The Shape of Mortar: Comparing Coefficients of Variation for Flower-Pot and Unshaped Mortars in Central Alta California

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Flower-pot mortars have often been held in high regard for their artisanship and association with changing sociopolitical systems during the Late Period in the San Francisco Bay-Sacramento Delta region. Recent attention has emphasized their role as socially valued prestige goods used in ceremonial feasts and as mortuary offerings. However, the possibility that they are the byproducts of craft specialization has only been marginally explored. This article compares coefficients of variation for flower-pot mortars and unshaped mortars to determine whether they are standardized in their design and what implications this may have for the organization of their production. When considered within their feasting context, flower-pot mortars can be understood as embodiments of social information communicating group identity, as controlled by elites underwriting the ritual mode of production.

This article is based on Palazzolo's (2022) research and seeks to contextualize flower-pot mortars in the San Francisco Bay-Sacramento Delta area (hereafter Bay-Delta) (Figure 1). Through extensive literature review, Palazzolo examined a sample of 52 sites containing approximately 227 flower-pot mortars and used the data to reconstruct the life history of these impressively manufactured and symbolically laden artifacts. One aspect of that study was to evaluate the possibility that flower-pot mortars are the product of craft specialization (Costin 1991).

To that end, Palazzolo (2022) employed methods similar to those of VanPool and Leonard (2002), who used the coefficient of variation (CV) to measure standardization of metates in the Casas Grandes region of northern Mexico. In their article, they argued that standardization cannot be represented as a dichotomy determined by an arbitrary cut-off (typically 10%). Their alternative method compares the distribution of CVs among related artifacts to measure their relative variation, representing differences in the organization of craft production (VanPool and Leonard 2002:715).

Palazzolo (2022) only provided CVs for flower-pot mortars in his sample and argued for their relative degree of standardization by referencing other researchers' work, none of which examined mortars in central California. This article remedies that by comparing the CVs of flower-pot mortars to unshaped mortars from several sites within the larger sample used for that thesis. The hope is to contribute not only to a greater understanding of craft production during the Late Period in the Bay-Delta, but also to help develop a more thorough empirical basis for recognizing specialization in milling implement industries.

FLOWER-POT MORTARS IN THE BAY-DELTA

The term "flower-pot mortar" is synonymous with "show mortar" and – in many typologies for the Bay-Delta – "type A mortar" (e.g., Beardsley 1954a, 1954b; Johnson 1942; Lillard et al. 1939). Buonasera (2012, 2013) formally defined flower-pot mortars as larger than can be held in one hand, with a fully shaped

