Lithic Technology and Logic of Technicity

Jens A. Frick[1,3] and Klaus Herkert[2,3]

[1]Universität Tübingen
Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters
Abteilung Ältere Urgeschichte und Quartärökologie
DFG project FL 244/5-1
Schloss Hohentübingen, Burgsteige 11
D-72070 Tübingen, Germany

[2]Universität Tübingen
Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters
Abteilung Ältere Urgeschichte und Quartärökologie
SFB 1070 „KulturenRessourcen" B01
Gartenstraße 29
D-72074 Tübingen, Germany

[3]Project Collective de Recherche „Le Paléolithique supérieur ancien en Bourgogne méridionale", Tübingen and Dijon

jens-axel.frick@ifu.uni-tuebingen.de
klaus.herkert@uni-tuebingen.de

Abstract: *The present-day research on lithic analysis provides very different approaches how stone artifacts can be recorded, analyzed, and interpreted. Most scholars agree today that a purely typological view should be avoided. The last three decades provided a technological approach to lithic research. Likewise, there are also very different approaches how lithic assemblages should be classified. Beside the Bordes-Binford debate if assemblages can be seen as made by distinct groups or if they are functional units, many other hypotheses have been formulated (like environmental, transformative or recycling approaches, production analysis, core classification criteria, as well as functional analysis within use-wear or hafting studies). In the context of lithic analysis, Eric Boëda's research is of outstanding interest, because he formulated many technological approaches that are very often used, and in some research traditions they are nearly standard. This paper uses his newly published work (Boëda 2013) as an opportunity to resume his litho-technological approaches, but also to discuss Boëda's approaches and try to integrate these into the context of lithic analysis.*

In his recent work, Eric Boëda sums up his litho-technological research of the past three decades and combines it with the sociocultural work of Gilbert Simondon, Yves Deforge, André Leroi-Gourhan and others. The focus lies on the understanding of how and why lithic artifacts develop and change through time, particularly with regard to production schemes and techno-functional aspects, wherein Boëda presents a classification of six different core-types. The theoretical work is concluded and elucidated with the example of blade industries in the Near East. More than only presenting a classical review or a summary of Boëda's latest work, this paper also aims to help make the complex theme accessible to non-French speakers. Thus, the emphasis lies on the theoretical, litho-technological aspects, particularly on the terminological understanding and the core-type classification. Since Boëda's work combines a broad spectrum of philosophical and theoretical framework with lithic analyses, we try to clarify and revise important points and supplement them with own approaches. The aim of this paper is to contextualize his approaches and show that they round out other lithic analysis to a more holistic view of lithic artifacts with the goal to contribute to complete the Paleohistoriography.

Keywords: *Lithic technology, core classification, theoretical background, terminology, development of production, production schemes*

Lithische Technologie und Logik der Technizität

Zusammenfassung: Die aktuelle Forschung im Bereich lithischer Analysen stellt sehr unterschiedliche Ansätze bereit, wie Steinartefakte aufgenommen, analysiert und interpretiert werden können. Die meisten Forscher stimmen heute überein, dass eine rein typologische Sichtweise vermieden werden sollte. Die letzten 30 Jahre der Forschung steuerten technologische Ansätze zur Diskussion bei. Ebenso gibt es sehr unterschiedliche Ansätze, wie lithische Inventare klassifiziert werden können. Neben und nachfolgend zu der Bordes-Binford-Debatte (inwiefern Inventare als Einheiten angesehen werden sollten, die von unterschiedlichen Gruppen hergestellt wurden oder ob diese funktionalen Charakter besitzen), wurden in diesem Kontext zahlreiche Hypothesen formuliert (Umwelt-, Transformations-, oder Recycling-Ansätze, Produktionsanalysen, Kernklassifikationskriterien, aber auch funktionale Analysen innerhalb von Gebrauchsspuren- und Schäftungsanalysen). Im Kontext lithischer Analysen ist die Forschung Eric Boëdas von herausragender Bedeutung, da zahlreiche technologische Ansätze formuliert wurden, die häufig Anwendung finden und in manchen Forschungstraditionen beinahe zum Standard gehören. Dieser Artikel nimmt sein neuestes Werk (Boëda 2013) zum Anlass, seine litho-technologischen Ansätze zu resümieren, darüber hinaus aber Boëdas Ansätze zu diskutieren und zu versuchen, diese in den Kontext lithischer Analysen zu setzen.

