A comparative look at the use of the potter's wheel in Bronze Age Greece.

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Abstract:
Analyses of Aegean Bronze Age pottery follow the standard dichotomy in dividing assemblages into wheelmade and handmade pots. This procedure causes two methodological problems. First, it ignores manufacturing methods that combined several techniques in the making of one vessel. And second, it assumes that all wheelmade pottery is made uniformly with the fast wheel. However, already in the 1950s did Foster draw our attention to the fact that unpivoted turntables can be used to reach rotation speeds sufficient for the making of small vessels or parts of large vessels (esp. rims) (1959a, b). Thus, this contribution intends to question our assumption of a uniform use of the potter's wheel across Minoan Crete and wishes to open up the debate to explore the great diversity of manufacturing processes employed by Bronze Age potters.

Introduction:
It is generally recognised that the potter's wheel made its first appearance in the MM IB period, although recent work at Knossos indicates that first wheel-use may pre-date the Old Palace period (Day, Wilson & Kiriatzi 1997: footnote 20). Two processes have been referred to in order to explain the introduction of this new technology to Crete: indigenous development and diffusion. The evolutionary school of thought considers the potter's wheel to be the result of a continuous indigenous evolution from a bat through to a turntable and finally to the potter's wheel. The diffusionist school of thought believes it to have diffused to Crete from the Near East either via the Greek mainland (Lefkandi, Lerna Tiryns, Kolonna) and Kythera where it has been evidenced already in the EH III period or via Egypt where the evidence indicates its appearance during the 6th dynasty (c. 2400-2300 BC) (Knappett 1999).

There are, however, methodological and factual problems with both hypotheses: While the wheel may indeed have been an indigenous development, we have to recognise that the mere existence of bats and turntables does not invariably and in linear fashion lead to the development of the potter's wheel utilising rotative kinetic energy (e.g. Arnold, Huttar & Nieves in preparation; Franken 1971) – highlighting the importance of studying ancient technologies within their social context and as expressions of social practice (Dobres 2000). If, on the other hand, the wheel was diffused from elsewhere one might expect to see a transfer not merely of the technology but also of shapes. While Minoan shapes bear no resemblance to either Greek mainland or Egyptian pottery, Watrous (1987: 67) argues that the goblet, carinated cup, conical cup, fluted kantharos and theriomorphic rhyta of the Old Palace period may represent imitations of well-known Near Eastern vessels and may thus indicate the source of the technology. Generally speaking, however, contacts between Crete and these outside regions were comparatively rare in the relevant period (Knappett 1999) and make a true diffusionist argument difficult to accept.

Research context and terminology:

"It is fair to say that most Minoan archaeologists believe there to have been a simple switch in MM IB from hand-building techniques to wheel-throwing. There are only rare exceptions to the prevailing assumption that there was, across the island, a sudden and inevitable substitution of wheel-made vessels for handmade ones" (Knappett 1999: 102). MacGillivray and Betancourt are among those scholars who have acknowledged the complexities of the terminology and evidence: MacGillivray, for example, recognises that widespread experimentation occurred in the Old Palace period resulting in intermediate manufacturing techniques which he termed 'proto-wheel-made' (1998: 55). Betancourt, while perpetuating the technology dichotomy, nevertheless provides evidence of a comparatively slow (and potentially incomplete) adoption of the potter's wheel at MM IB-MM IIA Kommos (1990). More recently, Knappett has drawn our attention to the existence of intermediate techniques at MM Knossos which he termed 'handmade and thrown' and 'semi-thrown/'coil-built and wheel-shaped' (1999).

As these examples demonstrate, manufacturing technologies were by no means straight-forward. Instead, we have to consider potters fully exploiting the potential of the wheel (wheelmade) and those utilising no rotational energy (handmade) only as the two extremes along a spectrum of techniques using more or less of continuous or discontinous rotation and possibly even combining a wide range of techniques in the making of one single vessel (Foster 1959a, b; Franken 1971**).**

Advantages and disadvantages of the potter's wheel:

Most scholars regard the potter's wheel as a technological improvement over turntable-type devices. Increased speed of production and improved evenness of the walls are highlighted as its main advantages. Disadvantages are the new motor habits which have to be learnt, the finer clay required for wheel-throwing and increased investment in equipment. However, anthropological and experimental studies have shown that these features are complex and impossible to disassociate from the socio-political context of manufacture and consumption.

