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Meaning in the making: The potter's wheel at Phylakopi, Melos (Greece)

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Abstract

It is now commonly accepted that technology is, to its very core, a social product through which we can explore cultural choices. This cultural dimension of technology will be examined with reference to the introduction and use of the potter's wheel at Phylakopi on Melos (Greece) during the Late Bronze Age. At this site, the co-existence of two different manufacturing techniques was so deeply embedded that, despite the presence of hybrid vessels, many aspects of the pottery production had become linked to either a local (hand-built) or Minoanising (wheel-thrown) tradition. It will be argued that the traditional hand-building technique was associated with individual and rooted facets of the Melian identity (such as kinship, social class, or gender). Reasons for the initial stimulus for adoption of the potter's wheel are considered to lie in its potential for competitive social practice through association with exotic, symbolically laden technologies, craft products and consumption rituals. The gradual application of the technology to ever more complex vessels, on the other hand, corresponds to the apprenticeship sequence outlined by Roux and Corbetta and may indicate an incomplete learning process or a certain lack of practice opportunities among local potters.

Keywords: Cyclades; Technology; Cultural choices; Potter's wheel; Apprenticeship; Identity; Late Bronze Age

Technology: 'Meaning in the making'

It is now commonly accepted that technology is, to its very core, a social product through which we can explore cultural choices. This outlook, however, is in stark contrast to what Pfaffenberger (1992) has called the 'Standard View' according to which technologies emerge and develop as a response to environmentally driven needs in a cumulative progression over time; taking Darwinism as a metaphor, it is assumed that those technologies best adapted to satisfy the relevant functional needs will be selected and propagated. Consequently, technological factors are directly related to the artefact's function while social meaning is seen to reside in function-less stylistic features that are often added to the surface (Binford, 1965; Dunnell, 1978). Central to this view is the assumption that manufacturing sequences are constrained by natural and physical parameters whereby each decision is seen to predict to a larger or smaller extent the next step within the sequence

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(Franken, 1971; Schiffer and Skibo, 1987, 1997; Schiffer et al., 1994; Steponaitis, 1983, 1984). Such a techno-functionalist approach leaves no space for the expression of socio-political meaning, such as identity, learning networks, kinship relations, or social stratification. This technology-society duality has, in the case of ceramic studies, often led to an emphasis on investigations of physical properties, such as strength, resistance to thermal shock or abrasion, porosity, and heating effectiveness (Hughes, 1981; Plog, 1980; Rice, 1984; Skibo, 1992; for a recent summary see Rice, 1996). Change in manufacturing processes was explained as performance orientated evolution towards a technological 'best-fit'. Social meaning, on the other hand, was seen to reside exclusively in decorative features.

Over the last three decades, the techno-functionalist approach has been strongly criticised for upholding the dualism between technology and society, for preserving the assumption that decisions at any level of the *chaîne opératoire* predetermine the next step in the sequence, and its reliance on non-representative, lab-based experimental work whereby certain technological features are measured and specific characteristics assumed but rarely tested in ethnographic contexts (Livingstone-Smith, 2000; Gosselain, 1998; van der Leeuw, 1993). It is now commonly accepted that the selection of raw materials and manufacturing techniques, for instance, should be considered as carrying social meaning in the same way as 'stylistic features'; technical behaviour is no longer perceived as merely a passive response to environmental or functional pressures but is acknowledged as being social practice itself (Dobres, 1999, 2000, 2001; Dobres and Hoffman, 1999; Gosselain, 1992, 1998; Hosler, 1996; Ingold, 1999; Jones, 2002; Lemonnier, 1986, 1992, 1993; Pfaffenberger, 1988, 1992; Roux, 2003; Schiffer, 2001; Sillar and Tite, 2000). All of the above scholars emphasise the active role of technology in the construction and reproduction of social relationships. Cultural choices are 'made solid' through preferences for raw materials, tools, equipment, gestures and knowledge. As a result, technical actions can help us explore underlying religious, symbolic, economic and political pressure(s) in relation to the expression of identity, ethnicity, gender, age, social boundaries, etc. Technology is hereby recognised as playing an important part in forging, reaffirming and/or contesting relationships and traditions. However, one should caution against the assumption that interaction between the social and material spheres follows a causal, linear trajectory whereby cultural views are easily translated into material expression; instead, this interaction is best visualized as "mutually reinforcing socio-material practices" whose dynamic creates a "meaningful arena in which humans simultaneously engage with each other and with their material world" (Dobres and Hoffman, 1999, p. 2). The dynamic qualities of the interaction between material, corporeal and meaningful experience are perfectly captured by Dobres' expression 'meaning in the making' (Dobres, 2001).

So many ways of making a pot

If we accept that technological activities are meaningful social practice then one would expect to see great variety of outcomes at each step of the *chaîne opératoire* instead of a narrow range of predetermined sequential solutions. And indeed, a brief cross-cultural survey of ethnographic literature demonstrates that the relationship between clay, temper, forming technique, shape and function is impacted on more strongly by social rules, traditions and taboos (often expressed in terms of 'habits') than by technological requirements: Cameroonian potters, for example, may add either sand or grog or dung or no temper at all to clay from the same source (Livingstone-Smith, 2000, p. 28, 36). Since function analysis has indicated that these clays do not actually require refinement or tempering and could be used without any additional treatment, the addition of (particular) tempering materials has to be understood as an important social practice (Gosselain, 1998, p. 89). Based on wide-ranging fieldwork, van der Leeuw unequivocally puts the myth of predisposed choices to rest by stating that

> "virtually all known prehistoric techniques of pottery-making, and most ethnographically observed ones, have a rather wide tolerance for clays and other raw materials needed, so that almost any of those techniques could probably be implemented almost anywhere, if need be by introducing a few minor modifications… The non-availability of the appropriate raw material(s) turns out to be only very rarely the limiting constraint in the manufacture of pottery" (1993, p. 239).

Great variation also exists in the conceptualisation of the pot and its forming sequence. Potters may, for example, perceive a vessel as a single unit or as a combination of individually layered horizontal or vertical additions; as a result, vessels can be built bottom-up, top-down, or in sections (uni-directional or multi-directional) (Diaz, 1966; Krause, 1984, 1985; van der Leeuw, 1993). With regard to the forming techniques used, modern scholars normally talk in terms of either hand-building techniques or wheel throwing. However, forming techniques are better understood as two points along a spectrum ranging from purely hand-built to purely wheel-thrown vessels with most methods lying somewhere in between these extremes or indeed utilising both at different stages of the manufacturing process (Blandino, 2003; Bresenham, 1985; Courty and Roux, 1995; Foster, 1959; Franken and Kalsbeek, 1975; Gelbert, 1999; Mahias, 1993; Miller, 1985; Nicholson and Patterson, 1985; Roux, 2003; Roux and Courty, 1998; Saraswati and Behura, 1966; van der Leeuw, 1993). The fact that a potter may combine different techniques in the making of a single vessel (Saraswati and Behura, 1966, p. 61) and evidence of different potters producing the same vessel type by different methods undermines the functionalist paradigm (Miller, 1985, pp. 221–222). Similarly, technical choices invoked for firing and post-firing treatment were shown to be functionally equivalent in field and laboratory experiments (Gosselain, 1998, p. 87).

