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REPAIR, RECYCLE OR MODIFY? THE RESPONSE TO DAMAGE AND/OR OBSOLESCENCE IN MYCENAEAN METAL VESSELS DURING THE PREPALATIAL AND PALATIAL PERIODS AND ITS IMPLICATIONS FOR UNDERSTANDING METAL RECYCLING

Stephanie Aulsebrook

Summary

Metals differ from other materials, with the exception of glass, because they can be melted down for recycling. This property gives metals an intrinsic value that is important for understanding their utilisation within past societies. Despite its significance, this form of metal recycling is hard to study as it is almost completely archaeologically invisible. Direct evidence is limited to deliberately fragmented metal objects, especially those found within the vicinity of a hearth or furnace, and written sources. Therefore it is difficult to assess the factors influencing recycling or the quantity of metal involved. This paper examines whether this type of metal recycling can be better understood by investigating circumstances where recycling was rejected, and repair or modification took place instead. Previous research has demonstrated that this occurred in a small minority of metal vessels from the Late Bronze Age Prepalatial and Palatial Mycenaean Greek mainland. The presence of repairs and modifications is here compared against aspects of these vessels' object biographies – including material, form, find location and chronology – to see whether these influenced the decision made against recycling. Only one modified vessel was found in this dataset, although repaired vessels were slightly more common. Repairs were mainly associated with particular types of large copper-alloy vessels that appear to have been primarily prized for their function rather than aesthetic appeal. Many repairs were apparently linked to the prioritisation of other production factors over the final vessel appearance. Generally vessels of precious metals and lead were not repaired, nor were certain copper-alloy vessel forms. It is suggested that these were typically recycled instead, with different chains of reasoning leading to the same choice. The single example in this dataset of a repaired silver cup may be related to a unique object biography that involved an especially close personal bond.

INTRODUCTION

Any artefact may incur damage during its manufacture and subsequent use. Sometimes this renders objects unusable and the broken remains are discarded. Three alternative courses of action are available: to repair the object to restore its original function; to recycle salvageable parts for another purpose; or to modify the object to address the effect of the damage. Of course it is not necessary for objects to be damaged in order to be considered obsolete. Changes in taste and fashion can affect the treatment of objects in a comparable way, or they may become out dated through technological change. The available responses are similar: discard, recycle or modify.

The study of these decisions can be structured using the concept of object biographies. Kopytoff (1986) was the first to suggest using the framework of a biography to systematically study the 'lives' of objects, with the intention of establishing a new approach for the investigation of the process of commoditisation and the movement of things between spheres of exchange. Since then, the usage of object biographies has moved beyond the issue of commoditisation and they have been applied to a variety of research questions. The term object biography can be understood as describing the changes in values and performances associated with an artefact (Hurcombe 2007, 41). Its trajectory is not necessarily linear (Joy 2009, 543). Object biographies are not just an archaeological tool; for instance, as part of the vertical and horizontal transmission of objects in the Homeric epics, the recounting of the genealogies of owners is a frequent occurrence and individuals are often linked to specific objects in their possession (Bennet 2004, 93, 95). Therefore, the object biography also represents a way in which some past societies may have conceptualised certain forms of material culture.

It is not possible, using the evidence available from the Prepalatial and Palatial Mycenaean metal vessels, to reconstruct a traditional narrative-style biography but, even within prehistoric and proto-historic societies, specific events and typical biographies can still be identified (Kopytoff 1986, 66; Joy 2009, 543-545). This is a similar concept to the social history of things, which concentrates on the long-term (Appadurai 1986, 34). Within the object biography framework, repair and modification can be seen as the realisation of a desire to extend the social life of an object (Jennings 2014, 170). Discard would mark the intention to end an object's social life. Recycling is more complex; its effect upon the biography of an object is dependent upon the surrounding circumstances, as discussed below.

One characteristic that sets metals apart from other materials in use during the Bronze Age (excepting glass) is their convertibility; the ability to turn metalwork, at any point in its lifecycle, back into raw metal. This means that, as well as recycling through re-use, metal artefacts can be melted down so that all trace of their former purpose is lost. It is this form of metal recycling that is under study here. The convertibility of metals means every piece of metalwork has a bullion value, which encourages individuals to recycle rather than discard. The object biographies of metal and glass artefacts can therefore be very different to objects manufactured in other materials.

This convertibility also means that metals are severely under-represented in the archaeological record (Wiener 1991, 326). The scale of this issue is highlighted by a comparison with ancient written sources. Pliny the Elder reported the existence of more than 3000 large bronze statues in Rhodes, yet this vision of the past is simply not reflected in the archaeological record (Mattusch 2014, 160). The physical process of metal recycling is also only archaeologically visible in exceptional circumstances, further hampering its study. This is an issue because such recycling would have affected trade and access to metals, and therefore impacted upon the wider economy. The loss of so much metalwork can also generate misleading impressions on the usage and availability of metals in past societies.

Some light may be shed on this form of metal recycling by examining situations where a decision was actively made against it, *i.e.* when metalwork was repaired or modified instead of being melted down. Studying the circumstances surrounding these other outcomes should lead to a better understanding of at least some of the factors that determined which metal artefacts were recycled, and perhaps why.

The present case study investigates evidence from metal vessels found on the Late Bronze Age Mycenaean southern Greek mainland (Fig. 1). It formed part of a wider project on diachronic trends in the usage and treatment of metal vessels in the Mycenaean Prepalatial and Palatial Periods, particularly within the socio-political sphere (Aulsebrook 2012). Therefore, the dataset used in this case study is restricted to vessels and vessel fragments that were recovered from contexts securely dated to one of three chronological phases of the Mycenaean Prepalatial and Palatial Periods (Table 1).¹ The dataset consists of 534 vessels manufactured from bronze, copper, electrum,²

Ceramic Dates	High/Low Absolute Dates (BC)
MH III/LH I-LH II	1700/1600-1635/1530
LH I/II-II/IIIA	1635/1530-1420/1390
LH IIIA-IIIB	1420/1390-1200/1185

Table 1. MH = Middle Helladic, LH = Late Helladic. The absolute dates are disputed due to persistently irreconcilable discrepancies between connections to the Egyptian archaeological record (Low Chronology) and scientific dating methods (High Chronology) (Manning 2010, 23; Warren 2010, 393).

¹ Vessels in contexts dated to the period LH IIIB-IIIC, such as the Athenian Acropolis Hoard (Montelius 1924, 155-156), Orchomenos Hoard (Spyropoulos 1970) and Schliemann Hoard from Mycenae (Schliemann 1878, 111-112; Catling 1964, 295) have been purposefully excluded from this study, because it is not possible to ascertain whether they were deposited before or after the collapse of the Mycenaean palatial system. This significant social change is likely to have had a profound impact upon the metal supply and the role of metal in society, both of which would have affected recycling choices.

² A natural or artificial alloy of gold and silver.



Fig. 1. Map of the Aegean with the sites mentioned in the text. Squares show sites from which repaired or modified vessels were recovered. Triangles show sites with possible evidence for metal vessel recycling. Image by author.

gold, lead and silver. They cover a wide range of forms and were intended for a wide variety of purposes, including cooking, drinking, eating, libations, lighting, pouring, serving, storage and weighing. A complete spatial and chronological overview of this dataset can be found in Aulsebrook 2012, 83-102.

