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FROM ARTEFACTS TO BEHAVIOUR: TECHNOLOGICAL ANALYSES IN PREHISTORY

ABSTRACT: Analyses of everyday objects (from pottery, flint, stone, osseous materials) form the basis of all archaeological research, regardless of the period, region, methodological approach or theoretical framework. Although methodology went through significant changes in past decades, especially regarding the importance of experimental and ethnoarchaeological methods, many of these analyses still relied on typology, and the theoretical discussions were less diverse and much slower. In recent years, a concept of technology as a cultural-driven phenomenon has become more widely accepted, largely influenced by the technological approach from the French anthropological and archaeological school. The conceptual paradigm of chaîne opératoire *is today a commonplace in almost every analysis of artefact manufacture, and it also triggered the creation of numerous different models for analyses from raw material managing through to the use and discard of artefacts. This paper discusses past and current approaches towards technology and its role within the given society. The combination of technological and contextual approach may not only improve our understanding of the artefacts in the context of a given society, their value, importance, function, and meaning, but also can help in starting the discussion on the creation of new theoretical frameworks for social phenomena such as raw material procurement, the organisation of craft production, the labour division, etc. The case studies on the bone industry in the Neolithic Balkans will be used as examples of the possibilities of such approach.*

KEY WORDS: Technology – Chaîne opératoire *– Prehistory – Neolithic – Balkans – Bone industry – Raw material managing – Craft production*

Any sufficiently advanced technology is
indistinguishable from magic.

Arthur C. Clarke, "Profiles of The Future", 1961

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INTRODUCTION

Technology is everywhere around us, as an inseparable part of our culture; it has a strong influence on arts and sciences, and our everyday lives are unimaginable without it, we use technology as symbols of status and prestige, (ab)use it in politics. It is no surprise, then, that we often perceive technology with certain sense of triumphalism, as a "rational", "effective" way of gaining "control over nature". The history of technology is often a history of achievements, technological discoveries and inventions, and it is generally regarded in terms of a linear "grand narrative" of progress, gradually leading to the modern world and its technological supremacy.

The human past was seen as constantly progressing from "primitive" to "technologically advanced", and even classified according to what is thought to be a dominant technique (e.g. Childe 1944). Technological innovations were considered to be the main, if not the only driving forces that shape societies and cultures (Pfaffenberger 1988).

Analyses of everyday objects (pottery, flint, stone, bone tools) create the essence of every archaeological research, regardless of the period, region, methodological approach or theoretical framework. Artefacts are our source for "reading" past lives – by studying them, we can make conclusion about people who made and used them, what their meaning and value were, how they were used, reused, and discarded. These objects can be: instruments (objects with a functional role), symbols, and/or documents. They have an initial value because they perform a certain function for the society or the individuals within it. As objects may have long lives, there may be many different contexts in the lifetime of an object (e.g. Spector 1993). They can also be bespoken (rare, luxury, hand-crafted objects), occasional, craft-produced objects or common, functional, mass-produced industrial objects; one class of artefacts may have examples of rare, crafted and mass-produced specimens, but also one and the same object may change its function and value through time (cf. Caple 2006).

Numerous methodological approaches have been developed for analyses of tool manufacture and use in order to gain a better understanding of their role within a given society. Also, theoretical frameworks have changed considerably since the beginning of archaeological research. This paper discusses past and current approaches focused on technology and its role within the given society and some of the possibilities for applying technological approach will be shown using examples from the bone industry in the Neolithic Balkans. Although the concept of technology as social and cultural phenomenon is more widespread in last few decades, analyses of multiple technologies and technical systems are still not that common. Also, sometimes interesting and instructive case studies on social aspects on technology remain inadequately noticed and are not fully incorporated in a more general interpretation of a given socio-cultural phenomenon. The combination of technological and contextual approach may not only improve our understanding of the artefacts in the context of the given society, their value, importance, function and meaning, but may also serve as a starting point for a discussion on the creation of new theoretical frameworks for social phenomena such as raw material procurement, the organisation of craft production, labour division, etc.

THE CONCEPT OF TECHNOLOGY

Technology is a conceptual approach to the material culture studies. Derived from the Greek word *τέχνη*, meaning skill, technology implies all human actions upon a given material. The term technology includes a full range of topics from individual level (body gesture, embodied knowledge in crafting) to the social and cultural setting of production. Everything is technological around us, and this includes not only artefacts, but all the structures, buildings, and even natural landscapes modified by human activities (cf. Greene 2006, Lemonnier 1992b).

Henry Hodges, one of the first scholars to devote attention to multiple technologies, distinguished technology from the study of stylistic details of artefacts (Hodges 1976). By this, he implied that technology was about the *process* of production rather than the endpoint (objects).

The view of technology as *practice*, as ways of doing or making something, is common for many researchers. For Robert Merrill (1977: vi) technology is "the culture surrounding the actions or activities involved in making or doing things", while Ursula Franklin (1992) understood technology as ways of *doing* something rather than simply ways of making something (that is, creating an object), so that there are technologies of prayer and of storytelling as well as of pottery production and weaving.

Heather Miller, in her book devoted to archaeological approaches to technology, defined it as a "set of actions and relationships: from production itself, to the organisation of the production process, to the entire cultural system of processes and practices associated with production and consumption" (Miller 2007: 4). She further defined the production as "the actual process of fabrication or creation, including both the material objects and the techniques and gestures used", organisation of production as "the organisational arrangement within which production takes place", and the technological system as an active system of interconnections between people and objects during the creation of an object, its distribution, and to some extent its use and disposal. In other words, technology or technological systems can be roughly described as processes and practices associated with production and consumption, from design to discard (Miller 2007: 5).

THE ANTHROPOLOGY OF TECHNOLOGY

In anthropology, the first and probably most influential work was that by the French anthropologist and ethnologist Marcel Mauss. Mauss was interested in how *culture* (as opposed to nature) influences and shapes human behaviour. His starting point was that something generally perceived as *natural* (for example, body posture, way of walking, etc.), was in fact *cultural.* His short but influential study, *Les techniques du corps,* analyses how people in different societies use their bodies (Mauss 1982 [1973]). The way a person eats, walks, sleeps, even holds and uses tools, differs, depends on a culture, age and sex. The accent of these studies is on the impact of a group on an individual, their relationships, as well as the questioning of *cultural* and *natural* in human behaviour (Deliège 2012 [2006]: 82–84, Lévi-Strauss 1982 [1973]: 13–15).

The ideas of M. Mauss had an important impact on humanistic sciences, including the analyses of the uses of bodies, gestures, etc., and, amongst other, technology. However, this new field of research was not widely acknowledged, and a body of both theoretical work and case studies was needed.

Mauss' work influenced the creation of the school of anthropology of technology, also labelled *technologie culturelle*. This group helped both to rehabilitate the study of material culture by demonstrating that any technical fact is a social or a cultural fact, and to widen the field of study of the technical system by showing the need to take into account all possible technical variants (Inizan *et al.* 1995: 14). Ideas of this school may be seen in the journal *Techniques et Culture,* and the works by André-Georges Haudricourt and Pierre Lemonnier (Haudricourt 1988, Lemonnier 1986, 1992b, 1993) deserve being outlined.

Pierre Lemonnier promoted, above all, the idea of anthropology of technological systems as a discipline that studies material culture in its social and economic contexts. He considers technologies not only things and means used by societies to act upon their physical environment, but also social productions in themselves (Lemonnier 1992b: 1).

He criticised the superficial interest in material culture of both ethnologists and archaeologists who restrain themselves in pure description of object, and especially criticises the lack of almost any theoretical considerations, noting that the study of material culture has long been "the study of lifeless objects." (Lemonnier 1986: 147). He argued that the anthropology of technology or the anthropology of techniques "must aim at the comprehension of a technical system, and thus observe, describe, and analyse technical processes and not attribute more or less simplistic symbolic significations to merely a few objects" (Lemonnier 1986: 180).

Social theory of material culture should deal with technologies in their most physical aspects, that is to say, with the way they are made and used for some action on the material world, but beyond immediate and most obvious informational aspects, such as styles. There are more subtle informational or symbolic aspects of technological systems that involve arbitrary choices of techniques, physical actions, materials, etc., which are not dictated by their function (Lemonnier 1992b).

Technology is a social phenomenon and therefore technologies must be considered in a general anthropological perspective as social productions that are determined by, or better, are compatible with other social phenomena. Since the features of these technological systems are not the simple result of physical constraints, either constraints internal to the technologies themselves, or constraints arising from the natural environment, the question of the influence of social choices has to be taken into account.

Every technique has five related components: 1) matter (the material on which a technique acts); 2) energy (the forces which move objects and transform matter, objects, tools, or means of work); 3) gestures (which move the objects involved in a technological action); and finally, 4) specific knowledge, which may be conscious or unconscious (Lemonnier 1992b: 5–6). These components form a system, and, within this system, multiple interactions exist; these components are interdependent and must be constantly adjusted

(Lemonnier 1986: 154). Some of the components may be limited by some non-cultural factors, such as the availability of raw materials. However, a material may exist in the society's environment and yet remain unused. Variations in any of the five elements of a technique provide a starting point for an anthropological investigation of technologies; the technological variability can inform us about non-technological phenomena. Any technique can also be decomposed into operations embedded in one another, each of them likewise constituting a "technique".

All techniques in a given society refer to one another – they can share the same resources, the same knowledge, the same tools, the same actors. Moreover, some techniques use the products of others, as well as the existence of operational sequences or of technical principles in common, creating multiple relations of interdependence, which gives them a systemic character.

All the technologies have systemic aspects, and we can talk about technological systems in the same way as, for example, ethnologists talk about kinship systems. Technological systems can be analysed in three levels. First, we can discuss how these five components interact with each other to form a technology. Second, if we consider all the technologies in a given society, we can analyse how they are interrelated. And finally, the third level of discussion is the relation between technologies and other social phenomena (Lemonnier 1992b: chap. 1). Analyses of multiple technologies, therefore, can expand the range of the studied cultural phenomena and at the same time provide a better understanding of the given culture and society (Lemonnier 1992b, 1993).

The work of Brian Pfaffenberger (1988, 1992) was very close to the French school. Following Mauss, he insists on defining technology as a total social phenomenon; for him, to create and use technology means to "humanise nature; it is to express a social vision, create a powerful symbol". A technology is far more than the material object; it unites the material, the social and the symbolic in a complex web of associations. Every technology is a human world, a form of humanised nature, which unifies virtually every aspect of human endeavour. To construct a technology is not merely to deploy materials and techniques; it is also to construct social and economic alliances, to invent new legal principles for social relations. (Pfaffenberger 1988: 249).

Against the "standard view's" picture of technological evolution from simple tools to complex machines, he suggests the concept of sociotechnical system, that "puts forward a universal conception of human technological activity, in which complex social structures, nonverbal activity systems, advanced linguistic communication, the ritual coordination of labour, advanced artefact manufacture, the linkage of phenomenally diverse social and non-social actors, and the social use of diverse artefacts are all recognised as parts of a single complex that is simultaneously adaptive and expressive" (Pfaffenberger 1992: 513).

