

CHAÎNE OPÉRATOIRE: THE CONCEPT AND ITS APPLICATIONS WITHIN THE STUDY OF TECHNOLOGY

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Resumen: *Chaîne opératoire*: el concepto y sus aplicaciones para el estudio de la tecnología. Partiendo de una revisión analítica de los trabajos que emplean el término *chaîne opératoire* desde sus orígenes y hasta el presente, se reconstruyen los orígenes del término y los diversos usos que se le han ido dando para el estudio de la tecnología en contextos arqueológicos y antropológicos. Se distingue entre *chaîne opératoire* como objeto de estudio (la cadena técnica operativa) y *chaîne opératoire* como un tipo particular de enfoque que ha llevado a diversos desarrollos, como son la definición de «alternativas tecnológicas» en distintos contextos, el estudio de influencias sociales y culturales en el ámbito de la tecnología, la incorporación de aspectos como agencia e innovación, y la colaboración entre ciencias de los materiales y arqueología. Se concluye argumentando que la *chaîne opératoire*, más que un enfoque único, es un conjunto de enfoques complementarios que pretenden una comprensión holística del papel de la tecnología en las sociedades pretéritas.

Palabras clave: *chaîne opératoire*, cadena técnica operativa, agencia, innovación, alternativas tecnológicas, arqueometría.

1. INTRODUCTION¹

In 1990 M. Edmonds claimed that the *chaîne opératoire*, besides other qualities, had «much to offer for studies of long term changes in the cognitive capabilities of

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different hominid populations» (EDMONDS, 1990: 58). Only four years later, N. Schlanger emphasised the necessity of «unleashing the *chaîne opératoire* for an archaeology of mind» (SCHLANGER, 1994). While the former finds in this framework a promising open door for future research, the latter somehow underlines the constraints it entails for the development of an interpretative archaeology. The contrast between such different views in such a short interval poses three main reflections: first, the ambiguous and debatable nature of the term *chaîne opératoire*; second, the flexibility of its approach - able to be freed and spread in order to embrace a new field of study, i.e. human mind; and third, stemmed from the preceding ideas, the appropriateness of a synthetic study which properly defines both the possibilities and the limits of approaching technology by means of the *chaîne opératoire*.

This paper is an attempt to contribute to this debate. In this sense, we shall address some considerations on the historical origins of the term as well as on the different uses and definitions that it has been given throughout the last decades. Thus we expect that the contrast between these and the traditional approaches—as far as it exists—shall be observed. Once the concept is clear and its newness verified, we will deal with some major theoretical issues and applications of the so-called «*chaîne opératoire* approach». Hence, we expect to hint at some interpretations of the actual achievements and challenges of such an approach or—as we shall argue—ensemble of approaches.

2. HISTORICAL CONSIDERATIONS

Although Sellet (1993, 106) quotes an early reference of the term *chaîne opératoire* in Brézillon's *La dénomination des objets de pierre taillée* (1968), most of the scholars agree that the authorship of the term and its pioneering applications are to be ascribed to both Marcel Mauss (1872-1950) and André Leroi-Gourhan (1911-1986). It was Mauss, anthropologist and sociologist, who founded the basis of this approach with his «total social phenomenon». From the consideration of technology as such, he deals with the fact that technological activity is constituted within an influent social and historical context and, thus, that these fields cannot be analysed in isolation (cf. EDMONDS, 1990). But a good understanding of Mauss' contribution requires a focus on some of his other ideas: according to him, when man creates and transforms he is at the same time creating and transforming himself (cf. SCHLANGER, 1994: 144). Consequently, the recognition and analysis of every stage of technical action becomes relevant, since it can provide information about the subject of that action and, moreover, about the society within which the given action is inscribed. We find this point particularly striking in the development of technological studies.

In the light of this starting point—but also making use of his archaeological and biological background—Leroi-Gourhan is capable to merge two philosophical and

epistemological positions traditionally considered as poles apart, i.e. Humanism and Naturalism (SCHLANGER, 1990). From this fusion he approaches in more detail the dynamic and contextually determined relationship between humans and materials through the examination of the «enchaîné» operational cycle of every technical activity. Yet, he not only provides the proper framework for a systematic description but also the clues to infer the «dialogue» between human being and raw material (SCHLANGER, 1994: 145).