The role of 'cultural choices' in modifying diversity

Although ethnographic and archaeological investigations have clearly demonstrated that functionalism lacks in explanatory power because "a choice made at one level does not automatically condition the choices made at the next levels" (Gosselain, 1998, p. 89), this does not imply that choices were randomly interchangeable. Clearly, choices *are* made with regard to the manufacturing sequence, materials and tools, and some solutions are retained while others are rejected. However, we should not think of these 'choices' as necessarily carefully considered options. It is unlikely that potters familiarised themselves carefully with all available techniques, discussed their advantages and disadvantages, and reflected upon the wider social and technical implications of a technical variant prior to adopting or rejecting it.[1] Rather we should regard these choices as firmly anchored in a much wider realm of experiences, perceptions and conceptualisations of the potter—what van der Leeuw has called his *'mappa mundi'*, his map of the world (van der Leeuw, 1993, p. 431). Thus, alternatives are never true alternatives and need to be considered in light of 'cultural choices' leading to a restricted number of culturally acceptable variants (Gosselain, 1998, p. 82; see Sillar, 1997, pp. 11–12 for the social meaning of the tempering material andesite). Interestingly, despite being ultimately limited by *cultural* factors, rejection of alternative ways of doing is often rationalised in terms of *technological* disadvantages (e.g. the electric potter's wheel will diminish control by the potter, a regulated kiln will break the pots) both by the subjects themselves and the researchers (Nicholson and Patterson, 1985, p. 237;Nicklin, 1971, pp. 42–43).

Anthropologists, economists, development agencies and market researchers have investigated the conditions that may lead to a successful adoption or, conversely, to rejection of new technologies. The importance of existing value systems, efficient information transfer, economic factors, customary motor habits, status of the advocate and/or potential adopter, ethnic identity, and politics have been emphasized, but no reliable, predictive formula has been found (Bargatzky, 1989; Barnett, 1953; Layton, 1989; McGlade and McGlade, 1989; Rogers and Shoemaker, 1971). In lieu of a mathematical equation scholars seem to have settled on the more fuzzy notion of 'compatibility'; new technologies must be somehow 'compatible' with the environment and the social (including technological) organisation of the society under investigation (Armit and Finlayson, 1995; Lemonnier, 1986, 1993; Mahias, 1993; Nicklin, 1971). While to predict the future of a technology remains notoriously difficult, as archaeologists we are in the enviable position to be able to work backwards into the past; instead of having to speculate about the future success or failure of an innovation we can trace it backwards to its beginnings. In the process, we may sometimes be able to reconstruct the socio-technical context of a new technology. In the following case study from the Greek Bronze Age, I will suggest that the introduction of a new technological invention, the potter's wheel, can only be understood when we consider technology as a meaningful marker of social identity Figs. 1 and 2.

[1] This is not to deny the fact that many potters were indeed well informed about alternative ways of doing, either through having heard about them or having observed them personally. See, for example, Nicholson and Patterson, 1985, p. 237.

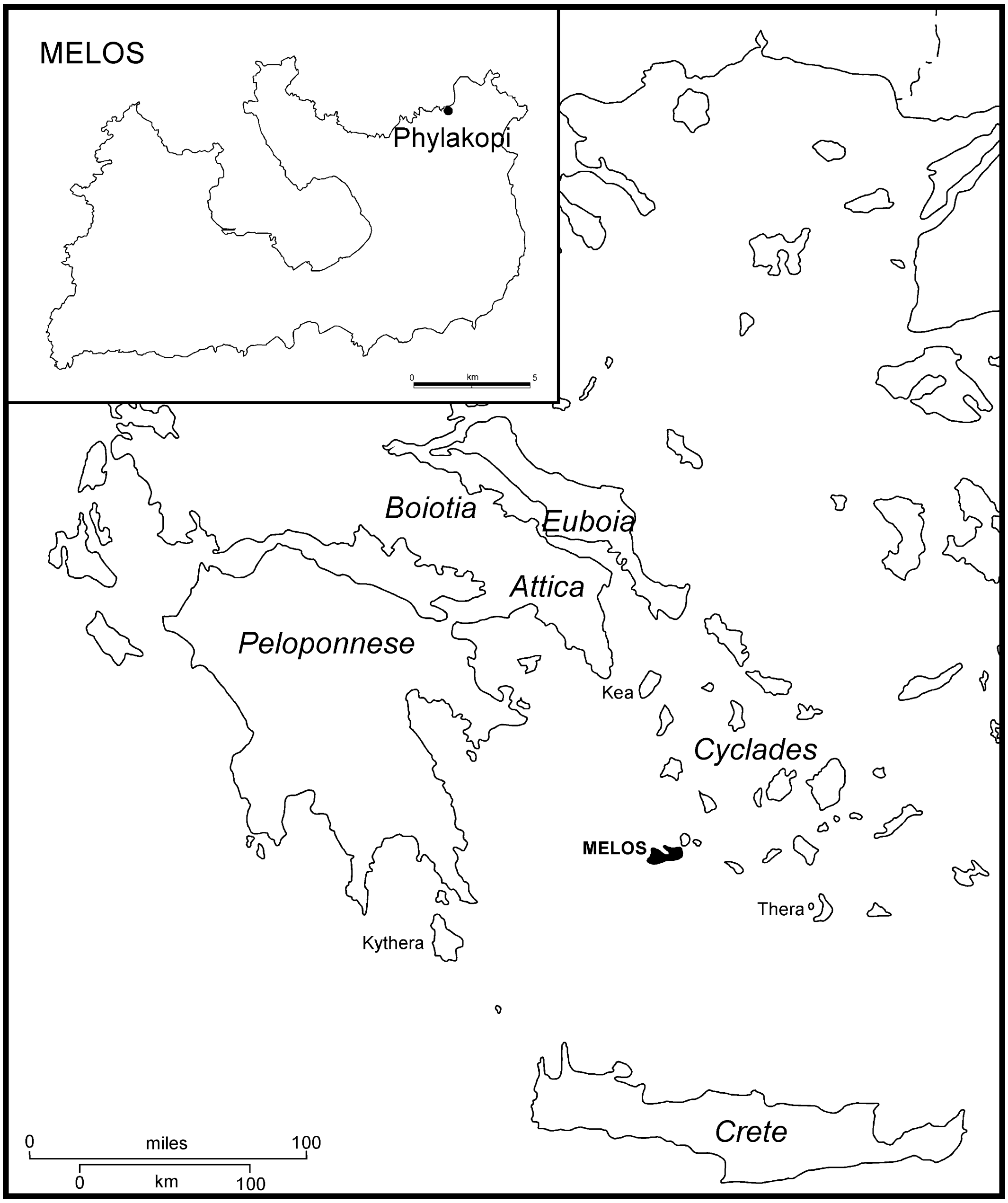

Fig. 1. The Aegean and Melos.

Case study: Bronze Age Greece Figs. 1 and 2

The potter's wheel

In comparison to Mesopotamia where the potter's wheel had already been introduced during the fourth millennium BC (Pollock, 1999, p. 5), its first appearance in Greece can be dated to the 'Lefkandi I' and Tiryns cultures of the EH IIB and III periods (Wünsche, 1977, p. 27). On Crete, our earliest evidence dates to the MM I–II period. Thanks to work by Xanthoudides (1927) and Evely (1988, 2000), we have a reasonably detailed understanding of the design, technical development and production context of the potter's wheel and potting supports on Crete (for a general discussion on potting devices see Rice, 1987, pp. 132–135) (Fig. 3). Evely has identified several dozens of wheelheads which were found at a