As *technique*, he defines "the system of material resources, tools, operational sequences and skills, verbal and nonverbal knowledge, and specific modes of work coordination that come into play in the fabrication of material artefacts". On the other hand, *sociotechnical system* refers to the "distinctive technological activity that stems from the linkage of techniques and material culture to the social coordination of labour". Therefore, the social anthropology of technology consists of three components: techniques, sociotechnical systems, and material culture. Every sociotechnical system arises from existing social and cultural resources and has traces of the context in which it originates (Pfaffenberger 1992: 497–501).

Contrary to the "standard view" of technology as *effective*, deprived of any ritual dimension, Pfaffenberger also stresses the importance of recognising the social dimensions of sociotechnical activity and its aspects that are not conditioned by economic or political causes. Sociotechnical systems can be understood, only by acknowledging that they produce power and meaning as well as goods; attention must therefore be paid in particular to the non-productive roles of technical activities: a "social anthropology of technology should adopt a principle of absolute impartiality with respect to whether a given activity "works" (i.e. is "technical") or "does not work" (i.e. is "magicoreligious") (Pfaffenberger 1992: 501–502).

In the history of technology the social constructivist approach was also present (labelled SCOT). The work by Wiebe Bijker and colleagues and their book "The Social construction of technological systems" (Bijker *et al.* 1987) need to be mentioned for their influence on anthropology and archaeology.

ARCHAEOLOGICAL APPROACHES TO TECHNOLOGY

The most notable work in archaeo-technology in general is the work of André Leroi-Gourhan (1964, 1965, 1971). He was the first to apply some of the principles outlined by M. Mauss in the archaeological research (cf. Lemonnier 1992a).

His most influential achievement is the creation of the concept of operational chain (*chaîne opératoire*). This is an analytic technique that explores the ways in which one artefact was made, used and discarded – starting with the obtaining raw material, through manufacturing technique, final shape, use (which includes thesauring, breakage, repair, sequences of re-use), until it is discarded, passing through all the stages of manufacture and use of different components. The concept of *chaîne opératoire* makes it possible to structure man's use of materials by placing each artefact in a technical context, and offers a methodological framework for each level of interpretation. Its aim is to reconstruct the organisation of a technological system and also to describe and understand all the cultural transformations that a specific raw material had to go through. It is a chronological segmentation of the actions and mental processes required in the manufacture of an artefact and its maintenance in the technical system of a prehistoric group (Inizan *et al.* 1995: 14, cf. also Sellet 1993).

The *chaîne opératoire* is not just about reconstructing the algorithmic sequence and identifying different steps, but is in fact a complex analysis of technological choices within a given society – it is not important only *how* one raw material was selected, but also *why* the specific raw material was chosen and not some other, why specific manufacturing techniques were employed and not any different ones, why the object was discarded in a certain way, etc. The concept therefore also implies a structuralistic analysis between existing elements, and also explores additional possible links between different elements within the system. There is a structure in making things: syntactic (as it involves sequences of decisions and operations), but also paradigmatic (in that the same things can be done in different ways; Leroi-Gourhan 1965, see also Sinclair 1995: 56, Vitezović 2011a: 16).

This concept has undergone many changes and its applications have gone in many directions since it was first applied to the study of stone tool assemblages. Initially created for the stone artefacts assemblages, and originally used mainly by French archaeologists, today it covers the whole range from stone (e.g. Inizan *et al.* 1995), bone (e.g. Averbouh 2000, Pétillon 2006) or ceramic (e.g. de la Fuente 2011) artefacts, to the analyses of cave art (e.g. Méndez Melgar 2008), from single artefact types (e.g. projectile points: Pétillon 2006) to analyses of large technical subsystems (Inizan *et al.* 1995), and also covers the span from the Palaeolithic to the ethnographic examples (e.g. Livington Smith 2007).

This, as Sellet (1993) observed, reflects in part the analytical potential of the concept, but it is also important that its capacity is far from being exhausted (for comments on the method, cf. also Bar-Yosef, Van Peer 2009).

Another concept created for tool analyses was the concept of *manufacturing continuum* or the *continuum of quality* (Choyke 1997, 2001b, Choyke, Schibler 2007). It was originally developed for bone tools and still has not met wider application, although it has a great interpretative potential.

One way of looking at worked osseous materials is in terms of the effort put into the manufacturing of individual objects. It reflects cultural attitudes towards the objects themselves and, possibly, attitudes towards the tasks they were used in. Objects are assessed in terms of: 1) the regularity in the choice of the species and skeletal element used in their manufacture; 2) the number of stages used in their manufacture; 3) whether they have been curated (related to the intensity of their use); and 4) their exploitation index, which measures the degree of working (the proportion of surface covered by manufacturing marks) relative to the degree of use (the proportion of surface covered by use wear, handling wear and degree of curation). Two classes can be distinguished. Class I tools are carefully planned according to a standardised template, made from selected raw materials and with at least a modicum of work invested in their manufacture, and they are intended for specific long-term, repeated tasks. Class II tools represent objects generally made in an *ad hoc* manner, that are used rather than worked; they give the impression of tools made for individual short-term tasks and mostly abandoned thereafter. Artefacts from an assemblage from a single site, or multiple assemblages from several sites, can therefore be aligned on this imaginary axis, thus revealing an overall character of the industry in question and also providing indirect information on the contexts in which they were found (for example, the prevalence of *ad hoc* tools may suggest non-permanent settlement, or completely used tools may come from a rubbish pit).

As archaeology as a discipline changed and as methodological approaches became more diverse, numerous researchers felt the need for creating new theoretical frameworks, especially for observing technology in a social context.

Among other things, processual archaeology introduced new or refreshed old approaches to the research of tool functions, the organisation of labour and economy in general. Ethnoarchaeological and experimental methods were especially improved both methodological and theoretically; a large body of case studies was made, and the methods gained the necessary scientific rigor. The pioneer of the scientifically based experimental method was the Russian archaeologist Sergei A. Semenov (Semenov 1957, 1968, 1976, see also Korobkova 2008), but with the advent of the processual theory, experimental work became widespread and common in archaeological research (for variety of approaches, cf. for example, Anderson *et al.* 1993, Longo, Skakun 2008).

Lewis Binford, although he never explicitly advocated a "technological approach", contributed significantly to the field, and he paid special attention to the problem of "style" and "function" of tools (cf. Binford 1983). His numerous ethnoarchaeological researches were oriented to this and to questions of settlement organisation. The most notable research was the one conducted among Nunamiut Eskimo communities (Binford 1978), but studies among Australian Aborigines are much more interesting for technological questions (Binford, O'Conell 1984, Binford 1986).

One of the essays, "An Alyawara Day: Making Men's Knives and beyond" aimed to corroborate that the testing of the validity of our interpretive principles must be made "in actual situations in which the dynamic (causal) and the static (derivative) effects are both observable" (Binford 1986: 555). The essay treats the social context and the technical process of tool production in order to create the basis for a discussion of the concept of style and for an analysis of the settlement typology, but at the same time Binford provided a thorough description on the making of knives, from the start (i.e. raw material procurement) to the final shaping of the product, along with preparation of handles, using resin for fastening, etc., thus giving the example of a detailed analysis, as demanded by anthropologist of technology.

Among researchers in North America, the concept of the behavioural approach to technology – created and practiced by Michael Schiffer and associates (Schiffer 1995, 1996, 2004, Schiffer *et al.* 2001, Skibo, Schiffer 2001, 2008, with references cited) – should be mentioned. Behavioural archaeologists were concerned with the diversity of human behaviour in the past, and the correlations between behaviour and the environmental context. Most of Schiffer's work was devoted to the site formation processes, but he paid attention to technology as well. This approach is based on the idea that every explanation of a technological change must be based on rigorous comparison among alternatives, in terms of their behavioural capabilities. The variability among artefacts is observed through four dimensions – formal, spatial, quantitative, and relational. The concept of the operational chain is broadened into the concept of a behavioural chain, which encompasses all the activities and processes during the life of an artefact within a cultural system.

The diversity of technology studies increased notably since 1980s, and many of them can be roughly defined as social constructivism, placing their focus on technological style and technological choices (e.g. Lecthman 1984, Lechtman, Merill 1977), agency (Dobres, Hoffman 1999), technology and gender (e.g. Dobres 1999, Sternke 2005, cf. also Killick 2004: 571).

Social constructivism implies the view that there is usually more than one technology that satisfies the minimum requirements for any given task; and that the choice of a particular technology among the alternatives may be strongly influenced by beliefs, social structure and prior choices of the society or group under study. Social constructionists reject explanations of technological change that include selection, market forces, efficiency, adaptation or the inevitability of progress, and so forth (cf. Killick 2004).

Technology can be used as a symbol to signify or demonstrate the identity of an individual or a group, and it can also be used as a symbol of ethnic identity (e.g. Wake 1999). Numerous studies dealt with the symbolic aspects of technology (e.g. Hosler 1995, Reid, MacLean 1995, Vitelli 1989), and two may be outlined – the symbolic use of raw materials (McGhee 1977) and the symbolism expressed in manufacturing techniques (Sinclair 1995, 1998).

The analysis by Robert McGhee (1977) of the raw material choices within the Thule culture in arctic Canada is probably the most famous example of the application of structuralistic analysis in archaeology (cf. Hodder, Hutson 2003: 57–58). McGhee demonstrated that the use of antler, ivory and bone for specific artefacts is linked to the Thule worldview, and reconstructed oppositions land/sea, summer/winter, man/women, antler/ivory. From the technological point of view, this study clearly shows how raw material choice depends on cultural – but is often unconnected with efficiency, availability or other "practical" – reasons.

Anthony Sinclair (1995, 1998) questioned the separation between the utilitarian and the symbolic and the very interpretation of tools as purely practical items, in a case study of Solutrean leaf-points. He argued that bifacial thinning techniques employed in the manufacture of specific tools during the last glacial maximum were chosen among other potential techniques "because of a saliency between the skills of precision, timing and strategic planning which are required both in the manufacture of these tools and in the complex subsistence economy in practice at this time" (Sinclair 1995: 50). The making of a tool is a structured process itself – there are practical rules for successful stone knapping, procedural rules for the making of particular forms – and yet there are also possibilities for individual choice and innovation. When considered in this way, the use of bifacial techniques can be interpreted as expressing control over timing and spacing, something which may have paralleled the newly introduced subsistence practices, while the structure of simple versus elaborate tools is in fact a continuum of individual variation between pieces brought about by agents exercising their own choices within a structure.

Sinclair demonstrated that these tools must be seen as items of material culture that are both utilitarian (i.e. used to do practical things) and also symbolic: they communicate meaning about both the nature of the tasks for which they are used and the people who perform them. This symbolic aspect of technology is not restricted to the form or the style of the tool, but symbolism pervades the entire process of manufacture, through the use of a salient set of skills and desires which are common to both technology and other practices within societies.