In this work I wish to explore briefly one aspect - increased speed of production which is often regarded as synonymous with the use of the potter's wheel. In general, wheel-thrown vessels can be made within minutes while coil-built vessels require hours (Table 1 and 2). However, mould-made vessels can be produced almost as quickly as wheel-made vessels (Arnold 1985). While time measurements leave no doubt as to the greater speed of the wheel, this picture is too simplistic. Even though the actual making of the vessel may be faster, clay still needs to be dug, transported to the workshop, prepared, wedged and ultimately fired. None of these stages will experience any reduction in time – in fact, the clay preparation may become more complex as it is commonly argued that wheel-throwing requires finer clays than handmade techniques (though anthropological data indicates that we should not generalise, see van der Leeuw 1993: 239). In fact, the main reason why the production time of handmade vessels appears so extended is because of the required drying time in between stages. However, depending on the type of vessel, even wheelmade vessels may require a certain amount of drying in between stages. More importantly, from the examples listed by Arnold (1985), it becomes apparent that, generally speaking, the two modes of production are positively correlated with specific manufacturing set-ups (e.g. wheelmade production with workshops; handmade with household production) making meaningful comparison difficult. As Reina rightly emphasised: a woman's time 'has little economic value' and she would therefore see no reason to improve the speed of the production (quoted in Nicklin 1971: 44). When comparing similar manufacturing circumstances, Nicklin notes that "the speed of some African hand techniques… would appear to compare favourably with throwing. For example, using the technique of tamping a hollow in the ground, the Sokoto potters were observed to form the body of round water-pots in three to five minutes each" (1971: 41). Thus, it is argued that wheel-throwing does not have an inherent speed advantage over handmade pots, although the changes that coincide with the use of the wheel (e.g. move to full-time production, market, increased demand) make it likely that there will be an overall increase in speed of the production. However, in order to present a realistic advantage, the potter's wheel needs to be exploited to its full potential and should not be combined with other techniques. Often, however, this is not the case as “a good many people who are described as ‘wheel’-using artisans are such only by courtesy. They only partially understand, or do not understand at all, the real potential of their instrument. For many of them… the wheel is merely an improved mobile platform or simple turntable” (Foster 1959a: 113; cf. also Nicklin 1971). If the wheel is not fully exploited for throwing pots, then any potentially existing advantages over non-wheel techniques cannot be not realised.

Identifiable characteristics of the potter’s wheel:
Even if the potential of the wheel is not always utilised, at least we can be sure that we recognise a wheelmade vessel when we see one – or are we? Courty and Roux have identified the following features are signs of wheel-thrown production (1995):

1. presence of striations and undulating ridges and grooves (rilling) running around the interior or exterior (or both) of the vessel walls
2. concentric striations on undersides of the vessel bases
3. ripples on the inner walls due to compression operations while narrowing the neck

However, even the authors acknowledge that all these features are polysemic and may be associated with other techniques besides wheel-throwing, particularly techniques which involve the fast-rotating wheel as a secondary procedure thus obliterating the traces of the original forming technique. Courty and Roux provide the example of such a manufacturing sequence: the body is first fashioned by coiling, then thinned by beating and then shaped on a wheel (1995: 18). The result is a pot whose surface features are identical to those observed on wheel-thrown pots (cf. Henrickson 1991). Concentric striations on vessels bases and ripples around the neck can also not be unquestioningly associated with wheel-made production. Concentric striations merely indicate the use of a rotational movement at the time of removing the vessel from the device. Ripples on the inner vessel walls only occur in the final stage of shaping a pot. Therefore, they cannot be significant of the mode of forming.

Not only should we be more careful about what we are observing macroscopically, but we should also acknowledge that the rilling features we conventionally associate with the potter’s wheel can also be achieved with rotating devices. While Childe gives 100 rpm as a minimum speed for a potter’s wheel (1954), this speed varies according to the potting stage. Experiments with modern potters have demonstrated that speeds are highest when centering and opening the clay (105-140 rpm) while drawing up the walls and finishing the rim is done at lower speeds of 60-85 rpm. However, it is perfectly possible to center and open the clay for a smaller vessel at 60 rpm; larger vessel, however, will require higher speeds (Foster 1959b: 62). This lower speed of 60 rpm brings us within the realm achievable by most turntable devices. Foster, for example, reports: “There is no question but that, at least for the smoothing of rims and necks, Rosa *spins* the molde and its pot with such velocity that motor patterns are much more closely related to those associated with true wheel throwing than with those associated with a mobile base…In finishing the neck of a *cántaro* she made approximately 15 revolutions in 10 seconds, or 90 rpms” (1959b: 57, 60; emphasis in original). He adds, “[c]ompetent Coyotepec potters routinely spin moldes at speeds of 60 to 90 revolutions per minute, and the momentum of a good-sized pot is such that the neck (and the neck alone) is shaped by the motionless hand against which the spinning pot throws its weight” (1959b: 61). These experiments show that the speeds achieved even by a turntable device would be high enough to allow the fashioning of necks and rims of large vessels as well as complete small vessels. Is it possible that the first wheel-thrown pottery was made on devices previously used for handmade manufacture or potter’s wheels that simply could not achieve faster rotation than 60 rpm?