Eric Boëda resümiert in seinem neuen Werk maßgeblich seine litho-technologischen Forschungen der vergangenen drei Dekaden und verquickt diese auf interdisziplinäre Weise mit sozialphilosophischen Ansätzen französischer Schule (Gilbert Simondon, Yves Deforge, André Leroi-Gourhan und andere). Der Fokus hierbei liegt vorwiegend auf der Frage des Verständnisses, wie und aufgrund welcher Umstände und Prozesse Steinartefakte sich entwickeln und verändern. Im Besonderen wird hierbei die Betrachtung auf Produktionsschemata und die Technofunktionalität gelegt. Innerhalb dieser wird erläutert, was ein Steinartefakt darstellt und wie es gegliedert werden kann. Ebenso entwickelt Boëda ein sechsgliedriges Klassifikationsschema für Kerne und deren Abbau. Im Anschluss wird das Erarbeitete anhand der chronologischen Entwicklung in seiner Tendenz an den klingenführenden Industrien des Nahen Ostens beispielhaft umgesetzt.

Über den Rahmen einer reinen Rezension hinausgehend, möchte dieser Beitrag jedoch neben einer klassischen Besprechung und inhaltlichen Zusammenfassung ebenso dazu beitragen, zahlreiche in der technologischen Betrachtung von Steinartefakten anzutreffende Begriffe zu erläutern und die komplexe Thematik des Werkes einem nicht französisch-sprachigen Publikum zugänglich zu machen. Der Schwerpunkt hierbei wurde auf die theoretischen und litho-technologischen Aspekte, insbesondere das terminologische Verständnis und die Kerntypenklassifikation, gelegt. Da sich das zu besprechende Werk dem Leser mit einem breiten philosophischen und theoretischen Hintergrund, jedoch nicht frei von inhaltlichen sowie strukturellen Mängeln präsentiert, werden die entsprechenden Punkte kritisch beleuchtet und erläutert sowie, wenn nötig, durch eigene Ansätze ausgebaut.

Das Ziel hierbei ist es, Boëdas Ansätze in den Kontext lithischer Analysen zu setzen und aufzuzeigen, dass diese andere lithische Analysen zu einer holistischeren Betrachtungsweise vervollständigen, mit dem Zweck, zur Paläo-Geschichtsschreibung beizutragen.

Schlagwörter: Steintechnologie, Kernklassifikation, theoretischer Hintergrund, Terminologie, Produktionsentwicklung, Produktionsschemata

Introduction

The present-day research provides very different approaches how lithic objects (stone artifacts) can be recorded, analyzed, and interpreted. It seems quite common that a purely typological view should be avoided, because it contemplates only an extraction of an assemblage of lithic artifacts and tries to give one single name to a lithic piece (e.g., Bordes 1961). Morphological analyses took a step forward describing how a lithic artifact looks, how it could be produced, and what its function could be (Hahn 1993). Lithic technological analysis combines these aspects with a better knowledge of physical parameters (breakage mechanics), techniques of production, experimental reproduction and use (as well as many more aspects) to understand the lithic object biography from procurement of the raw material, to production of lithic objects until the archaeological analysis.

Dealing with lithic artifacts, a researcher is faced with specific problems and questions concerning archaeological, geological, physical, physiological, psychological, and sociological aspects. Beside this, a holistic lithic analysis tries to explain the origin of the raw material, the use and function, the contextualization inside an archaeological site, and the environment, the development of form and function as well as the Paleo-history (and many other aspects). In the last years, many different approaches were formulated to find new ways to analyze and interpret lithic assemblages as well as their development in time. To name but a few of these, we refer to the approaches of Tostevin (2003, 2007, 2011, 2012) for cultural transmission, the transformation analysis by Weißmüller (1995), Richter (1997), and Uthmeier (2004a, b) and the techno-functional analysis of Eric Boëda, which is the main part of the underlying work of this paper. It is not the aim of this paper to give a complete overview of all newly formulated ideas inherent in studies dealing with lithic artifacts. Rather, it aims to explain a French work dealing with lithic technology to non-French researchers. As is often the case, we can see that there are many ways to formulate questions to the materials we can find in an archaeological context. The techno-functional approach and the idea of development lines were disseminated, among others, by Boëda, who pools these theoretical frames in his new work from 2013.

In this article, we discuss Eric Boëda's latest work on lithic technology: Techno-logique & Technologie. Une Paléo-histoire des objets lithiques tranchants, published in fall 2013 (Boëda 2013; printed version: soft cover, 264 pages, ISBN 978-2-36461-003-3 and digital version: PDF with 259 pages, ISBN 978-2-36461-004-0). Our aim is to combine two aspects. First, to review this work, and second, to explain terms used in litho-technological analysis. This article is neither a guide in the proper meaning of the word, nor a substitute of the discussed work of Eric Boëda. It does not aim to be a translation, but can be seen as a basis for further discussion about lithic analysis.