Brian Hayden (1998) dealt with the question of practical and prestigious technologies and their mutual relationships. Practical technology is meant to solve practical problems of survival and basic comfort, and includes, for example, techniques related to obtaining and processing food and raw materials, creating an adequate shelter and storage facilities, etc. One of the underlying principles in practical technology is to perform tasks in a satisfactorily efficient and effective way. For a given problem, the criteria used in choosing between alternative technological solutions are how effective each solution is and how costly each solution is. In general, practical technology is a logical and empirical response to stresses in the environment, although, from time to time, people may experiment with alternative solutions that deviate from optimal practical solutions (Hayden 1998: 2–3).

Hayden adopted the design theory as a conceptual framework for understanding prehistoric technology. This theory may be defined as a "means of creating or adapting the forms of physical objects to meet functional needs within the context of known materials, technology, and social and economic conditions" (Horsfall 1987, cited in: Hayden 1998: 4).

The basic premise of design theory is that when there is an initial problem to be solved (such as killing an animal, crossing a river, making fire, or making a tool), it may be dealt with at a very general level (such as designing a shelter), or at increasingly more specific levels (such as designing entrance shapes for shelters or designing attachment devices for structure elements, and so forth). Design theory principles assume that there are different kinds of constraints operating in the development of solutions for each problem and that trade-offs between constraints make it unlikely that there will be any single optimal solution to a problem but, rather, a number of more or less equally acceptable solutions. Among the most powerful of these constraints are functional requirements, material properties, availability, and production costs. Once a field of acceptable solutions for a given problem has been identified (via trial and error or actual planning), the choice of the solution that will be adopted may largely be a matter of cultural tradition, ideological values, style, etc. However, most of the constraints leading up to this level of decision are much more consequential in nature and, in the case of practical technology, play an absolutely primary, determining role. The most critical constraint acting upon the choices involved in making practical technologies consists first and foremost of effectiveness, or an object's performance characteristics; that is to say, how well a given solution performs the task it is meant to (Hayden 1998: 4–5).

On the other hand, prestige artefacts are not created to perform a practical task, but to display wealth, success, and power. The purpose is to solve a social problem or accomplish a social task, such as attracting allies, or bonding members of social groups together via displays of success. Therefore, the logic and strategy for creating prestige artefacts are fundamentally different from the logic and strategy for creating practical artefacts. Prestige technologies employ as much surplus labour as possible to create objects that will appeal to others and attract people to the possessor of those objects due to admiration for his/her economic, aesthetic, technical, or other skills. Contrary to L. Binford's (1983: 221–224) view of differences in status distinctions as emerging from systemic stresses (where the prestige items only reflect already established privileges), Hayden argued that prestige technologies play a key active role in acquiring status and power. The archaeological consequences of these divergent views are significant. The stress models mandate that major environmental, nutritional, or other stresses occur prior to the appearance of significant status distinctions. The aggrandiser model is predicated on the normal and reliable production of surpluses, and therefore no increases in overall morbidity or malnutrition mortality are expected prior to innovations. In fact, more pronounced evidence of feasting involving surplus food is expected to occur (Hayden 1998: 14).

A second important point of Hayden's theory is the one regarding relations of practical and prestigious technologies. Analysing the appearance and development of prestigious technologies among hunter-gatherer communities, he argued that many, perhaps even all of the technological achievements were initially developed as prestige technologies and only later evolved into more practical applications – pottery, metalworking, domestication of plants and animals, etc. (Hayden 1998: 17–18).

For explaining long-term changes in the role of technology, Steven Kuhn (2004) argued that the most applicable is evolutionary theory (Kuhn 2004: 563). Some of the examples of applying evolutionary theories are the approach to explaining technological variation and they are derived from a theory of technological investment (Bright *et al.* 2002, Ugan *et al.* 2003; cf. also Kuhn 2004): they consider the circumstances under which people would benefit by investing more in the production of particular kinds of artefacts. There are numerous possibilities that can still be explored within the evolutionary approach. According to S. Kuhn, the first priority is an increased focus on intra-group variation in technological strategies. A second priority is the exploration of potential interfaces between evolutionary and "non-evolutionary" approaches. And finally, there are possibilities for the application of evolutionary explanations of technological variation and change explored more extensively for complex, stratified societies and states (Kuhn 2004: 566–567).

As has been more or less widely acknowledged, technological practices are social constructions. However, they are constrained at the same time by the laws of physics and chemistry and by their geological, ecological, and historical settings. For example, the use of water power is not an option if there is no flowing surface water; sufficient fuel is necessary for most transformative crafts (pottery, metal working), etc. But, within these constraints there is usually more than one possible way of accomplishing a given technical task. A balance is needed, therefore, between observing technologies within their social context and their ecological surrounding, and a means to measure the possibilities and choices made between them. David Killick is warning against the possibility of finding "any single theoretical approach that is optimal across the whole two and a half million years of the human technological career", and he argues for the evolutionary approaches in cases such as, for example, the archaeology of mobile hunter-gatherers. He also does not consider any necessary conflict between functional and social constructionist approaches to the study of technology: each complements the other; archaeometry and experimental archaeology are perfectly compatible with social constructionist interpretations (Killick 2004: 575). S. Kuhn shares a similar view, stating that "fiercely defended boundaries between material, social and ideological approaches to understanding human behaviour, society and technology are a hindrance to learning and are intellectually unnecessary" (Kuhn 2004: 566).

PREHISTORIC TECHNOLOGY: THE CASE STUDY OF BONE INDUSTRY IN THE CENTRAL BALKANS NEOLITHIC AND AENEOLITHIC

Bone industry is the term that encompasses the assemblages of hard animal tissue (bone, antler, teeth, ivory, mollusc shell) – finished tools and other non-utilitarian objects, manufacture debris and semi-finished products (Averbouh 2000). Osseous raw materials are often the only organic materials that survive from prehistoric sites, and were used from the earliest prehistory alongside with flint, stone, and – from Neolithic onwards – ceramic. Bone industry is extractive-reductive craft, meaning that raw materials are transformed by mechanical modification (as opposed to transformative crafts; cf. Miller 2007: 43–44) and very often these raw materials were easily available (bones and teeth were taken from killed or dead animals; shed antler were simply collected). Difficulties in distinguishing worked from non-worked bone, along with low interest in zooarchaeology, as well as a greater interest in ceramic styles, etc., are the main reasons why bone industries have often been neglected in archaeological analyses.

However, bone industry may offer some insights into prehistoric societies that other industries cannot – such as understanding raw material choices (since what was available can be easily seen), possibilities of direct dating by ^{14}C method (cf. Bonsall, Smith 1990), use wear traces reveal the so-called "perishable technologies" (production from plant fibres and animal skins – e.g. Maigrot 2003), and many more. Some of these possibilities will be presented here on case studies of assemblages of osseous artefacts from the Starčevo (Early and Middle Neolithic) and Vinča (Late Neolithic/Early Chalcolithic) cultures (for absolute dates, cf. the latest results obtained by AMS method; Whittle *et al*. 2002, Borić 2009). Assemblages from the Starčevo culture include rich collections from Donja Branjevina and eponymous site of Starčevo-Grad (Vitezović 2011a, b), as well as several sites where the faunal remains were carefully collected during excavations and later examined for traces of human modifications by zooarchaeologist and/or the author (these include Divostin – Bačkalov 1979, Lyneis 1988, Vitezović 2011a; Drenovac – Vitezović 2007; Međureč, Velesnica, Ušće Kameničkog Potoka, Knjepište – Vitezović 2011a). Vinča culture assemblages taken into account are also those where the collection bias was reduced to minimum, i.e. the faunal remains were collected and examined (Selevac – Russell 1990; Divostin – Bačkalov 1979, Lyneis 1988; Drenovac, Motel Slatina – Vitezović 2007; Jakovo-Kormadin – Vitezović 2010; Stragari – Vitezović 2009; Vitkovo – Vitezović 2012a).

Raw material choices

In the Starčevo culture, the main raw material were different bones (metapodials, tibiae and other long bones, ribs, rarely astragals) and antlers, followed by teeth and mollusc shells (in low percentages or completely absent from some sites, cf. *Figure 1*). The choice of skeletal elements generally suggests their mechanical and physical properties were well known and adequately used (split long bones for pointed tools, flat bones for different burnishing tools, etc.). However, it is worth noting that only postcranial bones were used for tools, while cranial bones were almost never used (mandibles may occur as raw materials in later periods – cf. below).

The choice of species is generally in accordance with species presented in the faunal record: ovicaprines (*Ovis aries, Capra hircus*), cattle (*Bos taurus, Bos primigenius*), red deer (*Cervus elaphus*). There is, however, a general trend for choosing *Bos* bones for "special" items (those with a particularly demanding technique of manufacture, which often show signs of having been used for long time and were often repaired). The best example are spoons made from *Bos* metapodials, all carefully made, displaying highly skilful craftsmanship, often with traces of repair and re-use.

Antlers were mainly those from red deer, less often from roe deer (*Capreolus capreolus*). They were generally collected shed, perhaps in the vicinity to the settlement (often, unworked antlers may be found in the faunal record, suggesting they were not scarce). The ratio of antler tools varies from site to site, which for some may be explained by ecological reasons, but perhaps also reflects certain regional preferences and/or specialisation.

In the Vinča culture, we may see a similar situation in raw material choices: bones chosen mainly on the basis of their mechanical and physical properties, the prevalence for shed red deer antlers, and a low percentage of teeth and shells (*Figure 2*). Again, as in the Starčevo culture, only postcranial bones were used, while the cranial bones are generally avoided. As these bones were used in other, contemporary or later sites (for example, in the Neolithic in France; cf. Maigrot 2003), including Bubanj-Salcuţa-Krivodol Aeneolithic sites (unpublished material from the site Bubanj-Novo Selo near Niš, analysed by author), such a choice suggest other than practical reasons. Regarding the species used, we may observe an interesting fact here, that although the ratio of cattle rises in faunal record, the use of cattle bones decreases. An almost complete absence of pig (*Sus scrofa*) bones is also conspicuous (although they were well represented in faunal record).

Teeth were used rarely, and – with the exception of boar tusks – they were not transformed into tools. Perforated teeth were used as pendants since the Palaeolithic (cf. Taborin 2004), and in the Neolithic (in both the Starčevo and Vinča cultures) the mode of use has not changed. Again, the species seem to have been important – mainly wild ones were used (for example, from bear or wolf, cf. Babović 1984: 126, Russell 1990: 534). Red deer canines were the most valued (*Figure 3*); they were sometimes even copied in bone (see also Choyke 2001a). Perhaps the opposition wild vs. domestic (*sensu* Hodder 1990) may be observed here, and – if we take into account that red deer antlers were sometimes also used for decorative items – perhaps red deer had some special meaning or importance.