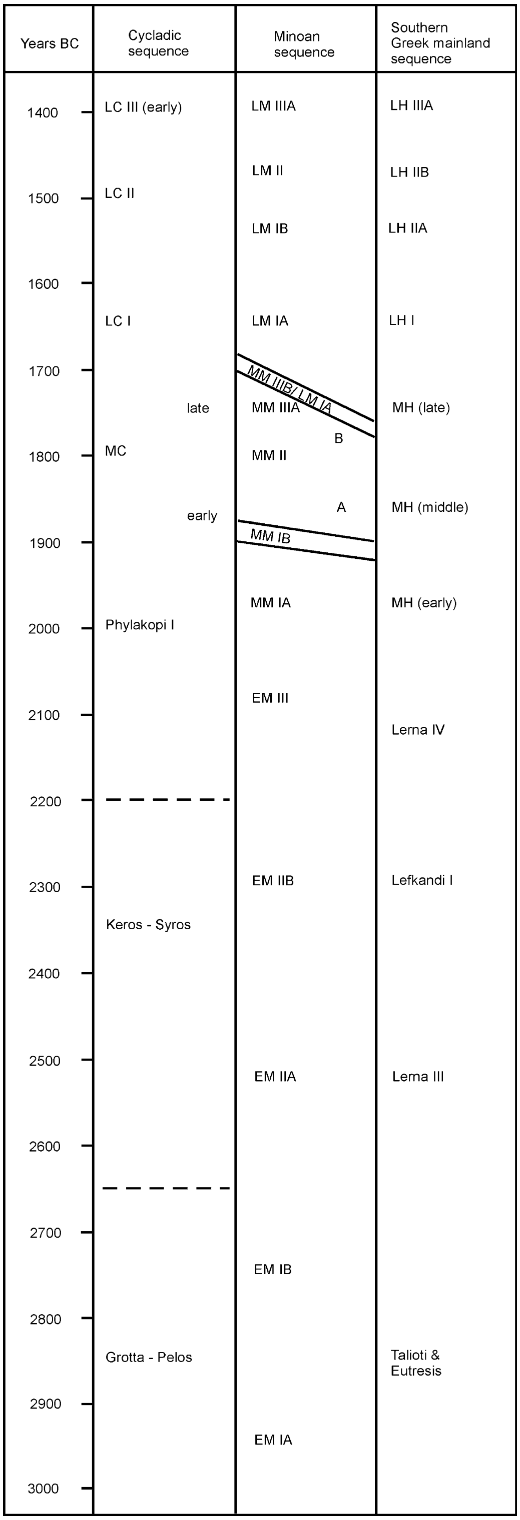

Fig. 2. Suggested chronology and synchronism for the Bronze Age Aegean (adapted from Barber, 1987; Manning, 1999; Warren and Hankey, 1989).

great variety of locations covering the Middle and Late Minoan periods. Not unreasonably, it has been assumed that these clay wheelheads—an essential part of the potter's wheel—can stand proxy for the actual device (Fig. 4). They are large (25–75 cm in diameter) and appear to fall into two weight categories with the smaller ones weighing 4–6 kg and the larger ones weighing 8–10 kg (Evely, 2000). Their lightweight design makes it unlikely that they were able to store the momentum in the same way as stone wheels which can weigh up to 40 kg. Until experimental work has clarified the design, efficiency and speed, three different scenarios can be upheld: an apprentice maintained the speed during the potting process, wheels were attached to heavy stone pivots in order to add essential weight, or these wheels were only used for the production of small vessels.[2] In the Cyclades, wheelheads have been found at Phylakopi on Melos, Akrotiri on Thera and Ayia Irini on Kea. They provide evidence of the use of the wheel at least by the (early) Middle Bronze Age, though most are contemporaneous with the New Palace period on Crete. Similarities in design, diameter and material make it likely that their capabilities were equivalent to wheels from Crete (Georgiou, 1983, pp. 75–78; Georgiou, 1986, pp. 36–39).[3]

However, it is important to emphasise that the existence of a potter's wheel does not necessarily imply the consistent utilization of rotative kinetic energy during the making of a vessel. Nor is the existence of surface features commonly associated with wheel-thrown pottery (e.g. rilling around the interior and/or exterior, concentric striations on the base and compression ripples around the neck) incontrovertible evidence of its use. Rilling around the interior or exterior surface, for example, can also be associated with techniques which involve the wheel as a secondary procedure such as coiling and then *wheel-shaping* a vessel using rotative

[2] The experimental reconstruction of a Canaanite–Israelite potter's wheel by Amiran and Shenhav provides our closest parallel. Here, a 60 cm wide wooden board was placed on top of a stone socket/pivot arrangement; the maximum speed that was attained with this potter's wheel was 60 rpm (1984).

[3] Although uncertain in the light of early evidence of wheel-thrown, Western Anatolian-derived shapes on the Greek mainland, the adoption of the potter's wheel often has been regarded as the inevitable outcome of interaction with Minoan Crete, from where this technology, so the assumption, was introduced to the Aegean islands together with other expressions of Minoan lifestyle (Papagiannopoulou, 1991, p. 61; Georgiou, 1986, p. 38).

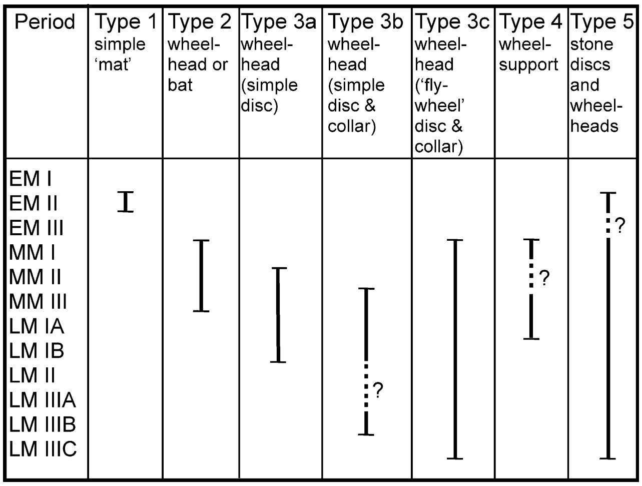

Fig. 3. Chronology of potting devices in Greece (based on Evely, 1988, 2000 and Eliopoulos, 2000).

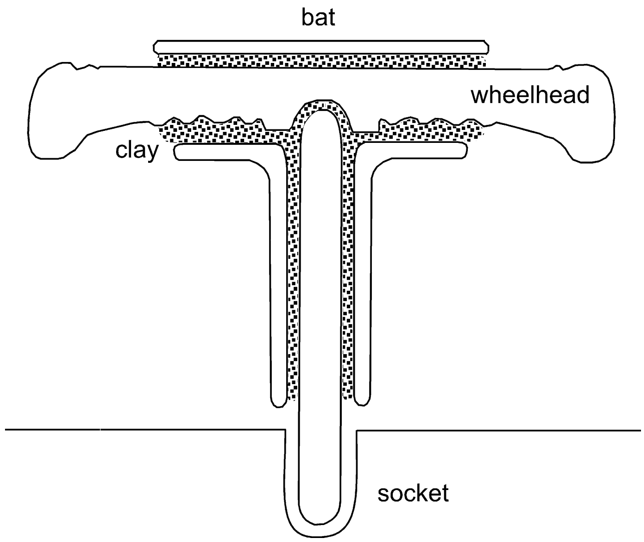

Fig. 4. Reconstruction of Minoan Potter's wheel (after Evely, 2000: fig. 11b).

kinetic energy (Courty and Roux, 1995; Roux and Courty, 1998; Henrickson, 1991). Concentric striations on vessels merely indicate the use of a rotational movement at the time of removing the vessel from the bat and concentric ripples around the neck only occur in the final stage of shaping a pot and are thus not necessarily related to the primary forming. Thus, what is conventionally considered a wheel-thrown vessel might in fact be wheel-shaped. Based on experiments, Courty and Roux have developed a methodology that allowed them to differentiate between truly wheel-thrown and wheel-shaped vessels (with a potential to further distinguish between up to four different wheel-shaping sequences) (1995; Roux and Courty, 1998), but there are still many grey areas.

While fieldwork for the below case study took place prior to the publication of Courty and Roux's articles and thus does not distinguish between wheel-throwing and wheel-shaping, Knappett's analysis of Middle Minoan pottery from Knossos, Crete, suggests the continued use of wheel-shaping for several generations after the introduction of the potter's wheel (2004), and it is possible that Phylakopi on Melos witnessed a similar development. Until a reliable method has been found to distinguish macroscopically between wheel-throwing and wheel-shaping, all subsequent references to 'wheel-made' or 'wheel-thrown' should be understood as referring to any kind of use of rotative kinetic energy during all or part of the forming process.

