Analyzing technological standardization: revisiting the Minoan conical cup

Hilditch, J.R.

Publication date
2014

Published in
Mediterranean ceramics: standardization, variation and people's choices (late 2nd to late 1st millennium BC)

UNDERSTANDING STANDARDIZATION AND VARIATION IN MEDITERRANEAN CERAMICS

MID 2ND TO LATE 1ST MILLENNIUM BC

Edited by
Antonis Kotsonas

PEETERS
Leuven - Paris - Walpole, MA
2014

Contents

Analyzing technological standardization: revisiting the Minoan conical cup

Jill Hilditch

Abstract

'Standardization' has traditionally been used to explain decreasing levels of formal and material variability within ceramic assemblages, with this decrease in variability often seen as a corollary to the development of mass production of ceramic goods, a key feature in the development of complex social and political structures within the Aegean. In this way, the concept of standardization has been perceived as a unilinear process, rather than a random or discrete phenomenon: once production moves beyond the 'household' then standardization becomes almost inevitable, to some degree. A touchstone for this argument is the potter's wheel, a device allowing vast quantities of vessels to be successfully produced in a shorter space of time. Yet the relationship between production technique and standardization of production is far from simple. Factors such as skill, production organization and conspicuous consumption can all affect the standardization of an assemblage over time. This paper seeks to highlight the physical characteristics of compositional and technological standardization, as seen through the chaîne opératoire *of conical cup production in the Middle to Late Bronze Age Aegean, and how the application of analytical techniques from the materials sciences can enhance our understanding of variability within the ceramic record and reassess traditional assumptions on the spread of the potter's wheel.**

Introduction

'Standardization' has traditionally been used to describe decreasing levels of formal and material variability within ceramic assemblages.[1] This decrease in variability is often seen as a corollary to the appearance of mass production within ceramic manufacture, upon which the development of complex social and political structures was predicated.[2] In this way, the concept of standardization has been perceived as a unilinear process, rather than a random or discrete phenomenon: once production moves beyond the 'household' then standardization of the end product is, to some degree, inevitable as production becomes increasingly specialized. A touchstone for this argument is the potter's wheel, a device allowing large quantities of vessels to be successfully produced in a shorter space of time. However, the relationship between production technique and standardization, or decreased material variability, is far from simple, as many of the papers in this volume attest, and factors such as skill, production organization and conspicuous consumption can all affect the degree of standardization, both spatially and temporally, within an assemblage.

Our understanding of how variability in the ceramic record is generated and characterized has broadened with the application of analytical techniques from the materials sciences, in combination with the use of increasingly sophisticated theories on human-material engagement, providing the modern archaeologist with a range of tools to consider patterns of material culture change.[3] Yet, surprisingly little study has been devoted to addressing technological standardization within the production process. The *chaîne opératoire* is a key framework for helping us pick apart the complex and socially embedded practice of ceramic production, i.e. identify where in the manufacturing process specific decisions have been made and allow more robust comparisons between different datasets,[4] yet it remains underused within technological studies that focus on the inter-related issues of standardization, specialization and the transmission of technical knowledge. This paper considers technological standardization, in other words where and how standardized behaviors and gestures appear within the production sequence, and their importance for archaeologists in trying to understand material culture change, using the Minoan conical cup of the late Middle and Late Bronze Age Aegean as a case study (*fig. 1*). This small handleless cup holds enormous potential for considering technological standardization and the impact this has for considering wider issues of technology transmission, culture contact and material correlates of skill. Through an integrated analytical programme of macroscopic, thin section petrography and automated scanning

Fig. 1. Late Bronze Age 'Minoan' conical cups at Ayia Irini, Kea (photo author; with thanks to E. Gorogianni and R. Fitzsimons).

electron microscopy with automated energy dispersive spectrometry (SEM-EDS), late Middle Bronze Age ledge-rim bowls and conical cups at Akrotiri, Thera, were investigated from a *chaîne opératoire* perspective and their production sequences reconstructed. This methodology assesses these shapes within the context of the whole ceramic assemblage, allowing detailed consideration of technological standardization

Standardization and the chaîne opératoire

Within ceramic studies, increasingly sophisticated analytical techniques, and their integration with macroscopic and experimental studies, have had an enormous impact on the study of standardization. Optical microscopy, and elemental analysis and imaging, have increased precision for investigating technological, compositional and metrical standardization within ceramic assemblages,[5] and afforded fresh perspectives on the production, distribution and consumption of these vessels. However, one potential disadvantage to ever-increasing accuracy in our analytical datasets is the growing gap between the interpretation of those results and the archaeologically meaningful world of past decisions and technical choices made by craftspeople. A solution to this issue can be sought in the *chaîne opératoire* framework,[6] where explicit manufacturing stages can be broken down into a series of compatible choices or behaviors, allowing for more valuable comparisons of data as well as highlighting the importance of contextual factors for the finished aesthetic of a ceramic corpus within space and time. As Olivier Gosselain points out, 'artifacts and *chaînes opératoires*, like individuals and socials groups, are not clearly bounded and monolithic units, but complex, dynamic, and profoundly mixed constructions'.[7] This approach is more sympathetic to the concept that standardization can only be a relative measure[8] and, therefore, no single aspect should be considered in isolation from the wider *chaîne opératoire* of production and context of consumption. All aspects, or indexes, of standardization[9] can be identified and studied within the *chaîne opératoire* framework, from raw material exploitation and processing right through to the firing process, to identify similar products from the same potting tradition or 'community of practice'.[10]

Traditionally, the culture history approach has equated standardized material culture assemblages to ethnic groups and mapped group distribution across space and time through the appearance of these assemblages and their components.[11] In contrast, post-processual approaches associate material patterning with the nature and degree of contact between communities through social, linguistic, political, and even religious, interactions, and recognize the potential for overlapping boundaries when considering these varying types of interaction.[12] The performance of a particular sequence of technical decisions, social practices and motor habits within material culture produc-

tion is the post-processual keystone for assessing group identity and the defining of broader social and cultural boundaries.[13] The *chaîne opératoire* of the French anthropological tradition[14] is one such framework for identifying and assessing these decisions and habits, as is *behavioral chain analysis* developed within American archaeological circles[15] and the more recent *dynamic systems framework*.[16] The work of Gosselain, in particular, amongst modern potting communities in Africa has highlighted the potential for specific groups or communities to be identified through the technical decisions made at each stage of the production sequence, and even in subsequent consumption behaviors.[17] Change in the overall sequence can be attributed to different choices within specific stages of the manufacturing sequence. These technical choices can vary considerably, from their visibility in the final product to how the potter learns this behavior, making some choices easier to adopt, or transmit, between individuals and groups of potters than others.[18] In this way, interactions between multiple communities can be assessed in a more dynamic way, taking into account directionality, duration, intensity and frequency of contact, with respect to human, environmentaland material agents, i.e. potters, raw materials, consumers and the finished pots themselves.[19] Gosselain highlights that raw material selection and processing, as well as fabrication or forming technique, are the least visible aspects of the *chaîne opératoire* to non-specialists and, therefore, provide more information on the internal learning processes and traditions of potters diachronically and spatially.[20] The relative 'invisibility' of particular technical behaviors that characterize group affiliation provide the most fertile ground for application of modern scientific techniques and, it can be argued, provide the most valuable datasets for interpreting compositional and technological standardization.