Marine mollusc shells (*Spondylus* and *Glycimeris*) are the most intriguing raw material here, since they were obtained through exchange of unknown character (cf. Dimitrijević, Tripković 2006, Vitezović 2007). Notable is, however, the fact that these items were often in long use and repaired (Dimitrijević, Tripković 2006, Vitezović 2012b). Bone and shell decorative items were sometimes copied in white stones (limestone or marble, e.g. at Divostin – McPherron *et al.* 1988, or Vinča-Belo Brdo – Babović 1984: 126–128, Dimitrijević, Tripković 2006: 246). Therefore we may assume that the osseous raw materials had some symbolic value, meaning and importance *per se*, either because of their origin (from a living creature) or because of their shiny white colour, or both (Vitezović 2012b, see also Luik 2007).

A comparison between osseous and other raw materials in the Starčevo and Vinča cultures is also interesting. Baked clay was used for a diversity of

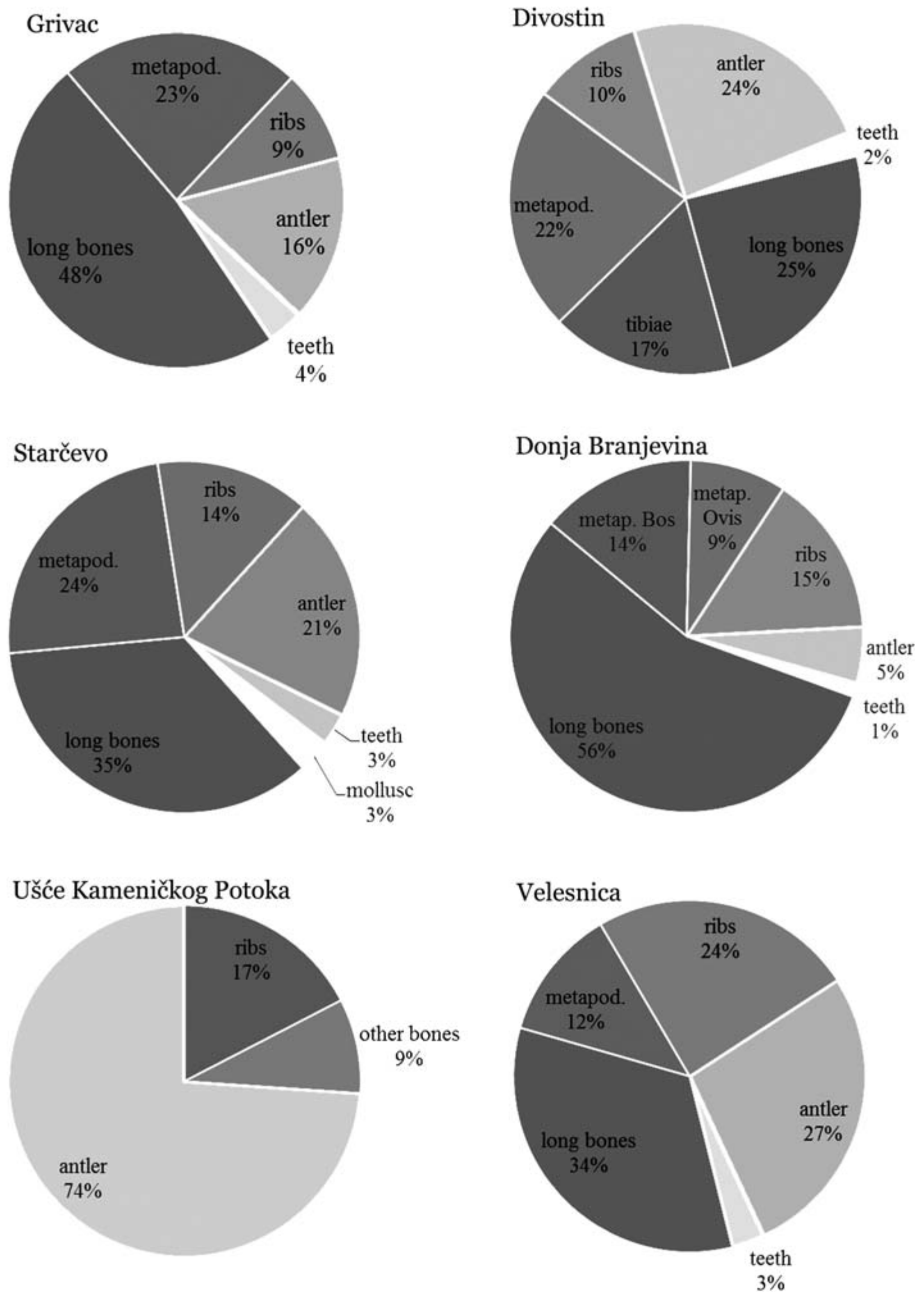

FIGURE 1. Percentages of used osseous raw materials from several Starčevo culture sites.

vessels, for both everyday and ritual use, and Vinča culture is especially famous for its anthropomorphic and zoomorphic figurines and anthro- and zoomorphic vessels. Stone figurines are extremely rare. Osseous raw materials were used for everyday tools and for non-utilitarian items such as jewellery or clothing pieces, but neither decorations on bones, such as those found in the Mesolithic in the Iron Gates Gorge region (e.g. Bačkalov 1979: 16–21), nor figurines were found. Bone can be used to shape a human figure, as is clearly demonstrated by numerous figurines found in the Aeneolithic (e.g. Angelov 1961, Manolakakis, Averbouh 2000), therefore, such a choice of raw material in central Balkans reflects a cultural attitude towards these materials.

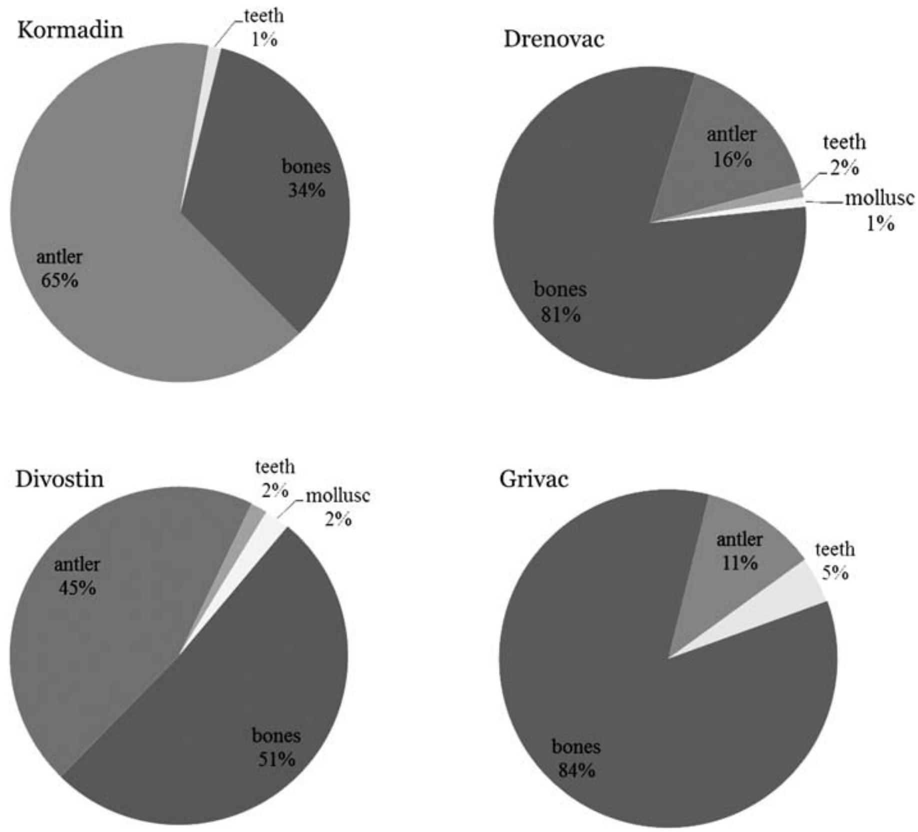

FIGURE 2. Percentages of used osseous raw materials from several Vinča culture sites.

Manufacture and tool forms

Manufacturing techniques used reveal a high technological knowledge of the raw material properties and skilful craftspersons, in both the Starčevo and Vinča cultures (cf. *Figure 4*). If we arrange tools on an imaginary axis of manufacturing continuum, we may observe a very low percentage of *ad hoc* tools (Vitezović 2007: 187–194, 2011a: 355–357). Repair is sometimes difficult to observe, especially in case of awls and other pointed tools, but it seems that most of those tools were used for a long time. Repair and re-use are most frequent and most notable when it comes to "special" items: jewellery pieces, and, in case of the Starčevo culture, spoons (Vitezović 2011a, b). The standardisation of types, subtypes and variants increased in the Vinča culture (Vitezović 2007).

Regarding tool forms, it is interesting to note that some bone and antler tools imitate the shape of stone counterparts: axes, adzes, chisels. Therefore, some tools, such as heavy cutting tools, may exist in different materials, but some artefact types – such as projectile points – were only made from osseous materials. Only a few projectiles from flint were recovered on the territory of the central Balkans (Šarić 2005), while

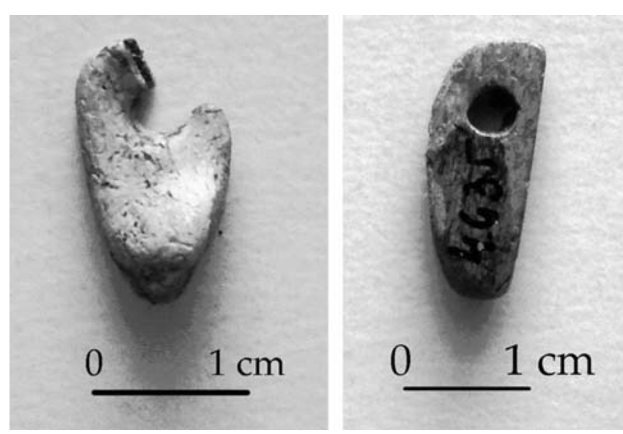

FIGURE 3. Pendant from red deer canine and a bone imitation (Divostin, Starčevo culture).

osseous projectiles are quite common in the Starčevo culture sites (on some sites, they can make up to 10–15% of total artefacts – Vitezović 2011a: 291–294).

The most interesting artefacts are the Starčevo spoons (*Figures 5, 6*). They are of Neareastern origin (cf. Sidéra 1998), although within Starčevo-Körös-Criş cultural complex represent a cultural and chronological marker (Nandris 1972, Nandris, Camps-Fabrer 1993, Beldiman 2007, Vitezović 2011a, b). Exclusively *Bos* metapodials were used, transformed into elongated spoons with long, thin handle and a triangular or leaf-shaped upper part, through a long, skill-demanding and time-consuming sequence of actions of cutting, scraping, burnishing, and polishing (cf. Nandris 1972, Vitezović 2011a: 320–326). They were in use for very long time: their surfaces are highly polished and worn out. The very mode of use is difficult to reconstruct, since the traces of multiple activities carried out by them overlap; traces of later use have erased traces of earlier use(s). Sometimes traces of breakage – after which the object continued to be in use – may be observed, and sometimes the broken handles were transformed into projectile points (for example, at Donja Branjevina – Vitezović 2011a: 87, 291–294, 2011b: 38).

