JASNA VUKOVIĆ

University of Belgrade, The Faculty of Philosophy, Department of Archaeology, Belgrade

LATE NEOLITHIC POTTERY STANDARDIZATION: APPLICATION OF STATISTICAL ANALYSES

Abstract. – This paper defines the notion of standardization, presents the methodological approach to analysis, points to the problems and limitation arising in examination of materials from archaeological excavations, and presents the results of the analysis of coefficients of variation of metric parameters of the Late Neolithic vessels recovered at the sites of Vinča and Motel Slatina.

Key words. – Pottery, standardization, Late Neolithic, Vinča, Motel Slatina, coefficient of variation, cumulative blurring.

Over the last decades, organization of craftsmanship production has become an important part of ceramic studies. The key issues in reconstruction of pottery production, and thus certain aspects of social organization, are the processes of product standardization and craft specialization. Until now, the most common statistic analyses of pottery vessel standardization have been based on the comparison of products of different potters[1], comparison of products of communities with different production organization and the degree of specialization[2], and analyses of products from one production series[3]. With the exception of the pottery material from the prehistoric cultures of American Southwest, which has been analyzed from various perspectives[4], analyses of standardization of archaeological material are still extremely rare and have mainly been conducted with respect to materials from historical periods[5]. Most analyses have been made within the framework of ethnoarchaeological research, in which data on the number of producers,

degree of specialization, quantity of vessels produced by the same potter in one series, and the total number of vessels produced by one potter/workshop in one period of time were available to researchers. Although all analyses discuss the possibility of application of methods and results on chronologically distant periods, they, however, often do not go any further than to remark that „further research will show…". Until today, no work dedicated to analysis of standardization in the earlier periods of prehistory has appeared. Thus, researchers into the Neolithic are faced with a number of difficulties and constraints. Prior to addressing the main issue (was there really any standardization in

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[1] Roux 2000; Longacre 1999; Stark 1995.

[2] Kvamme et al. 1996; Roux 2000.

[3] Blackman et al. 1993.

[4] Hegmon et al. 1995; Crown 1995; Mills 1995.

[5] Blackman et al. 1993.

place in the Neolithic?) the notion of standardization should be defined, methodological approach to analysis presented and problems and limitations arising in the analysis of excavated materials pointed out.

STANDARDIZATION: DEFINITIONS

Standardization is commonly defined as reduction in variability in shapes, dimensions and decorations of pottery vessels[6] or as reduction in variability manifested through a higher degree of homogeneity of raw materials or morphological properties of finished products[7]. It implies reduction not only in variations of products themselves, but also in production procedures, which implies simplification of production techniques[8]. Thus, it can be observed through all aspects of pottery production process (selection of raw materials, their processing, shaping, final treatment and firing), as well as through the aspects of production organization: its scale and mode of production[9]. Highly standardized products indicate that production relied on individuals who used clearly defined kinds of raw materials and routinely applied formalized production techniques, which all resulted in identical products[10]. Many authors argue that standardization is directly linked to production intensification and specialization[11], so „standardization hypothesis"[12] suggests that increased uniformity of finished products is a direct consequence of the increase and intensification in production, which is connected with economic specialization[13]. Conditioning of standardization by specialization is often disputed and no agreement has been reached yet; however, it should be emphasized that ethnoarchaeological research has revealed that standardization can exist independently of specialization, which is especially important when the subject of investigation is prehistoric communities.

Standardization is a process, but it is also a result of the process, which means that it reflects time and a moment in time. Therefore, clear goals have to be set for archaeological examination, or in other words, it has to be clear what is to be studied: standardization as a process in which uniformity of pottery vessels increased over time or the level of uniformity at a specific moment in time. For that reason, two different terms have been suggested for these two aspects of standardization: standardization would denote a process, while uniformity (or homogeneity) would refer to the result of the process[14]. Some authors argue that standardization as process has

to be viewed as part of economic intensification[15]. In terms of archaeology it is best measured by comparisons over wide scope: at regional level. On the other hand, uniformity is a static category which refers to a set of products, regardless of whether it concerns the products of one potter or the material from one site; that term does not bear implications related to the whole process or the time period in which homogeneity of products could be achieved.

Methodological issues

There are several important issues to be considered concerning research into standardization, among the others – the character of assemblage (whether it is the inventory of a household or the inventory of the whole community, for example) and production technology, but, first of all, the choice of methods of analysis and parameters as the data source. Therefore, the main methodological problems to be addressed are:

1. How can standardization as process
    "be measured"?

If standardization implies uniformization of vessel shapes and dimensions, then the measurable parameters appropriate for statistical analysis can be determined. The main problem, however, arises from impossibility to identify and prove the extent of standardization as process in any other way than by *comparing* two or more assemblages. Contrary to P. Rice's belief that comparison between the assemblages distant in space and time should be avoided[16], evidence provided over last years suggests the opposite. The development of statistical techniques and improvement of methodological appro-

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[6] Rice 1987; Rice 1996, 202.

[7] Mills 1995, 204.

[8] Rice 1981, 220.

[9] Scale of production refers to the size and complexity of production system which is influenced by several factors, such as production intensity and effect, labour investment, spatial organization of workshops or means of production and number of users (Costin 1991; Rice 1987, 180–181; Arnold P.J. 1991b, 364; Mills and Crown 1995, 3–4); mode of production indicates the way pottery was made, who made it and who it was for (Rice 1987, 181–182).

[10] Rice 1987, 202.

[11] Rice 1984, 1996.

[12] Blackman et al. 1993.

[13] Feinman et al. 1981; Kramer 1985; Rice 1981; Costin 2000.

[14] Rice 1996,179.

[15] e.g., Costin 2000.

[16] Rice 1981, 178.

ach have led to realization that it is the comparison of different assemblages, being spatially and chronologically distant, that enables determination of the basic regularities in measuring standardization and definition of the referential values which can be widely applied[17]. Comparisons in ethnoarchaeological research are relatively easy because not only that researchers have a sufficient number of whole vessels available to them but they also can obtain data concerning the manufacturing techniques and production organization. On the other hand, an analysis of archaeological materials proves more complex. Difficulty arises from small scale investigations where often no statistically valid sample is available. Considerable fragmentation of material and varied degrees of assemblage preservation pose another problem, creating a myriad of difficulties and limitations in measuring materials from different sites or different contexts. In addition, the difference in the assemblage time scope is often one of the key problems[18].

2. How can uniformity, i.e. standardization as result of the process „be measured“?

Uniformity, in other words the existence of standardization at a specific moment in time, is easier to prove and quantify from the archaeological perspective. In this case again, ethnoarchaeological research has the advantage of having a bigger number of samples, i.e. whole vessels. When it comes to archaeological materials, the analysis has to be confined to comparisons within functional classes, because the attributes of shape and ornamentation differ from class to class. Given the fact that similarity of products can occur even in the societies where pottery is made by non-specialists, which results from the community's standards, some authors recommend that archaeology should concern itself with defining the difference in the extents of standardization rather than determining its presence or absence[19].

3. Which variables are suitable for analysis?

Standardization is best documented by determining morphological variations of vessels. The variables can be divided into two main groups. Metric variables are the vessel attributes which can be measured, and thus serve as a statistical set of data. Metric variables, i.e. measurable attributes of shape, are suitable because they can be formally categorized. Their most important feature is that they can be applied to different assemblages[20]. Measurement of different dimensions and statistical comparison of sets of data is the major part of an analy-

sis, where the coefficient of variation is considered to be the most important unit and evidence of standardization.

On the other hand, stylistic variables cannot be quantified. Those refer to the vessel characteristics which are not affected by practical purposes; they can be imitated or limited, depending on social factors. The fact is that smaller metric differences within functional classes are not as prominent as variations in shape and ornamentation patterns, but their quantification poses a big methodological problem so that statistical methods for this kind of variables are extremely rare. Melissa Hagstrum analyzed standardization in painted ornaments based on statistical models[21] taking hand movements needed for execution of specific ornamentation (left-right, up-down, oblique, arched, spiral, and staggered) and applied motifs as parameters for the analysis.