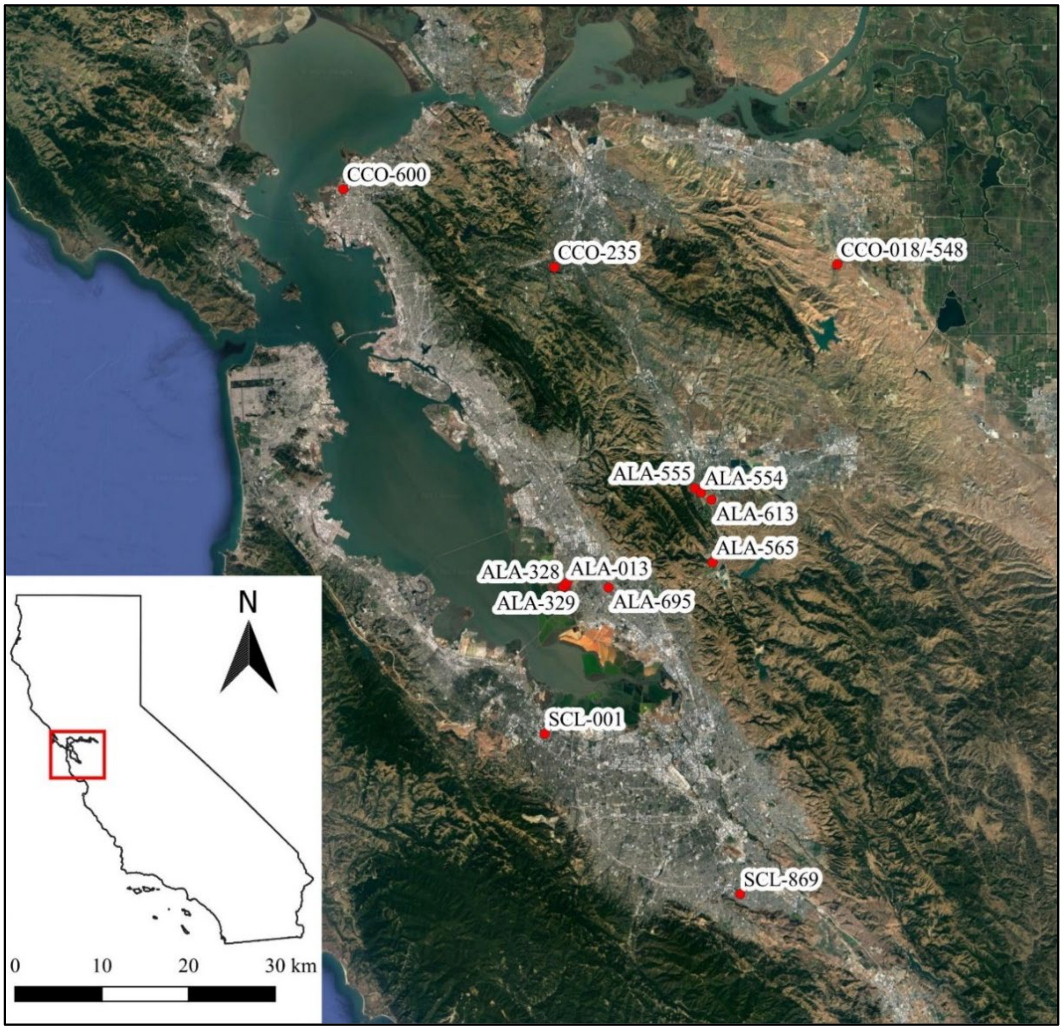

Figure 1. Sites included in the sample.

straight-sided or slightly curved exterior, a formally shaped rim that is square or slightly beveled, and an interior cavity that is deep and broad with straight upper walls. Flower-pot mortars have long been recognized and admired for their artisanship, even during early excavations (e.g., Schenck 1926:245). Beardsley (1954a: 31) stated that, "These ornamental mortars must have had connotations over-reaching their food-grinding function," evidenced not only by their design, but also their typical manufacture from non-local basalt and frequent inclusion as "killed" grave goods.

Within the Central California Taxonomic System, flower-pot mortars are also considered diagnostic of the Augustine Pattern, the archaeological manifestation of the Emergent/Late Period in the Bay-Delta (Bennyhoff 1982). This was a time of increased sedentism, status ascription, and ceremonial integration in which flower-pot mortars played no small part (Milliken et al. 2007:112, 116-117). Notably, the greater reliance on staple plant foods to support these changes would have predicated shifts in milling implement design, as well as reorganization of labor associated with their production and use (e.g., Buonasera 2013).

Despite the early regard for flower-pot mortar design and value, these artifacts have suffered from an all-too-common theoretical neglect shared by many types of ground stone (see Buonasera 2013:193; Palazzolo

2022:1-2, 6-7). Buonasera (2013:193) noted that an important shift away from this neglect was Leventhal's (1993) thesis. Utilizing a direct historical approach to assess the Ryan Mound (CA-ALA-329) archaeological assemblage, he argued that intensification of social systems in the Late Period integrated social and economic interaction spheres with linguistic and tribal territories. Referencing experimental data to estimate the time invested in mortar production, Leventhal (1993:25-26) further posited that flower-pot mortars were so expensive to produce that they should be considered primarily sociotechnic rather than technomic artifacts. He also noted similarities between these high-investment ground stone tools and large ceramic vessels in the Mississippian region, supporting the hypothesis that flower-pot mortars are elite wealth goods associated with prominent ceremonial feasting activity (Leventhal 1993:261-262).

The ground stone assemblage recovered from the Ryan Mound was examined again by Buonasera (2012, 2013) alongside similar assemblages to observe diachronic trends in the mortuary associations of ground stone milling tools. Building off Leventhal's conclusions, Buonasera (2012, 2013) investigated the relationship between flower-pot mortars and other wealth items. Quantifying shell bead lots as indicators of wealth, she found statistically significant differences between graves with flower-pot and bowl mortars and graves with other mortars or no ground stone. Buonasera (2013:205-206) also argued that flower-pot mortars were associated with feasts, comparing them to large, elaborate baskets used in parts of California for feasting activity.

