-filled cavity would fit within Triton's torso. Whilst submerged, unless the hole in the conch was initially plugged to trap the air within the figure, the torso would fill with water. It would drain rapidly once raised however, as long as the base was open or well perforated. When the Triton was allowed to sink again, the entrance of water through its base would force air out of the orifice in the conch above the water level. Sound might then be produced by this evacuation using any of the techniques described above. Adding to the theatre of the event, the Triton would sink beneath the waves as it blew its conch, finally disappearing to allow the sea-battle's unencumbered commencement.

⁵² Woodcroft 1851 (cit. note 7), sect. 48, p. 70.

⁵³ *Ibid.*, sect. 17.

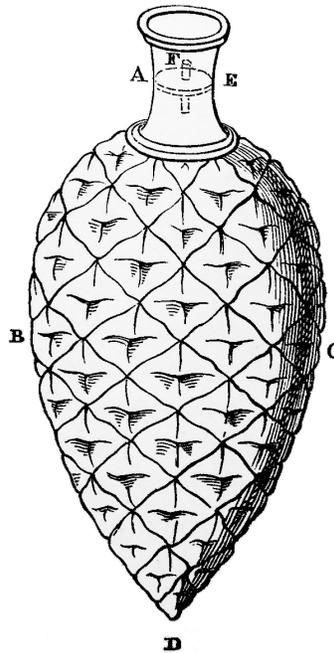


Figure 3. Whistling thyrus from Woodcroft 1851 (cit. note 7), sect. 48 on p. 70. Image in the public domain.

In order to assess the feasibility of the automaton design producing a tone sufficiently loud for its proposed application, we constructed a simple proof of concept (fig. 4). We used a 60 litre cylindrical drum for our air-cavity as this volume is roughly accommodated in the figure of a sculpture approximating a 60 kg human. It easily sits within the volume of a larger than life-sized figure. A lesser cavity volume could be employed just as well if a note of short duration was required.

We cut a 25mm diameter hole into the air-cavity drum's base. Through a second orifice in the drum's upper surface, a straight trumpet was inserted and sealed. The trumpet mouthpiece was fitted with a single reed (see fig. 4, detail). The 2kg drum and trumpet assembly was weighted at its base with 13kg of ballast, an amount determined empirically to be sufficient to act as a stabilizing keel.

Our arrangement generated an even 405 Hz tone for 2 minutes and 5 seconds as it sank. The mean intensity (n=5 measurements) of the tone was 109.8 dBa measured at the trumpet bell. This is very loud, loud enough for the intended application. Additionally,

since the Roman device was sounded across a lake, under many conditions the sound would have been amplified as it travelled across the surface.⁵⁴

The materials we used in our construction were primarily modern blow-moulded plastics. However, nothing specific to the design depends on this. Heron, for instance, recommended the use of metal plate and soldered bronze pipes which would work just as well.⁵⁵ The scale of the Triton is worth discussing briefly. To be effectively viewed from the shore by spectators, it was quite likely an automaton (android) of life-size or greater proportions. We have already seen that large automata were in use for processions. For instance, we referred above to the four-metre Nysa automaton in the procession described by Kallixeinos of Rhodes (note 46). The focus of Heron's *Pneumatics* is on miniatures and models though, and this might be considered as implicit support for the idea that his works were toys, trinkets and gadgets.⁵⁶ However, the hydraulic organs alluded to above were also important "usefully sized" pneumatic contributions to Roman culture.⁵⁷ The fire-engine that Heron describes⁵⁸ was also "useful". In fact, Heron implies it was in use (... οἷς χρῶνται ...). Given the use of large automata for spectacles in Rome, rather than being considered designs for toys, when Heron documents miniature machines he might, sometimes at least, better be regarded as describing prototypes for life-sized practical applications in the world he knew. Of course, in constructing larger versions of these, it may have been discovered that their operation was not scale invariant. In this case at least,

⁵⁴ Peter Goodwin, *How Everyday Things Work: 60 Descriptions and Activities* (Portland, Maine: J. Weston Walch Publisher, 1992), pp. 70-72.

⁵⁵ See, for example, *Pneum.* 1.148.16 on Schmidt 1899 (cit. note 7), p.14, 149.3 (p.18), 7.160.16 (p.56); these would correspond to Woodcroft 1851 (cit. note 7), p. 6 where in discussing the properties of atmospheric air Heron refers to a spherical vessel of metal plate, with a slender tube of metal, p. 7 where in describing a vessel for discharging liquids in varying proportions he refers to a tube soldered into the partition, and p. 10 where in discussing a water jet produced by mechanically compressed air he mentions a metal plate globe-shaped vessel.