Intentional and mechanical standardization

Several factors have an impact on appearance of standardization. Individual factors have to do with potter's individual skills and ability to innovate. Two main attributes of standardization can be distinguished in individual factors: intentional and mechanical standardization[22]:

1. Intentional attributes are conscientiously controlled by craftsmen and they refer to technological, morphological and stylistic features of a product, reflecting the function of vessels (economic, social, and political). The examples of the intentional attributes are: choice of raw materials, i.e. suitability of particular raw materials for specific purpose, morphology, which is related to the function (big/small, high/low neck, bowl/pot, etc.) and stylistic elements (type of decoration and motifs). In opinion of some authors[23], intentional attributes have little to reveal with respect to organization of production because their function is to meet specific functional and/or social needs.

2. Mechanical attributes depend on potter's motor abilities and skills and are consequence of unconscious activity. The variability resulting from such attributes shows the level and type of technological procedures,

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[17] For example Eerkens and Bettinger 2001; Roux 2003.

[18] Stark 1995, 234.

[19] Stark 1995, 233.

[20] Ibid.

[21] Hagstrum 1985.

[22] Costin and Hagstrum 1995; Roux 2003; Stark 1995, 235.

[23] Costin and Hagstrum 1955, 622.

and the levels of skills, aptness, experience, efficiency and motorics. They are often represented by choice and preparation of raw materials which are not related to functional requirements; variations in fabric and colour resulting from the choice of specific clay and pigments and firing techniques; variability in ornamentation metric characteristics, such as line thickness; insignificant variations in dimensions within classes; morphological and proportional variability within specific shapes[24]. From this perspective, metric variability of products will reflect the number of production units (individual potters or workshops), which is grounded on the hypothesis that the variability of mechanic attributes is in direct correlation with the number of potters or craftsmen groups[25]. In other words, if a substantial quantity of pottery exhibits just a little variability, involvement of a small number of specialized craftsmen in its production can be hypothesized.

Thus presented hypothesis implies that standardization directly depends on specialization. However, standardization can be a result of routine and continuously repeated operations. Standardized products appear due to accumulated experience, so that the potter's skill plays a major role in that process. Therefore, it is not only specialization that may reduce variability of pottery vessels but it can also be routinization. Some authors argue that a high degree of routine should not be mixed up with standardization[26]. This view has been proved true in ethnoarchaeological research in which the metric parameters (rim diameter, height and various proportions) of the vessels made by experienced potters were compared with the parameters of those that were produced by novices in pottery craft. The hypothesis was corroborated not only by statistic analysis but also in interviews with the potters who claimed that, although they themselves worked as they felt, it was the matter of practice and experience to produce a vessel of the standard size, from adding a specific quantity of admixtures to its shaping and firing. Ethnoarchaeological research among seasonal potters in south Veracruz (Mexico) has also provided evidence that standardization is neither necessary nor sufficient characteristic of pottery craft specialization[27]. Household production can achieve the level of dimension uniformity. Morphological uniformity can result from the use of particular tools (for example, length and width of tools for vessel shaping); measurements such as hand span and fingers, or fist size or length of arms[28], may have an impact on the rim diameter and height, which may result in uniformity of dimensions of products made by the same, not necessarily, specialized potter.

Social factors

An important factor in identification of standardization is the ratio between the number of potters and the number of vessel users, which affects variability in the total number of vessels in use. The representational sample of the pottery used and discarded by a community supplied by a few craftsmen will be less diverse than in the case where each household makes pottery[29]. Ethnoarchaeological investigations have also revealed that demand affects uniformity of ready-to-use products: consumers prefer to take vessels from potters whose products look the same, because they understand it to be an indication of the potter's skill; the similar situation can be found in a bigger market where middlemen play an important role in distribution[30]. Generally speaking, social concepts concerning attractiveness of products, confirmed in a number of places: India[31], Mexico[32], the Philippines[33], play an important role in creating pressure on potters to produce uniformed vessels.

Technological factors

Production techniques can also have an impact on standardization, even though potters may not be specialized. One of the ways is use of moulds. They need not be real moulds as those used in industrial mass production. Ethnoarchaeological examinations have provided ample evidence that the bottoms of broken vessels may have been used as moulds, with the result of uniformed dimensions of the produced vessels[34].

Measuring standardization:
metric variables and statistical analysis

As it has already been stated, metric variables are suitable for standardization analysis since they yield to formal categorization and can be utilized as a set of data for statistic analysis. Analytic methods for standardization analysis, however, can vary, with both advantages and disadvantages. In terms of variation analysis, the

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[24] Ibid.

[25] Cited according to Roux 2003, 769.

[26] Arnold 1991b, 91.

[27] Arnold 1991a.

[28] For example Underhill 2003, 208.

[29] Stark 1995, 233.

[30] Underhill 2003, 208.

[31] Sinopoli 1988, 586.

[32] Arnold 1999.

[33] Longacre 1999.

[34] For example Arnold 1991b, 96.

number of attributes of each individual variable (for example the span of a rim diameter) and the frequency of each individual attributes (for example, the number of the cases where every registered rim diameter is represented) are of paramount importance. Accordingly, the main statistic indicators relevant for analysis are: range of values, mean value and standard deviation[35].

Although different statistic techniques, notably variance analysis, have been used for standardization analysis[36], the opinion that the most reliable method to determine standardization is the analysis of the standard deviation value and coefficient of variation (CV) is gaining ground. The coefficient of variation represents a consistent and reliable measure of variation: it is defined as the standard sample deviation divided by the sample mean value, often multiplied by 100 and expressed as percent.

Research carried out by J. Eerkens and R. Bettinger[37], who argue that the analysis of coefficient of variation has to be the standard statistic techniques of standardization measuring, has shown the exceptional importance of two values for standardization analysis. The first value has been derived from so called the Weber fraction. Based on the fact that human abilities to discern differences in size between two objects or between a real object and the mental picture of it are limited by human perception, Ernst Weber has established that two objects have to differ in their weighs for more than 2% so that a human can notice the difference. Perception of other dimensions requires similar values – at least 3%. The first value of coefficient of variation derived by Eerkens and Bettinger from the Weber fraction is 1.7%. This value stands for the minimum quantity which human perception can notice without resorting to automatization or an independent standard. Depending on motor abilities and experience, variability increases and that percentage will be somewhat higher in practice, so that the CV value ranging from 2.5 to 4.5% is a typical variation in the size of products which an individual may create in manual production[38].

This hypothesis has been corroborated by ethnoarchaeological research. Products of non-specialized craftsmen from Los Tuxtlas in Mexico, who make pottery on a seasonal basis, exhibit the oscillation of the coefficient of variation values for the rim diameter from 3.3% to 4.7%[39]. W. Longacre has demonstrated that the values of coefficient of variation for the values of rim diameters, height and shoulder diameters in products of specialized potters from the Philippines vary between 2% and 5%[40]. Very low values of coefficient of varia-

tion obtained by the analysis of the products of highly specialized contemporary craftsmen in India and Spain (from 1.56 to 3.19%), although no automation is used for production, are explained by a high level of motor skills achieved through production of a considerable number of vessels[41]. Based on the values of coefficient of variation in vessels made in productions of varying intensity, that is to say by specialists with high annual production on one hand and non-specialized craftsmen with low annual production on the other hand, V. Roux has provided evidence that the values of coefficient of variation below 3% belong to large scale production (more than 14000 vessels annually per manufacturer), while those above 6% indicate small scale production (6000 or less vessels annually per craftsmen)[42]. Thus calculated annual production seems to be quite exaggerated and does not match the results of other ethnoarchaeological research. For example, potters using potter's wheel in China, with relatively high intensity of production, who are active in their craft throughout the year, reach annual production of about 230 vessels per potter, where the coefficient of variation is kept extremely low[43].

The second value emphasized by Eerkens and Bettinger is the theoretically derived value of 57.7%, which stands for completely non-standardized production. It is especially important for examination of archaeological materials, because the values of the coefficient of variation of 57.7% and higher point to the error committed by researchers when they put different classes of artefacts in one class, thus artificially increasing variability. High values of the coefficient of variation can indicate more than one producer, given different ideas of different people with respect to the ideal or model that a vessel should be made like.

By applying the hypothesis of the reliability of the coefficient of variation as the measure of standardization, Eerkens and Bettinger have demonstrated that

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[35] Standard deviation is the measure of dispersion in the main set; it indicates the average extent to which set elements deviate from the arithemtic mean of the set.

[36] Kvamme et al. 1996.

[37] Eerkens and Bettinger 2001.

[38] Eerkens 2000.

[39] Arnold 1991a.

[40] Longacre 1999.

[41] Roux 2003, 777.

[42] Ibid, 780.