Characterizing technological standardization

There are three traditional indexes for measuring or considering standardization: metric, compositional and technological.[21] It is difficult to conceive of a quantitative measure for compositional or technological standardization, such as those used for assessing metrical standardization.[22] This is due in part to the low visibility or invisibility of compositional and technological behaviors in the finished vessel, but also, perhaps more importantly, because these aspects of ceramic vessels are increasingly recognized as inherently bound up in the learning habits and skills of individual potters within wider socio-culturally-bounded ceramic producing communities.[23] Moreover, post-processual approaches to material culture would argue that developing such a methodology is unnecessary, particularly if we are to embrace 'contextual considerations and … non-linear narratives for the role of ceramic standardization and variation in human society'.[24] For instance, quantitative measures, such as the *F*-test,[25] the coefficient of variation or CV,[26] or cluster analysis[27] produce static datasets that are difficult to interpret with respect to human-material-environment interactions in the landscape. It is extremely difficult to move from quantitative measures to archaeologically meaningful interpretation, with very few methodologies explicitly outlining how quantitative data relate to deliberate past behaviors and activities. Recent shifts by archaeologists to integrate the *chaîne opératoire* within increasingly sophisticated analytical and experimental approaches to human-material engagement[28] offer a genuinely dynamic perspective through which to characterize and analyze production and consumption activities and, therefore, allow a more detailed consideration of where and how 'visible' metric standardization and 'invisible' compositional and technological standardization occurs within the assemblage. In turn, these new theoretically-informed integrated approaches can identify which processes were responsible for generating variation and the decisions or behaviors within that process that can ultimately shed light on the dynamics within ancient potting communities.

Embedding technological standardization

Potting raw materials, that is clays, sediments, sands and tempers (organic and non-organic), can be found in a multitude of geological and topographical settings. Despite the wide availability of potentially viable or workable raw material resources in the landscape for ceramic manufacture, a number of ethnoarchaeological studies have documented the often complicated and socially-dependent choices of which raw materials are eventually selected by potters and where they are collected.[29] These studies effectively highlight the range of 'contextual considerations', right from the very first stages of the manufacturing sequence. So, given the scope for socially-embedded behaviors to determine the starting material, is it still useful to assess compositional standardization? One potential answer is to investigate the deliberate processing of the exploited raw material by

the potter and the archaeologist's ability to subsequently characterize a ceramic paste with respect to these intentional behaviors and raw material source.[30]

Advances from material sciences techniques can characterize the indices of paste variation in more detail, from the textural and mineralogical information observed in thin section petrography to the bulk elemental compositional profiles provided by techniques such as neutron activation analysis (NAA), inductively coupled plasma mass spectrometry (ICP-MS) and x-ray fluorescence (XRF).[31] Very few analytical techniques offer the complete spectrum of diagnostic tools for assessing paste variation, though recent studies in scanning electron microscopy with automated energy dispersive spectrometry (SEM-EDS) have the potential to effectively 'bridge the gap' between petrographic and elemental techniques,[32] allowing for clay mineral identification and potential clay mixing behaviors alongside detailed mineralogical profiles of the fine and coarse fractions of the paste. Used within an integrated analytical program that also combines geological sampling and experimental replication, these analytical techniques allow archaeologists to reconstruct with ever-greater confidence the source of the exploited raw materials (clays and tempers) and how they have been altered or deliberately processed (levigated, sieved, crushed, tempered, mixed, etc.) by generations of potting communities. Dean Arnold's own ethnographic work in Latin America highlighted the importance of environmental (natural variation within and between sources), technological (choice of paste in combination with forming technique or desired physical property of finished vessel) and social (the learned behaviors and perceptions of both potter and consumer) factors that can influence specific exploitation and processing behaviors within the production sequence. His case studies reveal that production organization, and the degree of standardization these various models are associated with, had a smaller role to play in determining paste variation than previously thought.[33] Rather, paste standardization provides information on the identification of source communities (within a 3-4 km radius) and, therefore more accurately, the organization of ceramic *distribution*, charting the emergence and demise of source communities and the movement of their ceramic products.

In addition to decisions on the selection of raw materials and how to process those materials into a workable paste, the methods of forming the vessel shape are also embedded within potting communities, as the context in which gestures, techniques and actions are learned is always socially constituted.[34] However, whereas compositional variability can be assessed relatively by both potter and consumer, the forming technique is often invisible to the non-specialist consumer, and indeed specialists from other 'communities of practice'.[35] To complicate matters further, the visibility of a chosen forming technique in finished vessels is not constant and can vary enormously according to the degree of finishing of the vessel surface, the skill level of the producer, the shape produced (open vs. closed), the combination of chosen techniques (overprinting or removing traces of the first technique) and so on.[36] Indeed, the ways in which potters learn their skills often affects their very perception of *choice* in employing a particular forming technique.[37] As such, identifying standardization within the *chaîne opératoire* can be seen as a window for considering how technologies transfer, the number of people controlling or sharing that knowledge and the integration of new techniques within existing traditions. For example, ethnographic studies have shown that the adoption of the potter's wheel and the use of rotative kinetic energy (RKE) within the forming stage is usually not inherently visible in the finished vessel, particularly if the vessel is to be finished and decorated before firing. However, this assumes mastery or a high level of competency of wheel-assisted forming techniques by the potters making the vessels. Where more variable finished vessels appear in the archaeological record, we may interpret potentially greater numbers of potters introducing a higher level of idiosyncratic mechanical features, or perhaps production by less competent or skilled producers, such as apprentices. From the perspective of learning and adopting new behaviors within the *chaîne opératoire*, this may relate to the quick transmission of a new technique, perhaps inadequately mastered yet already widely adopted. Highly standardized vessels can indicate either fewer numbers of potters[38] or potters with an increased level of skill, suggesting a more limited (controlled?) transmission of the new wheel technique.[39] Despite the increase in efficiency in ceramic production associated with the adoption of the potter's wheel, the learning of this new technique is a time-intensive activity, with respect to the physical interactions between two potters and also the time it takes to learn and perform the technique competently. Therefore, the timeframe in which a new technique appears in the material record can shed light on the nature of these interactions, who is interacting with whom, over

how long a period and the direction in which this knowledge transfer takes place.