The main focus of the work lies on the understanding of how and why lithic artifacts can and do develop through time. With regard to questions of lithic technology, archaeologists are faced with a direct double relationship, tied together in reciprocal coevolution: man and environment on the one hand and man and technique on the other (Boëda 2013, 23/18)[1]: "*La relation de la technique à l'Homme se ferait en termes de capacité à répondre à de nouvelles contraintes culturelles et environnementales. Il ne s'agit plus alors d'une relation indirecte mais directe*". Lithic objects have to be seen as technical products, made and transformed by man. They show a specific structural potential. This potential, inherent to each object, represents the key information for understanding changes in conceptual behavior, production modes and tool morphology (shape and form). With regard to lithic objects/tools, Boëda emphasizes the fact that it is not only a question of their morphology, but of the function(s) they are intended to fulfill (Boëda 2013, 23/18): "*De fait, l'objet doit être perçu à travers sa dynamique structurelle: ce qui l'a amené à être, ce qu'il est, et non plus comme ce qu'il est à un moment donné, autrement dit sa forme*". Following Boëda, these technical changes, developments and diffusions seem to occur in evolutionary or progressive cycles. Boëda terms these cycles *lignées* (evolutionary lines), following a metaphoric law of technique. Boëda calls this *techno-logique* (logic of technicity). This idea or concept, on litho-technological schemes and lithic objects, including their techno-functional structuring, is mainly founded on the works of french philosophers such as

1 If there are citations of specific pages, we have to give the pagination of both versions (print/pdf).

Gilbert Simondon, Yves Deforge, Gilles Deleuze, Pierre Rabardel, Bernard Stiegler and André Leroi-Gourhan (Simondon 1958, 1964; Leroi-Gourhan 1964, 1965, 1983; Deleuze 1969, 2011; Deforge 1985; Stiegler 1994, 1998 a, b; Rabardel 1995).

The work is organized in three main parts: an epistemological, a theoretical, and an analytical section (as Boëda reveals in his conclusion: Boëda 2013, 223/217), framed by an introduction and a conclusion. Françoise Audouze wrote the foreword, emphasizing Boëda's interdisciplinary approach and his merits in his research regarding the identification and structuring of principal lithic production modes.

The epistemological section introduces the philosophical background of the whole work. The theoretical section is separated into two parts. The first concerns tools, their structure and functional units, while the second discusses cores. Here, Boëda develops a completely new way of categorizing cores and production structures and introduces the reader to his recently established system of core types. The analytical section deals with the history of Paleolithic laminar production in the Near East as a region of Boëda's research, trying to apply the aforementioned distinctive schemes on the archaeological record.

The first thing to point out is that in reading the work, we noticed (as indicated in the citation brackets) that this work was published in two slightly different versions: a printed version with 264 pages and a digital version with 259 pages. As far as we can tell, the main difference is that the printed version contains some more blank pages in the beginning of the book and therefore the pagination of print and PDF versions is not coherent. This is very impractical (and illogical), because if the work is cited in specific styles it is not clear which version was used. In consequence, the cited content can be on another page.

As far as we know, Boëda published some approaches explained in his 2013 work before (but we never had the chance to read his own *habilitation à diriger des recherches* from 1997 where some of the approaches could be summarized). The following list gives a short overview (not exhaustive) of his approaches published before the reviewed work:

- approaches of development lines (*lignées*) (Boëda et al. 2013)
- core classification (Boëda 2009; Koehler 2009; Boëda et al. 2013)
- techno-functional units (Boëda 1991; Lepot 1993; Soriano 2000; Boëda 2001)
- techno-genesis of laminar production in the Near East (Boëda 2006)
- definition of Levallois reduction (Boëda 1986, 1994)
- definition of bifacially discoidal reduction (Boëda 1993).

Also, he supervised many academic theses dealing with lithic analysis. Some recently mentored theses are those of H. Koehler (2009), S. Bonilauri (2010), A. Lourdeau (2010), and B. Chevrier (2013). His approaches influenced many researchers (to sum up a few): Laurence Bourguignon, Jean-Phillipe Faivre, Vincent Lhomme, Élisa Nicoud, Marie Soressi, and Guillaume Porraz.

The following sections review Boëda's latest work in its given succession. After that, we add explanations, notes and comments.