[43] Underhill 2003, 251–252.

archaeological materials exhibit linear correlation between the mean value and the standard deviation. Scatter dot diagrams, shown with the slopes of best-fit regression lines, are particularly important in that analysis. Steeper lines show assemblages characterized by less standardized attributes, while those closer to the X-axis, and thus to the value of 1.7%, show highly standardized assemblages[44].

Exceptional convenience of the coefficient of variation analysis is supported by the fact that it enables comparison between attributes of various values (for example: big – small), as well as attributes measured by different measuring units (for example: centimetres – grams), which is especially important for archaeological materials. Furthermore, the extent of standardization between different classes of archaeological materials (for example: stone tools in relation to ceramic vessels) can also be compared. In addition, the significance of functional parameters (volume, height) for standardization analysis should not be disregarded[45]. Ethnoarchaeological research has supplied evidence that the parameters which depend most on motor abilities are the height, shoulder diameter and rim diameter[46]. Besides, ethnoarchaeological investigations have shown that craftsmen's usual answer to the question about the part of a vessel which has to be standardized is that, regardless of the shape or function, it has to be the rim[47]. Stylistic parameters (for example: the thickness of painted lines or the shape of the rim), on the other hand, can exhibit by far higher variability, depending on aesthetic notions and producers' expressions[48].

Surely, the coefficient of variation values presented in this way are an ideal example. The real (low) values of the coefficient of variation indicating the existence of standardization (up to 5%) can be obtained only in ethnoarchaeological research, where it may be fairly easy to set aside and analyze products by every individual producer or vessels of one production series. However, the situation in examination of archaeological materials seems to be fundamentally different due to a likely lack of such data. The values of the coefficient of variation in archaeological materials, except in extraordinary cases, will be inevitably higher. There are many reasons for that. Taking into consideration that most of archaeological materials does not come from clear, closed units, „cumulative blurring" can undoubtedly be expected in analysis. It occurs in cases of depositions of products made by a number of producers, or from many production series over a longer period[49]. Such variability in results appears even with products

of specialized craftsmen. Some analyses of products made by contemporary specialized potters have shown that the values of the coefficient of variation are higher when all vessels of the same functional class are observed than when products of each individual producer are observed[50]. This becomes especially important if materials from a layer or pits are being studied, even more so for the periods of early pottery communities and the Late Neolithic. The analyses of archaeological materials which have been conducted so far have confirmed this. The analyses of the coefficient of variation in Early Red and White Ware ceramics from the American Southwest[51] reveals seemingly high values – ranging from 24% to 29% and 23% to 26% for the rim diameter; this range of values does not prevent researchers from discussing different degrees of standardization. Moreover, there are indications that the pottery with higher values may have been produced by producers in specialized communities (uniformed raw materials, extensive distribution), which supports the fact that the presence of products made by a number of producers results in higher values of the coefficient of variation.

Secondly, increased values of the coefficient of variation can result from creation of etic categories defined by researchers, in contrast to emic categories distinguished by producers[52]. This particularly concerns grouping of vessels according to their size, or in other words determination of vessel dimensional classes. Classes can be analyzed in ethnoarchaeological research according to the classification suggested by those who have made them[53], while archaeological material does not allow for such definitions. The question concerning analysis of archaeological material remains as to whether there is a way to create a more subtle division into dimensional classes as seen by their producers? Sometimes dimensional classes can be determined by observing the scatter dot diagram in which the values of the rim diame-

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[44] Eerkens and Bettinger 2001, fig.1.

[45] Ibid.

[46] Roux 2003, 777.

[47] Underhill 2003, 248.

[48] e.g., Hegmon et al. 1995.

[49] Blackman et al. 1993.

[50] Roux 2003, 775; Underhill 2003, 250.

[51] This is related to the Pueblo I period, i.e. the ninth and early tenth century AD; materials from five sites have been analyzed (Hegmon et al. 1995).

[52] Longacre 1999.

[53] Kvamme et al. 1995.

ter, shoulder diameter and height are discussed[54]. However, it often happens that only small- sized vessels can be clearly distinguished in those diagrams, while grouping of bigger-sized vessels cannot be discerned. The situation is further aggravated by evidence provided by ethnoarchaeological studies that ideas about dimensional classes vary from one producer to another[55]. There is no need to emphasize that in the case of archaeological material it is not possible to notice grouping due to the nature of the sample, i.e. remarkable material fragmentation, where measures of large vessels often cannot be taken.

In spite of hardship arising during analysis, occurring as a result of cumulative blurring, analyses of variability are an inevitable step in investigating organization of pottery production. To our best knowledge, they have not been applied onto archaeological materials from the Neolithic yet. The presence of large quantities of pottery fragments at all Neolithic sites undoubtedly indicates a widely spread pottery production, so that the possible existence of standardization of the Late Neolithic pottery needs to be investigated by application of quantitative methods.

PROBLEMS AND LIMITATIONS IN THE ANALYSIS OF STANDARDIZATION OF NEOLITHIC POTTERY

1. Material fragmentation

It is not surprising that most standardization analyses are based on ethnoarchaeological research, considering that the subject of such analyses are whole vessels which represent a valid statistic sample providing researchers with data on the most important metric parameters, i.e. values of rim diameters, heights and maximal diameters (shoulder diameters). One of the features of archaeological material is a frequent absence of whole vessels, which makes taking more measurements for one type/functional class impossible. Even if a certain number of whole vessels are available, it is still uncertain whether those vessels are the representative sample of a specific type/functional class, or their presence is only accidental or the result of a set of circumstances which has led to recovery of that particular vessel in one piece or to possibility of putting it together out of a myriad of pottery sherds. Therefore, the rim diameter is often the only measurement which can be taken for analysis.

Some papers point out wall thickness as a possibly convenient measure. However, if only fragments are available, it is the wall thickness of different parts of the vessel that is inevitably measured, which may create an artificial variability of results. It seems logical that the walls in the bottom or on the shoulders are thicker than on the neck. Forms with uniformed wall thickness from bottom to top are extremely rare. Therefore, wall thickness can only be taken as a parameter of certain kinds of vessels, for example conical bowls. Since they are unprofiled, the values of wall thickness are more likely to be equal along the whole height of the vessel.

One of the most important parameters of profiled vessels is the largest diameter, i.e. shoulder diameter. It is a measure which is often lacking in archaeological material. A special problem arises, for example, with Vinča amphorae with a narrow neck and a rim diameter which is always relatively small in relation to the overall size of the vessel. Most likely, the function of the narrow rim was to prevent the content from spilling out, so that its diameter does not need to be highly standardized – as long as it serves its purpose. On the other hand, the shoulder diameter, as well as the height of the recipient, could be standardized as the result of potter's skill or utilization of a certain „alternative" measure in production (the length of her forearm or arm, for example) or due to the need to put a certain quantity of foodstuffs into the vessel. Therefore, does it make sense to take into account rim diameters, the only available measure, when standardization is considered?

2. Comparative analysis: what to compare?

The only way to get data on existence/absence of standardization is to *compare* different parameters on the same group of vessels, different groups of vessel, and same groups of vessels from different contexts, or different sites, etc. The main recommendation of researchers is to make comparisons within a functional class, so that situation when non-comparable elements are compared can be avoided. Otherwise, a researcher may end up with results that cannot be interpreted or with artificially created variability leading to the dead end. However, is it really that easy to make division into functional classes?

At the first glance, determination of functional classes of the Vinča culture vessels on the basis of their forms appears to be relatively easy. However, it turns to be possible only in the most general sense: storage

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[54] Stark 1995.

[55] e.g., Nicholson and Patterson 1985, 236.

vessels for liquid and solid foodstuffs (amphorae), vessels for consumption of food and drinks (bowls), long-term storage vessels for solid foodstuffs (pithoi) and pots for food preparation (pans)[56]. For the time being, a more subtle division within general classes seems to be impossible, given the fact that traces of use-wear cannot be found on the vessels, while those indicating exposure to fire are completely lacking.

Examples of different dimensions are clearly present within each type of vessels (except perhaps bowls) and functional classes are likely to be distinguished on the basis of their size. However, there is a problem as to which criterion should be used to distinguish classes with respect to their dimensions. The absence of a sizeable sample of whole vessels, which can be analysed in the scatter dot diagram, prevents application of quantitative methods for that purpose. Apparently low variations in particular specific parameters, as it turns out, result in high values of standard deviation, and consequently values of coefficient of variation in statistic analysis, so that a division based on the researcher's impression seems to be quite unreliable and may lead to an artificial decrease in variability.