The Minoan conical cup, all things reconsidered

For discussions on standardization within Bronze Age ceramic production, there can be no greater case within the Aegean than that of the iconic conical cup, the small, handleless vessel that first appears on Crete during the Middle Minoan IIIA (circa 1700 BC) and which, by the peak of the Late Bronze Age, appears in diverse contexts from palaces to farmsteads throughout the 'Minoanized world', from Phylakopi on Melos,[40] Ayia Irini on Kea,[41] Akrotiri on Thera,[42] as well as Iasos[43] and Miletus[44] on the Anatolian coast (*fig.* 2). The conical cup is only a small part of a wider suite or package of artifacts and technologies that signify the impact of the Minoans throughout the Aegean world,[45] but, arguably, it is the most frequent and iconic example of non-Cretan communities participating in ritual practices, such as large-scale drinking and feasting activities, associated primarily with Cretan-based Minoan culture. Assumptions about these cups has been mainly driven by their appearance: small, plain, often very roughly made with little attempt to 'finish' the vessel, which, in combination with their staggeringly large numbers, had traditionally been interpreted as a lack of investment in their production and a need to produce as many as possible as quickly as possible. Routinization, standardization and the use of the potter's wheel are common terms in scholarly discussions of these iconic cups.[46] However, is it enough to simply acknowledge that these vessels form an extremely standardized corpus over a wide geographical area? What else can these standardized cups tell us about the social, economic and political contexts in which they were produced and consumed?

For the conical cup, timing, it seems, is everything. Their first appearance on Crete is something of an enigma: this curiously plain and handleless cup appears in the wake of earlier Protopalatial (circa 1950-1700 BC) regional traditions for elaborately decorated, handled drinking cups

Fig. 2. Map of the Aegean, with main sites discussed in the text.

of various shapes across Crete.[47] Despite the presence of varied conical cup shapes and their functional precursors, saucers and ledge-rim bowls, across Crete during the late Protopalatial period,[48] the iconic, standardized shape associated with Minoan culture does not appear until the Late Minoan IA (circa 1600-1525 BC), where it goes 'hand in hand with the emergence of Knossos as a supra-regional power'.[49] The emergence of Knossos, one of several earlier palatial centers of the island of Crete, as a powerful hub during the Neopalatial period (circa 1700-1450 BC) appears to usher in a greater role for cult practices within Minoan daily life and the conical cup becomes the vessel most associated with feasting ceremonies.[50] The Late Minoan IA also marks a horizon for conical cups appearing in significant quantities beyond the physical borders of Crete.[51] The short-time frame between the coalescing of a common, standardized conical cup shape on Crete itself and its appearance in non-Cretan contexts, both as an import and as a locally produced imitation of this iconic shape, seems particularly pertinent. Conical cups within off-island assemblages have long been considered one of the main material indicators for the influence of the Minoan world across Aegean contexts,[52] which, alongside particular architectural features (including lustral basins and pier-and-door hall partitions), material production technologies (the potter's wheel and the vertical loom) and Linear A script, have driven discussion of how and why Minoan culture is found so widely within this region.

Measuring up to the Minoans

Early studies on conical cups immediately recognized the standardized nature of this shape, across Crete and at settlements beyond Crete associated with increasing Minoan material traits. The first metrical assessment of dimensional standardization for conical cups took place at Ayia Irini on Kea, as part of a study to address changes in the organization of production for Keian potters during the later Middle Bronze Age and the Late Bronze Age.[53] Commenting upon their observations that conical cups show narrower ranges in morphological shape, weight and capacity across the Late Cycladic I to Late Cycladic II (circa 1600-1450 BC) periods, Jack Davis and Harriet Lewis sought to establish a link between ceramic production and the economic pressures faced by potters as production moved beyond the household level,[54] leading to cost controlling measures such as routinization, simplification and standardization: in essence, there was a 'trade-off of value for volume',[55] signifying less investment in the production of each vessel. This economic stimulus, they argue, also explains the earlier link between mechanization (the potter's wheel) and the mass production (by sheer quantity) of conical cups on Crete at the start of the Neopalatial period. So were potters at Ayia Irini simply copying the more standardized output of a technologically advanced Cretan ceramic industry? Davis and Lewis argue that this explains the decrease in range of cup profiles, but not the dimensional standardization between periods with cups of the same profile, with the evidence instead suggesting that both Ayia Irini and Cretan ceramic industries were following similar trajectories with respect to increased mechanization in production techniques.[56]

The need to move beyond a purely metrical or dimensional method for assessing conical cups and refocus on production decisions as well as consumption aspects was first proposed by Carl Knappett.[57] He advocated studying production so that we may fully integrate 'analysis of fabrics, forming and finishing techniques, firing methods, and the shape and size of the vessel involved, not to mention appraisal of the tools and contexts of production'.[58] Another parameter which Knappett highlighted for considering the full variation of conical cups is that of skill or the degree of competency achieved in using specific forming techniques among ceramic producing groups. Knappett makes a strong case for the link between the degree of skill or labor input (low) seen within conical cups, the number of potential producers (high), and the range of consumption contexts (wide), to best explain the lower quality, less time-invested production values of the Neopalatial period.[59]

The relationship between increased skill and metrical standardization of Cretan conical cups has also been discussed by Aleydis Van de Moortel,[60] who highlights that a more efficient use of clay leads to vessel walls becoming thinner and overall vessel size becoming smaller, resulting in less clay being used per vessel and, therefore, a standardized reduction in the weight of the finished vessel. She also highlights, however, that the number of 'carelessly produced and finished' conical cups found on Crete in the Late Minoan IA period suggests that more than just skill is playing a role in the physical characteristics of this shape.

Theran conical cups and *chaînes opératoires*

In her study of Late Cycladic conical cups at Akrotiri on Thera, Carole Gillis[61] applied statistical analysis to show that dimensional parameters of the conical cups display higher levels of variability than conical cups on Crete and, therefore, were most likely not produced by a Minoan potter.[62] She suggests that the cups were transmitted by travelling local Theran potters returning to Akrotiri who then adopted, adapted and manufactured the cups locally to meet demand, either for resident Minoan consumers or as a local response to newly established practices and customs transferred from the Minoan world.[63] A closer look at late Middle Bronze Age Minoan-inspired ledge-rim bowls (proto-conical cups) at Akrotiri was undertaken as part of a wider technological study of the later Middle Bronze Age ceramic assemblage at this important Cycladic site.[64] This analytical study integrated macroscopic analysis, thin section petrography and automated SEM-EDS to identify the raw materials, paste processing, forming techniques and firing regimes in order to reconstruct the choices and practices of potters working within the local ceramic tradition.