Most information concerning their usage is by necessity derived from study of the vessels themselves. Aegean iconographic sources are not especially informative for metal vessels; there are few depictions of vessels in use and the conventions regarding the artistic rendering of metals are still poorly understood.³ In contemporary Egypt, whose artistic conventions are better known, metal vessels carried by Aegean people have been identified in a number of paintings from Theban tombs (Wachsmann 1987). These are not scenes of tribute bearers, but probably demonstrate the export of such objects beyond the Aegean in ceremonial gift exchange (Panagiotopoulos 2001, 270-271). This interpretation may be supported by the Annals of Thutmose III, which mentions that Tinayu (often interpreted as the Greek mainland) provided a silver vase of Keftiu (Cretan) manufacture (Wachsmann 1987, 55. These terms are still disputed; for another interpretation see Vandersleyen 2003, 211).

³ There is no space here to enter a detailed discussion on this issue. The majority of images that include vessels (of any material) show them in a passive role, being carried by figures in processions. It is worth noting that for some of the depictions of vessel usage cited in the literature, such as the drinking scene in the Pylos megaron, no vessels were actually preserved; in the Pylian case drinking cups were added due to similarities with the Campstool Fresco at Knossos. For more information see Aulsebrook 2012, 376-384.

RECYCLING METALS

As stated above, recycling can be understood as the process of recovering salvageable parts from a broken or unwanted object, including salvaging the material by melting down an object. Recycling was a common practice across the Late Bronze Age Aegean for many different types of material. Ceramic sherds were often formed into scrapers, jar stoppers, and other small useful items. A LM I jewellery workshop at Poros on Crete contained an unfinished amethyst bead, as well as a sherd from a broken amethyst vessel from which beads could have been fashioned (Phillips 2012, 489). Even some of the larger unfinished ivory objects from the Cult Centre at Mycenae, no longer suitable for working into their originally intended form, may have been retained in the hope that the ivory could still be used for secondary manufacture (Krzyszowska 2007, 51). Metal can, of course, be reused in a similar fashion if needed or desired; for example, cast vessel pieces like handles and legs may have been kept for reuse as moulds for future vessel production (Budd, Taylor 1995, 137; for a possible example see Matthäus 1980, 83, no. 3). These examples give an indication of the range of materials that were recycled during this period and how widespread recycling activities were geographically.

Metal	Melting Point (°C)	Reference
Copper (Cu)	1083	Untracht 1968, 16
Gold (Au)	1063	Untracht 1968, 7
Silver (Ag)	950.5	Untracht 1968, 11
Lead (Pb)	327.5	Untracht 1968, 19
Tin (Sn)	231.9	Untracht 1968, 21

Table 2. A comparison of the melting points for metals used in Prepalatial and Palatial Mycenaean vessels. This is only a rough guide to the temperatures required, as impurities in the metal would affect the exact melting point (Evely 2000, 325). Alloys have a melting range rather than a single melting point; for a typical 10% tin bronze this is approximately 1020°C (Evely 2000, 328). No accurate instruments for the measurement of such temperatures existed during the Bronze Age. The crafters involved would have relied upon their senses, especially colour observation, to know when the appropriate temperature had been reached (Kuijpers 2015).

However, it is possible for any metal artefact to be recycled in another way, regardless of the techniques employed during its manufacture, by heating it to its specific melting point (which varies alloy by alloy; see Table 2). Once liquid, the structure of the metal is comprehensively reset and all traces of its former shape and previous object biography are removed.⁴ There is no limit to the number of times a piece of metal can be recycled in this way. Moreover some metals, such as gold, are so malleable that it is possible to physically reshape certain artefacts to a point where they are no longer recognisable without recourse to melting if so desired.

This means that, with the exception of glass (which can also be recycled through melting, Phillips 2012, 484), there was an important distinction between the recycling of metal and the recycling of other Bronze Age materials. For materials such as ceramic, ivory and stone, recycling was constrained by the shape, dimensions and any damage sustained by the original object. Artefact characteristics, which could include the fabric, profile or decoration, were often retained. In certain cases it is still even possible to identify the original source artefact. These traces may have been consciously incorporated into the identity of the new object as part of its biography.⁵ Yet because they can be melted down, these limitations need not apply to metal or glass. In this case, the physical evidence for the existence of a particular metal or glass object is effectively destroyed. Only a memory of the previous object can be incorporated into the biography of the new object, if desired, as part of an oral or written tradition. This special

⁴ It has even been suggested that all recycling of materials with this property should be properly termed ‘re-manufacture’ as no trace of their former usage remains (Hurcombe 2007, 44). However, in this paper the term ‘re-manufacture’ is reserved for cases where the metal from an artefact was recycled to make an exact replacement.

⁵ Although recycling can also beget loss of knowledge, especially if it is connected to discontinuity in ownership or the removal of such distinguishing traces.

property gives these materials what Sherratt has termed ‘convertible value’ (1994, 62). The ability to use, recycle and store them with little degradation or loss means societies are more likely to regard them as intrinsically valuable. Enough metal was in circulation within the Late Bronze Age East Mediterranean that it was used as a standard for exchange, a role underpinned by its convertibility (Sherratt, Sherratt 1991, 360; Artzy 2000, 29). Glass, lacking the same breadth of practical uses as metal during this period, remained too rare for its convertibility to be exploited in this fashion.

Although the importance of convertible value is socially ascribed, this concept is so significant (as it enables communities to develop durable yet highly tradeable wealth) that for some metals it has persisted into the modern age. Unlike many other materials, the retrieval of metals from deposition thus became and continues to be economically advantageous. The reuse of tombs (Boyd 2015, 155; and for the Post-Palatial Period, Dickinson 2006, 178) provided opportunities for Mycenaean metalwork to be recovered after deposition (Wolpert 2004, 135). Therefore the ease of recycling metals has led to their under-representation in the archaeological record (Kenoyer 2000, 105), either because metals were recovered or they were considered too valuable for deposition in the first place.

The study of metal recycling in the Late Bronze Age East Mediterranean has attracted some controversy due to its implications for the analytical role of Lead Isotope Analysis. This technique has been applied to metalwork and metallurgical debris to trace ore sources, thus enabling the reconstruction of ancient trading networks (Gale, Stos-Gale 1986). It is most effective for objects made from metal extracted from a single ore source; however, recycling is one process that can cause mixing between ore sources (Budd *et al.* 1995, 3). Initially, some proponents of the Lead Isotope Analysis technique argued that the quantity of metal recycled during this period was simply too insignificant to affect their methodology (Gale, Stos-Gale 1995, 34; Gale 1997). Over time, as these analyses have demonstrated that the great majority of the metal in circulation within this region came from only a few local sources, it has been realised that the risk from mixing is less problematic than hitherto feared (Stos-Gale 2009, 165). It has also become apparent that objects containing metal from more than a single ore source may be distinguishable in the results from Lead Isotope Analysis (Stos-Gale 2009, 168), and that, even though this may complicate the process of interpretation, this is a positive outcome as it potentially widens the range of research areas to which this technique can contribute (Pollard 2009, 187; Pryce *et al.* 2014, 289). However, metal derived from multiple ore sources was not necessarily from recycled scrap and although it is possible to identify freshly-smelted copper (Stos-Gale 2009, 165), there is no method currently available that can confirm the use of recycled metal for a specific object.