⁵⁶ Cf. Gilbert Argoud 1998 (cit. note 21), p. 137: "Tout suggère que les appareils proposés par Héron sont de petite taille, à caractère ludique ;" cf. Gilbert Argoud, "Héron d'Alexandrie et la machine à vapeur," in *Actes du XXVIIIe Congrès A.P.L.A.E.S. Saint-Étienne, 19-21 mai 1995*, edited by Bernard Jacquinod (Saint-Étienne: Publications de l'Université de Saint-Étienne, 1995), pp. 29-38, esp. pp. 37-8.

⁵⁷ Woodcroft 1851 (cit. note 7), sects. 76, 77 on pp. 105-9.

⁵⁸ *Ibid.* sect. 27 on pp. 44-5.

we have demonstrated that the design of an air pressure-operated trumpet-blowing Triton could be effective at life size.

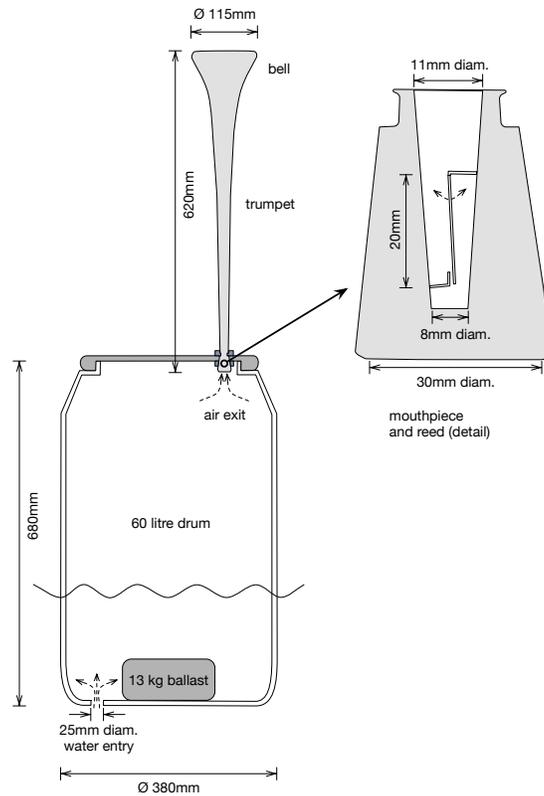


Figure 4. The proposed internal workings of the Triton automaton as reconstructed by the authors and Monash University Instrumentation and Technology Development Facility staff Brett A. Williams and Rod Cutts. The device consists of a 60 litre cylindrical drum with a small orifice in the base and another in the top through which the reed-fitted trumpet is sealed. Ballast fixed inside the vessel ensures that the assembly floats upright when released in water. The trumpet produces a steady 405Hz tone of ~110 dB for 02:05 minutes.

Heron and the pneumatic Triton in the Italian Renaissance

The influence of Heron's *Pneumatics* lasted well beyond the Roman imperial period, being repeatedly consulted by scientists, engineers, automaton-makers and garden water-works designers.⁵⁹ And whilst not bearing directly on the application of his technology to Claudius' automaton, further evidence of the applicability of Heron's pneumatics to the

⁵⁹ E.g., see *ibid.*, sect. 48; cf. Rausch 2012 (cit. note 24), pp. 58-60.

construction of signalling tritons in general, appeared in the Renaissance garden at Pratolino outside of Florence. The garden was designed and built for Francesco I de' Medici by Bernardo Buontalenti in the late 16th century. Many water-powered automaton-equipped grottoes were constructed, their designer taking recent translations of Heron's *Pneumatics*, and their early modern period illustrations, as his template.⁶⁰ The engineers and garden architects of the time also looked for inspiration to the tales of Ovid's *Metamorphoses*,⁶¹ Triton and his conch amongst them. Hence, it is hardly surprising to find that Giovanni Guerra, who visited and sketched the spaces of Pratolino, illustrates the Grotto of Galatea. His annotations explain that within the artificial ruin Triton sounds a beautiful trumpet. At this signal, Galatea emerges.⁶²

Conclusion

Based on the available evidence, Claudius' silver Triton as reported by Suetonius could effectively have been realised with the technology of his time. The ideas documented by Heron of Alexandria are clearly suited to the task. Although in the past Heron's focus on gadgets has been deemed frivolous, and some historians have felt it necessary to explain why he (and his contemporaries) never thought to put them to useful "work",⁶³ this

⁶⁰ Boas, *Hero. Pneum*; *ibid*.