A report of recent excavations at the Ohlone village of *Síi Túupentak* (CA-ALA-565/H) continues the trend of increasingly comprehensive analyses of flower-pot mortars (Byrd et al. 2019). Four of these types of mortars were recovered at the site in mortuary contexts and had been deliberately destroyed or "killed" before deposition, often through rim removal and quartering of the bodies. While the majority of other ground stone tools were made from local materials, the flower-pot mortars were manufactured from a geochemically discrete diabase material, as determined by XRF analysis (Byrd et al. 2019:182-190, 548-564; Johnson and Byrd 2021). Following inspection of possible nearby sources, the diabase at Mount Diablo was determined to be most similar to the flower-pot mortars, although no quarry was identified. Byrd et al. (2019:554) interpreted these data to suggest that flower-pot mortars have a unique "social life history" from their procurement at culturally significant locales to their ritualized destruction.

The concept of a social life history for flower-pot mortars was foundational to Palazzolo's (2022) thesis. Following a reconstruction of the life histories of flower-pot mortars using cross-cultural ethnographic, experimental, and archaeological data, he employed a multi-theoretical approach drawing on costly signaling and gender theory. Doing so allowed for a thorough exploration and testing of the previous hypotheses proposed for flower-pot mortars, including their status as prestige goods, their association with shifts in marriage practices and alliance building, and their use in feasting contexts. In particular, Palazzolo (2022) emphasized the ways in which flower-pot mortars can be reconceptualized as inalienable objects (see Mills 2004), which are embodiments of social identity used to legitimate hierarchy while also promoting collective group identity.

CRAFT SPECIALIZATION

The concept of craft specialization has been addressed by many different archaeological studies from multiple perspectives. Here, however, craft specialization is discussed as defined by Costin (1991). In this sense, craft specialization is a means of defining the organization of production in terms of how consumer demands are being met by producers of a particular good. It is distinguished from nonspecialized production by the amount of time spent in the activity, the proportion of subsistence obtained from the activity, the presence of a recognized title, name, or office for the person or activity, and the payment in money or in kind for the products of the specialist. Data required to identify craft specialization can be directly obtained from the specific place of production or indirectly through examining the finished product. Indirect evidence considered characteristics of specialized production systems include standardization, efficiency, skill, or regional variation (Costin 1991:18, 32).

Craft specialization is not a dichotomy of presence or absence, but a continuum following four general parameters (Costin 1991:8-11). These parameters are context (elite sponsorship, from independent to attached), concentration (from dispersed to nucleated), scale or constitution (from small/kin-based to factory/wage-labor), and intensity (from part-time to full-time). Through an understanding of how production is organized according to these parameters, the degree of craft specialization can be assessed. The ways in which these parameters interact can also be informative regarding how specialized production is organized (Table 1).

The Standardization Hypothesis

As no definitive quarry or manufacturing locus has been identified for flower-pot mortars, direct data to measure specialization is insufficient. Turning to indirect data, the efficiency of flower-pot mortars has been determined through experiments which indicate that they outperform other types of milling implements in processing both small seeds and acorns (Buonasera 2013). Further, as noted above, the elaborate design of flower-pot mortars has, *ipso facto*, been considered the product of skilled labor. Alternatively, questions of standardization or regional variation have been minimally explored. The focus of this article is on the former.

The standardization hypothesis simply states that a product of craft specialization will have less morphological variation than an unspecialized item. Due to specialized systems having a lower producer per consumer ratio, there is expected to be less individual variability in their crafts. The degree of standardization can therefore be interpreted as the relative number of production units, regardless of their size or scale of production. However, Costin (1991:33) cautioned that standardization may also be the result of economic

Table 1. Types of Specialized Production and Their Defining Parameters.

Type	Context	Concentration	Scale	Intensity
individual specialization	independent	dispersed	kin-based	part-time/full-time
dispersed workshop	independent	dispersed	wage-labor	full-time
community specialization	independent	nucleated	kin-based	part-time/full-time
nucleated workshop	independent	nucleated	wage-labor	full-time
dispersed corvee	attached	dispersed	wage-labor/kin-based	part-time
individual retainer	attached	nucleated	kin-based	full-time
nucleated corvee	attached	nucleated	wage-labor	part-time
retainer workshop	attached	nucleated	wage-labor	full-time

Note: From Costin (1991:10, Table 1.1).

decisions, whereby producers use a standard form or technique to lower costs, or mechanical, performance-related needs. In some cases, standardization is the result of social expectations and consumer demands, and in these cases may not accurately represent the number of producers (Costin 1991:34).