Direct evidence for metal recycling activities has been found at Prepalatial and Palatial mainland sites such as Nichoria (McDonald 1975, 80; Catling, Hughes-Brock 1992) and Tiryns (Rahmstorf 2015, 144-147), yet similar evidence for the recycling of metal vessels is poor. At Tiryns, three vessel fragments were found in secure Palatial Period contexts (Rahmstorf 2008, nos. 391, 760 and 765) but not in the contemporary crafting workshops (Brysbaert, Vettters 2013, tables 3-7). A piece of lead sheet, perhaps from a vessel, was identified in one workshop context (Brysbaert, Vettters 2013, 183 TN 748), but it is possible that this had been kept for use in other craft activities (Mossman 2000, 91) rather than for melting down. For example, two lead sheets with cut marks from a Tiryns workshop have been interpreted as possible backing supports for the shaping of gold foil (Brysbaert 2014, 43; Brysbaert, Vettters 2013, table 7). Therefore, the current physical evidence of metal recycling in Prepalatial and Palatial Mycenaean contexts can best be described as ambiguous.

There is clear evidence for metal vessel recycling at several sites in Crete. Alongside a small furnace and metalworking paraphernalia in the LM II levels of the Unexplored Mansion at Knossos were deliberately fragmented objects apparently intended for melting down and other items probably awaiting the same treatment, including vessels (Catling, Jones 1977, 57). The three large vessels found as part of this assemblage were all a generation older than the workshop (Popham *et al.* 1984, 207).⁶ Its interpretation as a metal recycling site has

⁶ Two large and intact copper-alloy vessels from this assemblage may have played an active role within metallurgical activities and were therefore not destined for immediate recycling (Popham *et al.* 1984, 207).

recently been disputed, because serviceable tools relevant to the carpentry and masonry industries were present (Blackwell 2011, 237). However, these tools also had roles in metallurgy (for example, drawing compasses were used in vessel manufacture; Davis 1977, 350-51) and the recycling of usable tools cannot be discounted. Although damaged tools may retain some functionality and recycling was costly in terms of time, resources and skill (Blackwell 2011, 270), social pressures may have encouraged their re-manufacture to observe certain ritual formalities or avoid breaking taboos. Therefore the presence of these tools does not preclude the interpretation of this area as a metal recycling site.

At Mochlos two bowls were found in Building A as part of a 'foundry hoard' of bronze and copper objects, mainly ingot fragments and waste scraps from metallurgical activity, which were probably destined for recycling (Soles, Stos-Gale 2004, 49). Two further hoards from Mochlos, one in House C.3 and the other in Building C.7, contained broken vessels as well as ingot pieces and other damaged objects, and were probably the collected metal wealth of private households that were ultimately destined to be recycled (Soles 2008, 147). At Poros, evidence for lead vessel recycling has been found. A few metres from a small LM IA crucible furnace, a large crushed lead vessel and a lead ingot were discovered in a niche in a wall awaiting usage (Dimopoulou 2012, 137). The furnace itself was surrounded by pieces of crucible, slag, metallurgical waste and further scraps. Although vessel pieces were found in the south wing of the palace at Zakro, alongside full bronze and copper vessels, it seems more likely that they were awaiting the final stages of construction in a workshop or perhaps were awaiting repair (Evely 2000, 341; Platon 1971, 216) rather than being intended for recycling.

Similarly deliberately fragmented objects have also been discovered in hoards on the Greek mainland. These were often found alongside complete objects and occasionally ingots or fragments of ingots. For example, the Poros Wall Hoard at Mycenae contained fragmented tools, weapons, vessels and ingots, as well as complete objects and ingots (Stubblings 1954, 292-294). This type of hoard has often been described as a 'foundry' hoard and has been interpreted as the intentionally concealed property of a smith (Spyropoulos 1972, 1; Knapp, Muhly, Muhly 1988, 237). Although the ownership of the contents of these hoards cannot be proven, given their similarities to the scrap assemblages discussed above, the curation of such material is likely to have been linked to metal recycling. The retention of these small fragments may demonstrate that scrap was not commonly melted into larger ingots for re-use; rather pieces equalling the required mass were selected when they were needed for a specific task (Soles, Stos-Gale 2004, 58).

None of the above examples provides evidence for the recycling of precious metals. A crucible found in the Unexplored Mansion did contain a gold-silver-copper alloy (Catling, Jones 1977, 62; Popham *et al.* 1984, 254) but this cannot be specifically linked to recycling. However, direct evidence for the recycling of precious metals has been found in the Eastern Mediterranean. Hoards containing broken gold and silver objects, often alongside raw material or objects related to metallurgy, have been discovered, such as that from Pyla-Kokkinokremos on Cyprus (Karageorghis, Demas 1984, 60, 62). The Amarna Letters, which provide evidence concerning contemporary Near Eastern diplomacy, routinely list the bullion weight of gold and silver diplomatic gifts and there are recorded examples of such gifts being recycled (Bachhuber 2006, 350). Therefore even artefacts with considerable social and cultural importance were not protected from being melted down. Evidence from the Gelidonya shipwreck (Bass *et al.* 1967; Bass 2010) and Cypriot hoards (Knapp, Muhly, Muhly 1988) indicates that considerable recycling of non-precious metals took place in this region as well (although see Matthäus, Schumacher-Matthäus 1986 who argue for a ritual interpretation of the Cypriot hoards). Although the cargo of the Cape Gelidonya ship included copper sourced from Laurion (Bass 2010, 800), this does not mean that a blanket approach to metal recycling was in operation in the Late Bronze Age East Mediterranean. Attitudes towards metal recycling, the objects and types of metal chosen for recycling, and its frequency are likely to have been influenced by local circumstances such as the ease of obtaining raw metal, the uses of specific metals and so on.

Contemporary Linear B texts provide some evidence for metal recycling in the Late Bronze Age Aegean. Tablet Jn 829 from the palace at Pylos records the prospective collection of bronze for recycling from both sanctuaries and certain officials; the specified quantity has been estimated to have been sufficient for 33000 arrowheads

or 142 spearheads (Palaima 2010, 367). It is uncertain whether this requisition was typical or an extraordinary demand due to an anticipated military encounter (Ventris, Chadwick 1973, 513). However, it is clear from this text that the palatial institution, at least at Pylos, had some role in metal recycling. In fact it has been argued that its complexity meant metal recycling was most likely to have been carried out under palatial control (Brysbaert 2011, 196). However, the process is akin to other metallurgical procedures and was probably not singled out for special treatment; the role of the palace may have been tied only to the organisation of bulk recycling operations, such as that recorded on tablet Jn 829.

The term ‘recycling’ can also be used to describe the process by which waste resources generated by one human activity are repurposed for another. The production of purple dye using Murex provides an example of this type of practice. Large collections of shell fragments have been found in several locations in the Aegean, such as in the central building at Monastiraki (Carannante 2011, 10). Producing this dye was an unpleasantly malodorous process unlikely to take place within such a high-status building, so this shell was probably waste material retained after dye production for ceramic temper or making lime (Carannante 2011, 11–12, 14). Waste scraps of metal generated by casting, shaping and finishing artefacts were probably regularly collected for recycling, as indicated by the contents of the Mochlos ‘foundry hoard’ in Building A (Soles, Stos-Gale 2004, 49). Written records from Pylos have revealed that bronzesmiths worked within the *ta-ra-si-ja* mechanism, a weighing system designed to reduce fraud when materials sourced through the palace were used in decentralised industries (Killen 2015a, 427; Killen 2015b, 805, 817). Waste scrap collection may have been integrated into this system.