As pointed out above, these theoretical principles and first practical attempts to accomplish a new strategy of studying technology have been developed, completed and corrected by other researchers over the last twenty years. Meanwhile, their progress has been looked upon by scholars outside the scope of the European continent, although —despite remarkable exceptions— «at the expense of leaving much of the related theoretical baggage behind in France» (VAN DER LEEUW, 1993: 284, footnote 7). This development and extension will be explored in the following sections. We will start by looking at definitions of *chaîne opératoire* so as to analyse the different ways in which the concept can be used.

3. SOME DEFINITIONS: THE *CHAÎNE OPÉRATOIRE* AS AN OBJECT

In the strict sense, the *chaîne opératoire* comprehends not more than an object of study. This term alludes to the sequence of actions involved in the production of an artefact. «Leroi-Gourhan defined this as the series of technological operations which transforms a raw material into a usable product» (CRESSWELL, 1990: 46).

Nevertheless, considering this quite simple definition we already find one of the major innovations that this concept implies for technological studies - i.e. the attention paid to the process of manufacturing. Historical-cultural archaeology intended to study ancient tools by means of the supposed evolution and dissemination of any given technological item through space and/or time (i.e. diffusionism and/or evolutionism). Later, the initiators of the New Archaeology linked technology and environment in order to explain the laws that ruled the «Darwinist» human adaptation to nature (cf. e.g. TRIGGER, 1992; GRACE, n.d.b). Both these approaches addressed the description and superficial examination of the end product, regardless the particular human activity that had originated it. In contrast, the concept of *chaîne opératoire* puts emphasis on every stage of the tools production, particularly the supply and properties of raw materials. The object of study becomes thus «longer»: research focuses not on a single item but on a sequence. Therefore, the possibility of an appropriate reconstruction of ancient technological systems is enhanced.

However, this is just the first step, the narrowest definition. We can easily find another explanation of the term which engages more issues: «In a technical activity, a *chaîne opératoire* takes the form of an ordered train of actions, gestures, instruments or even agents leading the transformation of a given material towards