This serves as the distinction between mechanical standardization (the unconscious result of repeated manufacturing behavior) and intentional standardization (representing a conscious choice on the part of the artisan to meet certain performance-related expectations). Costin and Hagstrum (1995:622-623) differentiate these types of standardization on the basis that mechanical standardization can be used to understand the organization of production, while intentional standardization only reflects specific functional or social needs. However, VanPool and Leonard (2002:713-714) reconsidered these concerns and argued that specialization enables the skill needed to produce intentionally standardized objects which fall within a range of acceptable variation beyond functional utility.

METHODS

As noted above, this article examines a small subset of the sample included in Palazzolo (2022). This sample was generated by literature review conducted through the California Historic Resource Information System at the Northwest, Central California, and North Central Information Centers. Of the sites examined in Palazzolo (2022), this article focuses on those that contained sufficient data to allow comparison between flower-pot mortars and unshaped mortars (Figure 1).

THE SAMPLE

Identification of flower-pot mortars in this study utilized the definition provided by Buonasera (2012, 2013). Specific criteria were: (1) high degree of exterior shaping; (2) an intentionally shaped flat or slightly rounded rim; (3) an intentionally shaped, flat base; and (4) generally large size. Variations include the straight, convex, or concave shape of the exterior walls, the inward or outward beveling of the rim, and the shape of the mortar cavity's interior base. Once flower-pot mortars were identified, they were categorized according to Beardsley's (1954a:9, 1954b:109-111) typology. These include three subtypes, typically differentiated by their exterior side walls: Type A1a is straight-sided, Type A1b has flaring or concave sides, and Type A2a has rounded or convex sides (Figure 2).

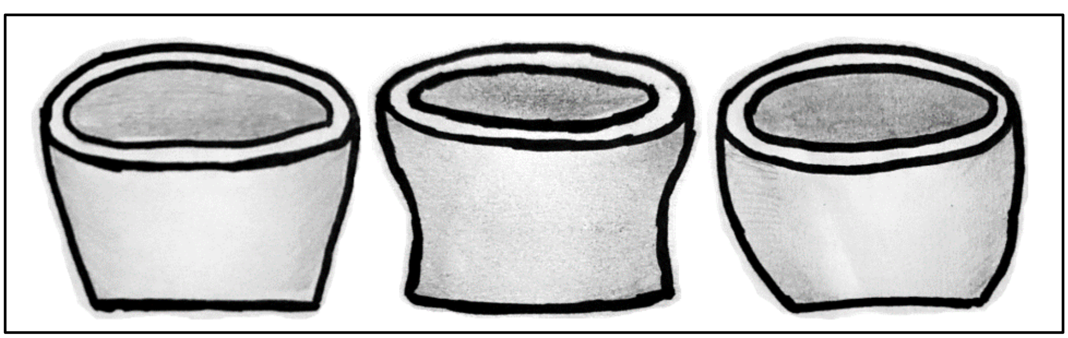

Figure 2. Flower-pot mortar subtypes (left to right): A1a, A1b, A2a (from Beardsley 1954a:Figure 3).

The Beardsley types were used primarily because flower-pot mortars are frequently identified in previous studies according to the typology. In most cases, the authors of the site reports included typological assignment; if they did not, typology was assigned based on photographs, drawings, or descriptions. For the purposes of this article, flower-pot mortars were compared to unshaped cobble, bowl, and boulder mortars from the same sites (Table 2). These were represented by the Beardsley (1954a, 1954b) types B1 and B2. Types identified as B- and C-series from Lillard et al. (1939) were included as well.

Table 2. Flower-Pot Mortars and Unshaped Mortars in the Sample.

Site	Number of Flower-Pot Mortars	Number of Unshaped Mortars
CA-ALA-013	1	5
CA-ALA-328	5	5
CA-ALA-329	11	1
CA-ALA-554	17	16
CA-ALA-555	6	6
CA-ALA-565	4	17
CA-ALA-613	4	26
CA-ALA-695	3	5
CA-CCO-18	2	13
CA-CCO-235	6	0
CA-CCO-600	2	1
CA-SCL-001	2	3
CA-SCL-869	1	2

For each mortar included in the sample, the variables of exterior length, exterior width, height, base diameter, rim thickness, interior depth, interior length, and interior width were examined. As is the nature of literature reviews, one limitation of this study is the inconsistency in which variables were measured and how they were recorded. Sample sizes for each variable can vary drastically, and in some cases metric data provided had to be adjusted to fit the analysis (e.g., assuming that a single exterior diameter indicated equal exterior length and width).