Evidence from fourteenth century BC Egypt suggests that scrap metal may have been used for the production of Egyptian Blue pigment (Tite, Bimson, Cowell 1984, 236). Egyptian Blue and several other metal-based pigments are known to have been used in the Aegean (Brysbaert, Melessanaki, Anglos 2006, 1098–1100; Sotiropoulou *et al.* 2010, 1831), although it has not been confirmed whether the Aegean pigments used scrap metal specifically, rather than bronze or copper ingots (but see Brysbaert 2008, 134–139). Of course, using metals for pigment manufacture was one of the very few ways in which the cycle of convertibility could be permanently halted. Indeed, it has been argued that the usage of green pigments was deliberately avoided in Aegean fresco painting because the colour was associated with the destruction of bronze and copper (Peters 2008, 203).

Many good potential reasons existed to recycle rather than discard metalwork. It is not necessary to link metal recycling to supply shortages, as some scholars have proposed (Ventris, Chadwick 1973, 510; also see Muhly 2003, 292), or modern ecological concerns (Knapp 2000, 48). Nor is scrap metal intrinsically more difficult to use than ingots as implied by Gillis (1997, 508), as despite the need for careful control of alloying, the colour of the metal can be distinctive enough to allow even relatively similar alloys to be distinguished by an experienced smith (Kuijpers 2015, 146). The convertibility of metal, and therefore the practice of recycling, must be regarded as integral to its usage.

This ability to easily recycle metals, as well as retaining usage of an economically valuable material, could then have been further exploited to achieve particular political or social goals. For example, French has suggested that Mycenaean elites may have used recycling to retain control over the disbursement of high-status stones, as well as other stones they considered to have been economically or politically important (2009, 288). This strategy could also have been applicable to metals, and may have been reinforced through like-for-like re-manufacture (Baboula, Northover 1999, 151). Indeed some artefacts, such as practice pieces produced by an apprentice or for the purposes of experimentation by a skilled artisan, may have been recycled immediately upon completion and were never actually intended to leave the workshop (Brysbaert, Vetters 2010, 35). A related group of objects were lead-casting prototypes, such as the LH IIIB tripod leg and LH IIIC spearheads found at Tiryns (Kilian 1984, 56). It is likely that these were recycled when no longer required, as they were not otherwise functional, and probably never left the workshop.

The evidence outlined above indicates that metal recycling took place in the Late Bronze Age Aegean. However, because these processes effectively erase an artefact’s biography it is impossible to reconstruct the reasons for recycling a specific object or to quantify how much metal was recycled in total. Yet our understanding can be enhanced by investigating the alternatives to metal recycling. Therefore this discussion now turns to the evidence concerning the decisions made to repair or modify metal vessels instead.

Site/ID	Bibliography	Form	Material
Skopelos/001	Platon 1949, 551, Γ 3; Matthäus 1980, 161, no. 209	<i>Amphora</i>	Copper Alloy
Dendra/038	Persson 1931, 98, no. 31; Matthäus 1980, 158, no. 205		
Dendra/039	Persson 1931, 98, no. 29; Matthäus 1980, 159-160, no. 208		
Mycenae/128	Karo 1930, 117, no. 581; Matthäus 1980, 165-166, no. 218	<i>Hydria</i>	
Mycenae/130	Karo 1930, 118, no. 601; Matthäus 1980, 166, no. 220		
Mycenae/131	Karo 1930, 118, no. 602; Matthäus 1980, 166, no. 221		
Mycenae/132	Karo 1930, 118, no. 603; Matthäus 1980, 166, no. 222		
Mycenae/133	Karo 1930, 118, no. 604; Matthäus 1980, 166, no. 223		
Mycenae/134	Karo 1930, 159, no. Vb; Matthäus 1980, 167, no. 224		
Dendra/041	Persson 1931, 98, no. 30; Matthäus 1980, 173, no. 245		
Mycenae/122	Karo 1930, 159, no. IVc; Matthäus 1980, 152, no. 192		
Dendra/057	Persson 1931, 94, no. 11; Matthäus 1980, 301, no. 457	Lamp	
Mycenae/098	Karo 1930, 116, no. 578; Matthäus 1980, 83-84, no. 6	Round-Based Cauldron	
Mycenae/100	Karo 1930, 117, no. 584; Matthäus 1980, 84, no. 8		
Mycenae/101	Karo 1930, 157, no. 595; Matthäus 1980, 84, no. 9		
Mycenae/107	Karo 1930, 156, no. 850; Matthäus 1980, 89, no. 21		
Dendra/046	Persson 1931, 92, no. 4; Matthäus 1980, 197-198, no. 299	Squat Jug	
Dendra/028	Persson 1931, 98, no. 33; Matthäus 1980, 108, no. 73	Tripod Cauldron	
Dendra/029	Persson 1931, 98, no. 34; Matthäus 1980, 108, no. 74		
Dendra/030	Persson 1931, 98, no. 35; Matthäus 1980, 108-109, no. 75		
Dendra/031	Persson 1931, 98, no. 32; Matthäus 1980, 109, no. 76		
Menelaion/007	Catling 2009, 271, no. M43	Unknown	
Mycenae/051	Karo 1930, 112, no. 518; Davis 1977, 195-196, no. 71	Cup	Silver

Table 3. List of repaired vessels from the dataset. ID numbers are taken from Aulsebrook 2012, in which Menelaion examples were originally categorised under Sparta.

REPAIRING VESSELS

Vessel repair was a common practice in the Late Bronze Age Aegean. In the ceramic corpus this was achieved through the insertion of lead pot mends. These could not restore water-tightness but at least returned some limited functionality (Lykiardopoulou-Petrou 2001, 475). For some large vessels such repairs were a temporary solution to avoid the need for immediate emptying (E. French, *pers. comm.*). Vessels could also be repaired when regarded as worth keeping despite the loss of functionality; perhaps for aesthetic reasons, because of their unique object biography or because they formed part of a specific set. These considerations were less applicable to metal vessels because restoration of full functionality and water-tightness was always achievable.

Twenty-three metal vessels, 4.3% of the dataset under study, were repaired in antiquity (Table 3). Repair was thus an infrequent, but not uncommon procedure.⁷ The majority of the repaired vessels come from Shaft Grave

⁷ Clarke (2013, 130) noted that a Cretan *hydria* from Chania (Matthäus 1980, 172, no. 238) may have been dented in antiquity and subsequently repaired by hammering the dent back out from the inside, leaving a patch of small indentations. However, many damaged, crushed and distorted metal vessels have been restored during conservation, thus it is difficult to be certain that the removal of such dents

IV at Mycenae (10 vessels) and Chamber Tomb 2 at Dendra (9 vessels). Shaft Grave IV, dated to LH I (Graziadio 1988), contained the largest assemblage of metal vessels on the Late Bronze Age Greek mainland. The other two vessels from Mycenae (Mycenae/101 and Mycenae/122) come from Shaft Grave V, also dated to LH I (Graziadio 1988). The Dendra vessels formed part of a larger cache that had been crushed into a hole in the stomion of the tomb, dated to LH IIIA (Persson 1931, 94). The Skopelos *amphora* also come from a mortuary context: the LH II Chieftain's Grave (Platon 1949, 551). All four of these contexts also contained metal vessels without repairs. The final site with evidence of a repaired metal vessel is the Menelaion, close to Sparta. This consisted of a single stray repair plate from a Mycenaean settlement context.⁸ Although nothing can be deduced about the vessel from which it came, except that it was most likely made of copper-alloy, the presence of this fragment hints at the existence of repaired metal vessels at a larger range of sites than is suggested by the mortuary evidence alone. Pottery from the same context indicated a deposition date of LH IIIA1 for this repair plate (Catling 2009, 271).