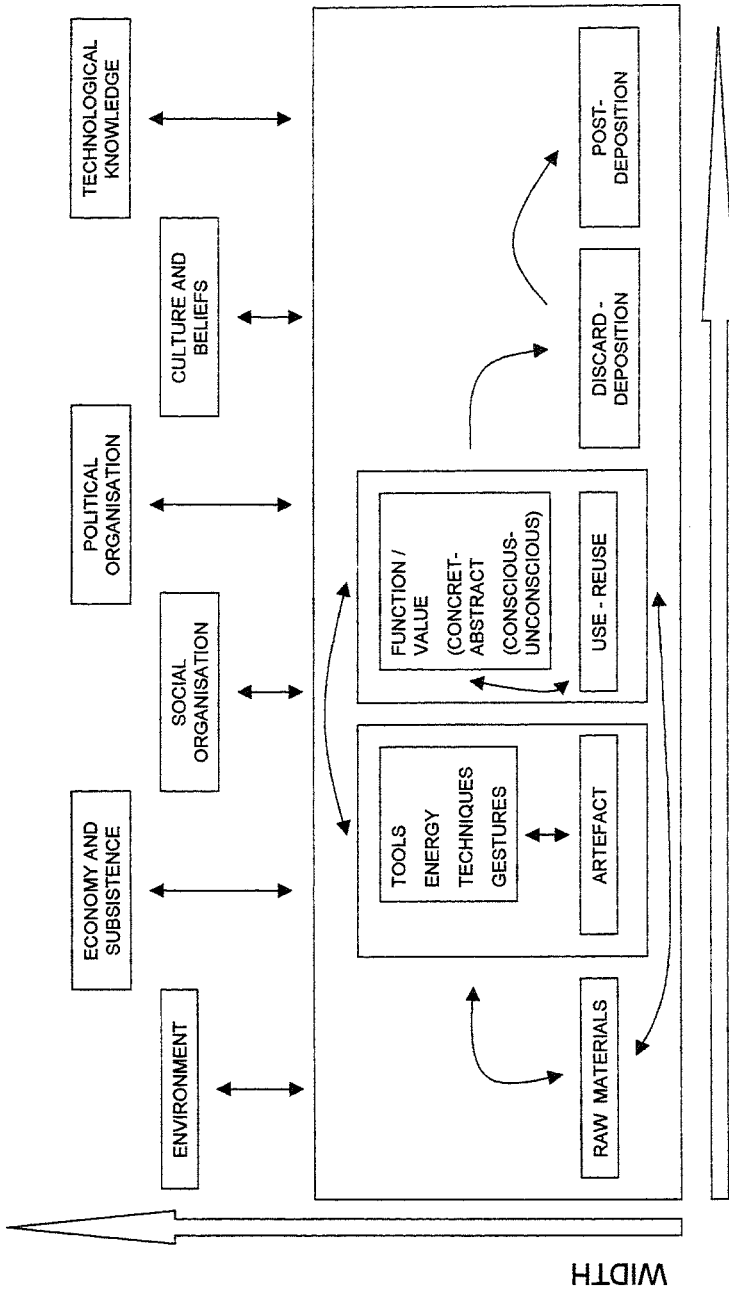


FIGURE 1: Diagram with the representation of the «length» and the «width» of the chaîne opératoire (transformed and completed after diagrams from Grace n.d.b. and Sillar & Tite 2000).

the manufacture of a product, through major steps that are more or less predictable» (KARLIN and MULIEN, 1994: 164, footnote 1). Through this definition we accomplish two new significant highlights which again distance this approach from the traditional: first, the relevance of the human being —the «agent»— joining the *chaîne opératoire*; second, the awareness of a «predictable project» that somehow leads us to the key topic of the technological knowledge. Thus, the *chaîne opératoire* appears as a succession of actions within which materials, humans — or other sources of energy—, gestures, tools and knowledge can be studied together.

Moreover, many researchers agree nowadays that this conceptual chain does not finish with the achievement of the manufactured product but when it is finally discarded after different uses and re-uses. Accordingly, we need to study not only the origins of any artefact but its entire life-history (cf. e.g. GRACE, n.d.a, n.d.b; PELEGRIN, 1990; SELLET, 1993; SILLAR and TITE, 2000). A wide range of analytical techniques are hence orchestrated to attain a comprehensive reconstruction of the operational sequence, such as analysis of wear traces, waste products, refitting, experimentation and diacritical studies, identification of late reshaping or functional changes, even spatial analysis to identify patterns of consumption, use and discard, as well as depositional and postdepositional processes.

4. MORE DEFINITIONS. THE *CHAÎNE OPÉRATOIRE* AS AN APPROACH

Up to this point, we have observed how the *chaîne opératoire* actually constitutes a new way of deeming the object of technological studies. We have attested how the target of our attention is «lengthened» to be scrutinised as a sequence of interrelated items. Now it is time to go into its further developments.

By extension, the term *chaîne opératoire* has been gradually used to name every approach devoted to its notion. Subsequently, we find papers where the *chaîne opératoire* is no longer defined as an object of study but as «a technological approach that seeks to reconstruct the organization of a technological system at a given archaeological site» (SELLET, 1993: 106) or «an interpretative methodology and analytical method capable of forging robust inferential links between the material patterning of technical acts and the sociopolitical relations of production accounting for them» (DOBRES, 1999: 124).

Whether called «*chaîne opératoire* approach» or just «*chaîne opératoire*», the major significance of the strategy defined above is that it deals with another dimension of the object of study. As we displayed above the «length» of this *chaîne*, now we shall address its metaphorical «width» (see Fig. 1).

The consideration of the technology as a «total social phenomenon» has led, on the one hand, to several studies that approached the material culture as a text (cf. e.g. HODDER, 1982; 1986; TILLEY, 1990; 1991; SHANKS and TILLEY, 1992).

But in the specific realm of the *chaîne opératoire*, on the other hand, it has encouraged an increasing focus on the operational sequence as a socially embedded reality. As a result, the relevance of the human choice in every stage of the technological activity has been pointed out. Furthermore, dealing with the so-called «technological choice» we address key subjects such as agency and society, cultural strains and innovation, historic relativism, or even the role of materials science in archaeological studies. That is why we refer to the «width» of the *chaîne opératoire*, for we can depart from the particular analysis of an item in order to reach the wider circle of the technological system; and we can even go further to draw conclusions about society, politics, culture or even human behaviour.