It should be noted that there is little temporal control for the unshaped mortar category, and many of these mortars were likely not synchronic. Thus, the expectation is that the variation in the dimensions of these mortars represents a truly random distribution. Furthermore, although flower-pot mortars are diagnostic of the Late Period, there is little refinement for this chronology and the literature review of flower-pot mortars throughout the Bay-Delta may indicate their use in earlier periods (Palazzolo 2022). The distinction is important in that this article examines general diachronic change in historically related technologies and does not suggest that these are two contemporaneous mortar production industries.

COEFFICIENTS OF VARIATION

To quantitatively measure standardization, the CVs for flower-pot mortars and unshaped mortars were calculated following the methods outlined by VanPool and Leonard (2002). The CV is useful because it is reliable at small sample sizes and controls for the absolute size of the variable being measured; this allows comparison of variables with differences in scale, size, and distribution (Eerkens and Bettinger 2001:494-498; VanPool and Leonard 2002:715). CVs are typically expressed as percentages, by multiplying the resulting coefficient by 100. Theoretically, CVs for human-made objects fall on a spectrum from 57.7% – representing truly random production – to 1.7%, the minimum amount of size variation perceivable to humans (Eerkens and Bettinger 2001).

In its most basic iteration, a CV is the standard deviation (*s*) of a sample divided by the sample mean (*x*), as shown in Formula 1.

(Formula 1) $$C_v = \frac{s}{x}$$

VanPool and Leonard (2002) employed a corrected CV (C_v*) in their analysis, which is an unbiased estimator for the sample size (*n*) presented by Sokal and Rohlf (1995:57-59). The corrected CV is used here, as shown in Formula 2.

(Formula 2) $$C_v^* = \left(1 + \frac{1}{4n}\right) C_v$$

Eerkens and Bettinger (2001:498-499) discussed the tendency for archaeological studies to compare CVs only qualitatively. They provided a means of quantitatively testing and determining statistically significant differences in CV distributions based on Feltz and Miller's (1996) asymptotic test for the equality of coefficients of variation, as shown in Formulas 3 and 4. Eerkens and Bettinger (2001) noted that this test is robust to departures from normality and comparison of CVs from populations with unequal sample sizes.

(Formula 3) $$D = \frac{\left(\sum m_j \times \frac{s_j}{x_j}\right)}{\sum m_j}$$

In Formula 3, *j* is an index referring to the site sample, n_j is the sample size of the j^{th} population, $m_j = n_j - 1$, s_j is the standard deviation of the j^{th} population, and x_j is the mean of the j^{th} population.

(Formula 4) $$D'AD = \frac{\sum m_j \left(\frac{s_j}{x_j} - D\right)^2}{D^2(0.5 + D^2)}$$

In Formula 4, *D'AD* is the test statistic distributed as a χ^2 random variable with *k*-1 degrees of freedom, *k* being the number of samples.

RESULTS

The descriptive statistics, CVs, and corrected CVs for flower-pot mortars and unshaped mortars in the sample are provided in Table 3. When compared to the spectrum of possible CVs proposed by Eerkens and Bettinger (2001), the CVs for flower-pot mortars are decidedly middling, while unshaped mortars are near to the estimated truly random variation of 57.7%. For all variables, the difference between flower-pot

Table 3. Coefficients of Variation for Flower-Pot Mortars and Unshaped Mortars.

Type	Variable	Number (n)	Mean (x)	Std. Dev. (s)	CV	Corr. CV
Flower-Pot Mortars	Ext. Length	53	35.669	7.406	20.763	20.861
	Ext. Width	51	35.337	7.114	20.132	20.230
	Height	54	22.160	3.876	17.492	17.573
	Base Dia.	23	25.761	3.478	13.499	13.646
	Rim	34	3.325	0.815	24.497	24.677
	Int. Depth	45	16.212	3.695	22.790	22.917
	Int. Length	29	30.833	7.531	24.425	24.636
	Int. Width	29	29.478	7.764	26.338	26.565
Unshaped Mortars	Ext. Length	90	28.838	11.978	41.534	41.650
	Ext. Width	90	23.349	9.350	40.044	40.155
	Height	88	16.056	6.505	40.517	40.632
	Base Dia.	19	21.566	9.133	42.349	42.906
	Rim	56	4.698	3.900	83.026	83.396
	Int. Depth	68	9.365	4.336	46.295	46.465
	Int. Length	45	17.175	6.870	39.999	40.221
	Int. Width	45	15.388	6.640	43.149	43.388

mortars and unshaped mortars is statistically significant ($p < 0.0001$ for all variables except interior length [$p = 0.015$] and interior width [$p = 0.017$]).