Therefore the deposition of repaired vessels continued throughout the Prepalatial and Palatial Mycenaean Periods, even if their existence was relatively rare. Although most examples of repaired vessels were concentrated in the Argolid, this is unsurprising given the general distribution of metalware on the Late Bronze Age Greek mainland (77.5% of this dataset come from the Argolid, Aulsebrook 2012). A similar reasoning can be applied to explain why almost all of the repaired vessels come from mortuary contexts; this was the primary way in which metal vessels became trapped in the archaeological record of this period.

The majority of the repaired examples are big copper-alloy vessels, many of which were formed from large sheets hammered into shape. Their repairs consisted of a small plate riveted over the hole or tear. Some vessels carried multiple repairs. All repairs on these copper-alloy vessels were left clearly visible and no effort was made to disguise their appearance. Although it has not been possible to determine the reason behind the damage to jug Dendra/046, analysis carried out by Matthäus (1980) did reveal that whilst some repairs were to fix damage sustained during usage, other repairs were needed due to manufacturing faults.

Hammering copper or bronze causes it to work-harden by distorting its crystalline structure (Hodges 1989, 73), making it increasingly brittle and liable to crack. This is counteracted through annealing, a process whereby the metal is heated and allowed to cool slowly; this restores the crystalline structure and erases the effects of work-hardening (Miller 2007, 162).⁹ Metals such as copper and bronze then must be pickled to remove a skin of oxide that would have formed on the surface during the annealing process; failure to remove this oxide before hammering recommences can also cause cracks to form (Clarke 2013, 41). The majority of issues arising during the production of *amphorae*, *hydriae*, round-based cauldrons and tripod cauldrons in particular seem to have resulted from insufficient or incomplete annealing. Why would this occur?

There are two plausible reasons. Hammering copper or bronze into large and consistently thin sheets is challenging, requiring smiths to constantly engage with the metal's changing characteristics to judge when annealing is needed. Examples of other large yet unflawed copper-alloy vessels from the same contexts demonstrate that there were highly-skilled smiths in these societies able to effectively prevent the harmful effects of work-hardening. Therefore if lack of skill was the factor underlying the problem of insufficient or incomplete annealing it was restricted to these vessel types, perhaps from the employment of lesser-skilled individuals or apprentices. To describe such smiths as lesser-skilled does not imply that they lacked the ability to form vessels, a competence that would have taken significant time to gain (Nordquist 1997a), but it takes even longer to learn how to respond effectively to unexpected problems (Bamforth, Hicks 2008, 152). It is worth bearing in mind that the variability in the constituents of metals

occurred in antiquity. Similar marks could also be formed through usage, post-depositional processes, excavation and post-excavation processes. Therefore this possible type of repair has not been included in the study.

8 A second repair plate was recovered from this site (Catling 2009, M44). However, the context from which it was recovered (the topsoil above a mixed LH IIIB/C deposit) cannot be securely dated to the Prepalatial or Palatial Periods and therefore this example has been excluded from the analysis.

9 It can be preferable to quench (speedily cool through immersion) an object to halt the recrystallation process immediately in order to obtain a desired crystalline structure (Clarke 2013, 40).

during this period would have impacted upon the rate of work-hardening. Clarke's findings from her experimental work on the manufacture of Minoan metal vessels using the commonly found unhafted hammers (Clarke 2014, 82) may also be relevant here; continuous hammering with such tools caused significant physical deterioration in the user and so, in her opinion, the forming of these larger vessels could not have been undertaken by one individual alone (Clarke 2014, 83-84; 2013, 178). Therefore, unless the workshop retained enough highly-skilled smiths, these large vessels were likely to have been worked on by people with variable skill levels.

Of course, even master crafters do not utilise their full skillset all the time (Olausson 2008, 33) particularly because they may give, or may be encouraged to give, other production factors priority. The alternative explanation for insufficient or incomplete annealing was the imposition of time or resource constraints. Pressure may have been exerted to reduce the manufacturing costs of these particular vessel types, either through economic circumstances or client preference, depending whether smiths were independent or attached specialists. Annealing is time-consuming, more difficult to perform on large unwieldy sheets and requires fuel¹⁰ for heating. The manufacture of a typical Late Bronze Age Aegean bronze or copper vessel would have required between five and sixty rounds of annealing (Clarke 2013, 78); generally, the size of the vessel correlated with the number of rounds of annealing needed. If production speed was prioritised, smiths may have routinely pushed the metal to its working limits to complete the vessel as quickly as possible. Time constraints do not only take the form of modern deadlines. Time efficiency may be of little importance if your time belongs to another (Nordquist 1997b), but the Linear B archives from Pylos indicate that this was not the case for at least some metallurgists; smiths seemed to have been considered relatively high status, owning both land and slaves (Gregersen 1997a, 49; Gregersen 1997b, 401; Gillis 1997, 511). Even if they were full-time specialists, the smiths would have had to balance the time commitment involved with the production of one of these large vessels with other obligations. It is also possible that productive success may have been understood as the correct observation of a particular schedule and appropriate rites (Voutsaki 1992, 44).

Both explanations imply that the producers and users of these vessels were unconcerned by any consequential damage to vessel appearance; other factors were deemed more important than producing a visually perfect specimen. This is in stark contrast to other contemporary types of large copper-alloy vessels, such as the ewer, where great care was taken to prevent flaws. Steps were also taken to enhance the overall appearance of ewers by hiding their main seam beneath a decorative band. This suggests there were two broad categories of large copper-alloy vessel, differentiated by the value placed on their aesthetic appearance. Skopelos/001, an *amphora* with a band to cover its seam and repairs for manufacturing defects, apparently fell between these groups.

Some damage to the cast lamp Dendra/057 can also be attributed to insufficient or incomplete annealing during the finishing stage, yet not all manufacturing faults were related to this particular problem. *Hydria* Mycenae/130 was made in two parts, but the lower section was too large and was therefore reduced in size to fit. This caused many folds and tears, some of which required repairs. Whether this stemmed from a measuring error or a decision to combine two pieces originally intended for separate vessels, manufacture of Mycenae/130 continued despite the substantial impact to its visual appearance.

Fewer repairs on these copper-alloy vessels can be securely associated with their usage (Matthäus 1980). Mycenae/132 had several repairs on the lower attachment of its vertical handle, suggesting it had been broken multiple times during the act of lifting the vessel. Some damage to Skopelos/001 was probably caused through usage as well, rather than acquired during manufacture (Matthäus 1982, 6).