The social meaning of the potter's wheel

Many archaeologists working in the prehistoric Aegean still regard pottery primarily as a dating device or as a means to understand the technical or organisational aspects of craft production. Meaning, on the other hand, is seen to reside in the use-context and the added decoration. To view the technology itself as meaningful social practice has only recently become a topic of scholarly debate. Kiriatzi and her colleagues, for example, investigated the introduction of the potter's wheel to Toumba in Central Macedonia during the Late Bronze Age where coil-building or pinching had been the traditional production method. Mycenaean-type pottery, with a particular preference for serving vessels, was made using the potter's wheel. Additional differences were observed in the raw materials (calcareous versus non-calcareous clays), their preparation (well-refined versus relatively coarse) and firing conditions (controlled kiln versus open-air firing). The authors argued that the use of Mycenaean-type pottery in socially charged situations created an arena for the negotiation of societal roles, identities and relationships (Kiriatzi et al., 1997). That technology can have social meaning has also been suggested for the MM I–II period in Crete. Together with specialist masons, scribes, and traders, Knappett envisages the existence of specialist potters who, through exposure to Near Eastern potters, began producing wheel-made vessels for the Knossian elite. Association of the new technology and hence the resulting vessels with distant and mysterious cultures and knowledge could have provided the aspiring palatial elite with a new means to consolidate and express their authority (Knappett, 1999; cf Roux, 2003 for a comparable Near Eastern case study).

While the two case studies view agency residing in different social groups (bottom-up and top-down, respectively) they both imply that technology is not a distinct subsystem of society but is inseparably linked to it and can therefore constitute socially meaningful practice. Unfortunately, due to our concerns with dating, technological sequences and style as well as the need of excellent datasets as a prerequisite for further analysis, investigations into the social context of technology are still underrepresented. Based on the belief that the social context of technological activities is paramount for a better understanding of past societies, this work wishes to explore the pottery production at Phylakopi on Melos.

Historical background

Melos (Fig. 1) has been an important island since at least the Upper Paleolithic when obsidian finds from the Franchthi cave on the Greek mainland indicate that people had begun to exploit Melian obsidian (Perlès, 1987). While obsidian is the most visible material, the use of kaolin for incised patterns on ceramics is dated to the 6th millennium BC (Pantelidou-Gopha, 1995, pp. 140–143). Surface scatters of lithics dated to the Saliagos culture (c. 5th millennium BC) present the first (seasonal) habitation remains on the island (Renfrew and Wagstaff, 1982). The transitional Grotta-Pelos culture is well-represented on Melos. While stratigraphic material from Phylakopi itself is scant, settlement-cemetery pairs (e.g. Pelos Pyrgaki-Pelos, Samari-Kalogries) give a good impression of the dispersed nature of habitation in this period (Renfrew and Wagstaff, 1982). The early Middle Cycladic Phylakopi I culture indicates that the settlement itself had become substantial. While there are altogether nine known sites on Melos, Phylakopi is emerging as the dominant centre on the island, foreshadowing complete nucleation in the late Middle Cycladic period (Renfrew and Wagstaff, 1982). After destruction at the end of the MBA, Phylakopi was rebuilt, and public buildings and the fortification wall were added (Renfrew, 1978) (Fig. 5).

Between the Middle and Late Bronze Age, Phylakopi—alongside many other sites in the southern Aegean, on the Greek mainland and along the coast of Asia Minor—showed a dramatic increase in the number of Minoan imports (actual objects as well as symbols and concepts) (Berg, 2000; Davis, 1992; Davis et al., 2001; Hägg and Marinatos, 1984). Excavations also showed growth in the quantities of local imitations, most visibly in the pottery. This escalating presence of Minoan features or local imitations and the inferred culture change has been called 'Minoanisation' (for summaries see Berg, 2000; Broodbank, 2004; Papagiannopoulou, 1991). Not unlike 'Romanisation' or 'Westernisation', 'Minoanisation' is steeped in imperialist notions and evolutionary views (Curchin, 1991, p. 55; Moore, 1987, p. 86; for Minoan examples see Cadogan, 1984, p. 14; Doumas, 1982, p. 8; Schachermeyr, 1978, p. 424; Wiener, 1984). While presented as an explanation

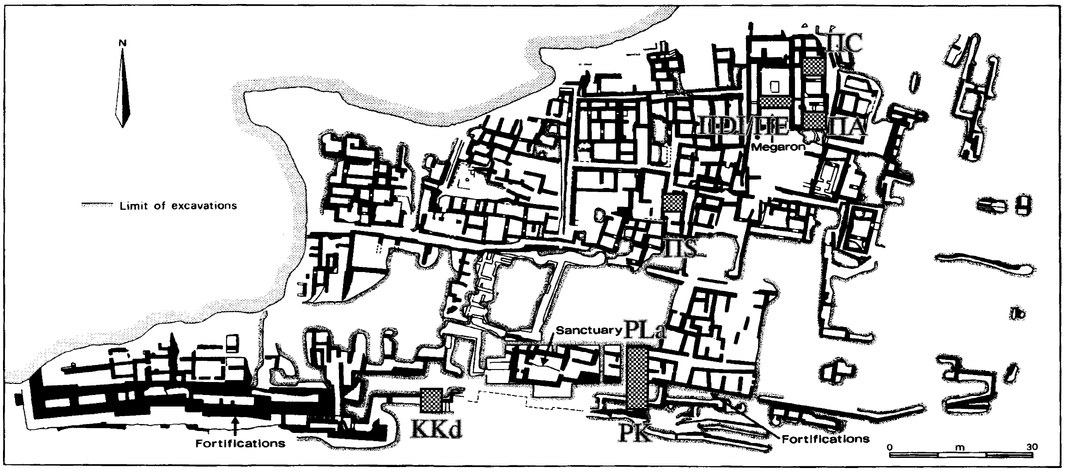

Fig. 5. The town of Phylakopi in the Late Bronze Age with excavation trenches indicated (Renfrew and Wagstaff, 1982: fig. 4.3; reproduced with permission from Colin Renfrew).

for the observed changes in material culture, the term is actually almost void of any intrinsic meaning as it is used as an all-encompassing catchphrase and carries no explanatory power (Berg, 2000). Culture change as a result of the conjunction of two principally autonomous societies can have a wide variety of consequences, ranging from complete assimilation of the two cultures to complete lack of impact. Not only are there differences in the depth of culture change but also in its direction and in its enforcement: are we witnessing a one-way or two-way process and who was the driving force behind the change? It has been suggested, for example, that the demand for Roman practices and items was in some cases locally driven, rather than imposed by the Romans themselves (Haselgrove, 1990, p. 46; Millett, 1990, p. 38). Thus, material culture must be seen as a dynamic force and as a means of communication, as suggested by studies of 'ethnicity' and 'cultural identity' (Banks, 1996; Jones, 1997; cf. Hodder, 1982). To understand the complex process of 'Minoanisation' (of the pottery production) at Phylakopi, we must immerse ourselves in the local context of all societies involved in the interaction and consider the hidden meaning behind any cultural changes (for Cycladic case studies see Berg, 2004; Davis, 1979, 1980, 1984; Davis and Lewis, 1985; Davis and Cherry, in press; Knappett and Nikolakopoulou, 2005).

Excavation history and research parameters

The history of archaeological exploration of Melos began in the late 18th century. First excavations of the settlement of Phylakopi occurred between 1896 and 1899 (Atkinson et al., 1904; Hogarth et al., 1897/98; Mackenzie et al., 1898/99; Mackenzie, 1963; Smith, 1896/97). Because of the subsequent discoveries on Crete, Dawkins and Droop undertook a small-scale supplementary excavation a decade later (1910/11; Barber, 1974). Renfrew revived excavations at Phylakopi between 1974 and 1977 to clarify the dating of specific features. An extensive interdisciplinary study of the whole island was conducted at the same time (Renfrew and Wagstaff, 1982). Preliminary reports and interpretative articles have been published (*Archaeological Reports* 1974–75, pp. 23–25; 1975–76, pp. 25–26; 1976–77, pp. 54–55; Cherry and Davis, 1982; Renfrew, 1978), while the final excavation report is close to publication (Renfrew, in press). Between 1989 and 1992, Sanders and Catling undertook a survey of Melos (*Archaeological Reports* 1989–90, p. 67). In 2003, a team from the British School in cooperation with the Greek Archaeological Service conducted a topographical and geophysical survey of Phylakopi in advance of the conservation of the site and its development for tourism (*Archaeological Reports* 2003–4, p. 71).