In the following sections we shall briefly discuss these issues stemmed from the analysis of *chaînes opératoires*. It is hoped that the approach shall thus appear properly characterised, prior to the final interpretation.

4.1. Technological choices and natural determinism

From Lemonnier's perspective, «perhaps because technical processes have to take place within the constraints of matter (Ö) scholars tend to consider techniques as a set of constraints» (LEMONNIER, 1993: 3). This conviction is probably due to the current perception of technology as the human run towards the supremacy in a hostile nature. Accordingly, the first processual studies of technology emphasised the limitations and conditionings with which the environment obstructed the technological development.

Obviously, nature somehow influences technological activity. We cannot build castles in the air. Nonetheless, it has been shown that technicians have a wide range of options amongst which they can choose. In other words, there are several ways of doing the same. Whatever the constraints are, their choices can take place in five main fields: raw materials, tools, energy, techniques and sequence of gestures (SILLAR and TITE, 2000: 4)

Following these asserts, several anthropologists and archaeologists have addressed *technological choices* within different spheres of technological activity, such as traps, weapons, house enclosures and clothes (LEMONNIER, 1986), irrigation settlements (PFAFFENBERGER, 1988), pottery production (e.g. VAN DER LEEUW, 1984; 1993; COBAS and PRIETO, 1998; PRIETO, 1999; LIVINGSTONE SMITH, 2000; POOL, 2000; SILLAR, 2000; SILLAR and TITE, 2000) or lithic technology (e.g. PERLÈS, 1987; SELLET, 1993; EDMONDS, 1995; GRACE, n.d.b). The usual methodology within this framework involves the inspection of all the possibilities that each context virtually offered to the human beings in order to achieve an artefact (e.g. a pot with a specific shape) or any other aim (e.g. capture a pig) and discerning which were the human choices in each stage. The next level of analysis entails the clarification of the reasons that brought each individual to make each decision. Thus, there is a return into the realm of influences and conditionings but necessarily dealing with society and culture, not

only with nature. In fact, many study cases reveal that not the easiest or the most «natural» way of doing things is always chosen. It may be argued, however, that the study of technological choices has not yet an appropriately defined methodology (ROUX, 2001), particularly in what regards to the interpretation of the different choices. As a recent approach to technology, the most adequate strategies of analysis are still to be developed.

4.2. Social and cultural constraints, agency and innovation

As pointed out above, in search of the conditionings of the technological choices we cross the threshold between individuals and society. Influencing each choice we can find the palpable material strains but also, and even more significantly, the «technological constraints, the economic and subsistence base, the social and political organization, and the ideology or belief systems of the people making the choices» (SILLAR and TITE, 2000: 4). From this starting point, the researchers of the *chaîne opératoire* study technologies «as integrated webs weaving skill, knowledge, dexterity, values, functional needs and goals, attitudes, traditions, power relations, material constraints, and end-products together with the agency, artifice, and social relations of technicians» (DOBRES, 1999: 128). The context within which the technological action takes place leaves its signs in the product; therefore, we can research that context through the examination of these remaining clues. The evolution of the late prehistoric ceramic production in NW Iberia serves as a case study to illustrate this assert: it has been shown how the main variations in the technology of the vessels seem to be the result of changed social patterns and new relationships between humans and environment (COBAS and PRIETO, 1998).

As a result of these approaches, the relation between individual and context is understood in a dynamic way. Technology appears then as an arena in which the personal choice has to deal with the socio-economical imperatives, the cultural conditionings and the inherited technological knowledge. In this intermediate field the *agency* plays its role. Within a given society, no act or experience takes place independently of that society and its rules; every experience is influenced by the configuration of different «fields of pressure» (BORDIEU, 1997: 146). Thus, if from the *chaîne opératoire* framework we address the topic of the agency we can perceive how technological activities contribute unconsciously to the reproduction and consolidation of the social and mental constructions.