There is also textual evidence for the retention of damaged copper-alloy vessels. One tripod cauldron at Pylos was described as having burnt legs, and another had two legs missing (Palaima 2003, 198). It has been suggested that these vessels were kept because of their cultic importance (Palaima 2003, 198). Alternatively they could have been in storage awaiting repair (Chadwick, Ventris 1973, 235), or destined for recycling.

10 Although the lower temperature requirement for annealing means that the use of charcoal is not necessary (Clarke 2013, 150), the combustion of charcoal is easier to control and it is thus less difficult to maintain a steady temperature (Evely 2000, 352; Blitzer 1995, 527). Charcoal has been found in the vicinity of several Aegean metalworking sites such as Building T at Kommos (Blitzer 1995, 527).

Mycenae/051 is an intriguing exception to this pattern linking repairs to large copper-alloy vessels. This silver cup was found in Shaft IV of Grave Circle A, alongside many repaired copper-alloy vessels. The original handle, probably broken during usage, had been removed and replaced. The obsolete rivets had then been carefully filed down to minimise the repair's visual impact. This implies that the aesthetics of the cup remained a primary consideration.

Artefacts of precious metal were not immune to being damaged during usage. Strengthening elements, particularly in handles and rims, were common in silver and gold vessels; evidently their fragility was recognised and measures were taken to prevent damage, but it is unlikely that such methods were always effective. The lack of other examples of repaired gold and silverware implies that broken specimens were routinely recycled instead.¹¹ Why then was an exception made for the silver cup Mycenae/051? The cup itself was plain and unremarkable; another six of the same type were found alongside it as well as many much more elaborate vessels. This atypical decision could be evidence of a personal attachment to this specific cup, probably stemming from a unique object biography. Its repair could be considered a reflection of sentimental nature.

MODIFYING VESSELS

The best-known example of Aegean vessel modification involved Egyptian stone vessels exported to Crete (Warren 1997). Some conversions were relatively minor, such as drilling a hole in the base to create a *rhyton* (Phillips 2011, 94) or adding decoration (Phillips 2008, 83). Egyptian vessels were also inverted, the base removed to create a new opening and the excess material used to plug its former mouth (Phillips 2008, 80). The intention was to transform Egyptian vessels into recognisably Minoan forms, which would have taken less effort than hollowing out a new vessel (Phillips 2011, 98; Bevan 2007, 125). This phenomenon was unique to Crete, although some converted examples were then exported to the Greek mainland (Phillips 2008, 80).

One metal vessel had undergone remodelling post-manufacture. This was the copper *amphora* Dendra/039, which also bore repairs to its foot. It was modified into a *hydria* by removing one vertical handle and adding a horizontal handle below the remaining vertical handle (Fig. 2). Care was taken to ensure the vessel remained usable. The attachments of the removed handle were flattened and the upper corner riveted down to prevent accidental injury. This was not intended to hide the modification, as these now defunct attachments remained clearly visible. It is impossible to tell whether the repairs to its foot were carried out before or after this transformation.

Conversion was less expensive in terms of resources and time than manufacturing a new vessel from scratch, but this came at the cost of losing the original vessel. This is the only occurrence of a modified vessel in the dataset, implying such procedures were rare. Of course it is not certain how many modified Prepalatial and Palatial Mycenaean metal vessels have been lost over time.

The alteration may have been a response to specific pressures for a *hydria* at short notice. The *ad hoc* production of a *hydria* in this way is quite surprising. The original *amphora* was particularly tall compared to most *hydriae* from this period and the mouth much wider, making the converted vessel more akin to the early *hydriae* found in the Shaft Graves, rather than its contemporaries. Whether this was deliberately intended is not possible to determine. The removal of the second vertical handle makes it clear that the addition of the horizontal handle was not to aid in the handling of this vessel, but to physically convert this vessel from one type to another.

11 Matthäus (1980, 220) stated that another silver cup, from Chamber Tomb 24 at Mycenae, had also been repaired and that Davis had incorrectly described the technique of this cup. Davis, who physically handled the cup herself, recognised the so-called repair as a false attachment plate (1977, 298), a feature found on another earlier vessel from Mycenae (1977, 198). The use of three round-headed rivets to fasten it, mimicking the typical handle attachment method for these vessels, and its placement exactly where a handle attachment plate would be expected also contradict the interpretation of Matthäus.

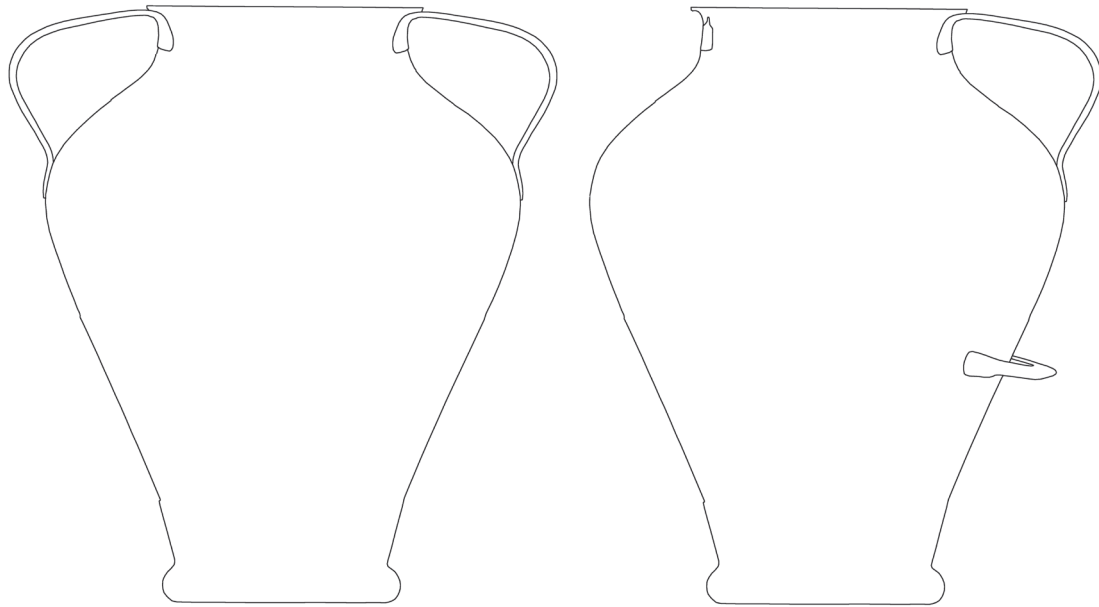


Fig. 2. Drawn reconstruction of vessel Dendra/039 before (left) and after (right) conversion. Drawing by author. Adapted from Matthäus 1980, plate 24, no. 208.