VanPool and Leonard (2002) compared the CVs for slab metates, through-trough metates, round-cornered metates, and square-cornered metates. They argued that the slab metates, with CVs ranging from 31% to 48%, were unstandardized, while the through-trough and round-cornered metates were closer to an average of 15% to 20%. They argued that these types are the byproduct of generalized producers creating uniform milling tools. The square-cornered metates, with CVs ranging from 9% to 13%, are far more likely to be the product of craft specialists. Searcy (2011:133-135) compared these values to CVs for metates manufactured by contemporary artisans in the highlands of Guatemala and stated that CVs ranging from 7% to 20% are consistent with standardized products.

Altogether, this suggests that flower-pot mortars are moderately standardized. The lowest CVs (height and base diameter) may be the result of functional constraints, particularly if the mortars were used while the tool user was sitting with their legs positioned around the mortar. The higher degree of variation in exterior length and width indicates that these variables were less constrained by functional needs, but there was still a low tolerance for deviation from an ideal shape (Eerkens and Bettinger 2001:493). The highest CVs are those associated with the interior dimensions of the mortar cavity and the mortar rim (discussed below).

To greater examine differences in standardization between the flower-pot mortar subtypes, CVs were calculated and compared for each independently. As only two A1b mortars were included in the sample, they were not considered here. The results are presented in Table 4. For the most part, A1a and A2a mortars have similar CVs, with the only statistically significant differences being between exterior length ($p = 0.0008$) and exterior width ($p = 0.0053$). Thus, even when shaped, convex-sided mortars have greater variation than those with straight sides, the latter representing a greater investment in the exterior design of flower-pot mortars.

Table 4. Coefficients of Variation for Flower-Pot Mortar Subtypes.

Type	Variable	Number (n)	Corr. CV
All Flower-Pot Mortars	Ext. Length	53	20.861
	Ext. Width	51	20.230
	Height	54	17.573
	Base Dia.	23	13.646
	Rim	34	24.677
	Int. Depth	45	22.917
	Int. Length	29	24.636
	Int. Width	29	26.565
A1a	Ext. Length	33	15.54
	Ext. Width	31	15.94
	Height	34	15.47
	Base Dia.	17	9.69
	Rim	20	22.98
	Int. Depth	20	24.24
	Int. Length	20	24.73
	Int. Width	31	21.14
A2a	Ext. Length	13	32.52
	Ext. Width	13	30.19
	Height	13	18.11
	Base Dia.	5	13.81
	Rim	4	8.01
	Int. Depth	6	27.61
	Int. Length	6	33.22
	Int. Width	10	31.36

DISCUSSION

Socially Prescribed Use

Wiberg et al. (2010:179) proposed that flower-pot mortars are, in terms of function, better classified as vessels and were not used for food processing. In part, this claim relies on the bevel noted on many flower-pot mortars along the interior edge of the rim and uniform across the circumference. They argued that if the bevel were the result of use-wear, there should be a corresponding lateral abrasion on pestles used with the mortar (Wiberg et al. 2010). At CA-CCO-018, they found no evidence of such pestle use-wear.

However, lateral use-wear on pestles has been identified at other sites (Lentz 2012:196-198; Pastron and Bellifemine 2007:103). An experiment comparing the lateral use-wear on a pestle with the bevel of a flower-pot mortar rim, recovered from the same mortuary context at CA-ALA-554, found that the length of the pestle use-wear matched the depth of the mortar (Lentz 2012). When aligned with the bevel, the pestle struck the middle of the mortar cavity; flower-pot mortars sometimes exhibit a unique concentration of use-wear in this middle section of the cavity, often forming a secondary depression (Buonasera 2013:197-198; Johnson 1942:325).

Referencing Lentz (2012), Byrd et al. (2019:551, 557) argued that the rim bevel represents a stylized practice of use for flower-pot mortars. In this sense, flower-pot mortar use involved a highly specific engagement between the pestle and the mortar. They also referred to the practice of rim destruction at CA-ALA-554 as an indication of the cultural significance that rims of flower-pot mortars embody. Palazzolo (2022) found that throughout the Bay-Delta region, there is a clear preference for flower-pot mortar destruction that focuses on rim removal. If the bevel on rims does indicate a prescribed performance associated with use, then rim removal is an effective means of signaling the end of that tool's life both in a functional and symbolic sense.