Strict raw material choice, demanding manufacturing technique and very long use are the characteristic of the Starčevo spoons that put them into the category of "prestigious" objects (cf. above, Hayden 1998). Carefully prepared and objects that are labor-intensive to produce were often used for status/identity dislplay (cf. Hayden 1993), and the elaborated manufacturing method may have symbolic meaning (cf. above, Sinclair 1995). It may be, therefore, suggested that these objects had high value and importance, and may have brought and/or reflected the status and prestige to craftspersons and owners (craftsperson may be the owner and user, but not necessarily).

Craft production, specialisation, trade and exchange

Craft production is still not being analysed adequately when it comes to the Neolithic communities. Specialisation is often associated with ranked societies (cf. Clark, Perry 1990), and the presence of workshops still has not been adequately analysed (cf. Miller 1996). Recently, craft production and the possibilities for specialisation were analysed on the example of Neolithic Greece by Catherine Perlès and Karen Vitelli (Perlès, Vitelli 1999). Studies focused on craft production in the

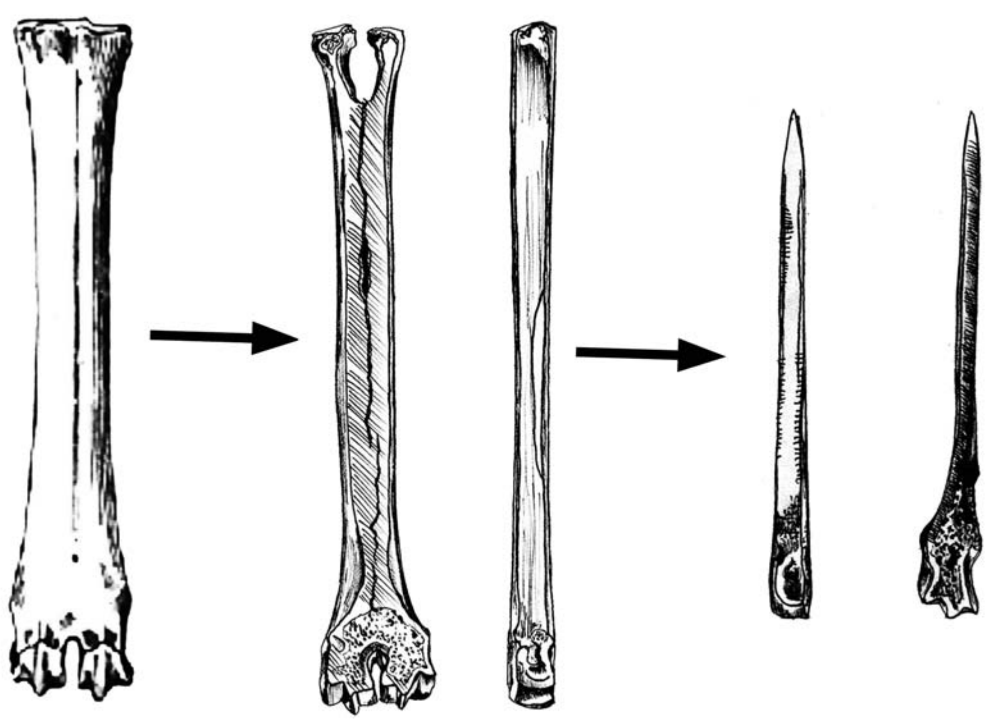

FIGURE 4. Simplified *chaîne opératoire* for awl production: ovicaprine metapodial, semi-finished tool, final form of an awl.

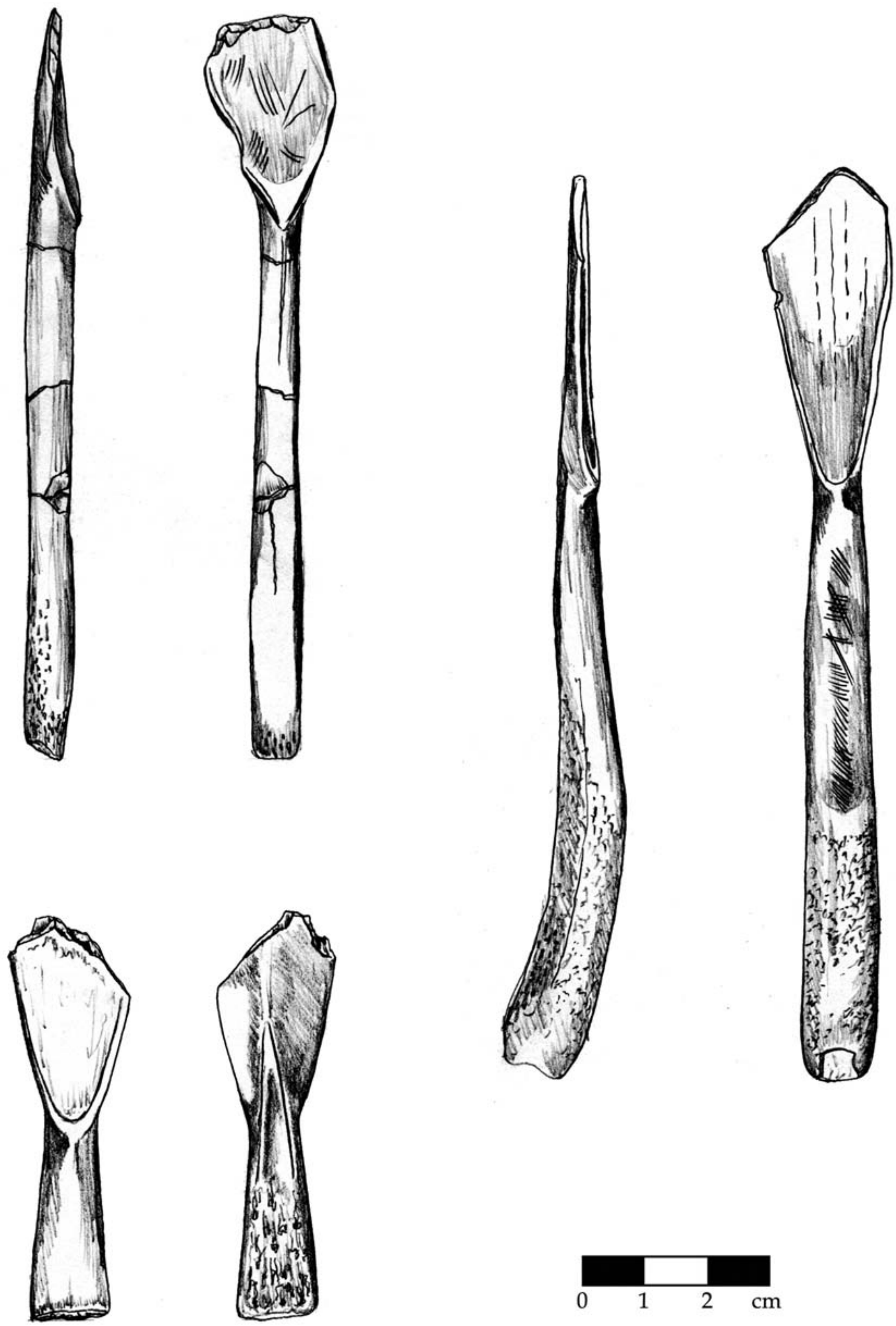

FIGURE 5. Examples of Starčevo spoons from the eponymous site, Starčevo-Grad.

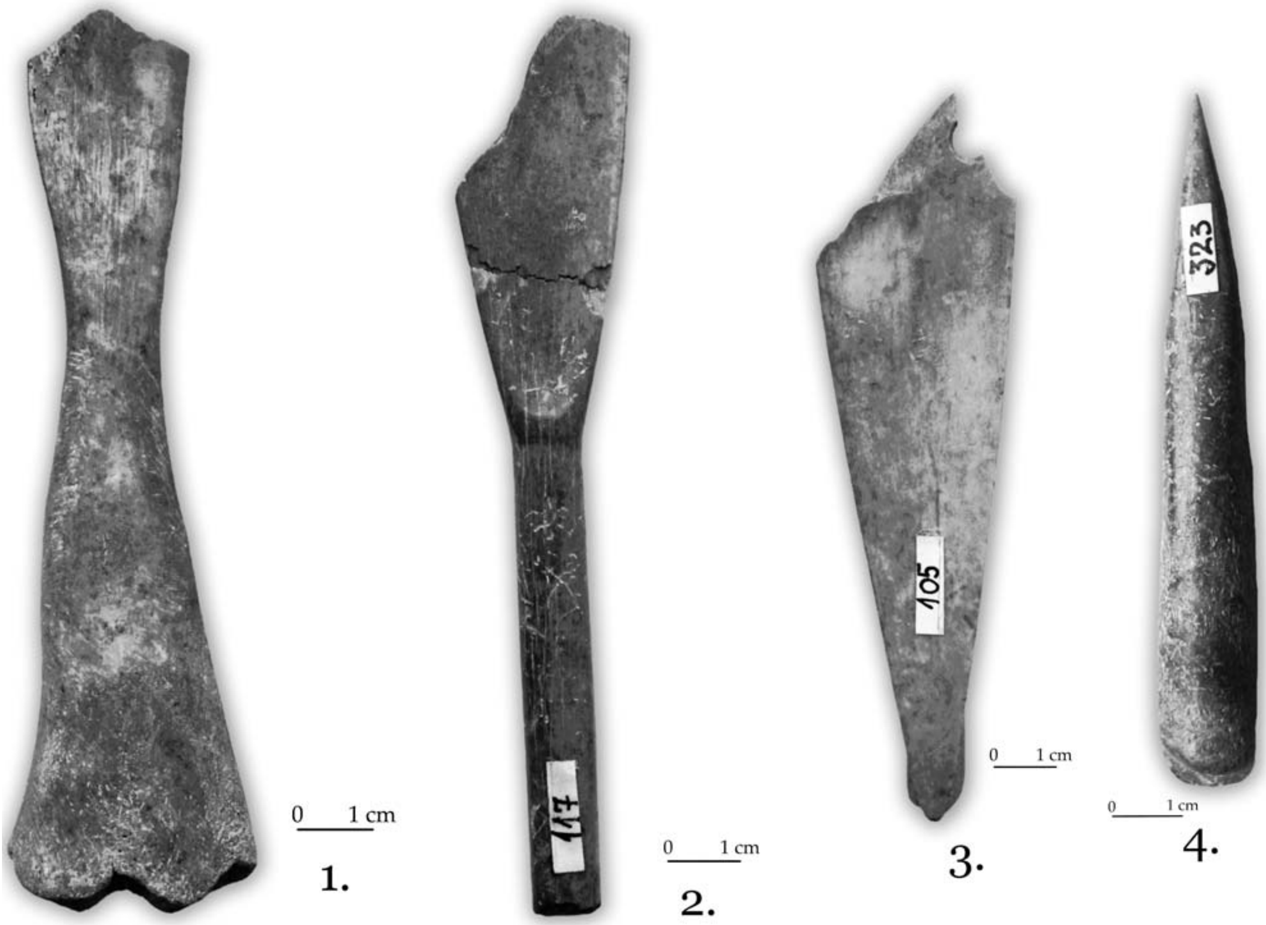

FIGURE 6. Sequences in manufacture and use of spoons, after examples from Donja Branjevina: 1, semi-finished object; 2, used spoon; 3, repaired spoon; 4, projectile point made from spoon handle.