Many would argue that Renfrew's 1974–77 excavations of Phylakopi (Fig. 5), upon which my analysis is based, present us with one of the best ceramic assemblages of the Aegean prehistoric world, remarking in particular upon up-to-date excavation practices, the retention of all of the excavated pottery and its excellent state of preservation—further complemented by selective assemblages from preceding investigations. However, while without doubt an exceptional collection, four major issues need to be raised here: first, the 1974–77 excavations were designed to investigate different structures in unconnected parts of the town, resulting in trenches whose deposits could not be reliably related chronologically without resorting to statistical procedures each with its own set of problems (Davis and Cherry, 1984, in press); second, while each trench did provide a fine-grained sequence, individual deposits frequently had too small a sample size for meaningful statistical analysis. Third, the trenches were very small and did not allow the exploration of one complete architectural unit, thus depriving us of important contextual information. Fourth, although every attempt was made to detect joins, the highly fragmentary state of the pottery (less than 1% of the studied were complete) made identification of shapes, motifs and forming technique often problematic; in addition, assignment of forming technique(s) to shapes was based on the fragments studied and may conceal the existence of hybrid vessels where different techniques were applied to different body parts of the same vessel (Berg, 2000).

Seven of Renfrew's excavated trenches provided reasonably large sample sizes and a chronological coverage of the Middle Cycladic to Late Cycladic II periods: trenches ΠA, ΠDI/ΠE, ΠC from the Megaron area, trench ΠS from the Pillar Crypt area, and trenches KKd, PK, PLa along the fortification wall (Fig. 5). Of those, trenches ΠA and PLa together contained almost 70% of all fragments. In terms of temporal coverage, 40% of all fragments came from MC layers, the remainder belonging to the LC I–II periods. Overall, I studied 74,557 sherds and 479 complete vessels (for a summary of major shape categories, see Fig. 6). All ceramics were analysed macroscopically according to 45 variables, the most important ones for this work being fabric, shape, forming technique, and motif. Resulting percentages are based on sherd count (Berg, 2000).[4]

Middle and Late Bronze Age pottery at Phylakopi

Two fabric groups can be clearly distinguished macroscopically and petrologically (Fig. 7) (Davis and Williams, 1981; Jones, 1986, pp. 271–272; Barber and Hadjianastasiou, 1989, pp. 154–156). The Local Fabric Group ranges from semicoarse to very coarse clay with an orange to brown colour palette. All shapes (local as well as imitations of Minoan shapes) and surface treatments have been recognised in this fabric. Included in this fabric group, but distinguishable from this fabric by its softer clay,[5] is the 'conical cup' fabric which was exclusively used for small, open Minoan shapes and normally remained unpainted. The Cycladic White Fabric Group is characterised by its whitish, often finely levigated clay. Common shapes are traditional Melian serving vessels, especially cups and jugs, often decorated in Black and Red naturalistic and curvilinear designs (Berg, 2000).

Analysis of the pottery assemblage from Phylakopi demonstrated that, as at other Cycladic settlements, there was a rapid increase in locally produced wheel-made pottery between the late MC and the LC II period (Fig. 8). However, when broken down by fabric group, it becomes apparent that the bulk of wheel-made vessels occurred in the 'conical cup' fabric which specialised in small, open Minoan shapes (especially cups)—larger Minoanising shapes were made in the Local Fabric. The increase in the use of the wheel for the Cycladic White and the Local Fabric Group was noticeable but generally remained under 30% of the total production (Fig. 9) (Berg, 2000).

Interestingly, the pattern of adoption appeared to follow a particular sequence, namely from small open to large closed vessels, that is from simple to complex vessels in terms of the skill required for their manufacture. Fig. 10 shows that in the late MC period only a few, small open vessels (conical cups, bell cups, straight-sided cups, saucers) were wheel-made. During the early and middle LC I period, other small open shapes are added to the wheel-made repertoire (panelled cups, hemispherical cups, rounded cups) as well as one large (20–30 cm in height) open shape, the conical rhyton, a new Minoan-style shape. During the late LC I/II period, an increasing number of shapes are wheel-made. Newcomers are the semiglobular cup, the Melian bowl, the lamp and the amphora. The cup, bowl and

[4] For any interpretation it should be born in mind that the sample size for Cycladic White fabric in middle LC I is small.

[5] No systematic analysis of firing temperatures and conditions was undertaken as part of this study; however it is possible that the softness of the 'conical cups' fabric indicates different firing conditions to that of the other fabrics (cf. Orton et al., 1993, p. 138). That differences between fabrics can be expressed also in distinct firing processes has been shown by Kiriatzi and her colleagues (1997).

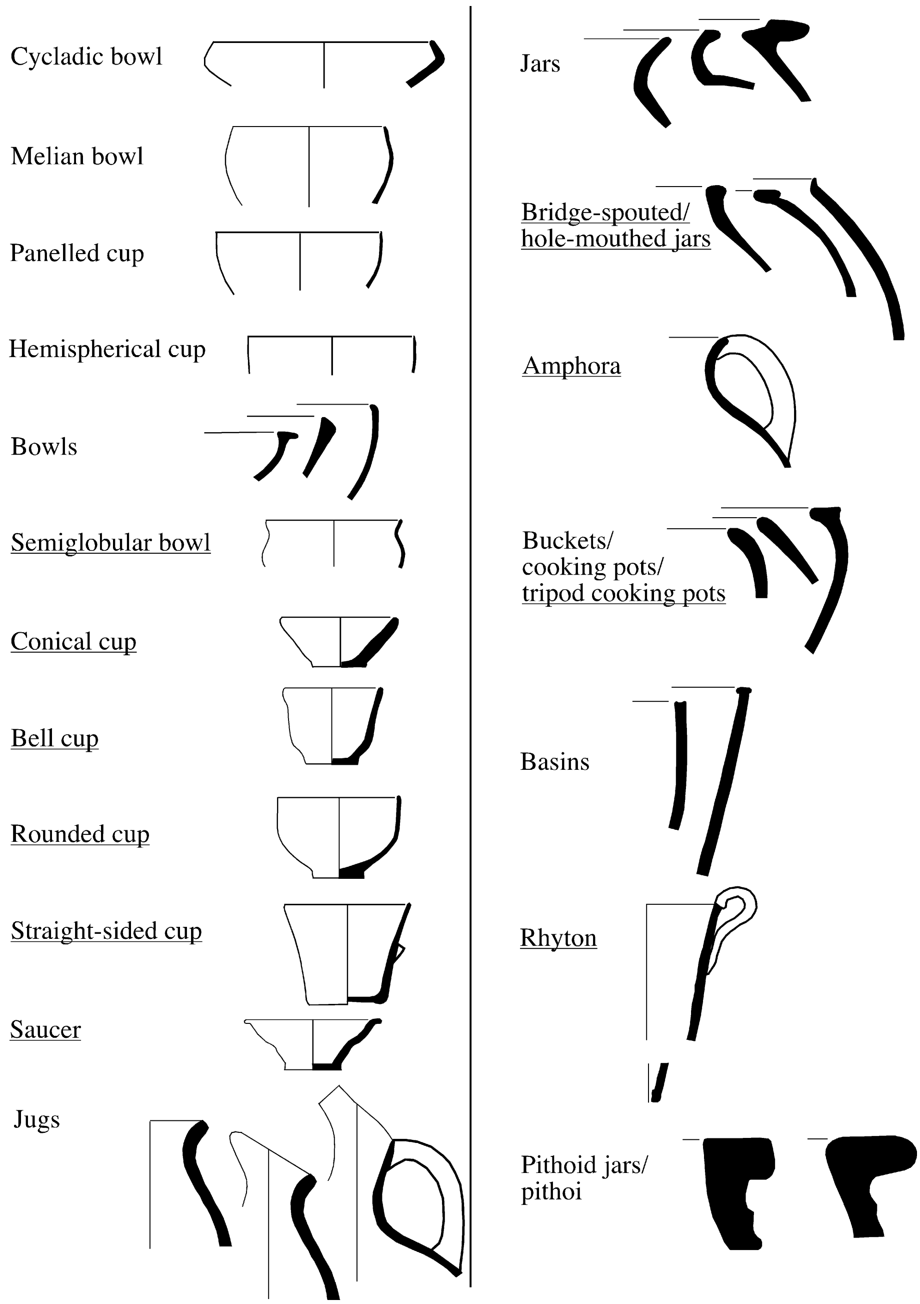

Fig. 6. Common vessel shapes at Phylakopi. Minoanising shapes are underlined Scale 1:5. with permission from Colin Renfrew.

lamp are all small open vessels. The amphora is the first example of a wheelthrown, restricted vessel of c. 30–40 cm in height with a narrow orifice.