Macroscopic analysis of late Middle Bronze Age ceramics from Akrotiri and collected sediments from the nearby Archangelos-Loumaravi Complex in southern Thera led to the identification of three subgroups compatible with the locally available raw materials: fine, semi-fine to semi-coarse and coarse. Within the local repertoire, four vessel shapes (cooking pots, ledge-rim bowls, Cycladic cups and beaked jugs) were assessed with respect to specific behaviors within their production sequences, from exploitation through to preparation, forming, finishing and firing. Samples from each macroscopic category were taken for petrographic analysis to investigate composition and technological behaviors in more detail, with a smaller number of these samples also analyzed using automated SEM-EDS with QEMSCAN®.[65] The results of the reconstructed *chaînes opératoires* for four local ceramic vessel types can be seen in figure 3.

Compositionally, the local repertoire appears relatively heterogeneous with respect to iron content, as seen in the range of refiring colours produced in the laboratory.[66] The range of fabric coarseness throughout the samples suggested that the majority of the samples taken from Cycladic cups, jugs and ledge-rim bows displayed little to no processing of the exploited raw materials, with a few Cycladic cups representing deliberate fining of the raw material (most likely crushing) and, at the other end of the spectrum, the cooking pots representing deliberately tempered pastes. With respect to deliberate tempering, two sub-groups were identified, one showing the addition of metamorphic rock grains (quartz-feldspar-biotite-chlorite schist-phyllites compatible with the basement rocks of Thera and exposed on the inner caldera wall today) and the other with additional volcanic rock grains and in some cases organic temper too. The SEM-EDS analysis revealed that the clay matrices of the various samples are compatible across this range of processing behaviors, suggesting the heterogeneity seen in iron content is a natural feature of the raw material and not affecting by the processing behaviors applied by the potter.

At the forming technique stage, the ledge-rim bowls were the only shape to show evidence of RKE in their production, though during the finishing (or decorating) stage, the ledge-rim bowl appears alongside the Cycladic cups and cooking pots in the 'slipped' category and the Cycladic cups and beaked jugs in the 'plain' category. Only the beaked jugs show traces of 'matt-painting'. Finally, the firing atmosphere reveals that only the cooking pots were exposed to significant quantities of oxygen during the firing process, giving them a naturally darker color than the neutrally fired, pale buff colored ledge-rim bowls, Cycladic cups and beaked jugs.

The reconstructed *chaînes opératoires* show that the Middle Bronze Age ledge-rim bowls fall firmly within the range of choices employed for other vessel types within the local assemblage at the exploitation, preparation, finishing and firing stages. The only stage in which they differ is the forming stage, as this Minoan-inspired shape is the only form to display use of RKE. The ledge-rim bowls were made using the 'wheel-coiling' technique, a combination of coiled rough-outs and rotative kinetic energy to join, thin and shape the walls,[67] and represent the first vessels at Akrotiri to have been manufactured locally using the potter's wheel.[68] The coil traces can be seen clearly in figure 4, which shows the interior of a conical cup from Akrotiri. The use of wheel-coiling for only these shapes is an additional degree of technological standardization within an already narrow range of behaviors and choices within the local ceramic production tradition, revealing that these Minoan-inspired shapes were deliberately manufactured using a technology associated with the Minoan world. Subsequent macroscopic analysis of local Late Cycladic I conical cups from Sectors

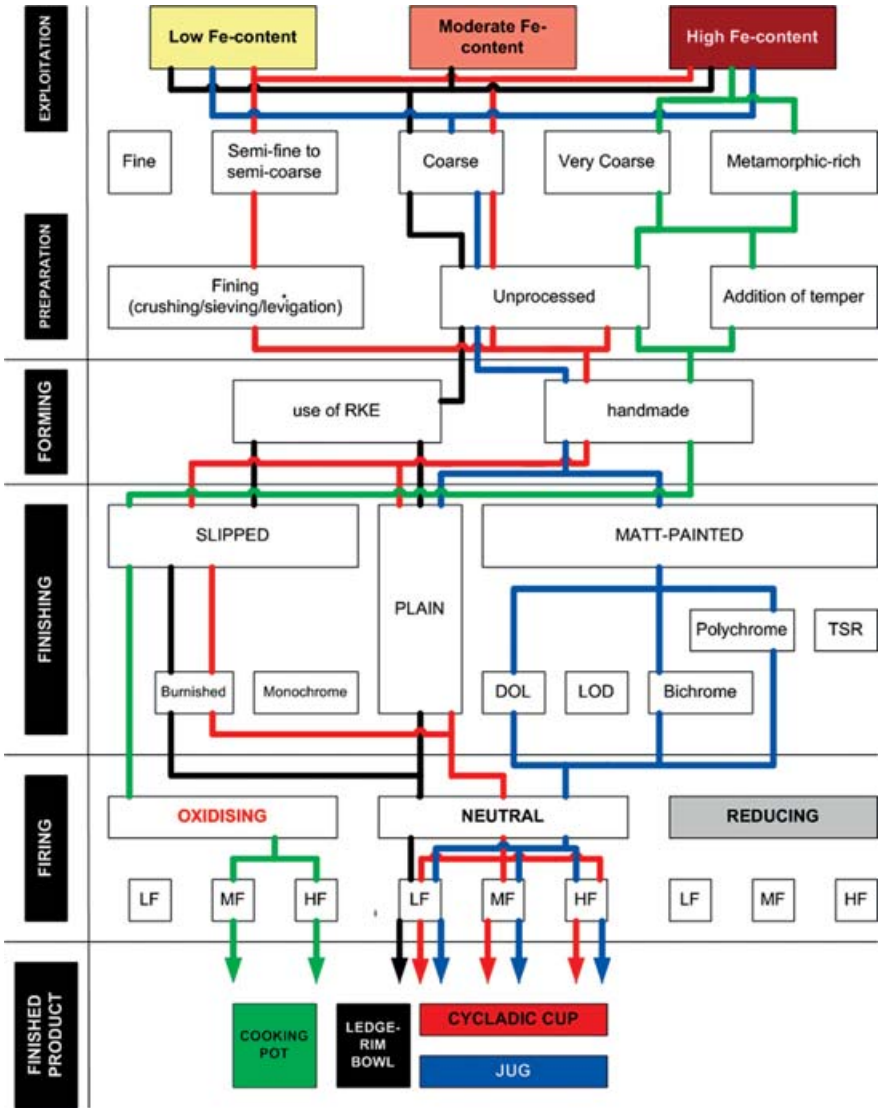

Fig. 3. Reconstructed chaînes opératoires of different vessel shapes from Middle Bronze Age (Phase C) Akrotiri.