Starčevo culture are very scarce; for the Vinča culture they are slightly more numerous (e.g. Chapman 1982, Tringham, Krstić 1990, Tripković 2007); more detailed technological case studies as well as new theoretical frameworks are, however, needed for a more thorough approach to the problem.

A few preliminary points can be made, however. Increased standardisation and increase in production are observed as a general trend in the Vinča culture (cf. Tringham, Krstić 1990, Tripković 2007, Vuković 2011). The standardisation observed within the bone industry (Vitezović 2007) and its increase from Early/Middle to Late Neolithic/Early Aeneolithic reflects the situation among other crafts: increased standardisation in manufacture signifies standardised flint tools used, while standardised tool shapes reflect high production in "perishable crafts", i.e. the processing of hides and plant fibres.

Workshops and working places were identified with certainty only at one Vinča culture site, at Jakovo Kormadin (Vitezović 2010). The find included manufacture debris, mainly flakes from antler cortex with traces of cutting and scraping with a flint tool (over fifteen fragments were identified with certainty, additional fragments with eroded edges were also present), as well as several unfinished tools from antler (*Figure 7*). They were discovered within one pit dwelling, where a workshop for flints was also identified (Bulatović *et al.* 2010). Possibilities for presence of other workshops were suggested on the basis of the presence of manufacture debris and semi-finished products at several Starčevo culture (Starčevo, Divostin – Vitezović 2011a: 362–364) and Vinča sites (Drenovac, Divostin – Vitezović 2007: 195, 2011c). Any analyses of workshops within central Balkans Neolithic and

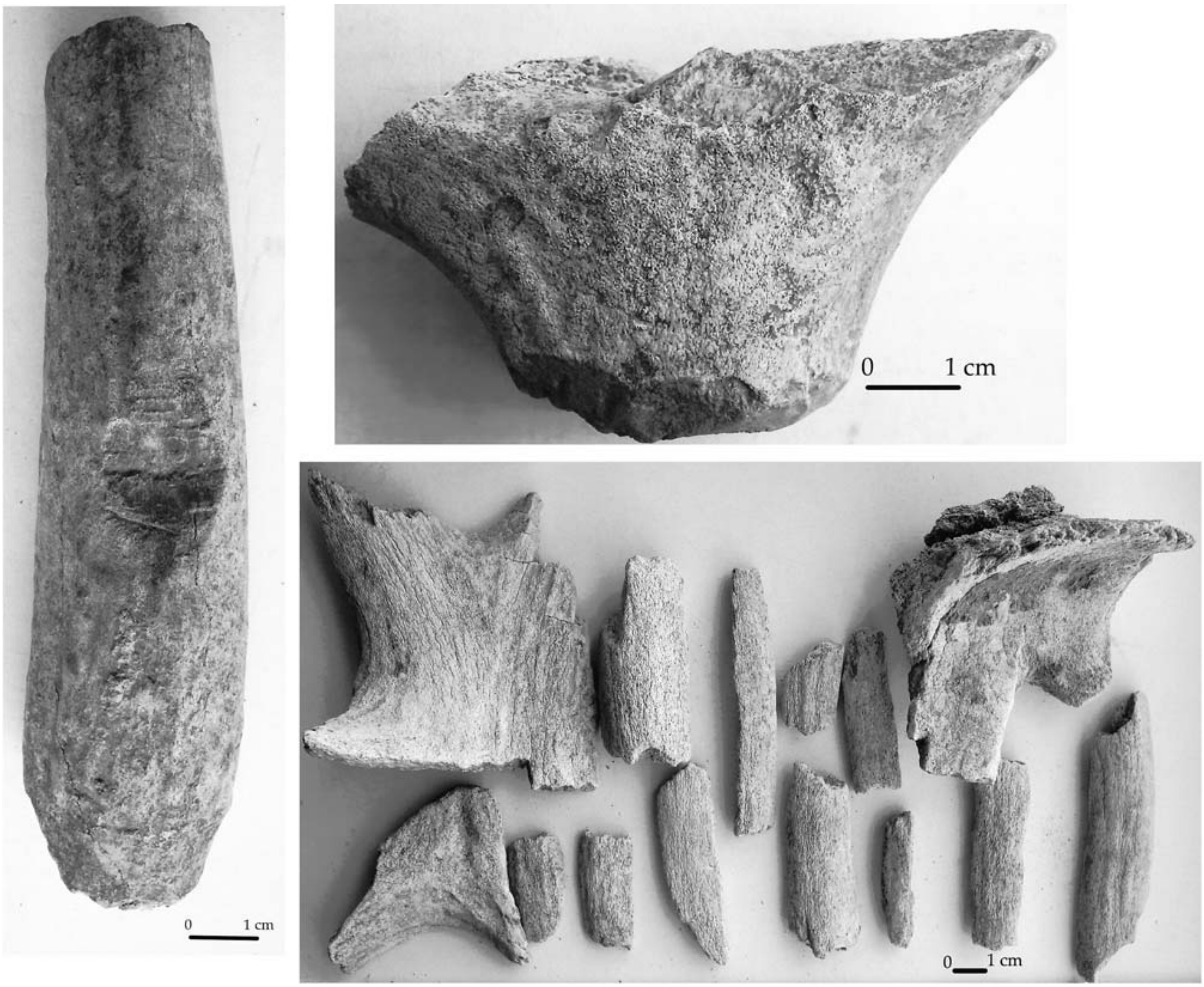

FIGURE 7. Semi-finished tool, raw material piece and manufacture debris from antler workshop (Jakovo-Kormadin, Vinča culture).

Aeneolithic, however, cannot be made prior to analyses of other activity areas.

The presence of trade and exchange can be confirmed with certainty only for artefacts from exotic raw materials, such as *Spondylus* and *Glycimeris* shells, noted on numerous sites (for example, Starčevo and Vinča in the Danube valley, Drenovac and Divostin in the Morava valley – cf. Vitezović 2012b). However, certain small scale exchange can be supposed as well. The most notable is the case of two multi-layered sites in central Serbia, Grivac and Divostin, found at a small distance from one another. The differences among bone industries from Starčevo layers are quite conspicuous – the antler industry from Divostin is very rich both in terms of quantity but they also show high quality in manufacture. Manufacture debris and raw material pieces with traces of removing the blanks were also discovered, suggesting the intensive activity of antler acquiring, processing and use. On the other hand, antler artefacts from Grivac are of poor quality, found in small number and numerous traces of repair were also noted, as if there was a need for saving raw material. A suggestion was made (Vitezović 2011), therefore, that there was a certain level of regional specialisation present – the inhabitants of Divostin were engaged in processing antler and probably wood working (most of tools were axes, adzes and punching tools, most likely used for wood working). At Grivac, no evidence for antler processing was discovered; therefore, the rare antler objects may have been obtained through exchange. The model of regional specialisation was suggested for Early Neolithic in Thessaly (Perlès 2004), however, data on other crafts within both Starčevo and Vinča cultures are insufficient (for example, differences in stone or flint industries, although some possible stone tool workshops have been identified; cf. Antonović 2003). Different ratios of some raw materials are visible in both Starčevo and Vinča culture sites and this may suggest the possibility of economic specialisation within sites in a given region. It may be assumed that one (or perhaps several, but not all) of the sites within one region was specialised in the collection and working of antlers, and perhaps also specialised in tasks related to antler tools (such as wood-working).

DISCUSSION AND CONCLUSION

At first glance, prehistoric bone industries often give impressions of *ad hoc* use of kitchen debris. Inadequate collection and processing of faunal remains often blurs their actual quantity, and therefore it is often considered that they cannot provide quality information.

The analyses of bone industries from Neolithic and early Aeneolithic sites from the territory of Serbia, however, demonstrated that this is a true industry, characterised by a high degree of knowledge regarding raw materials and their qualities, skilful manufacture, organised raw material collection, processing, and even up to a certain extent by the exchange of raw materials and finished products, on both micro and macro scale.

The analysis of manufacturing continuum demonstrated high standardisation, meaning the uniform choices of raw materials, as well as uniformity in manufacturing techniques and final forms.

On the local level, a certain degree of specialisation may be present among the craftspersons. Although some simple items may be crafted by any member of the community, a high level of uniformity and the demanding technique of numerous artefact types demonstrates that skilful craftspersons were also involved. On the regional level, it may be noted that some settlements were specialised for collecting, processing and using antlers.

The bone industry also revealed certain symbolic values brought by and/or displayed by raw materials themselves, especially those from non-domesticated species (from wild fauna or those collected outside the settlement), as well as the value marked by or given to the very skill of a craftsperson.

Different approaches for artefact analyses have been developed, and are still multiplying, aimed at encompassing the wide variety of possible functions, meanings and values – as well as the possible changes of roles and symbolism – within a given society, the active roles they may play in shaping identity of a group or individual, etc. The technological approach represents not just one of numerous theoretical frameworks; unlike some other approaches, this is a framework that attempts not to focus on one side of artefact analysis, but instead on a variety of different, contemporarily existing, aspects of a given artefact assemblages.

The prehistoric technology in different regions still has many questions unanswered. In the case of central Balkans Neolithic, for example, the problem of raw material managing and the very organisation of the craft production are not adequately treated; also the questions of craftspersons (their skills, technological knowledge, level of specialisation, etc.), their status and roles, as well as the question of small- and large-scale exchange need to be addressed.

A comprehensive study of technology is needed for better understanding past societies. The analysis of technological subsystems, such as flint or bone industry, must include not only typology and traceology, but it must also take into consideration models for raw material management, modes of re-use and discard, as well as possibilities of symbolic and prestigious values. Only then will the integration of data and the analyses of multiple technologies – as well as a study of the role of technology in everyday and ritual life of prehistoric communities – be possible.

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REFERENCES

ANDERSON P., BEYRIES S., OTTE M., PLISSON H. (Eds.), 1993: *Traces et fonction: les gestes retrouvés.* Centre de Recherches Archéologiques du CNRS, Études et recherches archéologiques de l'Universitéde Liège n. 50. Université de Liège, Liège.