This particular pattern has also been observed at Ayia Irini on Kea, Akrotiri on Thera, Knossos on Crete, and Toumba in Central Macedonia (Berg, 2000; Kiriatzi et al., 1997; Knappett, 1999; Papagiannopoulou, 1991) and seems to be almost generic. An explanation for this phenomenon has been proposed by an outstanding ethnographic and experimental study by Roux and Corbetta (1989).

The potter's wheel at Phylakopi: Biomechanical and physical constraints

In 1986 and 1987, Roux and Corbetta carried out ethnoarchaeological fieldwork in New Delhi, India,

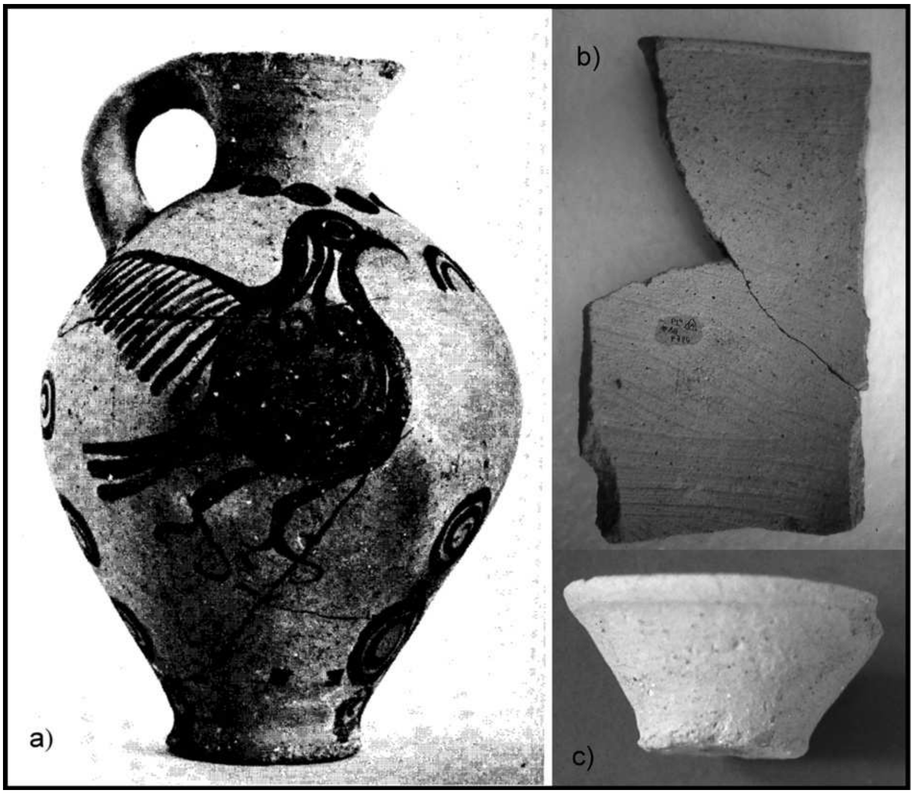

Fig. 7. Melian fabrics. (a) Cycladic White (Renfrew and Wagstaff, 1982: plate 16.2), (b) 'local' fabric, (c) 'conical cup' fabric. All with permission from Colin Renfrew.

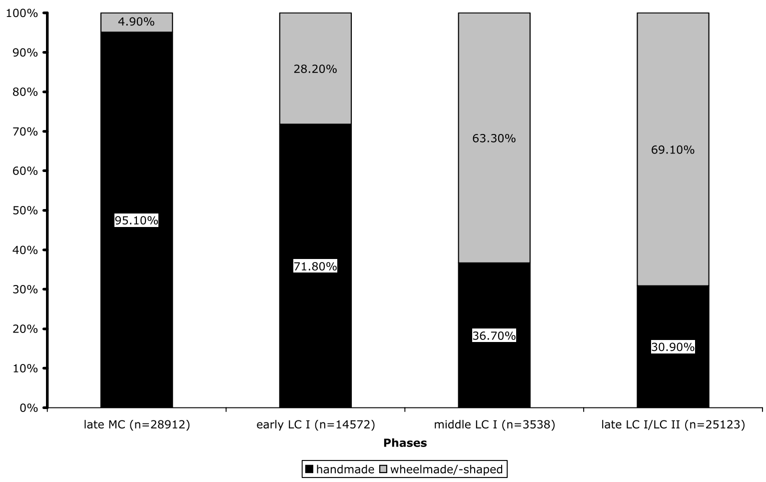

Fig. 8. Phylakopi: Development of wheel-made/-shaped and handmade pottery through time.

with the aim of investigating whether or not wheel-using potters are craft specialists (that is, wheel-throwing requires specialised knowledge and a sustained period of learning) and how (if at all) this manifests itself in the archaeological record (1989). To achieve their aim, the authors investigated the duration and nature of apprenticeship through ethnographic and experimental data. Based on experiments with potters of different levels of competence and a control group of non-potters, the authors were able to demonstrate that acquisition of the necessary skills is very time consuming; this is because

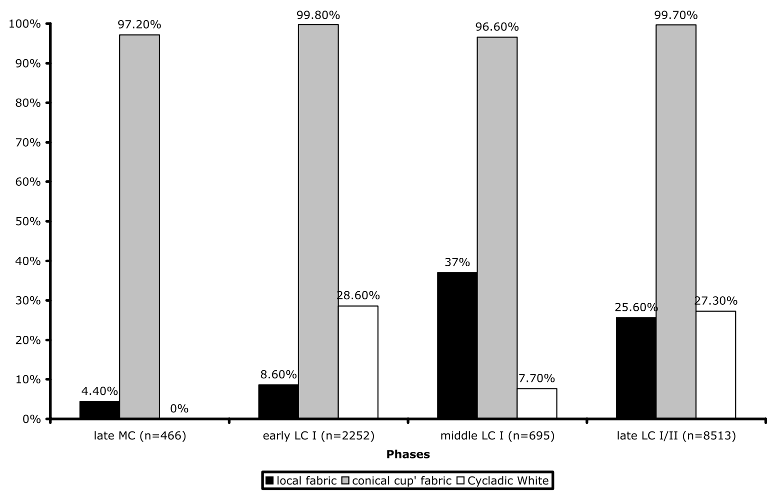

Fig. 9. Phylakopi: Development of wheel-made/-shaped use according to fabric.