Therefore, researchers find themselves forced to rely on typological classification. This again can yield unreliable results, because typology is often based on classification which seems logical to a researcher, but from the point of view of those who produced pottery may seem absurd. This is a factor which archaeologists cannot be aware of, nor they can control or exclude it.

Special difficulty arises when materials from different sites have to be compared. Material can exhibit various degrees of preservation, but also may not be typologically or functionally uniformed; certain classes present at one site may be lacking at another; the quantity of samples suitable for analysis can be disproportionate. Sites being associated with the same period do not need to be literally contemporary, which opens the possibility of comparing different stages of standardization as process, not as result of process.

3. Nature of context

According to recommendations in the literature, products of a number of craftsmen or products of one production series should be ideally compared. Unfortunately, since contexts indicating a pottery workshop in the Neolithic are completely lacking, the number of craftsmen is impossible to determine, and, thus, their products cannot be identified. This difficulty seems to be the most trying to overcome. Are there any contexts in which the existence of standardization can be at least implied?

As far as the Late Neolithic is concerned, there are confirmed contexts of houses burnt in fire, which undoubtedly show pottery material that was being used in one period of time. The material from the house seems suitable considering a remarkable number of whole vessels found there, which allows for measurement of all the parameters needed. Naturally, pottery vessels from such a context are not necessarily products of one potter or a part of one production series, but it can be reasonably assumed that it will display less variability than material from the layer. On the other hand, pottery vessels from those "convincingly determined" contexts are fairly meagre. Although some researchers argue that, if analysis is based on comparison of coefficient of variation values, no very big sample is necessary, it seems that this should not be definitely accepted. 30 pieces for each sample is recommended for statistical analysis in social sciences[57]. Such a requirement is almost impossible to fulfill, since it is not logical to expect that in each house at least 30 vessels for each functional or dimensional class can be found. Therefore, materials from houses does not represent a valid statistical sample, and the researcher is forced to use the sample from the layer, which itself is prone to „cumulative blurring".

SAMPLE FOR ANALYSIS

After a century of exploration, Vinča pottery has become well known today, with vessel morphology being the basis for differentiation between development stages of the Vinča culture[58]. However, research into Vinča pottery mainly ends with typological analysis. No doubt the late Vinča pottery gives an impression of uniformity, in colour and surface treatment in the first place, but also in dimensions and shapes. In order to examine this impression by quantitative methods, a statistical analysis, i.e. the analysis of coefficient of

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[56] It is astonishing that no cooking pot has been recovered during the 2002 to 2009 excavations in Vinča. Only a few fragments with somewhat coarser fabric have been found. Judging from their characteristics, they could have belonged to a vessel for thermal processing of food.

[57] Underhill 2003, 247.

[58] For example Garašanin 1979; Schier 1996.

variation from two sites – Vinča and Motel Slatina – was made. All material excavated at Vinča between 2004 and 2006 was taken, although it belonged to different contexts. This was justified in the light of the fact that it was the first analysis of standardization of Neolithic pottery production, so that such a study could point to methodological problems and a possible correction of the approach to analysis. Besides, this material was also assigned for the comparative analysis with the material from Motel Slatina site (1962 excavation), for which documentation was missing so that the material was the total excavated material regardless of the context. In addition, given the effect of cumulative blurring, which has already been pointed out several times, it was logical to analyze materials which were assumed to be especially prone to it and thus make an attempt at reducing its effects to a reasonable extent by application of statistic analysis.

As for functional differentiation between pottery shapes, amphorae were selected as a group of vessels. Considering that on amphora samples no use-wear traces, either those resulting from exposure to fire or from effects of different chemical processes within the contents of the vessels, had been noticed, they were assigned to the group of vessels for foodstuffs storage. However, difficulty immediately arose since the material, especially from the layer, was to a large extent fragmented, allowing for only one parameter to be taken – the value of the diameter rim. On the other hand, the material from houses was much better preserved allowing for other measurements to be taken, but difficulty experienced here had to do with a small number of whole vessels. Disproportion in the quantity of pieces belonging to one sample was a serious problem. Again, in order to test methodology and possibility of analysis, this problem was taken into consideration, but analyses were conducted regardless of it.

In terms of typology, amphorae can be divided into a number of groups based on shapes, manners of rim modelling and shapes of the neck. However, when it comes to function, these characteristics are not of crucial importance. The only parameter of significant importance for determining the function is openness/closeness, i.e. the height and diameter of the neck. This is the characteristic which defines ease with which it was possible to access the content, thus indicating the length of storage and/or the kind of stored foodstuffs. Accordingly, amphorae with a narrow and high neck can be classified into the group of liquid storage vessels, in which the narrow neck prevented liquid from

spilling out easily, while the ones with wider opening, i.e. a lower neck were probably used for storage of solid foodstuffs, cereals, since their wide opening enabled an easy manipulation of content (it is wider than a hand, and a smaller vessel with which the content can be scooped is small enough to pass through it). The question is whether the rim diameter is a sufficient measure, especially when it comes to closed vessels. The possibility that the rim diameter of closed amphorae does not necessarily represent a valid measure for determination of standardization has already been pointed out. Nevertheless, since this was the only available measure, it was included in the analysis.

The analysis comprised the total of 205 samples of the rims of amphorae with a wide neck and 58 samples of amphorae with a narrow neck from the layer at Vinča. The values of the rim diameters show an extremely wide range: between 10 and 40 cm for both classes. At 29.07 and 35.41%, respectively for two classes, the values of the coefficient of variation of the observed amphorae are quite high. Given the range of the rim diameter values, it can be asserted with certainty that the high values of the coefficient of variation result from the presence of vessels of different classes in the sample. If the extreme values (above 25 cm) are discarded, the coefficient of variation values become a little bit lower, dropping to 22.08 and 24.41%. These values still indicate almost non-standardized production, although they have to be taken with reservations.

The second group contains bowls. It is amazing that bowls of various types absolutely dominate in the pottery material excavated at Vinča from 1999 to 2006, making 71% of typologically assignable fragments. Since they yield such a big sample, bowls are the most suitable kind of pottery vessels for standardization analysis. The high frequency of bowls in the whole material, naturally, does not imply that each fragment allows all measures to be taken. Actually, the percentage of measurable fragments is proportionally small. Unlike amphorae and storage vessels, the measurable fragments allow a significant number of measures to be taken, which ensures more reliable final results. Among bowl fragments, bowls with inverted rims make the most represented group: 47%. These bowls predominate in the later phases of the Vinča culture and are characterized by uniformed features: relatively fine fabric with fine sand admixtures; more than 95% of bowls have burnished or polished surfaces. The shape of the rim is not always uniformed: being evenly rounded, tapered symmetrically or flattened. They are also characterized by unifor-

med ornaments: they often have burnished zone from the rim to the shoulder on both sides, while the body is decorated with burnished lines often making complex motifs. Unfortunately, due to fragmentation of material, they are not always visible, but it is often the case that a bunch of burnished lines divide the inner side into four sections. Although they may not be filled, it is not uncommon that they are filled with various burnished motifs, from those quite simple like slanted parallel lines to more complex ones such as hatched triangles, chessfields, or even series of burnished spirals. The outer side of the upper cone is often decorated with shallow, fine channelling (30%) – straight or arched. Sometimes, at the bottom or on the shoulder of those vessels, Vinča signs appear, usually in the shape of the Latin letter X, or taking a somewhat more complex form.

Biconical bowls with pronounced carinated shoulder follow bowls with inverted rims – 35%. Similarly to the previous type, they also have uniformed characteristics: mostly fine fabric with admixtures of fine sand and burnished and polished surfaces. The upper cone without a profiled neck is often vertical, although there are cases with slightly flared upper cone. With an insignificant number of exceptions, those bowls are always decorated. Pronounced carinated shoulder is commonly decorated with wide, slanting channelling creating a plait motif. The upper cone may have fine, narrow slanting channelling, while a burnished ornament is placed on the inner side of the body, exhibiting the same characteristics as the previous type of bowls. Vinča signs can be found on these vessels, both at their bottoms and shoulders.