Nevertheless, not everything is determined in the realm of technology. As there are *unconscious choices*, there must be space for the *conscious choice*. In fact, this is one of the reasons objected to the idea of «technological somnambulism» (cf. PFAFFENBERGER, 1988: 238). The discernment of this relative freedom, on the one hand, allows a comprehension of the role of technological activity as a means of responding the established *habitus* (PAPOUSEK, 1989; VAN DER LEEUW, 1989; DOBRES and HOFFMAN, 1994; DOBRES, 1999), and, on the other hand,

it offers a sound basis to define both homogeneity and diversity within a particular group (PRIETO, 1999). Furthermore, it recalls more attention to another fundamental issue of material culture studies, i.e. *innovation*.

The focus on innovation has been useful to prevent archaeologists from wasting more time seeking foreign influences in order to explain each novelty (UCKO, 1989). But the detailed analyses of particular cases have also provided brilliant evidence of the fact that technological advances are not assimilated unquestionedly. On the contrary, we have to realise that each society makes its own choices so as to decide whether or not to accept a given technological innovation, and that a technological advance successful in some society might be neglected in another one. Sociological and anthropological explorations give us budding examples of this assertion (e.g. PFAFFENBERGER, 1988; AKRICH, 1993; PÉTREQUIN, 1993). Moreover, even in the case that a technological item is accepted, its value may be markedly different from one society to another or from one field to another within the same society (EDMONDS, 1995).

4.3. Relativism and universalism

The current collaborations between sociologists, social anthropologists and archaeologists and the development of Ethnoarchaeology as a discipline have definitely shown us the relativism of our knowledge and worldviews. Undoubtedly, our concepts and attitudes are strongly conditioned by our sociohistorical context. Hence, avoiding the transposition of our views while interpreting past societies becomes hard but compulsory, and to define general laws of human behaviour seems hardly possible.

These statements have been taken into account in the study of *chaînes opératoires* and technologies in general. While the exclusiveness of each society is seen as decisive factor in the configuration of each technological system, the unaware transposition of our present WASP's —white Anglo-Saxon protestant— values in the interpretation of ancient technologies can be noticed. (cf. e.g. PFAFFENBERGER, 1998; INGOLD, 1990).

However and fortunately, the alertness of relativism does not impede every attempt of general interpretation. Adopting an adequate «epistemic relativism» rather than an absolute «judgmental relativism» (SHANKS and HODDER, 1995) might constitute a suitable groundwork for interpretation. Yet, since it is impossible to explain unknown societies without resorting to known conceptual frameworks (HERNANDO, 1995: 55), we consider as crucial the necessity to improve our historical, anthropological and archaeological knowledge. The wider our knowledge, the higher our possibilities become in finding the most suitable explanatory model.

Taking these principles into account and also considering the general rules of human neurophysiology, some scholars have been capable to combine the study of the *chaîne opératoire* as an embedded reality with the search of general interpretations. As can be seen in Ingold's reflections on the universal features of

the technology (INGOLD, 1990) or van der Leeuw's search of regularities in human perception and cognition through the study of material cultures (VAN DER LEEUW, 1994).

4.4. Behaviour, behaviorism and behavioral chain

Both the study of embedded technologies and the attempt of achieving general interpretations usually involve a stress on the idea of human *behaviour* (e.g. RICHARDSON, 1989; WIESSNER, 1989; SCHIFFER, 1995; SCHIFFER and MILLER, 1999; MARTIN WOBST, 2000) Therefore, and because we have found some divergence in the uses of the term and its derivatives, a brief comment on some different applications of this concept within the *chaîne opératoire* approaches is considered adequate.

Initially, we shall deal with *behaviorism*. This term labels a particular approach within which many psychologists have tried to explain human performance scientifically, as a series of responses to given stimuli. Processual archaeologists somehow adopted this methodological assumption in order to define simple and deterministic cause-effect relationships in the study of early societies. As a result, the term «behaviorism» has been sometimes used to refer to a deficiency of the New Archaeology (WHITLEY, 1998).

Nevertheless, this «behaviorism» has little to do with Schiffer's concept of «behavioral archaeology» and, more in specific, with his «*behavioral chain*». Defined as «the sequence of all activities in which an element participates during its 'life' within a cultural system» (SCHIFFER, 1995: 57), the «behavioral chain» represents a strategy of studying technologies founded in Marvin Harris' appreciations and developed by Northern American archaeologists. Despite its independent origin, this approach shares with the *chaîne opératoire* the stress on the production and life of the artefact as a sequence of interlinked stages. On the other hand, one of its particularities is the emphasis on the «action» conceived as the study object, rather than smallest segments of the operational sequence or larger links between society and technology (SELLET, 1993: 107).