Review section one – techné and logos

Following a short introduction (Boëda 2013, 21/15 to 23/17) the work starts with its *Première partie - Un regard épistémologique* (Boëda 2013, 25/19 to 42/36), where Boëda focusses on the connection between typology and technology in prehistoric lithic research history. Treating typology and technology separately leads to loss and omission of important information preserved and in parts present in the "epiphylogenetic memory" of lithic artifacts (Boëda 2013, 36/30). Given that the archaeologist's aim is not only to understand either the forms of objects given at a certain time (of discard) in human history or the way of productional technique(s), but the whole of Paleolithic man's/society's all days needs and the ways to satisfy them via the production and use of lithic objects, we have to keep in mind that there are always people behind these objects, the producers, inventing new forms, operating in different ways, driven by traditions, environmental changes but also raw material constraints.

Tools can be modified and production schemes can be optimized, according to the technical capacities of the producers (Boëda 2013, 41/35): "*La technicité des objets est régie par des « lois » d'évolution propres à la structure des objets mais avec une nécessaire interaction entre l'homme et la technique. Nous pouvons alors parler de coévolution entre l'Homme et la technique. L'Homme crée la technique et la technique régie par des « lois » d'évolution propres à la structure des objets, informe sur son potentiel de devenir*". The evolutionary character introduced here is not determined to be linear but reflects developments which respond to techno-functional demands. As a general tendency, a progressive shift from unspecific (*abstraite*) to more specific (*concrète*) forms can be observed (Boëda 2013, 23/18): "[…] [C]*ertaines conceptions d'objets peuvent évoluer du fait de leur potentiel structural et répondre ainsi à de nouvelles contraintes fonctionnelles, alors que d'autres objets n'évolueront pas, en gardant le même registre fonctionnel et ceci quel que soit le type humain et son environnement*".

Briefly outlined, it signifies the technological development of artifacts or tools as well as production schemes and concepts in general from an *abstraite* to a *concrète* state, "*évoluant vers une meilleure efficacité*" (Boëda 2013, 34/28).

This genesis can be observed for different groups of artifacts (e.g., blades) as well as for the ways and concepts of their production. Thus, in accordance with the mentioned works of Simondon, Deforge and Leroi-Gourhan, we are faced with progressive tendencies and lines evolving through time along with man. The term used in the present work to refer to this theoretic concept is that of the *lignées* (Boëda 2013, 179/173): "*Nous définissons les éléments d'une lignée comme tout objet ayant la même fonction d'usage et mettant en oeuvre le même principe (Deforge 1985)*". The concept of the *lignée* is borrowed from Leroi-Gourhan and related to his understanding of *tendance* which designates a change in move/progress or an operating scheme, based on a functional logic, which is inherent to the technical object that is defined by *matériel* and *geste* (Boëda 2013, 35/29).

The *tendance* is part of Leroi-Gourhan's diachronic perception of technology, while the synchronic perception of technology provides information about temporality and spatiality and is related to the concept of the *chaîne opératoire*. This understanding of technology is always embedded in internal (e.g., tradition) and external (e.g., environment) milieus that are specific for each cultural group in time and space and therefore embedded in historical variability. These factors of structural dynamic are reflected in the produced objects and the production itself tending to more efficacy. Herein lies the internal logic of technicity, the human driven liaison of *techné* and *logos* – the *techno-logique*. The genesis of the technical object is the key factor for the understanding of Boëda's latest work.

Review section two – products and production schemes

From this theoretical point of view, Boëda starts his second section: *Le sens techno-logique de l'évolution: une clef pour la compréhension de la technicité humaine* (Boëda 2013, 43/37 to 174/168), where he first redefines the term 'tool' as an object consisting of three different but related parts (*partie préhensée*, *partie transmettice* and *partie transformative*) and their relation to his techno-functional approach (UTF – *Unités techno-fonctionelles*) and modifications (Boëda 1997). In the second part of the section Boëda switches from products to production and introduces the reader to his latest core type classification approach, where he distinguishes six different core types respectively structures of production.

Tools and products

Boëda's understanding of a tool (fr. *outil*) descends from Leroi-Gourhan (1964) who wrote that a tool never exists without action. For Boëda (2013, 46/40), a tool always consists of three components (see Fig. 1.1):

- the tool itself (*artefact*)
- the scheme of usage (*schème d'utilisation*)
- the energy used in the action (*energie*).

In this work, he adds the energy used to transform other materials with the tool. But unfortunately he never explains this energy, he settles for explanation of the manual use of energy and the direct and indirect grasp of the tool. The comprehension of the schemes of usage derives from ethnological and experimental research. Another methodology to understand tools is the use-wear analysis, but it is only briefly discussed in the work (Boëda 2013, 48/42).