⁶¹ For instance, the French engineer, water-works designer and architect, Salomon de Caus, explicitly advises the study of Homer's *Illiad* and Ovid's *Metamorphoses* (see Matteo Valleriani, "Ancient Pneumatics Transformed During the Early Modern Period," *Nuncius*, 2014, 29:127-173). De Caus provides a detailed design, description and illustrations for a *Grotto of Neptune* in which the god is turned in a water-powered procession led by two conch-blowing tritons; Luke Morgan, *Nature as Model: Salomon De Caus and Early Seventeenth-Century Landscape Design* (Philadelphia: University of Pennsylvania Press, 2007), p. 41.

⁶² See Giovanni Guerra, *Prospettiva Della Grotta Della Galatea* (Vienna, Architektur, Graphische Sammlung, Albertina, 1598), fol. 37216, available at patolino.mpiwg-berlin.mpg.de/imageServer?generic=no&showall=no&group=42&filename=Guerra_GSA_04_Galatea; (accessed 16/3/2017); cf. Salomon de Caus, *Les Raisons Des Forces Mouvantes Avec Diverses Machines Tant Utiles Que Plaisantes: Aus Quelles Sont Adioints Plusieurs Dessesings De Grottes Et Fontaines* (Frankfurt: Jan Norton, 1615), bk. 2, prob. 27.

⁶³ See, for example, Eduard Jan Dijksterhuis, *The Mechanization of the World Picture* (London: Oxford University Press, 1961), vol. I, pp. 93-94.

perspective has been obsolete for some years.⁶⁴ The Claudian Triton is further evidence of the tenuousness of the position. It is a concrete application of technology for audiovisual spectacle. And while material proof that Heron's automatic temple doors, or his holy-water vending machine,⁶⁵ for instance, were ever used in his era to attract patrons to a real temple is absent, the Triton is an important, documented and practical Roman application of the pneumatic principles Heron (and Ctesibius and Philo) explored. Some, perhaps tenuous, material evidence for the application of Heron's pneumatics in ancient Rome beyond the school of Alexandria is potentially found in a bronze *branch with birds* from the House of M. Fabius Rufus, Pompeii.⁶⁶ This is a 25cm high sculpture from the 1st century CE of a shrub divided into several branches. Birds are perched upon three of these in a manner that, it has been proposed, may indicate it was a garden ornament fashioned after Heron's singing fountain.⁶⁷ In all these cases, from temple to garden to spectacle, Heron seems keen to take advantage of his engineering knowledge, hiding the mechanism of his inventions to heighten their effect on the spectator. As Bosak-Shroeder argued: "Making these devices seem magical makes Heron seem like a magician, maybe even a divine magician like Hephaestus, and it allows those who build and use his automata to *associate* themselves with Hephaestus' powers."⁶⁸ The Triton then, fits coherently among the tendencies of Claudius as documented by Suetonius and other Roman historians, and is in step with the general application of technology for

⁶⁴ See Tybjerg 2003 and 2005 (cit. note 9), Bosak-Shroeder 2016 (cit. note 47), p. 128-30 and others have drawn attention to Heron's considerable contribution to the cultural demand of his time for religious miracles as well as his defence of engineering as a practical strand of ancient philosophy. Also, see Lebrère 2015 (cit. n. 44), pp. 43-5 who stresses the important role of the *automata* in the royal agenda of the Ptolemies and Bernard Vitrac, "Mécanique et mathématiques à Alexandrie: le cas de Héron," *Oriens-Occidens*, 2009, 7: 155-199, esp. p. 158, 168-9, 191-5.

⁶⁵ Woodcroft 1851 (cit. note 7), sects. 21, 37, 38 and 21 on pp. 37 and 57-60.

⁶⁶ Superintendency of Archaeology, Pompeii. Inv. 14142.

⁶⁷ Rita Amedick, "Il 'Cosmo' Artificiale Degli Automi," in *Eureka! Il Genio Degli Antichi*, edited by Eugenio Lo Sardo (Napoli, Italia: Electa Napoli, 2005), pp. 125-143, p. 134.

⁶⁸ Bosak-Shroeder 2016 (cit. note 47), p. 128; cf. Tybjerg 2003 (cit. note 9), p. 451 also cited by Bosak-Shroeder, *ibid*; also, Annie Bonnafé, *Poésie, nature et sacré I. Homère, Hésiode et le sentiment grec de la nature* (Lyon: Maison de l'Orient, 1984), p. 101 also cited by Lebrère 2015 (cit. n. 44), p. 43; cf. Gilbert Argoud 1998 (cit. note 21), p. 134.

spectacle by imperial Roman leaders. It is unfortunate that we know of no alternate sources in support of Suetonius' account of the figure, but even without this, there is little reason to doubt its authenticity. It provides further evidence of the willingness of the Romans to put the science and technology of their time into practice.

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