The attributes for analysis of bowls are slightly more numerous, but some important attributes are still missing. Unfortunately, although there are a certain number of vessels that are preserved along the whole height, their number is proportionally small, so that it cannot be taken as a valid sample. On the other hand, the diameters of the rims and shoulders from the inner and outer side, the height of the upper cone and the wall thickness were taken. Given unequal thickness of bowl walls at different heights, especially in the shoulder section, which grows in thickness, thickness was taken, wherever possible, from the lower cone, close to the bottom. At the end, the analysis also included not so frequent fragments of conical bowls, which makes 14% of all bowl fragments. These are vessels with slightly coarser fabric and without decoration. It was possible to take measures of rim diameters and wall thickness from this group of bowls.

Like the material excavated in Vinča, fragments of three types of bowls from Motel Slatina site were included in statistic analysis: conical, with inverted rims and biconical bowls with pronounced carinated shoulder. When compared to the Vinča material, the Motel Slatina material exhibits some differences. The frequency of conical bowls is to a certain extent higher than the frequency of other two types. On the other hand, biconical bowls with inverted rims and pronounced carinated shoulder are to a large extent undecorated, so that in this regard they significantly fall behind the Vinča material. As is the case with the Vinča material, the measured attributes include rim diameters, external and internal shoulder diameters, the height of upper cone of biconical bowls and wall thickness.

At the end, it should be stressed that the group of bowls with pronounced carinated shoulder is in terms of morphology rather a diverse group of bowls. They are assigned to the same group mainly due to their biconical features which are emphasized by application of a band with a triangular cross section at the joint of the two cones. They may differ typologically in some elements, such as curvature of the lower cone or position of the upper cone. However, when it comes to production techniques, they are very similar, which is why they are regarded to be one group regardless of insignificant typological differences.

RESULTS OF ANALYSIS

The values of coefficient of variation for metric attributes of Vinča bowls are shown in Table 1. Conical bowls display the biggest range of diameter values (27), followed by bowls with pronounced carinated shoulder (26), while bowls with inverted rims prove to have the smallest range of values (12). As expected, conical bowls exhibit the highest variability, while a small range of values indicates quite remarkable uniformity of bowls with inverted rims. On the other hand, special attention should be given to seemingly considerable variability of bowls with pronounced carinated shoulder. The wide range of values, as in case of conical bowls, could indicate considerable variability, which would imply a low degree of standardization, also indicated by a relatively high value of the coefficient of variation (23.18%). The coefficient of the upper cone height displays the similar value (21.38%). However, when the values of coefficient of variation for shoulder diameters, both external and internal, are considered,

type/functional class		rim diameter	shoulder diameter (outside)	shoulder diameter (inside)	height of upper cone	wall thickness
conical bowls	mean SD CV (%)	*n*=33 27.1212 6.98998 **25.78**				*n*=33 9.18 2.284 **24.88**
bowls with inverted rim	mean SD CV (%)	*n*=367 17.5940 2.40588 **13.67**	*n*=44 20.0705 2.20312 **10.98**	*n*= 4 18.75 3.40343 **18.15**	*n*=308 2.3321 0.52299 **22.42**	*n*=367 5.96 1.633 **27.4**
bowls with pronounced carinated shoulder	mean SD CV (%)	*n*=106 18.6698 4.32869 **23.18**	*n*=15 18.8933 2.85994 **15.13**	*n*=15 17.6667 2.60951 **14.77**	*n*=78 2.8564 0.61085 **21.38**	*n*= 105 5.03 1.267 **25.18**

Table 1. The values of coefficient of variation for metric attributes of Vinča bowls

Табела 1. Вредности коефицијената варијације за метричке параметре здела из Винче

the values of coefficient of variation appear to be much lower (15.13 and 14.77%). Consequently, the reason for high values of rim diameters can lead to a wrong conclusion. Many samples of bowls with pronounced carinated shoulder do not have vertical, but slightly slanted upper cone. Since this morphological feature does not seriously affect functional requirements, and in terms of classification represents nothing more than a subtype of the main type, the samples with a slanted cone were not assigned into a different group. It should be noted that, when vessels with a slanted rim are excluded from the sample, the coefficient of variation value drops to 13.87%, which is a result matching the other values. A vessel with a slanted upper cone will inevitably have a bigger rim diameter than samples with a vertical upper cone. A bigger or smaller diameter needs not be positively correlated with other dimensions of the vessel. In other words, the height of a vessel and shoulder diameters of all subtypes of bowls with pronounced carinated shoulder will be approximately the same, regardless of the rim diameter. As for some other functional classes of vessels, such as storage vessels, for example, different values of rim diameters can indicate that vessels belong to different dimensional classes. Definitely, this is not the case here, which is supported by low values of the coefficient of variation for shoulder diameters. It seems that we have an unusual situation here, which, however, may be expected in analysis of archaeological material. Since the shape of the upper cone does not affect, in any way, the main function of the vessel, it can be considered a stylistic variable. Stylistic variables, as

pointed out earlier, cannot be quantified and they depend on craftsmen's personal preferences. On the other hand, this stylistic variable does affect the metric variable, which is considered especially suitable because it can be quantified. This example shows that stylistic and metric variables should not be considered separately, due to their obviously closed correlation the consequence of which, unfortunately, can be blurred in the final results of statistic analysis. Variability in the values of upper cones can be explained in the similar manner.

Speaking about blurring of results, relatively high values of wall thickness deserve attention. The range of ten and the coefficient of variation value of 24.88% can be considered a valid result. Since conical bowls are unprofiled, and wall thickness is uniformed along the whole height of the vessel, their significant variability can be noted and quite remarkable non-standardization claimed. On the other hand, the values of wall thickness of the other two groups of bowls are also high. Those results (27.4% and 25.18%) should be taken with serious reservations. Having in mind that biconical bowls have quite unequal wall thickness, especially on the upper cone and shoulder section, which is often thicker, the only way to determine uniformity is to measure wall thickness always at at the same point. This, however, is not possible due to considerable material fragmentation and frequent absence of the lower cone, so that the measures were taken from the only available sections, mostly on the upper cone. Therefore, the analysis results showing significant variability of this attribute can be safely discarded.

type/functional class		rim diameter	shoulder diameter (outside)	shoulder diameter (inside)	height of upper cone	wall thickness
conical bowls	mean SD CV (%)	*n*=99 25.914 6.0149 **23.21**				*n*=99 8.58 2.181 **25.41**
bowls with inverted rim	mean SD CV (%)	*n*=47 21.257 3.0000 **14.11**	*n*=47 22.809 3.0495 **13.36**	*n*= 47 21.277 3.1395 **14.75**	*n*=47 2.857 0.55 **19.25**	*n*=44 6.01 1.193 **19.85**
bowls with pronounced carinated shoulder	mean SD CV (%)	*n*=33 21.758 3.6145 **16.61**	*n*=33 22.167 3.3040 **14.9**	*n*=33 20.227 3.3027 **16.32**	*n*=33 2.439 0.7681 **31.49**	*n*= 33 6.39 1.735 **27.15**

Table 2. The values of coefficient of variation for metric attributes of Motel Slatina bowls

Табела 2. Вредности коефицијената варијације за метричке параметре здела са локалитета Мотел Слатина

type/functional class		rim diameter	shoulder diameter (outside)	shoulder diameter (inside)	height of upper cone	wall thickness
conical bowls	Vinča Motel Slatina	**25.78** **23.21**				**24.88** **25.41**
bowls with inverted rim	Vinča Motel Slatina	**13.67** **14.11**	**10.98** **13.36**	**18.15** **14.75**	**22.42** **19.25**	**27.4** **19.85**
bowls with pronounced carinated shoulder	Vinča Motel Slatina	**23.18** **16.61**	**15.13** **14.9**	**14.77** **16.32**	**21.38** **31.49**	**25.18** **27.15**

Table 3. The values of coefficient of variation for metric attributes of bowls from both sites

Табела 3. Вредности коефицијената варијације за метричке парамтре здела са оба локалитета

The results of the coefficient of variation analysis for bowls from the site of Motel Slatina are shown in Table 2. As is the case of Vinča bowls, conical bowls display the widest range of variability (the same value range of 27), while the other two groups of values are very low, especially for diameters – rim diameters as well as shoulder diameters, and are consistent with the results of the Vinča material.

The coefficient of variation values for all metric attributes from the two sites are shown in Table 3. It has already been demonstrated that conical bowls represent an extremely variable group of vessels. The values of the coefficient of variation for the rim diameters of 25.78% and 23.21% show that standardization of this types of bowls cannot be asserted. Nevertheless, those

values, like all others, should be taken with certain reservations given the possibility of cumulative blurring. The values of other two groups of bowls show sharply lower values.