COMPARATIVE EVIDENCE FROM CRETE

It may be productive at this point to look to comparative evidence regarding the repair and modification of contemporary Cretan metal vessels.¹² Crete has often been suggested as the possible source for many metal vessels found on the Greek mainland and, although this idea partially stems from the simplistic dichotomy applied to the aesthetic sensitivities and crafting achievements found in Minoan and Mycenaean material culture that still resurfaces every so often despite its rejection many decades ago (Vermeule 1975, 10, 28), more solid evidence can be found to support this assertion. A cauldron found in Shaft Grave IV of Circle A at Mycenae was inscribed with a Linear A sign (Karo 1930, 116, no. 576; Palaima 2003, 190-191), which strongly suggests a connection to Crete. Another indicator is the reference to vessels 'of Cretan workmanship' (ke-re-si-jo we-ke) found in the Linear B archive of LH IIIB Pylos (Ventris, Chadwick 1973, 237; Palaima 2003, 199). Moreover, even a quick glance through the main publications of Aegean metal vessels (Davis 1977; Matthäus 1980) confirms the close similarities between the Cretan and mainland repertoires throughout the Late Bronze Age. If a vessel was produced on Crete, repairs rectifying manufacturing flaws would have taken place there. Repairs in response to usage damage may have taken place on Crete or the mainland, depending on the object biography of the vessel. If we accept that at least some Cretan vessels were exported to the mainland, differences in the pattern of repairs between the two regions may imply a distinction between vessels produced for internal consumption on Crete and those destined for export. If we reject this hypothesis, such a distinction could instead reflect contrasting approaches to metal vessel repair.

The earliest known example of a repaired Cretan metal vessel comes from Quartier Mu at Mallia. A Middle Minoan two-handled dish had a visible repair plate riveted just below the rim, where there was a tear (Matthäus 1980, 277, no. 413). Two cauldrons from House A at Tylissos, dated to LM IB, had been fitted with visible repair plates (Matthäus 1980, 82-83, no. 1 and 4). Two jugs from Chamber Tomb 4 at Sellopoulo, dated to LM IIIA1 (Popham, Catling 1974, 206), had been repaired in antiquity. One jug, which was undecorated, had been mended

12 This section is a brief overview based upon data in Davis 1977, Matthäus 1980, Evelyn 2000 and Clarke 2013.

twice during its production (Popham, Catling 1974, 236-238, no. 31, fig. 23). The second jug was ornamented with a bird protome; it had two repair plates riveted inside to cover small cracks (Popham, Catling 1974, 236, no. 28, fig. 23, pls. 41a-d; especially pl. 41a as the rivets for one patch are visible on the right hand side).

A *lekane*, from the same tomb, had apparently required repair during manufacture (Matthäus 1980, 264, no. 390). The handle attachment on another *lekane*, from Chania, evidently failed; new holes were made in the attachment plate and the surrounding vessel wall area was damaged during reattachment (Clarke 2013, 140; Matthäus 1980, 267, no. 403). A *hydria* from the LM IIIA Tomb 36 at Zapher Papoura had several rivets added either side of a small tear beneath its lower handle (Matthäus 1980, 172, no. 242). The most radical repair was also to a *hydria*, from Chania, which had sustained damage to its base (Matthäus 1980, 172, no. 238). The broken section was not removed and the new base plate was simply riveted over it (Evely 2000, 384).

No action had been taken to disguise these repairs.¹³ Much of this repair work has been described as of a poor standard, in terms of the riveting and shaping of the patch (Evely 2000, 384). In contrast, a decorated LM IB one-handled basin from Mallia had a small discreet rectangular repair patch over one external handle attachment plate, held in place with several small rivets. From the accompanying illustration (Matthäus 1980, pl. 40) it is clear that this repair would have been barely perceptible and certainly unnoticeable from a distance. Therefore, although a slightly different range of vessels are involved, the findings from Crete would seem to support the existence of two groups of large copper-alloy vessels distinguished by the importance placed on their aesthetic appearance, as seen on the mainland. However, this pattern is complicated by the fragmented remains of another decorated vessel, a two-handled basin from Sellopoulo Tomb 4. This was found with a repair patch curved to fit the sharp wall-base transition characteristic of this vessel form (Popham, Catling 1974, 233, no. 23, fig. 21). Being 12.5 cm long and with at least fifteen rivets, it is likely that this repair would have been relatively visible. No vessels manufactured from precious metals were reported to have been repaired in antiquity (Davis 1977; Evely 2000).

In general, the Cretan evidence is very similar to that found on the mainland. Precious metal vessels and certain types of copper-alloy vessel either carried no repairs or had been inconspicuously repaired, with the exception of the two-handled basin from Sellopoulo. Repairs made to other types of large copper-alloy vessels were left visible.

No examples of modified Cretan vessels were found. The known dates for these repaired Cretan vessels range from MM to LM IIIA, which supports the Greek mainland data on the longevity of this practice. It is important to remember that even if vessels were made on Crete, the potential existed for them to have been treated differently on the mainland. Prepalatial and Palatial mainland elites had the opportunity to reject visibly repaired vessels as unsuitable trade objects or gifts. Instead they incorporated them into the same practices as undamaged specimens; practices that were part of Mycenaean culture, such as their deposition in elaborate funerary assemblages, which were not derived from their usage on Neopalatial Crete.

DISCUSSION

The recyclability of metal means the re-manufacture of any metal artefact is not dependent upon the sourcing of new metal. When damage is incurred or an object is considered obsolete, there are two available options beyond that of disposal. Additional labour time and auxiliary resources, such as fuel, can be invested to produce a new artefact. Alternatively the original object can be repaired or modified, which could potentially affect its visual appearance. There is evidence for the employment of both of these strategies in the Mycenaean metal vessel corpus.

It is important to bear in mind that repairs are not always considered aesthetically damaging. Broken Japanese ceramics, especially those used within tea ceremonies, were repaired through a time-consuming process known

13 Another vessel, said to have come from East Crete, had two similarly visible repairs; this vessel was an undecorated socketed pan (Matthäus 1980, 142, no. 167).

as *kintsugi*; the repair was made with layers of lacquer then usually covered by powdered metal, particularly gold¹⁴ (Roma 2013, 62). This technique celebrated the damage accumulated during usage, and ceramics repaired by *kintsugi* often increased in value (Starling, Rekade 2013, 641; Roma 2013, 62). *Kintsugi* added a new chapter to the object biography of these ceramics, elaborated on their life story and converted what could have been regarded as a negative event into a positive outcome. However, it is unlikely that the repairs on Mycenaean metal vessels were considered to augment their aesthetic value or to provide a positive physical mnemonic of an event in their object biography. Repairs do not appear on large copper-alloy vessel forms, such as the ewer, that incorporated measures to enhance their appearance. Where a repair had been made to a more valuable silver cup (Aulsebrook 2012, 137-9), it was subsequently disguised rather than visually exaggerated.

The aesthetic value of an object is only one form of value. These large copper-alloy vessel types with repairs were still costly items in terms of the resources, time and skill required for their production. Yet they often carried other manufacturing flaws as well including coarsely-cut and unfinished rivet heads (Mycenae/098), irregular sheets (Mycenae/100, Mycenae/101), irregular handle attachments (Mycenae/098), or unfinished seams (Mycenae/122). Of the five relevant vessel shapes (*amphora*, *hydria*, *krater*, round-based cauldron and tripod cauldron) just over a quarter were affected by these defects, a percentage significantly higher than any other vessel form. This issue was particularly pronounced during the Shaft Grave Period, which accounted for 93% of the vessels affected. Indeed no tripod cauldrons, which were a later form only in use after the Shaft Grave Period (Aulsebrook 2012, 145), carried such flaws. This seems to indicate that, over time, higher standards were applied to these large copper-alloy vessels, yet the addition of visible repairs was still deemed acceptable. Cretan vessels with visible repairs were also not always finished to the high standard expected for other bronze and copper vessels. For example, the undecorated jug from Sellopoulo was judged to have a roughly made handle (Popham, Catling 1974, 238, no. 31). Both repaired Sellopoulo jugs had uncovered seams, in contrast to the ewer with decorated seam masking band found in the same tomb (Popham, Catling 1974, 236, no. 30).