Beta and Delta at Akrotiri reveal the same pattern, with over 95% of the cups studied definitively showing some trace of RKE in their production (rotated string-cut base, visible coil seams or tortional strain on the interior at the lower wall).[69]

The 2008 analytical study supports Gillis' argument, providing robust evidence across the entire *chaîne opératoire* that the ledge-rim bowls and conical cups are firmly embedded within local Theran production sequences. For the ledge-rim bowls and conical cups analyzed, there seems to have been little attempt to refine the clay paste in imitation of the very fine fabrics of contemporary Minoan imports. If itinerant Minoan potters had produced these vessels, then we would expect to see Minoan traditions of paste processing within the production sequence, as the work of Evangelia Kiriatzi on Kythera has convincingly demonstrated.[70] Instead, these wheel-fashioned vessels were manufactured using local clays, with low paste processing, just the same as the clay used for the local handmade pots, indicating the same technical decisions and therefore deliberate social choices of clay recipe. The appearance of wheel-fashioned pots at Akrotiri tells us that the local potters at Akrotiri were not simply replaced by their Minoan counterparts; rather the local Theran potters had sustained contact with Minoan pot-

ters, allowing them to learn the wheel technique, which they then incorporated into their own local traditions. It would seem then that potters at Akrotiri actively chose to produce small handleless vessels designed for use in Minoan ritual practices using a specifically Minoan technology. Yet, potters do not produce vessels in a vacuum and if we consider the consumers of such vessels, then we can also infer that at least some of the inhabitants of Akrotiri were deliberately participating within Minoan drinking and feasting ritual practices. These rituals required specific shapes, such as the conical cup and ledge-rim bowl, and deliberate formation techniques - as seen through technological standardization - was used to enhance the intrinsic value of these novel artifacts. It seems that their 'adoption and distribution is inextricably linked, not only to consumption practices but the choices involved in the production of these vessels by off-island communities'.[71] To some extent, these vessels are actually far *more* standardized than previously assumed, as even their production method seems to conform to the ideal of the Minoan object, requiring at least partial use of the potter's wheel. Learning a new technique such as the potter's wheel is a time-intensive activity, with respect to the physical interactions between two potters and also the time it takes to learn and perform the technique competently. The almost simultaneous appearance of these technologically standardized vessels across a wide geographical area begs us to ask more detailed questions from these off-island assemblages: who was making these vessels beyond the borders of Crete? Where and how did they learn this new skill? How long did it take to learn the skills required to perform RKE and be able to use them with sufficient competency?

Fig. 4. Coil macrotraces visible on the lower interior wall of a wheel coiled Late Bronze Age conical cup from Akrotiri.

We must also refocus our questions to incorporate wider issues of consumption within our increasingly complex considerations of production and distribution. Van de Moortel emphasizes the importance of consumption behaviors for driving increased metric homogeneity within this shape, as the desire of Neopalatial Minoan elites to consolidate power through feasting and drinking ceremonies[72] led to 'the evolution of a simple mass-produced conical cup type without prestige value',[73] which may have been emulated by other elite groups across Crete at this time. The morphological and stylistic simplicity of the conical cup would have made them 'eminently iconic and highly recognizable', allowing them to become 'an effective means for Knossian elites to objectify and embed their power in material practices'.[74] Malcolm Wiener points to the striking standardization of Late Minoan IA conical cups as representing 'a symbiotic relationship' between their production and consumption contexts; 'it is the large number of users which require their existence and the method of mass production which makes large-scale drinking/feasting feasible'.[75] If non-Cretan communities such as Akrotiri were choosing to participate within Minoan practices and regional interactions to increasingly greater degrees over the course of the later Middle to Late Bronze Age, then it is significant that the conical cup is produced locally beyond Crete using the same RKE forming technique that potters used on Crete, despite the presence of strong local potting traditions making *functionally equivalent* local shapes with non-RKE techniques. This suggests that the wheel was not a direct response to economic factors demanding increased output or routinization, as the earliest locally wheel-fashioned examples appear in small quantities and could equally have been manufactured just as easily using non-RKE techniques. This leaves us considering the 'iconic nature' of the conical cup itself, a shape 'imbued with value through the method of its creation' and appearing where there was consumer desire to share in specific Minoan ritual practices.[76]

Conclusion

This study has used the concept of technological standardization to discuss the adoption and transmission of the potter's wheel during the later Middle Bronze Age of the Aegean. By utilizing the *chaîne opératoire* approach within an integrated

analytical research program, specific stages of the ceramic production sequence can be characterized and considered with regards to the behaviors and choices of the individual potters and the wider community in which they were carrying out their craft. This methodology has allowed archaeologists to look beyond the surface of ceramic vessels and their metrical or dimensional aspects of standardization and ask more complex questions that seek to understand the dynamic interactions between craft specialists through time and the mechanisms that drive technology transmission and material culture change. It is clear that the adoption of the potter's wheel beyond Crete during this period is a complex phenomenon and one that should be investigated technologically from the level of the individual site in order to consider larger regional patterns. Given the conditions required for learning and adopting the potter's wheel, the humble conical cup is in fact one of the most effective technological markers throughout the prehistoric Aegean, signifying intense, long-term contact between Minoan and Cycladic potting communities. This is not the end of the story, however, many questions remain with respect to the social and technological aspects of craft knowledge transmission, but at least there is a methodology now at our disposal that can tackle the integration of analytical datasets and social practices in a more robust and dynamic way.

Notes

* I am grateful to Antonis Kotsonas for asking me to participate in this volume despite not taking part in the original EAA session. The case study discussed here formed part of my doctoral research at Akrotiri and would not have been possible without the generous support and assistance of Irene Nikolakopoulou, Carl Knappett and Iro Mathioudaki. I would also like to thank Professor Christos Doumas for allowing me to carry out my research at one of the most wonderful sites I have ever known. This discussion of conical cups has benefitted hugely from ongoing discussions with my colleagues at Ayia Irini, including Evi Gorogianni, Natalie Abell, and Joanne Cutler, and I remain indebted to the director, Evangelia Kiriatzi, and staff of the Fitch Laboratory of the British School at Athens for their logistical and academic support. Lastly, I would like to thank the anonymous reviewers for their constructive comments on this paper.