The line diagram showing the metric attributes of bowls with inverted rims makes it clear that the values of rim diameters and external shoulder diameters from both sites are quite close (fig. 1). The bowls from Motel Slatina have lower values of wall thickness than the bowls from Vinča. The reason is not considerable variability of the Vinča material, but the fact that wall thickness of the Slatina material was always measured on the lower cone, near the bottom, which resulted in lower values of coefficient of variation at that site. It was not always possible at Vinča, because
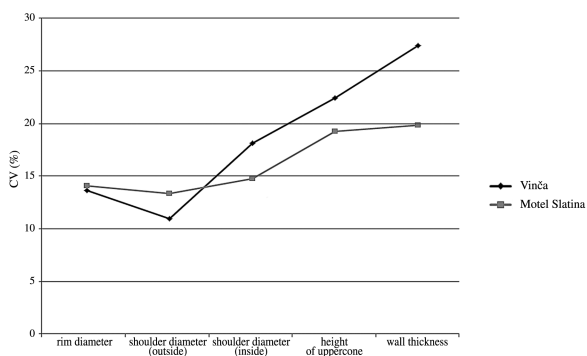
Fig. 1. The line diagram showing the metric attributes of bowls with inverted rims
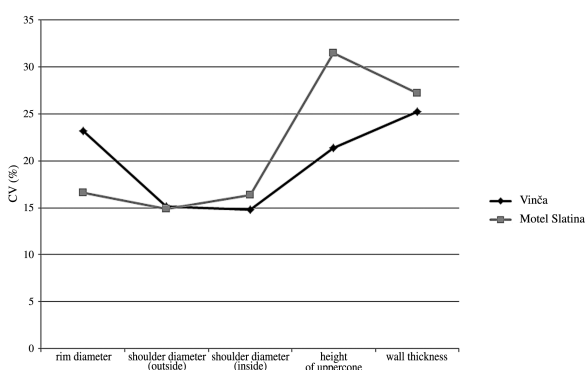
Сл. 1. Вредности CV за зделе са увученим ободом

Fig. 2. The line diagram showing the metric attributes of bowls with pronounced carinated shoulder

Сл. 2. Вредности CV за зделе са пластично наглашеним раменом

the material sample was made up of more than 300 fragments, out of which a large majority was with a preserved upper cone only, which normally has somewhat thicker walls.

The difference seemingly supporting the hypotesis that the Slatina material is more standardized than the Vinča material reffers to values of rim diametres for bowls with pronounced carinated shoulder (fig. 2). Higher variability observed in the Vinča material has already been commented. The difference between the coefficient of variation values for the height of upper cones, with higher variability in Slatina bowls, can be explained in the similar way. The height of the upper cone is considered a stylistic variable, since it cannot affect functional requirements of bowls to a significant extent, and seems to be mirroring potter's personal expression. The values of shoulder diametres from both

sites are almost identical and they should inform on the degree of standardization in the Late Neolithic.

The summary scatter dot diagram (fig. 3) shows that vessels from both sites have fairly similar values, considering that there is just a slight difference in the slope of best-fit lines. The line for Motel Slatina shows a somewhat sharper slope. We have already pointed out that the Slatina sample is smaller in number that the Vinča sample. That material is likely to have been screened during excavation, with only representative examples being preserved. On the contrary, the Vinča sample, which consists of a bigger number of fragments, includes all recovered fragments, without any prior selection. Therefore, these results should be interpreted with certain reservations and it can be logically hypothesized that the Vinča material is, if not more standardized, than equally standardized as the Slatina material. It should also be taken into consideration that stylistic attributes are the reason for higher variability of the Vinča material.

Cumulative blurring: how to avoid it?

Several times we have pointed out the possibility that the final results of values of coefficient of variation could be underestimated as the result of cumulative blurring. Cumulative blurring stems from a number of factors: long time deposition, and the possibility that the sample contains products of a number of potters. These are the
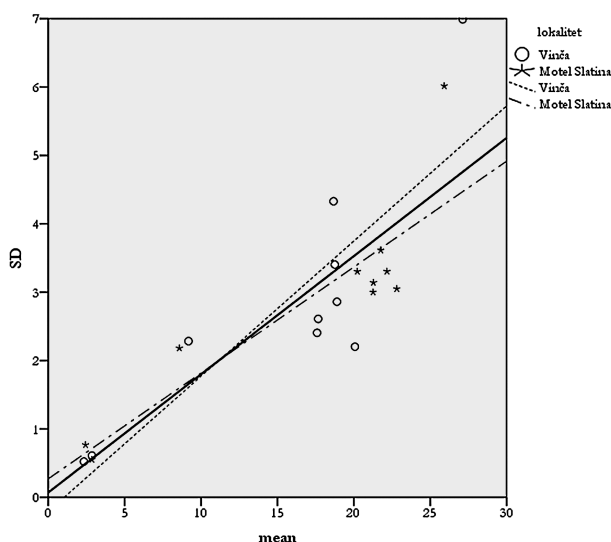

Fig. 3. The scatter-dot diagram showing mean-standard deviation relationship for datasets from two sites

Сл. 3. Дијаграм расшурања на коме се испишују односи између просечних вредности и вредности сшандардне девијације за оба локалишеша

type/functional class	rim and shoulder diameter ratio			internal and external shoulder diameter ratio	
bowls with inverted rim	Vinča	mean= 0.922383587	CV (%)=3.11	mean= 1.099257	CV(%)=2.22
		SD= 0.028755553		SD= 0.024407	
	Motel Slatina	mean= 0.932364646	CV(%)=5.02	mean= 1.075418464	CV(%)=3.8
		SD= 0.046815648		SD= 0.040922928	
bowls with pronounced carinated shoulder	Vinča	mean= 0.920525308	CV(%)=7.7 (6.86)	mean= 1.070343759	CV(%)=2.81
		SD= 0.070864426		SD= 0.030133304	
	Motel Slatina	mean= 0.979351201	CV(%)=5.04	mean= 1.099134965	CV(%)=3.68
		SD= 0.049365429		SD= 0.040510489	

Table 4. The values of the ratio between the rim diameter and the shoulder diameter and internal and external shoulder diameters for both sites

Табела 4. Вредности коефицијената варијације за пропорције здела са оба локалитета

factors that cannot be eliminated, because data regarding the time required for formation of each assemblage are not available, and there is no way to distinguish work of each single potter. The third factor with an impact on blurring is researcher's inability to distinguish dimensional classes of vessels. Is there any other way to exclude at least this factor?

The coefficient of variation values for ceramic bowls from the Late Neolithic, including cumulative blurring, can be still considered relatively low. By inspecting material, even without more complex statistic analysis, one gets an impression of uniformity, not only of shapes, but also dimensions. Accordingly, the hypothesis has been made that *if we hypothesize the existence of standardization, the relations between different metric parameters should be constant regardless of the size of a vessel.* In this way, one of the causes of cumulative blurring can be avoided. Ideally, the ratios between rim and shoulder parameters and the height of the whole vessel should be compared, but due to an insufficient number of whole vessels, such calculations are not possible. On the other hand, the data regarding shoulder diameters of greater number vessels are available. Consequently, the proportions were analysed; in other word, values of the ratio between the rim diameter and the shoulder diameter and internal and external shoulder

diameters were taken as metric parameters for statistical analysis. The results are shown in Table 4.

The results of the processed data show that the coefficient of variation values calculated in this way are considerably lower than those calculated for each individual parameter. The only value that differs significantly from other values is the value of the ratio between rim and shoulder diameters of bowls with pronounced carinated shoulder from Vinča. It has already been explained why coefficient values for this type of bowls increase and for that reason the value without samples with slanted rims is shown in brackets. The low value for the relation between internal and external shoulder diameters, which does not exceed the value of 38.6%, is striking.

The results of this analysis add to the already confirmed hypothesis that in the Late Neolithic the existence of highly standardized products may be asserted. The coefficient of variation values below 4% are most typical of the relation between external and internal diameters of the shoulder, so we can conclude that they are constant. The reason may be found in the production techniques. It is certain that the shoulder of bowls with inverted rim is the joint point of the two previously modelled parts of the vessel, thus being the most sensitive part of the vessel. The joint of two cones is

the point of stress, i.e. the section of the vessel with the highest risk of breakage, either during firing or while being used. Therefore, it is not surprising that this kind of vessel has a thickened shoulder to allow coils to stick together. Potter's attention in the process of vessel shaping must have been directed to this part of the vessel in particular. Since thickness of the joint between the two cones does not reflect functional requirements or stylistic elements, but it primarily depends on the production techniques, this parameter could surely be considered a mechanical attribute which best reflects potter's motor abilities and skills.