Only 5% of these five types of large copper-alloy vessels were decorated, compared to an average across the dataset of 39%, and their aesthetic impact was apparently sidelined in favour of other factors. These could have included the speed, cost or efficiency of production. Another possibility is that smiths who were building up their vessel forming skill set were put to work on these types of vessel, rather than shapes such as the ewer, which were expected to be finished to a higher standard. Their role may have been more utilitarian and they were perhaps more frequently used by attendants or servants in a 'backroom' capacity, rather than by elite individuals. This of course does not mean that they were hidden from view, but such usage would ensure that their visual appearance would have come under less scrutiny from elite individuals simply because they were positioned further away. In general, the importance of demonstrating access to them seems to have outweighed the importance of their aesthetic appearance, to the extent that these vessel types were still considered suitable funerary gifts on at least four occasions.

A different approach was taken to other contemporary types of large Mycenaean copper-alloy vessel (perhaps including Skopelos/001) and to precious metal vessels. Many of these were decorated, manufacturing flaws were far rarer and minor where they did occur, and the single example of a repair had been disguised. Since the presence of reinforcement features suggests awareness of potential damage, yet examples of these vessel types with actual damage are so exceptional, it implies that broken specimens were recycled instead. It may seem paradoxical that more carefully made vessels were more readily relinquished for recycling, but this may have been because their visual appearance was so important. Since other repaired precious metalwork was deposited in tombs (Phillips 2012, 484), it seems unlikely that repaired precious metal vessels were specifically excluded from the mortuary sphere.

There are three vessels that do not quite fit this general pattern. The object biography of the repaired silver vessel Mycenae/051 is highly atypical. As discussed above, there was nothing otherwise out of the ordinary about it, especially when compared to some of the elaborate and unique vessels placed in the same grave. The Shaft Grave Period was an important time during the formation of Mycenaean elite identity (Voutsaki 1999, 114). Perhaps it

14 For a colour image of a vessel repaired with *kintsugi* see Mikami 1976, fig. 107.

was in this potent atmosphere that a special bond was forged between a particular individual and this vessel, which may have been maintained even after death by the deposition of the cup in the grave.

Even before its production was complete, the *amphora* Skopelos/001 was an anomaly. The visibility of its manufacturing and usage repairs contrasts with the seam masking band, simple plastic handle decoration and otherwise good shaping of the body (Matthäus 1982). This is the earliest known metal *amphora*, and it may well be that the typical object biography intended for this vessel type was still in flux. The third vessel, the two-handled basin from Sellopoulo, is also intriguing. Except for the repair, this was a typical specimen; decorated and well formed. It is possible that the household made such frequent use of it that it could not be spared for re-manufacture, or that there was some difficulty preventing re-manufacture taking place. Alternatively, it may have been damaged only a short while before the funeral and therefore repair was favoured over re-manufacture.

No lead vessels were repaired or modified. However, despite apparently sharing the same pattern of decision making as the precious metal and large copper-alloy vessels that did not bear repairs, it does not seem likely that the same reasoning lay behind this choice. Lead was accorded a low status in the hierarchy of metal value (Aulsebrook 2012, 137-139) and very few lead vessels (12% of this dataset) were ever decorated. They also carried few manufacturing flaws but this was probably linked to the ease of working lead, which anneals at room temperature and thus does not work-harden (Mossman 2000, 90). Patches would also be more difficult to apply to lead vessels than to vessels of bronze or copper because of the different working properties of the former. These factors probably encouraged the re-manufacture of lead vessels over repair. As discussed above, broken lead vessels may have also been recycled into sheets, which were useful in other crafting activities (Mossman 2000, 91), rather than being immediately melted down.

Modification was not a common procedure, nor was it used as a solution to deal with changes in taste. This may have been because of the strong continuity in metal vessel forms throughout the Mycenaean period, so that some types were still found, practically unchanged, almost five centuries after their first appearance in the archaeological record (Aulsebrook 2012, 165-71). Therefore such considerations may have been irrelevant for the Mycenaean metal vessel corpus. Furthermore, vessel alteration left visual scars that were most likely regarded in the same way as repair plates: aesthetically undesirable. The single example of a modified vessel in this dataset therefore had an unusual object biography, made more so by the unique appearance of the final product. This did not match the shape of contemporary *hydriae* and no effort was made to alter the form, except for the change in the handle configuration. This was therefore only really a modification in the function of the vessel, creating a strange *amphora-hydria* hybrid. The object biography of this vessel prior to its conversion would have remained plain to all those who encountered it.

CONCLUSIONS

Studying the biographies of these objects has demonstrated that there was no single approach to the repair of Mycenaean metal vessels. The evaluation of several different competing factors resulted in a policy of repair for only a narrow group of large copper-alloy vessels. By examining the gaps in this dataset on repair and modification, it seems the vessels that were more likely to be recycled were those given the greatest investment in crafting skill and time. Therefore vessels of precious metal and other large copper-alloy vessel types for which visual appearance was a primary concern were also the most likely to be sent for re-manufacture rather than repair. This is not to say that the crafting skill and labour were not appreciated or understood,¹⁵ and we should certainly not try to use the treatment of these objects to label Mycenaean societies as uncultured or basely materialistic. Evidence from many sources points to the significance of heirlooms within Prepalatial and Palatial Mycenaean culture (Aulsebrook forthcom-

15 As suggested by Davis when discussing the Töd Treasure from Egypt, in which folded silver vessels were discovered; she suggested this was because the Egyptians did not value the workmanship of these vessels, which she herself believed to be rather poor because their decoration is 'imprecise and hastily done' (1977, 75).

ing). Such artefacts were deliberately curated and valued because of their object biography and antiquity. However, this added value (Sherratt 1994, 63) could be relinquished when required. Yet, just as recycling is an integral part of the usage of metals, so the destruction and creation of craft may have been seen as a fundamental cycle keeping these highly-skilled artisans at work. Recycling was thus essential to maintain standards of quality within this sphere of material culture.¹⁶

At first glance, it therefore seems surprising to find that the vessels made from lower-valued lead were treated in the same way. However, although there was a similarity in outcome, the decision to repair or recycle these very different types of metal vessel in fact hinged upon completely distinct reasons. Repair was reserved for a small group of large copper-alloy vessels, whose ownership was valued over appearance possibly because they were considered utilitarian. Perhaps, in one case, an exception was made for a silver cup because it was an object with specific personal value. It is, then, important to acknowledge that metals were not treated uniformly; differentiation in recycling decisions existed both between different types of metal and between different types of artefact. This general pattern was further complicated by the appearance of special cases.

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¹⁶ Ironically, this seems to imply that the vessels most likely to have been chosen by Mycenaean individuals for recycling were precisely those that museums tend to prioritise for conservation and display. This disparity between the past and present treatment of such vessels actually springs from the same source; the high value placed upon these artefacts primarily because of their material, rather than their form, craftsmanship or context of use.

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