	late MC	**early/middle LC I**	**late LC I/LC II**
Cycladic bowl	hand	hand	hand
Melian bowl	hand	hand	hand
other bowls	hand	hand	hand
panelled cup	hand	hand and wheel	hand
hemispherical cup	hand	hand and wheel	hand and wheel
tumbler	hand	hand	---
semiglobular cup	hand	hand	wheel
rounded cup	hand	wheel	wheel
conical cup	wheel	wheel	wheel
bell cup	wheel	wheel	wheel
straight-sided cup	wheel	wheel	wheel
saucer	wheel	wheel	wheel
jugs	hand	hand	hand
jars	hand	hand	hand
bridge-spouted/ hole-mouthed jars	hand	hand	hand
amphora	hand	hand	hand and wheel
buckets/cooking pots/**tripod cooking pots**	hand	hand	hand
basins	hand	hand	hand
pithoid jar/pithos	hand	hand	hand
tub	hand	hand	hand
lamp	hand	hand	hand and wheel
rhyton	---	hand and wheel	wheel

Fig. 10. Phylakopi: *dominant* forming technique by shape (*all* local fabrics; Minoanising shapes in bold; hand = handmade; wheel = wheelmade/-shaped; hand and wheel = equal proportions of handmade and wheelmade/-shaped).

potters have to master any one stage before they can acquire the necessary new skills (e.g. motor activities) to move on to the next level of difficulty. They estimated that it will take a minimum of 10 to 15 years for an apprentice to become proficient. Contrary to coil-building, the long duration of the apprenticeship in wheel-throwing is primarily due to biomechanical and physical constraints and is therefore of universal relevance. Cultural differences may shape the social organisation of an apprenticeship a

	STAGE 1	STAGE 2	STAGE 3
VESSEL HEIGHT REACHED	6 cm	22 cm	> 22 cm
TYPE OF POT MADE	Little and big fairy lamp	Jar lid, 10 cm vessel, 20 cm vessel	30 cm vessel

b

	STAGE 1	STAGE 2	STAGE 3
VESSEL HEIGHT REACHED	5-8 cm	20 cm	> 20 cm
TYPE OF POT MADE	Cup, saucer	Rhyton	Amphora

Fig. 11. (a) Height stages of a potter's apprenticeship (after Roux and Corbetta, 1989). (b) Height stages of Melian potters.

but do not substantially influence its duration (1989, p. 88, 140–143).[6]

More importantly for archaeologists, their ethnographic and experimental work has demonstrated that this learning process is expressed in an increase in pot size as the potter becomes more and more competent. Fig. 11a identifies the three main learning stages: During Stage 1 apprentices do not yet know how to centre the clay on the wheel effectively. As a result, they will be limited to throwing small open vessels of up to 6 cm in height. Once apprentices have learnt how to centre the clay and use asymmetrical but simultaneous hand movements they can move on to throwing larger vessels of up to 22 cm in Stage 2. However, only the most experienced potters can throw unrestricted or restricted vessels higher than 22 cm and thus reach Stage 3.

This experimentally derived sequence mirrors the pattern observed at Phylakopi (Fig. 11b): At first, small open vessels such as cups and saucers were wheel-thrown. Most of these are well below 10 cm in height and were probably thrown 'off-the-hump', requiring no perfectly centered lump of clay. Later, in addition to other types of cups, we witness the addition of the rhyton, a large open vessel of about 20 cm in height, to the wheel-thrown repertoire. Despite being rather large, the rhyton is a vessel easy to manufacture as it is an open shape without any sharp angles. While it can easily be made in one piece, rhyta made of two separate halves that were later joined are common. In the final stage, there is evidence of wheel-thrown closed vessels of up to 40 cm in height. These amphorae can be made in one piece, but study of the fragments suggests that the Melian potters preferred to form the base and body using coils[7] while joining the separately thrown neck and rim later.

If interpreted correctly, we can indeed observe the progressive stages of a wheel-throwing apprenticeship at Phylakopi, indicating that the adoption of the potter's wheel was slow and gradual as each new generation built on existing skills and acquired an increased 'everyday' familiarity with the new technology. However, as amphorae were made in two parts (regardless whether the base was coil-built or wheel-thrown) I am left to conclude that the Melian potters never attained the final stage of the apprenticeship and thus never learnt to exploit the potter's wheel to its full potential; while some may

[6] Experiments undertaken by psychologists have demonstrated that the 10-year rule for achieving expert performance as a potter is not specific to this activity but is universally applicable to complex specialist tasks (e.g. sports, chess, computer programming). "Expert… performance [is] shown to be mediated by cognitive and perceptual-motor skills and by domain-specific psychological and anatomical adaptations" (Ericsson and Lehmann, 1996, p. 273). Ten years of extended, daily and *deliberate* practice are required to achieve the highest level of expertise in a certain area. Instead of innate talent or exceptional skill, only task-specific daily practice over ten years coupled with motivation is seen to correlate with the highest level of performance or achievement (Ericsson and Lehmann, 1996; cf. Ingold, 2001). This data indicates that the wheel-throwing technique can, in principle, be acquired by anybody who is willing to invest the required effort. At the same time, improvement beyond the initial stages is governed by physio-technical consideration as well as opportunity for daily practice.

[7] Due to the fragmentary state of the assemblage it was rarely possible to firmly assign bases to specific shapes. While the majority of bases are clearly handmade, there are several examples of wheel-made bases.

argue that making an amphora in two (or more) sections may simply be a matter of *choice* (rather than necessity) on the part of a potter, discussions with modern potters indicate that it would be unusual for somebody to revert to a slower, more complicated manufacture once they have achieved a sufficiently high level of competence to throw a vessel as one (Veronica Newman and Sandy Budden, pers. communications; Arnold's Mexican case study (1999) demonstrates that a decrease in skill is only sought in a re-organisation of production to include *unskilled* labour). Additional circumstantial evidence is provided by the study of decoration on complete vessels in the museum's collection: virtually no vessel shows evidence of the use of a rotating potting device for the application of decoration—horizontal bands or lines were not made by pressing a brush against a rotating vase but by drawing them free-hand. As wheel-throwing is a radically different technique from, for example, coil-building, it requires the acquisition of entirely new and unfamiliar motor skills as well as continuous and directed exercise in order to progress to the next stage. Not only may established potters have been incapable of acquiring these new skills, but those that did make the leap may have found progression towards larger and more complex shapes difficult without continuous practice and learning support. Several hypotheses can be put forward for this scenario: (1) The necessary expert learning support was unavailable, thus prohibiting progression to more advanced stages of learning. (2) Potters were working only on a seasonal basis for the population of a medium-sized Cycladic town (c. 1400–3000 inhabitants; cf. Renfrew and Wagstaff, 1982, pp. 139–140, 252) and lacked regular learning opportunities to improve further (see Footnote 5). If standardisation is accepted as one of the potential indicators of (full-time) craft specialisation, then results from a recent statistical analysis of conical cups strongly suggest that production at Phylakopi was only part-time (Berg, 2004). Thus, it is indeed possible that the slow and incomplete advance in technology may at least in part be due to the lack of learning opportunities, task-specific daily practice, motivation, and/or experimentation. However, a third scenario should also be considered, namely that socio-cultural taboos may have prevented the application of wheel-throwing techniques to large closed vessels (though this hypothesis is undermined by the partial use of the wheel for throwing the lower body of several large vessels).

The potter's wheel at Phylakopi: Social constraints

While lack of expertise might have restricted the *use* of the potter's wheel primarily to open shapes, the types of vessels that were wheel-thrown indicate that the *choice* of this technology was social practice. Fig. 10 shows that most of the shapes that were wheel-thrown were primarily of Minoan origin. They include a wide range of cups, as well as lamps, amphorae, and rhyta. Other large Minoanising shapes, such as hole-mouthed jars, bridge-spouted jars and cooking pots, were normally hand-built, although few wheel-made examples exist of the jar types. The great majority of local shapes, on the other hand, were hand-built.[8] Further analysis demonstrates that the observed pattern permeated all aspects of the pottery production, including fabric, forming technique and decoration (Berg, 2000): the 'conical cup' fabric was exclusively used for small, open Minoanising shapes which were wheel-thrown. Cycladic White was primarily used for local shapes which were handmade. The local fabric was used for both, but Minoanising shapes were regularly wheel-made while those following the local tradition were predominantly made by hand. Decoration also follows this trend. Minoanising motifs are more commonly found on Minoansing shapes and traditional motifs on local shapes. When the local fabric was used for Minoanising shapes a pale slip was often added to mirror the pale Cretan clay (cf. Evely, 2000, p. 263 for a comparable example from Chania on Crete). Potter's marks only occur on local shapes and never on Minoanising ones.