Bowls with a pronounced carinated shoulder, also with low coefficient of variation values, still display higher variability. Therefore, the technique of their manufacture should be analyzed. If the number of steps in vessel production is observed, it is evident that there are more steps here. Bowls with inverted rims are likely to have been made out of two previously shaped cones (lower ones could have been made in a kind of a mould from lower parts of previously broken vessels, while upper cones could have been created by forming coils or slabs)**,** which having been joined, were meticulously burnished in order to ensure better adherence between two parts, thus preventing breakage. However, there was one step more in production of vessels with a pronounced carinated shoulder. The pronounced carinated shoulder was often added in the form of a plastic band onto previously connected cones. The cones were not thickened along the joint, so that the band applied in this manner could be regarded as a kind of reinforcement which would additionally glue two parts of the vessel[59]. The thickness or width of the band was of no significant importance, either in terms of vessel function or production technique; it was the element with characteristics which may have varied from one potter to another. Although it was possible that the forming technique of vessels with reinforcement in the form of a band on the joint had resulted from practical reasons, there is no doubt that the pronounced carinated shoulder was soon to be recognized by potters as the element of the vessel which allowed creativity: shoulders of these vessels were often decorated with fine channelling. Therefore, unlike vessels with inverted rims, the shape and dimensions of the shoulders of these bowls can be regarded as stylistic variables. Stylistic elements certainly cause the occurrence of higher variability, because they mirror potters' individual representations, leaving their motor abilities aside. Consequently, vessels with a pronoun-

ced carinated shoulder exhibit higher variability than the first group of bowls.

DISCUSSION

The statistic analysis of metric parameters of ceramic vessels from the two Late Neolithic sites has shown that identification of standardization is possible even on archaeological material. The difficulty arising, in most cases, from exceptional material fragmentation and inability to distinguish a relevant sample is still a remarkable, almost insurmountable obstacle. Therefore, an attempt has been made to make analyses based on the available data.

Vinča pottery exhibits relatively high level of standardization, which is primarily recognized in the values of coefficients of variation for metric parameters. However, when the results of analysis are interpreted, a number of questions which deserve special consideration arise.

First of all, the analysis has revealed that bowls are „more standardized" than storage vessels. For the beginning, it has to be pointed out that material fragmentation is the main problem to be faced during analysis: insufficient quantity of whole vessels certainly reduces the possibility of getting relevant results. This is the fact which we have to consider prior to interpretation. Besides, many authors have stressed that standardization can be noticed with vessels of smaller size in the first place. Vinča bowls display a high level of standardization, while storage vessels, at least according to the data available to us at the moment, do not. Such disparity inevitably leads to the conclusion that what we see is a „partial" standardization. In other words, the following questions are posed:

1. Does bowl standardization show only the degree which standardization as process reached in the later phases of the Vinča culture? This would mean that the process of standardization had not been completed yet, so that potters had not developed their skills to the extent that they could be exhibited on larger vessels. If this was the case, it had to do with a relatively low intensity of production in which the producers were still „novices" who had taken up pottery craft as one of additional activities.

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[59] Vuković 2010.

2. Considering formation processes, could standardization of bowls be a consequence of their more dynamic use compared to amphorae and pithoi, which resulted in a higher breakage rate creating conditions for greater demand? In this case, potters must have produced bowls frequently, unlike amphorae and pithoi, which were produced only occasionally; intensity of bowl production was higher, which undoubtedly led to accumulation of experience and an increase in motor abilities, eventually resulting in their high standardization. Rare production of other vessels, on the other hand, given a lack of practice, resulted in high variability.

3. Was it, for some reason, important to have standardized bowls, while such requirements did not concern other types of vessels? This be the case, bowls may have had a significant social or economic function, and their uniformity was important to the whole community, or even beyond. What function may it have been? The symbolic role of vessels, especially bowls, is often emphasized in ceramic studies. The vessels could have reflected the importance of the social elite who aspired to emphasize their power through control over production of certain products to which only they were entitled. On the other hand, the economic role of vessels cannot be denied. It is well known that in the Late Neolithic there was very intensive trade which brought to Vinča and the other sites luxurious raw materials, such as spondylus shells and obsidian. The fact that there was trade in other, especially agricultural products should not be neglected, although so far there is no clear evidence for that. However, one thing seems to be completely neglected in all studies and analyses of standardization: a discussion on the measurement system as one of prerequisites for development of trade. It is very likely that bowls, in addition to other functions, may have been used as measuring cups, so that it seems logical that their dimensions were uniformed. This hypothesis is supported by the similar results obtained from two different, relatively distant sites. The conception and perception with respect to the vessel size appear to have been uniformed in a wider area. Furthermore, we can assume that storage vessels were not used as transport vessels, i.e. „packaging" for goods that was distributed by trade, since goods may have been transported in some other way, in baskets, or sacks, for example. Thus, measuring cups played a key role in measuring food quantities. The shape of bowls here becomes an interesting issue. Bowls with inverted rims seem to be especially suitable for this function. The joint of two cones can be easily noti-

ced. It is especially pronounced because the shoulder is „pulled out" with respect to the rim. The joint of the cones could easily reflect the level to which the vessel should have been filled. In order to emphasize that point, the whole upper cone is inverted, since in this case its height does not have considerable functional importance, which is supported by the fact that it is almost always very low (range of values are about 3 cm), but they display relatively high variability (22.42, and 19.25%). On the contrary, the height of the lower cone is an important measure. This be the case, undoubted standardization is not a consequence of routinization, but also of certain economic requirements. Metric attributes can be characterized as intentional, according to the classification by K. L. Costin, who stresses that intentional attributes do not reflect production organization, since they are imposed by social and/or economic norms and functional requirements. This understanding should be reconsidered. If there was standardization conditioned by the existence of a measurement system, one may logically assume the existence of craftsmen who were expected to work up to a certain widely accepted standard; it must have also implied stronger organization of production in which specialization of crafts might be included.

4. Were bowls and storage vessels produced by different craftsmen? In the previous text, we pointed out that the reason of the phenomenon of cumulative blurring is the presence of a number of potters. A relatively low variability in bowls could indicate a small number of potters, while, on the other hand, a high variability in storage vessels reflect a bigger number of potters. If this is the case, storage vessels may have been produced within each individual household. They are products of a big number of potters who worked with a low intensity, or in other words, they produced a small number of vessels, probably seasonally. The relative uniformity of bowls, as pointed out earlier, indicates a higher intensity of production. Thus, it is likely that in the Late Neolithic there were some craftsmen who were working to meet their own needs along with other craftsmen who were a bit specialized and worked to meet the needs beyond their household, i.e. a wider market.

If the results obtained from Vinča bowls, excluding conical bowls, are considered, similar questions emerge. Bowls with inverted rims are not only more frequent than bowls with pronounced carinated shoulder, but they also exhibit a higher level of standardization when compared to the other type. The conclusion is that bowls

with inverted rims were widely used, often broke and therefore more frequently produced than other types of bowls, which helped development of craftsmen's superior skills resulting in uniformed products. Bowls with a pronounced carinated shoulder, however, display much more diverse stylistic elements. They are mirrored both in morphological characteristic, such as the shape of rims, the thickness and width of the band along the joint between two cones, the position of the upper cone (which is mostly vertical, but there are examples with slightly slanted upper cone), and in ornamentation. Those bowls have more luxuriant decoration and elaborate motifs[60]. Stylistic parameters, unlike metric ones, are more difficult to quantify, and consequently statistically process. Nevertheless, a few assumptions can be made. Generally speaking, a higher variability both in stylistic and metric parameters is explained by a larger number of craftsmen. On the other hand, relatively low coefficient of variation values still indicate the existence of standardization, which would favour the opposite assumption. Consequently, we can pose the question as to whether two kinds of bowls are products of different potters or their difference is the result of different functional and social – economic requirements? It is very difficult to answer to this question. It seems almost unlikely that those were the products of different craftsmen, although the differences are obvious. Stylistic diversity of bowls with a pronounced carinated shoulder can be explained by less rigid requirements, functional and social-economic. This was the area where craftsmen could indulge their creativity. Stylistic elements of these vessels seem to have been their primary concern. Thus, they are likely to have had not economic but social role to play, which is supported by the fact that they had somewhat more limited use than bowls with inverted rims. However, to associate them with the social elite would be an exaggeration, since they are not rare and they are present in all structures. Nevertheless, it can be assumed that they had less practical and more symbolic function.