1 See Kotsonas (this volume, pp. 7-23).
2 Brumfiel/Earle 1987; Costin 1991; Costin/Hagstrum 1995.
3 Dobres/Hoffman 1994; Dobres/Robb 2005; Tite 2008; Roux 2008.
4 Gosselain 1992, 2000.
5 Blackman et al. 1993.
6 Cresswell 1990; Leroi-Gourhan 1993; see also Zurbach/Esposito (this volume, pp. 49-57).
7 Gosselain 2000, 208.
8 Sinopoli 1988.
9 As outlined by Kotsonas (this volume, pp. 7-23).
10 For definition of community of practice, see Wenger 1998; Lave/Wenger 1991.
11 Trigger 1989; O'Brien/Lyman 2002.
12 Hodder 1985, 2000.
13 Roux/Corbetta 1989; Stark 1998; Gosselain 1998, 2000; Roux/Courty 2005.
14 Cresswell 1990; Leroi-Gourhan 1993; Gosselain 1992, 2000.
15 Schiffer/Skibo 1987; Arnold 2000; Skibo/Schiffer 2008; Schiffer 2004.
16 Roux 2003.
17 Gosselain 1998, 2000.
18 See van der Leeuw 1993 for discussion of conceptual anchors within a ceramic sequence; Gosselain 1992, 2000.
19 Roux 2003; Hilditch 2008; Knappett 2011.
20 Gosselain 1992, 2000.
21 Blackman et al. 1993.
22 Sinopoli 1988; Arnold/Neff/Bishop 1991; Kvamme et al. 1996; Eerkens/Bettinger 2001; Roux 2003; Hirshman et al. 2010.
23 van der Leeuw 1984, 1993; Costin 1991; Lemmonier 1993; Arnold 2000; Wallaert-Pêtre 2001.
24 Kotsonas (this volume, p. 17).
25 Kvamme et al. 1996.
26 Eerkens/Bettinger 2001; Roux 2003.
27 Hirshman et al. 2010.
28 Hilditch 2008; Roux 2011; Jeffra in press.
29 Arnold 1985; Neupert 2000; Gosselain/Livingstone-Smith 2005.
30 Shepard 1956; Peacock 1970; Whitbread 1987, 1995; Arnold 2000.
31 For a summary of analytical techniques that can be used to address questions of ceramic production, distribution and consumption, see Tite 2008.
32 Knappett et al. 2011; Hilditch et al. forthcoming.
33 Arnold 2000, 336.
34 van der Leeuw 1993; Wenger 1998; Gosselain 2000.
35 Lave/Wenger 1991; Wenger 1998.
36 Courty/Roux 1995.
37 Rice 1991; Arnold/Nieves 1992; van der Leeuw 1993, 2008; Gosselain 2000, 192-193.
38 Costin/Hagstrum 1995.
39 Longacre 1999; Roux 2013; Jeffra 2013.
40 Berg 2004.
41 Davis/Lewis 1985.
42 Gillis 1990; Knappett/Nikolakopoulou 2008.
43 Momigliano 2012.
44 Kaiser 2009.
45 See Hägg/Marinatos 1984; Broodbank 2004; Davis/Gorogianni 2008; Macdonald/Hallager/Niemeier 2009.
46 Davis/Lewis 1985; Gillis 1990; Knappett 1999; Van der Moortel 2002; Berg 2004, 2007.
47 Knappett 1999, 416-418; Knappett/Hilditch in press; Wiener 2011, 359-360; for a thorough discussion of Prepalatial precursors and their links with contemporary Near Eastern and Egyptian conical cups/bowls, see Wiener 2011.
48 Knappett 1999; Van de Moortel 2002; Knappett/Cunningham 2003; Girella 2007.
49 Knappett/Hilditch in press; Knappett 2005.
50 Knappett 1999; Knappett/Hilditch in press; see also Knappett et al. 2008 for the emergence of Knossos as a hub within southern Aegean networks.
51 Davis/Lewis 1985; Knappett 1999; Berg 2004.

[52] Branigan 1981; Gillis 1990; Wiener 1990; Knappett/Nikolakopoulou 2005; Momigliano 2012.
[53] Davis/Lewis 1985.
[54] See van der Leeuw 1977; Peacock 1977.
[55] Davis/Lewis 1985, 82.
[56] Ibid. 90.
[57] Knappett 1999.
[58] Knappett 1999, 415.
[59] Ibid. 418.
[60] Van de Moortel 2002.
[61] Gillis 1990.
[62] For a critique of her methods, see Knappett 1999, 415.
[63] Gillis 1990, 113-115.
[64] Hilditch 2008.
[65] Hilditch 2008, chapters 5 and 6.
[66] Controlled refiring experiments on small archaeological ceramic chips were carried out to remove the original firing conditions and allow a relative assessment of iron content based upon the refired colour (see Whitbread 1986 for extended methodology).
[67] For stages of RKE use, see Courty/Roux 1995.
[68] Knappett/Nikolakopoulou 2008.
[69] Initial assessment carried out by the author with the assistance of M. Nugent, with current work underway with C. Jeffra.
[70] Broodbank/Kiriatzi 2007.
[71] Knappett/Hilditch in press; see also Berg 2004 on using the potter's wheel to produce a perfect copy of Minoan conical cups at other Cycladic sites.
[72] Wiener 1984, 20-21; Gillis 1990; Knappett 1999; Van de Moortel 2002.
[73] Van de Moortel 2002, 203.
[74] Knappett/Hilditch in press.
[75] Wiener 2011, 363.
[76] Knappett/Hilditch in press.

Bibliography

Arnold, D.E. 1985, *Ceramic theory and cultural process*, Cambridge.

Arnold, D.E. 2000, Does the standardization of ceramic pastes really mean specialization? *Journal of Archaeological Method and Theory* 7, 333-375.

Arnold, D.E./H. Neff/R.L. Bishop 1991, Compositional analysis and 'sources' of pottery: An ethnoarchaeological approach, *American Anthropologist* 93, 70-90.

Arnold, D.E./A.L. Nieves 1992, Factors affecting ceramic standardization, in G.J. Bey III (ed.) *Ceramic production and distribution: An integrated approach*, Boulder, 93-113.

Berg, I. 2004, The meanings of standardisation: Conical cups in the late Bronze Age Aegean, *Antiquity* 78, 74-85.

Berg, I. 2007, Meaning in the making: The potter's wheel at Phylakopi, Melos (Greece), *Journal of Anthropological Archaeology* 26, 234-252.

Blackman, M.J./G.J. Stein/P.B. Vandiver 1993, The standardization hypothesis and ceramic mass production: Technological, compositional, and metric indexes of craft specialization at Tell Leilan, Syria, *American Antiquity* 58, 60-80.

Branigan, K. 1981, Minoan colonialism, *BSA* 76, 23-34.

Broodbank, C. 2004, Minoanisation, *Proceedings of the Cambridge Philological Society* 50, 46-91.

Broodbank, C./E. Kiriatzi 2007, "The first Minoans? of Kythera revisited: Technology, demography, and landscape in the Prepalatial Aegean, *AJA* 111, 241-274.

Brumfiel, E.M./T. Earle 1987, Specialization, exchange and complex societies: An introduction, in E.M. Brumfiel/T. Earle (eds), *Specialization, exchange and complex societies*, Cambridge, 1-9.

Costin, C.L. 1991, Craft specialization: Issues in defining, documenting and explaining the organization of production, in M. B. Schiffer (ed.), *Archaeological Method and Theory* 3, Tuscon, 1-56.

Costin, C.L./M.B. Hagstrum 1995, Standardization, labor investment, skill, and the organization of ceramic production in Late Prehispanic highland Peru, *American Antiquity* 60, 619-639.

Courty, M.A./V. Roux 1995, Identification of wheel throwing on the basis of ceramic surface features and microfabrics, *Journal of Archaeological Science* 22, 17-50.

Cresswell, R. 1990, A new technology revisited, *Archaeological Review from Cambridge* 9, 38-54.