ANGELOV N. [АНГЕЛОВ Н.], 1961: Rabotilnica sa ploski kosteni idoli v selištnata mogila pri s. Hotnica, Tarnovsko [Работилница са плоски костени идоли в селищната могила при с. Хотница, Търновско]. *Arheologija [Археология]* 3, 2: 34–38.

ANTONOVIĆ D., 2003: Neolitska industrija glačanog kamena u Srbiji. (Neolithic ground stone industry in Serbia). Arheološki institut, Beograd.

AVERBOUH A., 2000: *Technologie de la matière osseuse travaillée et implications palethnologiques.* Thèse de doctorat. Université de Paris I, Paris.

BABOVIĆ LJ. [БАБОВИЋ Љ.], 1984: Oruđe i oružje od kosti i rožine [Оруђе и оружје од кости и рожине]. In: S. Ćelić [С. Ћелић] (Ed.): *Vinča u praistoriji i srednjem veku.* [*Винча у праисторији и средњем веку*]. Pp. 117–120. Srpska akademija nauka i umetnosti [Српска академија наука и уметности], Beograd.

BAR-YOSEF O., VAN PEER P., 2009: The chaîne opératoire approach in Middle Paleolithic archaeology. *Current Anthropology* 50, 1: 103–131.

BAČKALOV A., 1979: *Predmeti od kosti i roga u predneolitu i neolitu Srbije. (Bone and antler objects in the Pre-Neolithic and Neolithic of Serbia).* Savez arheoloških društava Jugoslavije, Beograd.

BELDIMAN C., 2007: *Industria materiilor dure animale în preistoria României. Resurse naturale, comunităţi umane şi tehnologie din paleoliticul superior până în neoliticul timpuriu*. Asociaţia Română de Arheologie, Studii dePreistorie, Supplementum 2. Editura Pro Universitaria, Bucureşti.

BIJKER W., HUGHES T., PINCH T. (Eds.), 1987: *The social construction of technological systems: New directions in the sociology and history of technology*. MIT Press, Cambridge.

BINFORD L., 1978: *Nunamiut ethnoarchaeology.* Academic press, New York.

BINFORD L., 1986: An Alyawara day: Making men's knives and beyond. *American Antiquity* 51, 3: 547–562.

BINFORD L. R., O'CONNELL J. F., 1984: An Alyawara day: The stone quarry. *Journal of Anthropological Research* 40: 406–432.

BINFORD L., 1983: *In pursuit of the past.* Thames and Hudson, New York.

BONSALL C., SMITH C., 1990: Bone and antler technology in the British Late Upper Palaeolithic and Mesolithic: The impact of accelerator dating. In: P. M. Vermeersch, P. Van Peer (Eds.): *Contributions to the Mesolithic in Europe. Papers presented at the forth international symposium "The Mesolithic in Europe"*. Pp. 139–151. Leuven University Press, Leuven.

BORIĆ D., 2009: Absolute dating of metallurgical innovations in the Vinča culture of the Balkans. In: T. L. Kienlin, B. W. Roberts (Eds.): *Metals and societies: Studies in honour of Barbara S. Ottaway.* Pp. 191–245. Universitätsforschungen zur prähistorischen Archäologie, Vol. 169. Habelt, Bonn.

BRIGHT J., UGAN A., HUNSACKER L., 2002: The effects of handling time on subsistence technology. *World Archaeology* 34: 164–181.

BULATOVIĆ A., KAPURAN A., STRUGAR N. [БУЛАТОВИЋ А., КАПУРАН А., СТРУГАР Н.], 2010: Неолитски стратум на локалитету Кормадин у Јакову – ископавања 2008. године (The Neolithic stratum at the archaeological site of Kormadin in Jakovo – excavations of 2008). *Annual of the city of Belgrade [Годишњак града Београда]* 57: 11–42.

CAPLE C., 2006: *Objects. Reluctant witnesses to the past.* Routledge, London, New York.

CHAPMAN J., 1981: *The Vinča culture of the Southeast Europe*. BAR International Series 117. Archaeopress, Oxford.

CHILDE G., 1944: Archaeological ages as technological stages. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland* 74, 1/2: 7–24.

CHOYKE A., 1997: The bone tool manufacturing continuum. *Anthropozoologica* 25–26: 65–72.

CHOYKE A., 2001a: Late neolithic red deer canine beads and their imitations. In: A. Choyke, L. Bartosiewicz (Eds.): *Crafting bone: skeletal technologies through time and space – Proceedings of the 2nd meeting of the (ICAZ) Worked Bone Research Group, Budapest, 31 August–5 September 1999*. Pp. 251–266. Archaeopress, Oxford.

CHOYKE A. M., 2001b: A quantitative approach to the concept of quality in prehistoric bone manufacturing. In: H. Buitenhuis, W. Prummel (Eds.): *Animals and man in the past. Essays in honour of Dr. A. T. Clason, emeritus professor of archaeozoology Rijksuniversiteit Groningen, the Netherlands*. Pp. 59–66. ARC-Publicatie 41, Groningen.

CHOYKE A. M., SCHIBLER J., 2007: Prehistoric bone tools and the archaeozoological perspective: research in Central Europe. In: C. Gates St-Pierre, R. Walker (Eds.): *Bones as tools: current methods and interpretations in worked bone studies.* Pp. 51–65. Archaeopress, Oxford.

CLARK J., PERRY W., 1990: Craft specialisation and cultural complexity. *Research in Economic Anthropology* 12: 289–346.

DE LA FUENTE G. A., 2011: Chaîne opératoire, technical gestures and pottery production at southern Andes during the Late period (c. AD 900–AD 1450) (Catamarca, Northwestern Argentina, Argentina). In: S. Scarcella (Ed.): *Archaeological ceramics: A review of current research*. Pp. 89–102. Archaeopress, Oxford.

DELIÈGE R., 2006: *Une histoire de l'anthropologie. Écoles, auteurs, théories.* Éditions de Seuil, Paris. (Serbian translation: *Istorija antropologije. Škole, pisci, teorije*). XX vek, Beograd.

DIMITRIJEVIĆ V., TRIPKOVIĆ B., 2006: *Spondylus* and *Glycymeris* bracelets: trade reflections at Neolithic Vinča-Belo Brdo. *Documenta Praehistorica* 33: 237–525.

DOBRES M.-A., HOFFMAN C. R. (Eds.), 1999: *The social dynamics of technology: practice, politics and world views.* Smithsonian Institution Press, Washington, London.

DOBRES M.-A., 1999: Technology's links and *chaînes*: The processual unfolding of technique and technician. In: M.-A. Dobres, C. R. Hoffman (Eds.): *The Social dynamics of* *technology: Practice, politics and world views.* Pp. 124–146. Smithsonian Institution Press, Washington, London.

FRANKLIN U., 1992: *The real world of technology*. Canadian Broadcasting Corporation (CBC) Massey Lecture Series. Originally published in 1990 by CBC Enterprises. ON: House of Anansi Press Ltd., Concord.

GREENE K., 2006: Archaeology and technology. In: J. Bintliff (Ed.): *A Companion to archeology.* Pp. 155–173. Blackwell Publishing, Oxford.

HAUDRICOURT A., 1988: *La technologie, science humaine: Recherches d'histoire et d'etnologie des techniques.* La maison des sciences de l'homme, Paris.

HAYDEN B., 1993: Investigating status with hide-working use-wear: a preliminary assessment. In: P. Anderson, S. Beyries, M. Otte, H. Plisson (Eds.): 1993: *Traces et fonction: les gestes retrouvés.* Pp. 119–130. Centre de Recherches Archéologiques du CNRS, Études et recherches archéologiques de l'Universitéde Liège n. 50. Université de Liège, Liège.

HAYDEN B., 1998: Practical and prestige technologies: The evolution of material systems. *Journal of Archaeological Method and Theory* 5, 1: 1–55.

HODDER I., HUTSON S., 2003: Reading the past. Current approaches to interpretation in archeology (3rd ed.). Cambridge University Press, Cambridge.

HODDER I., 1990: *The domestication of Europe.* Basil Blackwell, Oxford.

HODGES H., 1976: *Artifacts: An introduction to early materials and technology*. Gerald Duckworth, Co. Ltd., London.

HOSLER D., 1995: Sound, color and meaning in the metallurgy of the Ancient West Mexico. *World Archaeology* 27, 1: 100–115.

INIZAN M-L., REDURON-BALLINGER M., ROCHE H., TIXIER J., 1995: *Technologie de la pierre taillée.* CNRS et Université de Paris, Paris.

KILLICK D., 2004: Social constructionist approaches to the study of technology. *World Archaeology* 36, 4: 571–578.

KOROBKOVA G., 2008: S. A. Semenov and new perspectives on the experimental-traceological method. In: L. Longo, N. Skakun (Eds.): *'Prehistoric technology' 40 years later: Functional studies and the Russian legacy.* Pp. 3–8. Archaeopress, Oxford.

KUHN S. L., 2004: Evolutionary perspectives on technology and technological change. *World Archaeology* 36, 4: 561–570.

LECHTMAN H., 1984: Andean value systems and the development of prehistoric metallurgy. *Technology and Culture* 25: 1–36.

LECHTMAN H., MERILL R., 1977: *Material culture: styles, organization and the dynamics of technology.* West Publishing, St. Paul.

LEMONNIER P., 1986: The study of material culture today: toward an anthropology of technical systems. *Journal of Anthropological Archaeology* 5: 147–186.

LEMONNIER P., 1992a: Leroi-Gourhan, ethnologue des techniques. *Les Nouvelles d'Archéologie* 48/49: 13–17.

LEMONNIER P., 1992b: *Elements for and anthropology of technology.* Ann Arbor, Michigan.

LEMONNIER P., 1993: Introduction. In: P. Lemonier (Ed.): *Technological choices: transformation in material cultures since the Neolithic.* Pp. 1–35. Routledge, London.

LEROI-GOURHAN A., 1964: *Le geste et la parole.* Éditions Albin Michel, Paris.

LEROI-GOURHAN A., 1965: *Évolution et techniques 1: L'homme et la matière*. Éditions Albin Michel, Paris.

LEROI-GOURHAN A., 1971: *Évolution et techniques 2: Milieu et techniques.* Éditions Albin Michel, Paris.

LÉVI-STRAUSS C., 1973: Introduction à l'oeuvre de Marcel Mauss. In: M. Mauss (Ed.): *Sociologie et anthropologie*. Presses Universitaires de France, Paris. (Serbian translation: 1982: Uvod u delo Marsela Mosa. In: M. Mos (Ed.): *Sociologija i antropologija I.* Pp. 9–58. Prosveta, Beograd).

LIVINGTON SMITH A., 2007: *Chaîne opératoire de la poterie: Références ethnographiques, analyses et reconstitution.* Musée royal de l'Afrique centrale, Tervuren.

LONGO L., SKAKUN N. (Eds.), 2008: *'Prehistoric technology' 40 years later: Functional studies and the Russian legacy.* Archaeopress, Oxford.