Returning to the CVs presented in Tables 3 and 4, it appears that the rims of flower-pot mortars were not standardized to the same degree as the exterior dimensions. Initially, this seems to contradict expectations that the rims of flower-pot mortars were highly stylized. However, VanPool and Leonard (2002:720-721) proposed that there should be a positive relationship between a variable's CV and the degree to which that variable is impacted by tool use. As the interior cavity dimensions have the highest CVs and the exterior shape variables have the lowest, these expectations seem to be met. Following this argument, the CVs suggest that the rims of flower-pot mortars were impacted by use in the same way the interior would have been.

Visual Performance Characteristics

VanPool (2001:127-130) proposed that CVs are also an effective means of identifying functional traits, which are those subject to selection (see Dunnell 1978). Functional traits should have lower variation than stylistic traits (i.e., not subject to selection); if this is the case, exterior design of flower-pot mortars is the most likely attribute affected by selection. As noted above, standardization of flower-pot mortar height and base diameter may be due to the constraints of flower-pot mortar size. However, the disparity between exterior length and exterior width CVs for A1a and A2a mortars indicates that this is not the case for these variables. Rather, exterior side wall shape is likely a visual performance characteristic (Schiffer and Skibo 1997:30-31) influenced by selection because it is "important for social use and information exchange . . . [and] may be under selection at the scale of replicative success" (VanPool 2001:129). This recalls Costin's (1991:37) comment that intentional standardization may not be associated with economic behavior when consumers demand social information be embedded in the object, usually at greater cost.

Although not quantified in the provided metric values, exterior shape may also be selected due to symmetrical design. Symmetrical structures have been discussed for other lithic tools and the evolutionary preference for symmetry may have a biological basis (Nowell 2000:155-162). An experiment conducted by Mühlenbeck et al. (2016) suggested that although aesthetic preference for symmetry may be culturally specific, symmetrical patterns cross-culturally have a higher gaze fixation preference than non-symmetrical designs (also see Nowell 2000:162-164). Considering the higher degree of standardization for A1a mortars, it may be that straight-sided mortars were more symmetrical, particularly along the vertical axis.

An important factor to consider in a discussion of visual performance characteristics is the context of use. Various authors have argued that flower-pot mortars were used primarily during large, intertribal feasting events (e.g., Buonasera 2013:205-206; Byrd et al. 2019:553, 557; Leventhal 1993:262-263). Feasts serve as both a venue for the negotiation of status and social capital and the reification of communal identity, a process to which flower-pot mortars may have been integral (Palazzolo 2022). Furthermore, feasting underwrites the production of goods associated with the feasting activity (Spielmann 2002). Thus, feasting can provide not only a context of use, but also a context of production which facilitates craft specialization.

If exterior shape is a visual performance characteristic with social use functioning in a feasting context, the question remains as to what information is being communicated. Mills (2007) noted that as cooking and serving vessels are focal points for feasting events, their size, form, and decoration will reflect the group size, viewing distance, and social context of the feast. Exterior shape is highly visible, suggesting that this variable was intended to appeal to a large audience in an open setting. Alternatively, other decorative traits, such as shell bead appliques, imply a much smaller scale and closer proxemics. While the latter may indicate material wealth and status, the former may better represent group identity.

Parameters of Production

Following Costin and Hagstrum (1995:621-624), standardization should reflect scale and concentration of production. Assuming scale is restricted due to the socio-economic context, concentration may be more accurately represented by standardization. The CVs presented here indicate that the most standardized variables for flower-pot mortars are base diameter and height, regardless of subtype, while exterior length and exterior width are more standardized for A1a straight-sided mortars than A2a convex-sided mortars.

The distinction between intentional and mechanical standardization rests largely on the principle of whether the standardization of a variable is conscious or not. While it is argued here that the exterior shape of flower-pot mortars is a visual performance characteristic significant to the socially prescribed use of these artifacts, it is unclear whether the decision is a conscious design or a subconscious tendency toward symmetry. Association with A1a mortars and larger bead lots in mortuary contexts indicates that these mortars were more highly valued than A2a mortars (Palazzolo 2022), supporting the premise that straight exterior side walls were a consumer-demanded trait.