Davis, J.L./E. Gorogianni 2008, Potsherds from the edge: The construction of identity and the limits of Minoanized areas of the Aegean, in N. Brodie/G. Gavalas/J. Doole (eds), *Orizon: A colloquium on the prehistory of the Cyclades*, Cambridge, 339-348.

Davis, J.L./H.B. Lewis 1985, Mechanization of pottery production: A case study from the Cycladic islands, in A.B. Knapp/T. Stech (eds), *Prehistoric production and exchange: The Aegean and eastern Mediterranean*, Los Angeles, 79-92.

Dobres, M-A./C.R. Hoffman 1994, Social agency and the dynamics of prehistoric technology, *Journal of Archaeological Method and Theory* 1, 211-258.

Dobres, M-A./J.E. Robb 2005, Doing agency: Introductory remarks on methodology, *Journal of Archaeological Method and Theory* 12, 159-166.

Eerkens, J.W./R.L. Bettinger 2001, Techniques for assessing standardization in artifact assemblages: Can we scale material variability?, *American Antiquity* 66, 493-504.

Gillis, C. 1990, Akrotiri and its neighbours to the south: Conical cups again, in D.A. Hardy/C. Doumas/J.A. Sakellarakis/P.M. Warren (eds), *Thera and the Aegean World* III, I: *Proceedings of the third International Congress, Santorini, Greece, 3-9 September, 1989*, London, 98-117.

Girella, L. 2007, Toward a definition of the MM III ceramic sequence in south-central Crete: Returning to the traditional MM IIIA and IIIB division?, in F. Felten/W. Gauss/R. Smetana (eds), *Middle Helladic pottery and synchronisms*, Wien, 233-256.

Gosselain, O.P. 1992, Technology and style: Potters and pottery among Bafia of Cameroon, *Man* 27, 559-586.

Gosselain, O.P. 1998, Social and technical identity in a clay crystal ball, in M.T. Stark (ed.), *The Archaeology of Social Boundaries*, Washington DC, 78-106.

Gosselain, O.P. 2000, Materializing identities: An African perspective, *Journal of Archaeological Method and Theory* 7, 187-217.

Gosselain, O.P./A. Livingstone Smith 2005, The source: Clay selection and processing practices in sub-Saharan Africa, in A. Livingstone Smith/D. Bosquet/R. Martineau (eds), *Pottery manufacturing processes: Reconstruction and interpretation. Acts of the XIVth UISPP Congress, University of Liège, Belgium, 2-8 September 2001*, Oxford, 33-47.

Hägg, R./N. Marinatos (eds) 1984, *The Minoan thalassocracy: Myth and reality. Proceedings of the third International Symposium at the Swedish Institute in Athens, 31 May-5 June 1982* (Skrifter Utgivna av Svenska Institutet i Athen 4), Göteborg.

Hilditch, J. 2008, *Reconstructing technical choice, social practice and networks of exchange in the Middle Bronze Age of the Cyclades: The ceramic perspective*, PhD Dissertation, Uni-

versity of Exeter (http://hdl.handle.net/10036/49133).
Hilditch, J./D. Pirrie/C. Knappett/G.K. Rollinson/N. Momigliano forthcoming, Taking the rough with the smooth: Using automated SEM-EDS to integrate coarse and fine ceramic assemblages in the Bronze Age Aegean, in B. Jervis/S. Coxon/E. Sibbesson (eds), *Insights from Innovation - new light on archaeological ceramics: A conference in honour of David Peacock*, Southampton.
Hirshman, A.J./W.A. Lovis/H.P. Pollard 2010, Specialization of ceramic production: A sherd assemblage based analytic perspective, *Journal of Anthropological Archaeology* 29, 265-277.
Hodder, I. 1985, Boundaries as strategies, in S.W. Green/S.M. Perlman (eds), *The archaeology of frontiers and boundaries*, New York, 213-230.
Hodder, I. 2000, Agency and individuals in long-term processes, in M-A. Dobres/J.E. Robb (eds), *Agency in Archaeology*, London, 21-33.
Jeffra, C.D. 2013, A re-examination of early wheel potting in Crete, *BSA* (FirstView) http://dx.doi.org/10.1017/S0068245413000038
Jeffra, C.D. in press, Experimental approaches to archaeological ceramics: Unifying disparate methodologies with the chaîne opératoire, *Archaeological and Anthropological Sciences*.
Kaiser, I. 2009, Miletus IV: The locally produced coarse wares, in C.F. Macdonald/E. Hallager/W-D. Niemeier (eds), *The Minoans in the central, eastern and northern Aegean - new evidence*, Athens, 159-166.
Knappett, C.J. 1999, Can't live without them: Producing and consuming Minoan conical cups, in P. Betancourt/ V. Karageorghis/R. Laffineur/W-D. Niemeier (eds), *MELETEMATA: Studies in Aegean Archaeology presented to Malcolm H. Wiener as he enters his 65th year*, Liège, 415-421.
Knappett, C.J. 2005, *Thinking through material culture*, Philadelphia.
Knappett, C.J. 2011, *An archaeology of interaction: Network perspectives on material culture and society*, Oxford.
Knappett, C.J./T. Cunningham 2003, Three neopalatial deposits from Palaikastro, East Crete, *BSA* 98, 107-187.
Knappett, C.J./T. Evans/R. Rivers 2008, Modelling maritime interaction in the Aegean Bronze Age, *Antiquity* 82, 1009-1024.
Knappett, C.J./J. Hilditch forthcoming, Colonial cups? The Minoan plain handleless cup as icon and index, in C. Glatz (ed.), *Plain and simple: The evolution and significance of plain pottery traditions in the second millennium BC Near East and East Mediterranean*, Walnut Creek.
Knappett, C.J./I. Nikolakopoulou 2005, Exchange and affiliation networks in the MBA southern Aegean: Crete, Akrotiri and Miletus, in R. Laffineur/E. Greco (eds), *Emporia: Aegeans in the Central and Eastern Mediterranean: Proceedings of the 10th International Aegean Conference, Italian School of Archaeology, Athens, 14-18 April 2004* (Aegaeum 25), Liège, 175-184.
Knappett, C.J./I. Nikolakopoulou 2008, Colonialism without colonies? A Bronze Age case study from Akrotiri, Thera, *Hesperia* 77, 1-42.
Knappett, C.J./D. Pirrie/M.R. Power/I. Nikolakopoulou/J. Hilditch/G.K. Rollinson 2011, Mineralogical analysis and provenancing of ancient ceramics using automated SEM-EDS analysis (QEMSCAN®): A pilot study on LB I pottery from Akrotiri, Thera, *Journal of Archaeological Science* 38, 219-232.
Kvamme, K.L./M.T. Stark/W.A. Longacre 1996, Alternative procedures for assessing standardization in ceramic assemblages, *American Antiquity* 61, 116-126.
Lave, J./E. Wenger 1991, *Situated learning: Legitimate peripheral participation*, Cambridge.
Lemonnier, P. 1993, Introduction, in P. Lemonnier (ed.), *Technological choices: Transformation in material cultures since the Neolithic*, London, 1-35.
Leroi-Gourhan, A. 1993 (1965), *Gesture and speech*, Cambridge.
Longacre, W.A. 1999, Standardization and specialization: What's the link?, in J.M. Skibo/G.M. Feinman (eds), *Pottery and people: A dynamic interaction*, Salt Lake City, 44-58.
Macdonald, C.F./E. Hallager/W-D. Niemeier (eds) 2009, *The Minoans in the central, eastern and northern Aegean - new evidence*, Athens.
Momigliano, N. (ed.) 2012, *Bronze Age Carian Iasos: Structures and finds from the area of the Roman Agora (c. 3000 - 1500 BC)*, Rome.
Neupert, M.A. 2000, Clays of contention: An ethnoarchaeological study of factionalism and clay composition, *Journal of Archaeological Method and Theory* 7, 249-272.
O'Brien, M.J./R.L. Lyman 2002, The epistemological nature of archaeological units, *Anthropological Theory* 2, 37-56.
Peacock, D.P.S. 1970, The scientific analysis of ancient ceramics: A review, *World Archaeology* 1, 375-389.
Peacock, D.P.S. 1977, *Pottery and early commerce: Characterisation and trade in Roman and later ceramics*, London.
Rice, P.M. 1991, Specialization, standardization, and diversity: A retrospective, in R. Bishop/F.W. Lange (eds), *The ceramic legacy of Anna O. Shepard*, Colorado, 257-279.
Roux, V. 2003, A dynamic systems framework for studying technological change: Application to the emergence of the potter's wheel in the Southern Levant, *Journal of Archaeological Method and Theory* 10, 1-30.
Roux, V. 2008, Evolutionary trajectories of technological traits and cultural transmission, in M.T. Stark/B.J. Bowser/L. Horne (eds), *Cultural transmission and material culture: Breaking down boundaries*, Tuscon, 82-104.
Roux, V. 2011, Anthropological interpretation of ceramic assemblages: Foundations and implementations of technological analysis, in S. Scarcella (ed.), *Archaeological ceramics: A review of current research*, Oxford, 80-88.
Roux, V. 2013, Spreading of innovative technical traits and cumulative technical evolution: Continuity or discontinuity?, *Journal of Archaeological Method and Theory* 20, 312-330.
Roux, V./D. Corbetta 1989, *The potter's wheel: Craft specialization and technical competence*, New Delhi.
Roux, V./M.A. Courty 1998, Identification of wheel-fashioning methods: Technological analysis of 4th-3rd millennium BC Oriental ceramics, *Journal of Archaeological Science* 25, 747-763.
Roux, V./M.A. Courty 2005, Identifying social entities at a macro-regional level, in A. Livingstone Smith/D. Bosquet/R. Martineau (eds), *Pottery manufacturing processes: Reconstruction and interpretation. Acts of the XIVth UISPP Congress, University of Liège, Belgium, 2-8 September 2001*, Oxford, 201-214.
Schiffer, M.B. 2004, Studying technological change: a behavioral perspective, *World Archaeology* 36, 579-585.
Schiffer, M.B./J.M. Skibo 1987, Theory and experiment in the study of technological change, *Current Anthropology* 28, 595-622.
Shepard, A.O. 1956, *Ceramics for the archaeologist*, Washington DC.
Sinopoli, C. 1988, The organization of craft production at Vijayanagara, South India, *American Anthropologist* 90, 580-587.
Skibo, J.M./M.B. Schiffer 2008, *People and things: A behav-*