This is not the place to go into further examinations of the behavioral chain approach. However, we have estimated that at least its mention was worthwhile for two particular reasons: first, for the strong similarities existing between this concept and that of *chaîne opératoire*; and second, because of some criticism recently made against the supposed «behaviorism» of Schiffer's approach (MARTIN WOBST, 2000: 40-41). From our view, regardless its name, the behavioral chain constitutes a framework which is much more flexible and constructive than the narrow «behaviorism» of some traditional approaches. Contrasting to the definition of mechanical associations in which the artefact is a mere instrument, Schiffer implements a dynamic view in which the artefact has its «life», «participates» and «interacts» with energy sources (SCHIFFER, 1995). Hence, we do not agree with the connections between this approach and those somehow obsolete.

4.5. The role of materials science

We cannot finish this study of the developments of the *chaîne opératoire* research before referring to the important role that materials science may—even should—play in it. Since both theoretical archaeology and scientific archaeology have sometimes been disapproved—the former because of its disjoining in what regards to material reality, the latter for its lack of aims or interpretations—now we face the «challenge» of bringing them closer together (SILLAR and TITE, 2000). Scientific approaches to technology necessarily reduce the scale of the analysis in order to achieve the most proof and objective knowledge of the examined item. Although their results might appear ahistorical and descriptive, the theoretical framework provided by the *chaîne opératoire* can integrate them so as to attain a comprehension of ancient technologies and choices based on reliable data. This might be reached by the previous definition of pondered research agendas.

M. Edmonds addresses this topic in a paper titled «Description, Understanding and the *Chaîne Opératoire*» (EDMONDS, 1990). Materials science can improve the description; thus the understanding shall be more satisfactory; and only after these stages we will accomplish the most suitable *chaîne opératoire*. In this sense, this desirable contribution of the scientific approaches has recently been summarised: «First, materials science provides the methodology for reconstructing past technologies. Second, it allows us to assess the extent to which physical and chemical performance characteristics have influenced past technological choices and, thus, provides a baseline against which the role of cultural factors can be considered» (SILLAR and TITE, 2000: 17).

Science and interpretation are perfectly complementary. In this sense, science-based archaeology emerges as a foremost approach to deal with technological chains.

5. CONCLUSION: THE *CHAÎNE OPÉRATOIRE* AS AN ENSEMBLE OF APPROACHES

The primal goal of the *chaîne opératoire* is that it has provided every technological study with an *aim*, in contrast to traditional senseless typologies. Consequently, many different standpoints can merge in search of the understanding of past technologies. Therefore, for instance, one researcher can address the physical properties of a stone while another one can deal with the social value of any gesture or artefact, but all their conclusions intend to be articulated in quest of the comprehension of the technological system, its agents and, moreover, the functioning of the entire society. Under the same label, «*chaîne opératoire*», an *ensemble* of diverse but complementary approaches are thus integrated.

The *chaîne opératoire* emerges as a *flexible* structure that allows the movement through fields heuristically divided such as nature, technology, style, society and

culture. Besides, this flexibility encourages a well-balanced *interdisciplinary research*, namely amongst anthropologists, archaeologists and materials scientists.

The concept of *chaîne opératoire* has meant a breakthrough in the development of technological studies and its future is widely promising. Particularly, we willingly expect the introduction of this concept in the field of archaeometallurgy. The potential of the *chaîne opératoire* ensemble of approaches has been shown in many case studies, namely of ceramics and lithic artefacts, amongst others. However, this concept is rarely found in archaeological studies of metals. Research should follow the steps of Lechtman (1979; 1985; 1996) and further explore the role of cultural and social issues in the realm of ancient metallurgies. We consider the *chaîne opératoire* as one of the most appropriate ways to achieve such an aim.

In archaeological and anthropological research, the space between material and culture cannot be filled effortlessly, and indeed we must be aware of too daring interpretations (LEMONNIER, 1990a; 1990b; EDMONDS, 1995: 18-19). However, dealing with the *chaîne opératoire* we may walk cautious steps on such a fascinating path.

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