Since we know that the Melian potters used the potter's wheel as competently as can be expected for the different stages of the learning process, we have to reject the idea that they were physically incapable of applying the technique also to their local shapes. By using the wheel for Minoanising shapes, the potters produced exact copies of Minoan originals, including the pale fabric colour, shape, the forming process and the decoration. Melian shapes, on the other hand, continued to be manufactured according to the local tradition, namely using local shapes, handmade production and traditional motifs. For as yet unknown reasons, many Melian potters regarded the two traditions as *conceptually* different—what was appropriate for the production of

[8] Exceptions to the rule are the Melian bowls and few other small open cup shapes.

Minoanising vessels was inappropriate for the production of local shapes.[9] Ethnographic studies have drawn attention to the potential for manipulation and expression of identity in the different stages of the pottery production process and may, therefore, provide clues as to why changes in the primary forming technique are often perceived as 'incompatible' with traditional ways of doing, and are consequently often resisted. In his Cameroonian case study, Gosselain found that "certain facets of identity were related consistently to certain stages of the *chaîne opératoire*" (2000, p. 189). He was able to distinguish between three technico-social categories:

(1) *Techniques that leave visible evidence on the finished product* (e.g. tempering or mixing clays, secondary forming techniques, decoration, certain firing techniques and most post-firing treatments). Easily visible techniques allow other potters, customers, relatives and neighbours to be aware of an individual's techniques. As a consequence, these features are easily transmittable, fluctuate through time and reflect the more superficial, situational and temporary facets of identity; they often are a response to changing social, economic, or symbolic pressures.
(2) *Techniques that leave no visible traces on the finished product but are observed by fellow workers*, especially when the work is done on a collective basis (e.g. clay selection, extraction, processing and firing). Consequently, modifications are likely to reflect adjustment to local or regional identities.
(3) *Techniques that do not leave visible traces on the finished product* (e.g. primary forming techniques which are generally obliterated by secondary forming treatments). They are most resistant to change as they are based on specialized gestures and motor habits acquired through repeated practice. Thus, primary forming techniques reflect the most individual and rooted aspects of social identity, including kinship, learning networks, gender and social class (Gosselain, 1998, 2000; Gelbert, 1999; cf. Mahias, 1993 and Arnold, 1999 with reference to India and Mexico, respectively).

While Category 2 needs to await future scientific analysis, Categories 1 and 3, I would argue, can be identified at Phylakopi. On one hand, we have the rapid adoption of easily visible features, such as Minoan shapes, motifs and fabric colour. Being easily visible, the adoption of these features signals more superficial desires and may have been a response to customer demand, reflecting what Wiener has called the 'Versailles effect' (1984). On the other hand, the hesitant adoption of the actual forming technique and, indeed, the resulting technological division in the pottery production at Phylakopi are reflections of deep-rooted aspects of identity, such as kinship, identity or gender, making the adoption of a new technology all the more poignant. However, given the existence of hybrid vessels (functionally or socially) that combine Minoanising and local features in non-deterministic ways, it is probably best to consider the above pattern as presenting two extremes along a continuum (rather than a strict dichotomy) with an adherence to the Minoan tradition on one end and the local tradition at the other. Indeed, the existence of variability indicates that the observed pattern was not accepted by all potters and should thus be considered socially meaningful in itself.

No hint of any conceptual division is, for instance, visible at Ayia Irini on Kea where the adoption of Minoan shapes and the wheel-throwing technology were much more inclusive, extending to a much greater degree also to local shapes. Here, the new technology was incorporated into the potter's repertoire without resulting in any kind of division (Berg, 2000).

Conclusion

It has become apparent that technology can no longer be viewed in purely technical terms and as such as neutral in meaning. Forming techniques, in line with any other aspect of technology, have been

[9] The use of two different production technologies within a social unit is a common phenomenon also in modern societies. In her study of Andean potters of Las Anima, Hosler explains the use of two different manufacturing methods (prop-method and free-form method) as a social strategy employed by the two competing social groups within the village. This division is indicated by spatial stratification, status distinction and gender role differences (1996). With this case study in mind, I studied the assemblage from Phylakopi in order to assess whether the production of local wares and Minoanising shapes was undertaken at the same workshops or whether different workshops specialised in the manufacture of either tradition. Unfortunately, the fragmentary nature of the assemblage prohibited a high enough resolution of the data. As regards spatial patterning no coherent case can be presented as Renfrew's excavations were limited to few small and unconnected areas.

shown to be a social product imbued with meaning. As a result they are open to manipulation in social negotiations. By associating the production technique, the finished product and the meaning placed on its use in society, the Phylakopi case study has illustrated that practical and socio-symbolic contents of a technology interacted in subtle ways, and that ‘technologies’ can embody non-verbal cultural choices.

Unlike at other settlements, the introduction of the potter’s wheel did not lead to a complete replacement of traditional handmade techniques. However, the preferential application of the potter’s wheel to Minoanising shapes hints at the existence of social taboos associated with this relatively novel forming technique. While the new technology might have caused social tension, the incorporation of Minoanising shapes into the existing repertoire appears to have been welcomed. The increase of Minoanising shapes was so pronounced that Furumark referred to a complete replacement of the traditional pottery repertoire through soulless copying of Minoan shapes (1950, pp. 195–199). While exaggerating the scale of copying, his comment clearly highlights the islanders’ need and desire for these new kinds of vessels (and may also explain the existence of hybrid combinations). The reason for an increased desire is commonly assumed to lie in the potential use of Minoan pottery as a status symbol (cf. Papagiannopoulou, 1991, p. 118). As Dawson and colleagues argued, “groups may wish to enhance their prestige in their own or the eyes of others by taking on the materials, symbols, and regalia of other groups—there is almost a magic of the power rubbing off by imitation” (Dawson et al., 1974, p. 48). This hypothesis is further supported by vessel function. For an object to function as status symbol it needs to be used in socially charged situations; this makes storage and processing vessels less suitable as they are primarily used in private. Serving vessels, on the other hand, will also be used during semi-private or public occasions and are therefore suitable communication vehicles. As most Minoan or Minoanising vessels fall under the category of serving vessels (e.g. cups, spouted jars, jugs) it is likely that at least part of their function was to be used in situations of social significance, such as drinking and feasting. The occurrence of hundreds of conical cups (as well as bell-shaped cups, saucers, straight-sided cups) points towards the enactment of competitive, resource- and labour-intensive consumption strategies, possibly related to alcoholic beverages (Berg, 2004; Hamilakis, 1996, 1999). As vessel shape and production technique are inseparably linked to each other, it is not only Minoanising pots but also the potter’s wheel which became associated with a foreign culture and its consumption patterns. Arguably, it was the introduction of the potter’s wheel that first permitted participation in new, Minoan-style drinking and feasting rituals by increasing the output of drinking vessels (e.g. conical cups) to a hitherto unknown level.

In addition to illuminating social practice, the above case study also provides important insights into learning processes. If Roux and Corbetta’s model for apprenticeship stages is indeed considered generic due to its emphasis on biomechanical and physical factors, then we can witness an incomplete learning process among the potters at Phylakopi. While potters were able to produce vessels of up to 20 cm in height—indicating that local potters only achieved Roux and Corbetta’s Stage 2, but did not achieve the highest level of expertise—then the learning phase from first introduction through to competent mastery of the technology was drawn out over 200–250 years. Part-time work, incomplete information transfer, and/or cultural norms can all be argued to have stood in the way of a quick and complete adoption of the technology. It is only with the penetration of the succeeding Mycenaean culture into the Cyclades that we see Melian potters consistently producing large closed vessels with the potter’s wheel.

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