The base diameter and height of flower-pot mortars may have functional implications for use, reflecting how the mortar users position themselves around the tool. Such manufacturing decisions might be made with a specific individual in mind, or with intuitive knowledge of the average person's height and posture. The high rate of standardization across A1a and A2a mortars suggests these variables were not visual performance characteristics in the same way as exterior side walls. For heuristic purposes, the exterior side walls of flower-pot mortars are considered intentionally standardized, while the height and base diameter are considered mechanically standardized. Regardless of intentionality, VanPool and Leonard (2002) pointed to how standardization reveals the skill of the artisan, which Costin and Hagstrum (1995) associated it with intensity of production.

Altogether, standardization suggests that production of flower-pot mortars was fairly concentrated. Other scholars have discussed preference for specific lithic material types, particularly igneous rock, in flower-pot mortar production (e.g., Johnson and Byrd 2021). In the current sample, 72% of flower-pot mortars are manufactured from typically non-local igneous rock, while 85% of unshaped mortars are made from more locally available sedimentary rock. Flower-pot mortar producers may have been relatively concentrated in the vicinity of these igneous rock sources, such as Mount Diablo.

The parameters for flower-pot mortar production are then relatively nucleated, likely kin-based, and high intensity, although restricted in the latter parameter by the relatively low demand for objects with such long use-lives. This suggests that flower-pot mortar producers were either organized into a specialized community or a nucleated corvee, depending on the context of elite sponsorship. Although Costin (1991:12) noted that fully attached specialists can only exist with the presence of an elite class, it seems likely there was a high degree of relative elite control over flower-pot mortar production.

Costin and Hagstrum (1995:621-623) suggested that labor investment should increase with elite involvement, as producers would be more concerned with social and political information encoded in the design of their goods than with efficiency or competition, which an independent producer would prioritize.

Further, they noted that "…the practice of conspicuous consumption [underlies] the often high labor intensity of attached craft production" (Costin and Hagstrum 1995:621). The high manufacturing cost of flower-pot mortars is what led Leventhal (1993) to urge reconsideration of these objects as primarily social in function, and Palazzolo (2022) has demonstrated how elites can benefit from using flower-pot mortars as costly signals, an evolutionary equivalent to the economic concept of conspicuous consumption.

In discussing specialized production among small-scale societies, Spielmann (2002) suggested that the parameter of elite sponsorship be reconsidered as attachment to ritual context rather than an economic class. If flower-pot mortars were socially valued goods used for feasting within a ritual mode of production, the ritual context may define the degree of attachment for community specialists (i.e., at the household or kin-based level). What Spielmann (2002:202) leaves open is, "whether those in charge of the facilities or the ceremonies . . . had the capacity to channel productive labor in particular ways and to exert some control over the materialization of ideology." The stance taken here, echoing Palazzolo's (2022) conclusions, is that those responsible for organizing a feast could very much command labor and the materialization of ideology; indeed, they relied on the ability of prestige goods such as flower-pot mortars to convey that control.

CONCLUSION

While craft specialization is defined by far more than morphological standardization, this article has explored the possibility that the shape of flower-pot mortars conveys a great deal of social information. As inalienable goods (Mills 2004), they are repositories of knowledge and social memory, both reiterating hierarchical differences in society and reinforcing a communal identity. Although there is still a great deal to be learned about ground stone production and milling implement industries, flower-pot mortars may provide insight into incipient specialization of high-prestige goods in central California (see VanPool and Leonard 2002:712).

The CVs calculated for flower-pot and unshaped mortars confirm that the former are significantly more standardized in all regards, while a comparison of flower-pot mortar subtypes indicates that straight-sided mortars were more standardized in their shape and more highly valued. Further, the variation in flower-pot mortar design supports a socially prescribed use, whereby there were clear expectations for the appearance of the tools and how users engaged with them. This is evident in the patterns of use-wear along flower-pot mortar rims and the visual performance function of the exterior shape.

Still, flower-pot mortars are not standardized to the same degree as other milling implements that are produced by craft specialists, such as utilitarian metates from northern Mexico (VanPool and Leonard 2002) or the market economy of contemporary highland Guatemala (Searcy 2011). As goods produced within a small-scale society associated with ceremonial feasting, the specialization of flower-pot mortars is likely within the context of a ritual mode of production (Spielmann 2002). In such a situation, kin-based community specialists are attached to the ritual context that underwrites their labor. The ritual is then controlled, to a certain extent, by an elite who uses the social information embedded in flower-pot mortars to communicate their economic and ideological authority.

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