Statistic analyses of metric parameters of the ceramic vessels from the late Vinča period have shown a high level of standardization. However, the difference in the degrees of standardization between different functional classes, and different metric parameters within each individual class, poses many questions. In reply to each question the issue of specialization of crafts, both at individual and community level, emerges: from individual production within each household to specialized, socially controlled and highly organized production. Therefore, more complex comparative research into pottery from several sites should be made in order to shed light onto other aspects of economic and social organization in the Late Neolithic.

Translated by Marin Markoš

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[60] This refers primarily to the Vinča material; the Slatina vessels are mostly undecorated.

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Резиме: ЈАСНА ВУКОВИЋ, Универзитет у Београду,
Филозофски факултет, Одељење за археологију, Београд

СТАНДАРДИЗАЦИЈА КАСНОНЕОЛИТСКЕ ГРНЧАРИЈЕ: ПРИМЕНА СТАТИСТИЧКИХ АНАЛИЗА

Кључне речи. – Грнчарија, стандардизација, касни неолит, Винча, Мотел Слатина, коефицијент варијације, кумулативно замагљење.

Организација занатске производње последњих деценија заузима значајно место у студијама керамике. Кључна питања у реконструкцији керамичке производње, а самим тим и одређених аспеката социјалне организације, представљају процеси стандардизације производа и специјализације заната. Стандардизација се најчешће дефинише као смањење варијабилности облика, димензија и украса керамичких посуда или као смањење варијабилности која се манифестује већом хомогеношћу сировина или морфолошких особина готових производа. Она подразумева не само смањење разноврсности самих производа, већ и поступака у изради, па стога подразумева и поједностављење техника израде. Многи аутори сматрају да је стандардизација у директној вези са интензивирањем производње и специјализацијом, па „хипотеза о стандардизацији" предлаже да је већа униформност готових производа директна последица повећања, интензивирања производње, која је повезана са економском специјализацијом.

На појаву стандардизације утиче низ фактора. Индивидуални фактори односе се на вештину и способност иновације појединачних мајстора. Код индивидуалних фактора разликују се два основна атрибута стандардизације: намерна и механичка стандардизација. Намерни атрибути су свесно контролисани од стране занатлије и односе се на технолошке, морфолошке и стилске особине производа, које одражавају функцију посуде. Механички атрибути зависе од моторичких способности и вештине мајстора и последица су несвесне радње. Варијабилност која настаје као последица овог атрибута показује ниво и тип технолошког поступка, ниво вештине, увежбаности, искуства, ефикасности и моторике.

Стандардизација се најбоље идентификује утврђивањем морфолошких варијација посуда. Варијабле се могу поделити на две основне групе. Метричке варијабле су они атрибути посуда који се могу измерити и тиме послужити као статистички сет података. Метричке варијабле, тј. мерљиви атрибути облика, погодне су јер се могу формално категоризовати, а њихова најважнија особина је да их је могуће применити на различите асемблаже. Мерење различитих димензија и статистичко поређење сетова података у анализи игра главну улогу, где се као најважнија јединица и доказ стандардизације истиче коефицијент варијације. Коефицијент варијације представља постојану и поуздану меру варијације; дефинише се као стандардна девијација узорка подељена са просечном вредношћу узорка, често помножена са 100 и изражена у процентима. За анализу стандардизације од посебног значаја две вредности: прва износи 1,7% и представља минималну количину варијабилности коју људска перцепција може да опази без коришћења аутоматизације или неког независног стандарда. У зависности од моторичких способности и искуства, варијабилност се повећава и тај проценат ће у пракси бити нешто виши, па ће вредност CV од 2,5 до 4,5% представљати типичну варијацију у величини производа које ће појединац израдити приликом ручне израде. Друга вредност је теоријски изведена вредност од 57,7%, која представља потпуно нестандардизовану производњу. Она је посебно значајна за истраживање археолошког материјала, јер вредности коефицијента варијације од 57,7% па навише указују на грешку коју је истраживач починио мешајући различите класе артефаката у исту, тако вештачки повећавајући варијабилност. Када се ради о археолошком материјалу, у анализи ће се појавити „кумулативно замагљење", које настаје када постоји депозиција производа више мајстора, из више производних серија током неког дужег временског периода.

Анализа коефицијената варијације за метричке параметре примењена је на керамичке посуде са два каснонеолитска налазишта – Винчу и локалитет Мотел Слатина. Анализирани метрички параметри су: пречници обода, унутрашњи и спољни пречници рамена и дебљине зида. Резултати су показали да посуде за складиштење показују релативно не-

стандардизовану производњу (за амфоре из Винче вредности 29,07, односно 35,41%, тј. 22,08 и 24,41% без екстремних вредности). Коничне зделе такође показују релативно велику варијабилност (пречници обода: Винча – 25,78% и Мотел Слатина – 23,21%). С друге стране, различити параметри здела са увученим ободом и здела са пластично наглашеним раменом показују далеко ниже вредности, посебно код спољног пречника рамена (10,98, односно 13,36%; 15,13, односно 14,9%). Имајући у виду да су такви резултати потцењени због ефекта кумулативног замагљења, постављена је хипотеза да би, уколико претпоставимо постојање стандардизације, односи између различитих метричких параметара били константни без обзира на величину посуде. Зато су анализиране пропорције; другим речима, као метрички параметар за статистичку анализу узете су вредности количника пречника обода и пречника рамена и спољног и унутрашњег пречника. Резултати обрађених података показују да су овако добијене вредности коефицијента варијације драстично ниже од оних добијених за сваки појединачни параметар (између 3 и 7% за различите пропорције), што недвосмислено указује на висок ниво стандардизације.

При интерпретацији резултата анализе, међутим, отворио се низ питања. Пре свега, анализом је уочена појава да су зделе „стандардизованије" од посуда за складиштење.Та појава могла би да се објасни на неколико начина: присуством мајстора који раде са различитим интензитетом или последицом веће потражње за зделама. Једна од могућности је да су зделе, осим осталих функција, могле имати и функцију мерица; стога је сасвим логично да њихове димензије буду уједначене. У прилог овој тези иде и чињеница да су анализе показале сличне резултате на два различита, релативно удаљена локалитета, што само потврђује чињеницу да је схватање и перцепција величина посуда била уједначена у ширем региону. Такође, онда би требало претпоставити да посуде за складиштење нису коришћене и као посуде за транспорт, тј. као „амбалажа" за робу која се

трговином даље дистрибуира, већ је роба преношена на други начин, у корпама, врећама и сл. Зделе са увученим ободом, чини се, обликом посебно погодују оваквој функцији. На њима је упадљив спој два конуса, који је посебно изражен тиме што је раме „извучено" у односу на обод. Спој два конуса би стога лако одражавао ниво до кога се посуда пуни; да би се боље истакло то место, цео горњи конус је увучен, а његова висина у том случају нема већег функционалног значаја, што потврђује и чињеница да је он готово увек веома низак (распони вредности су око 3 cm), али показује релативно велику варијабилност (22,42, односно 19,25%). Насупрот томе, висина доњег конуса представља значајну меру. Уколико је ово случај, несумњива стандардизација није последица само рутинизације, већ и одређених економских захтева. Стилска разноликост здела са пластично наглашеним раменом може се објаснити мање ригидним захтевима, како функционалним, тако и социјално-економским. То је поље где су мајстори могли да испоље своју креативност. Чини се да су код ове врсте здела стилски елементи у првом плану. Стога је вероватно да су оне имале не економску, већ социјалну улогу, што потврђује и чињеница да су биле у нешто ужој употреби него зделе са увученим ободом.

Статистичке анализе метричких параметара касновинчанских керамичких посуда показале су висок ниво стандардизације. Разлике у степену стандардизације код различитих функционалних класа, као и код различитих метричких параметара у оквиру сваке појединачне класе, међутим, отворила су многа питања. У одговору на свако питање неизбежно се појавило питање специјализације заната, како индивидуалне, тако и на нивоу заједнице; од индивидуалне производње у оквиру сваког домаћинства до специјализоване, друштвено контролисане и високоорганизоване производње. Због тога је потребно спровести комплекснија компаративна истраживања грнчарије са више различитих локалитета, која би у будућности расветлила и друге аспекте економске и друштвене организације у касном неолиту.