LUIK H., 2007: Dazzling white. Bone artefacts in Bronze Age society some preliminary thoughts from Estonia. In: A. Merkevičius (Ed.): *Colours of archaeology. Material culture and society. Papers from the Second Theoretical Seminar of the Baltic Archaeologists (BASE) Held at the University of Vilnius, Lithuania, October 21–22, 2005.* Pp. 49–64. Interarchaeologia, Vilnius.

LYNEIS M. 1988: Antler and bone artifacts from Divostin. In: A. McPherron, D. Srejović (Eds.): *Divostin and the Neolithic of central Serbia*. Pp. 301–323. University of Pittsburgh, Pittsburgh.

MAIGROT Y., 2003: *Etude technologique et fonctionnelle de l'outillage en matières dures animales dans La station 4 de Chalain (Néolithique final, Jura, France).* Thèse de Doctorat. Université de Paris I, Paris.

MANOLAKAKIS L., AVERBOUH A., 2000: Grandes lames et grandes statuettes, marqueurs de l'activité funéraire dans le Chalcolithique de Bulgarie. In: P. Bodu, C. Constantin (Eds.): *Approches fonctionnelles en Préhistoire: XXVe Congrès préhistorique de France, Nanterre (24–26 novembre 2000).* Pp. 155–165. Société préhistorique française, Paris.

MAUSS M., 1973: *Sociologie et anthropologie*. Presses Universitaires de France, Paris. (Serbian translation: 1982: *Sociologija i antropologija I.* Prosveta, Beograd).

MCGHEE R., 1977: Ivory for the Sea Women: the symbolic attributes of a prehistoric technology. *Canadian Journal of Archaeology* 1: 141–149.

MCPHERRON A., RASSON J., GALDIKAS B., 1988: Other artifact categories. In: A. McPherron, D. Srejović (Eds.): *Divostin and the Neolithic of central Serbia*. Pp. 325–343. University of Pittsburgh, Pittsburgh.

MÉNDEZ MELGAR C. A., 2008: Cadenas operativas en la manufactura de arte rupestre: un estudio de caso en El Mauro, valle cordillerano del Norte Semiárido de Chile. *Intersecciones en Antropología* 9: 145–155.

MERRILL R. S., 1977: Preface. In: H. Lechtman, R. S. Merrill (Eds.): *Material culture: styles, organization and dynamics of technology.* Pp. v–vii. Proceedings of the American Ethnological Society. West Publishing Co., St. Paul.

MILLER M. A., 1996: The manufacture of cockle shell beads at Early Neolithic Franchti Cave, Greece: A case of craft specialization? *Journal of Mediterranean Archaeology* 9, 1: 7–37.
MILLER H. M.-L., 2007: *Archaeological approaches to technology.* Academic Press, Elsevier, Oxford.
NANDRIS J., 1972: Bos primigenius and the bone spoon. *Bulletin of the Institute of Archaeology, London* 10: 63–82.
NANDRIS J., CAMPS-FABRER H., 1993: Fiche cuillers à base en V du FTN. In H. Camps-Fabrer (Ed.): *Fiches typologiques de l'industrie osseuse préhistorique. Cahier VI. Éléments récepteurs.* Pp. 153–162. Université de Provence, Aix-en-Provence.
PERLÈS C., 2004: *The Early Neolithic in Greece. The first farming communities in Europe.* Cambridge University Press, Cambridge.
PERLÈS C., VITELLI K., 1999: Craft specialization in the Neolithic of Greece. In: P. Halstead (Ed.): *Neolithic Society in Greece*. Pp. 96–107. Shefield University, Shefield.
PÉTILLON J.-M., 2006: *Des Magdaléniens en armes. Technologie des armatures de projectiles en bois de cérvide en Magdalénien supérieur de la grotte d'Isturitz (Pyrénées Atlantiques).* Éditions CEDARC, Treignes.
PFAFFENBERGER B., 1988: Festishized objects and humanized nature: toward an anthropology of technology. *Man* 23: 236–252.
PFAFFENBERGER B., 1992: Social anthropology of technology. *Annual Review of Anthropology* 21: 491–516.
REID A., MACLEAN R., 1995: Symbolism and the social contexts of iron production in Karagwe*. World Archaeology* 27, 1: 144–161.
RUSSELL N., 1990: The bone tools. In R. Tringham, D. Krstić (Eds.): *Selevac. A Neolithic village in Yugoslavia.* Pp. 521–548. UCLA, Los Angeles.
SCHIFFER M. B., 1995: *Behavioral archaeology: First principles.* University of Utah press, Salt Lake City.
SCHIFFER M. B., 1996: Some relationships between behavioral and evolutionary archeologies. *American Antiquity* 61: 643–662.
SCHIFFER M. B., 2004: Studying technological change: A behavioral perspective. *World Archaeology* 36, 4: 579–585.
SCHIFFER M. B., SKIBO J. M., GRIFFITHS J. L., HOLLENBACK K. L., LONGACRE W. A., 2001: Behavioral archaeology and the study of technology. *American Antiquity* 66: 729–737.
SELLET F., 1993: Chaîne opératoire: the concept and its applications. *Lithic Technology* 18, 1–2: 106–112.
SEMENOV S. A. [СЕМЕНОВ С. А.], 1957: *Pervobitnaya tehnika [Первобитная техника].* Materiali i issledovaniya po arheologii SSSR, no. 54, Izdateljstvo AN SSSR, Moskva, Leningrad [Материалы и исследования по археологии СССР, Но. 54, Издательство АН СССР, Москва, Ленинград].
SEMENOV S. A. [СЕМЕНОВ С. А.], 1957: *Razvitie tehniki v kamenom veke [Развитие техники в каменом веке]*. Nauka, Leningrad [Наука, Ленигрaд].
SEMENOV S. A., 1976: *Prehistoric technology. An experimental study of the oldest tools and artefacts from traces of manufacture and wear*. Barnes and Noble, Wiltshire.
SIDÉRA I., 1998. Nouveaux éléments d'origine Proche-Orientale dans le Néolithique ancien balkanique: analyse de l'industrie osseuse. In: M. Otte, (Ed.): *Préhistoire d'Anatolie. Genèse de deux mondes.* Pp. 215–239. Études et recherches archéologiques de l'Université de Liège n. 85. Université de Liège, Liège.
SINCLAIR A., 1995: The technique as a symbol in Late Glacial Europe. *World Archaeology* 27, 1: 50–62.
SINCLAIR A., 1998: The value of tasks in the late Upper Palaeolithic. In: D. Bailey, (Ed.): *Archaeology of value.* Pp. 10–16. Archaeopress, Oxford.
SKIBO J., SCHIFFER M. B., 2001: Understanding artifact variability and change: A behavioral framework. In: M. B. Schiffer (Ed.): *Anthropological perspectives on technology.* Pp. 139–149. American foundation New World studies series, Albuquerque. University of New Mexico Press, Albuquerque.
SKIBO J., SCHIFFER M. B., 2008: *People and things. A behavioral approach to material culture.* Springer, New York.
SPECTOR J., 1993: *What this awl means*. Minnesota Historical Society Press, St. Paul.
STERNKE F., 2005: All are not hunters that knap the stone – a search for a woman's touch in Mesolithic stone tool production. In: N. Milner, P. Woodman (Eds.): *Mesolithic studies at the beginning of the 21st century.* Pp. 144–163. Oxbow Books, Oxford.
ŠARIĆ J., 2005: Chipped stone projectiles in the territory of Serbia in prehistory. *Starinar n. s.* 55: 9–33.
TABORIN Y., 2004: *Langage sans parole. La parure aux temps préhistoriques*. La maison des roches, Paris.
TRINGHAM R., KRSTIĆ D., 1990: Conclusion: Selevac in the wider context of European prehistory. In: R. Tringham, D. Krstić (Eds.): *Selevac. A Neolithic village in Yugoslavia.* Pp. 567–616. UCLA, Los Angeles.
TRIPKOVIĆ B. [ТРИПКОВИЋ Б.], 2007: *Домаћинство и простор у касном неолиту – винчанско насеље на Бањици. (Household and space in the Late Neolithic – Vinča settlement at Banjica).* Serbian Archaeological Society, Belgrade [Српско археолошко друштво, Београд].
UGAN A., BRIGHT J., ROGERS A., 2003: When is technology worth the trouble? *Journal of Archaeological Science* 30: 1315–1330.
VITELLI K., 1989: Were pots first made for foods? Doubts from Franchthi. *World Archaeology* 21, 1: 17–29.
VITEZOVIĆ S., 2007: *Koštana industrija u neolitu srednjeg Pomoravlja*. MPhil thesis. Faculty of Philosophy, Belgrade University, Beograd.
VITEZOVIĆ S. [ВИТЕЗОВИЋ С.], 2009: Коштана индустрија са локалитета Страгари-Шљивик (Bone industry from the site Stragari-Šljivik). *Kruševački zbornik [Крушевачки зборник]* 14: 135–160.
VITEZOVIĆ S. [ВИТЕЗОВИЋ С.], 2010: Неолитска коштана индустрија са локалитета Кормадин у Јакову – ископавања 2008. године (The Neolithic bone industry of Kormadin in Jakovo – excavations of 2008). *Annual of the city of Belgrade* [*Годишњак града Београда]* 57: 43–66.
VITEZOVIĆ S., 2011a: *Koštana industrija u starijem i srednjem neolitu centralnog Balkana*. PhD thesis. Faculty of Philosophy, Belgrade University, Beograd.
VITEZOVIĆ S., 2011b: Early and Middle Neolithic bone industry in northern Serbia. *Acta Archaeologica Carpathica* 46: 19–60.

VITEZOVIĆ S., 2011c: Domestic space in Vinča culture and interpretations of activity areas. In: *Paper presented at 17th Annual Meeting of the European Association of Archaeologists, Oslo, Norway, September 14–18, 2011*. Pp. 71. EAA, Oslo.

VITEZOVIĆ S. [ВИТЕЗОВИЋ С.], 2012a: Коштана индустрија са локалитета Витково-Трифуновићи (ископавања 2001. године). (Bone industry from the site Vitkovo-Trifunovići (excavations in 2001)). *Kruševački zbornik [Крушевачки зборник]* 15: 351–376.

VITEZOVIĆ S., 2012b: The white beauty – Starčevo culture jewellery. *Documenta Praehistorica* 39: 215–226.

VUKOVIĆ J., 2011: Late Neolithic pottery standardization: Application of statistical analyses. *Starinar n. s.* 61: 81–100.

WHITTLE A., BARTOSIEWICZ L., BORIĆ D., PETTIT P., RICHARDS M., 2002: In the beginning: new radiocarbon dates for the Early Neolithic in northern Serbia and south-east Hungary. *Antaeus* 25: 63–117.

WAKE T., 1989: Exploitation of tradition: bone tool production and use at Colony Ross, California. In: M.-A. Dobres, C. R. Hoffman (Eds.): *The social dynamics of technology: practice, politics and world views.* Pp. 186–208. Smithsonian Institution Press, Washington, London.

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