Where to from here?

The realisation that much of what we have regarded as wheelmade on a fast wheel may actually only be wheel-shaped on a turntable device begs great questions for archaeologists. No longer can we confidently rely on the rilling on the outside or inside walls for an identification of wheelmade manufacture. Macroscopic observations may thus be misleading. However, there are still a few characteristics and scientific techniques that may provide us with clues: among the macroscopically observable characteristics are rilling marks – and it is not so much their presence but their interrupted and uneven nature that may indicate discontinuous rotative motion and thus the use of a turntable device. But as this technique requires complete or nearly complete vessels, its application is limited.

Several authors have suggested thin section analysis as a means to differentiate forming techniques but as they only review a small part of the vessel, they will only provide limited information. Instead, radiographic examination has become a widely used tool for the study of pottery technology (e.g. Carr 1990; Glanzman & Fleming 1986; Lang & Middleton 1997; Leonard *et al.* 1993; Rye 1977).

An alternative approach would be to investigate experimentally the capabilities of ancient potter’s wheels. While we have over 100 remains of clay wheels (only 2 stone ones) from Bronze Age Crete, their throwing potential remains unknown. The closest comparison is the experimental reconstruction of a Canaanite-Israelite potter's wheel by Amiran and Shenhav who reconstructed a 60 cm wide wooden board on top of a stone socket/pivot arrangement; the maximum speed that was attained with this potter's wheel was 60 rpm (1984). Our evidence from Crete, however, is based primarily on over 100 clay wheelheads which appear to fall into two weight categories: the smaller ones weighing 4-6 kg and the larger ones weighing 8-10 kg (Evely 1988, 2000). While attempts have been made to reconstruct the potter's wheel design (Figure 1), an assessment of its abilities would require experimental work. As it stands, their light weight makes it unlikely that they were able to store the momentum in the same way as stone wheels which weigh up to 40 kg. Three interpretations are possible: 1) clay wheels were attached to heavy stone pivots in order to maintain the momentum, 2) an apprentice maintains the speed while the potter throws the vessel, or 3) these wheels were only used for the production of small vessels. Until experimental work has been done, radiography is our best means through which to understand the primary forming techniques of vessels, and thus appreciate the abilities of the potter's wheel through an analysis of the final product. It is for this reason that I am devising a research project which employs radiography to determine the manufacturing method and to determine whether our macroscopically observed categories are meaningful in light of modern scientific techniques.

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Illustrations:

Type of vessel	Actual time spent (hours:minutes)	Elapsed time (days:hours:minutes)
Serving vessel	9:52	7:7:14
Food bowl	4:37	5:1:0
Medium cooking pot	4:3	3:22:18
Small cooking pot	3:15	3:22:18
Large jar	14:55	7:0:35

Table 1. Time needed to produce coiled vessels among the Shipibo-Conibo (after Arnold 1985: table 8.1).

Vessel dimensions/cm - Mouth*Bottom*Height*Circumference	Mean throwing time of 5 vessels each (minutes:seconds)
19*22*34*83	2:52
20*24*36*87	3:23
20*23*48*92	3:11
20*23*48*92	3:38

Table 2. Mean production times of wheelmade pottery in India (after Arnold 1985: table 8.2).

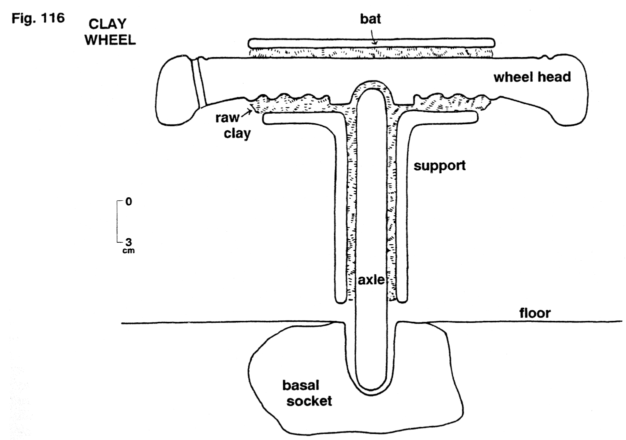

Figure 1: Reconstruction of a Minoan potter's wheel (taken from Evely 2000: fig. 116).