ioural approach to material culture, New York.
Stark, M.T. (ed.) 1998, *The Archaeology of social boundaries*, Washington DC.
Tite, M.S. 2008, Ceramic production, provenance and use - a review, *Archaeometry* 50, 216-31.
Trigger, B.G. 1989, *A history of archaeological thought*, Cambridge, 211-223.
Van de Moortel, A. 2002, Pottery as a barometer of economic change: From the Protopalatial to the Neopalatial society in central Crete, in Y. Hamilakis (ed.), *Labyrinth revisited: Rethinking 'Minoan' archaeology*, Oxford, 189-211.
van der Leeuw, S.E. 1977, Towards a study of the economics of pottery making, in B.L. Beek/R.W. Brant/W.G. van Watteringe (eds), *Ex Horreo*, Amsterdam, 68-76.
van der Leeuw, S.E. 1984, Dust to dust: A transformational view of the ceramic cycle, in S.E. van der Leeuw/A.C. Pritchard (eds), *The many dimensions of pottery*, Amsterdam, 707-773.
van der Leeuw, S.E. 1993, Giving the potter a choice: Conceptual aspects of pottery techniques, in P. Lemonnier (ed.), *Technological choices: Transformation in material cultures since the Neolithic*, London, 238-288.
van der Leeuw, S.E. 2008, Agency, networks, past and future, in C.J. Knappett/L. Malafouris (eds), *Material agency: Towards a non-anthropocentric approach*, New York, 217-248.
Wallaert-Pêtre, H. 2001, Learning how to make the right pots: Apprenticeship strategies and material culture, a case study in handmade pottery from Cameroon, *Journal of Anthropological Research* 57, 471-493.
Wenger, E. 1998, *Communities of practice: Learning, meaning and identity*, Cambridge.
Whitbread, I.K. 1986, Firing and refiring tests in the context of ceramic thin section studies, *Bulletin of the Experimental Firing Group, University of Leicester* 4, 30-6.
Whitbread, I.K. 1987, A proposal for the systematic descriptions of thin sections towards the study of ancient ceramic technology, in Y. Maniatis (ed.), *Proceedings of the 25th International Symposium of Archaeometry (ISA)*, Amsterdam, 127-138.
Whitbread, I.K. 1995, *Greek transport amphorae: A petrological and archaeological study*, Athens.
Wiener, M.H. 1984, Crete and the Cyclades in LM I: The tale of the conical cups, in R. Hägg/N. Marinatos (eds), *The Minoan thalassocracy: Myth and reality. Proceedings of the third International Symposium at the Swedish Institute in Athens, 31 May-5 June 1982* (Skrifter Utgivna av Svenska Institutet i Athen 4), Göteborg, 17-35.
Wiener, M.H. 1990, The isles of Crete? The Minoan thalassocracy revisited, in D.A. Hardy/C. Doumas/J.A. Sakellarakis/P.M. Warren (eds), *Thera and the Aegean World* III, 1: *Archaeology*, London, 128-161.
Wiener, M.H. 2011, Conical cups: From mystery to history, in W. Gauss/M. Lindblom/R.A.K. Smith/J.C. Wright (eds), *Our cups are full: Pottery and society in the Aegean Bronze Age. Papers presented to Jeremy B. Rutter on the occasion of his 65th Birthday*, Oxford, 355-368.