Every tool user has a functional and a cultural aspiration. Both are highly variable, because every tool can match different usage schemes and the same usage can be done with different tools (Boëda 2013, 49/43). Additionally, the function of a tool can change as time passes. This results in an incorporation of the tool into a system of the user, the worked material, the invested energy and the tool itself (Boëda 2013, 49/43 to 53/47). The next step is to structure cutting tools into functional entities. In Boëda's past work the internal structuring of a tool consisted of two parts (Boëda 1991, 1997; Lepot 1993): a handle (*préhensile*, different forms, dimensions and technical features) and a transformation part (the cutting edge). Boëda (2013, 54/48) adds the differentiation of a third part to this scheme: the transmitting part (*partie transmettrice*), which guides the energy from the handle to the cutting edge and back. In the case of a composite tool, the handle as well as the transmitting part can include external parts as a wooden haft or a glue to fix a lithic artifact in a haft (Figs. 1.3 and 1.5). Boëda describes this much later in the work (Boëda 2013, 221/215, fig. 145).

A lithic artifact can be organized into three sections (Boëda 2013, 54/48 to 88/82) (see Fig. 1.2):

1. a working part that can transform other materials (*partie transformative*)
2. a handle or hafting part (*partie préhensée*), and
3. a transmitting part that transfers energy from one to the other (*partie transmettrice*).

To determine these parts, the morphology is of importance. To our knowledge, the first approach to determinate transformative and prehensile parts on artifacts from a Middle Paleolithic context (La Ferrassie couche M2e) was formulated at the beginning of the 1990s (Lepot 1993). Boëda shows different examples of how the units of an artifact can be described, mostly in a combination of traditional and technical drawings as well

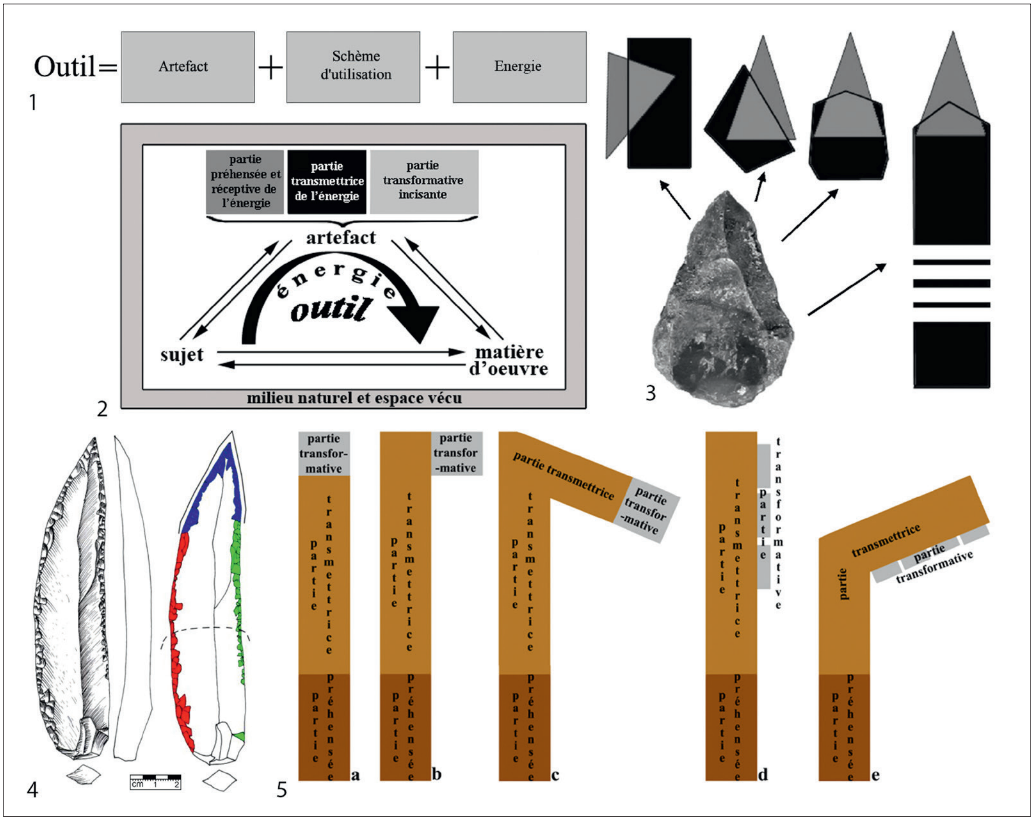


Fig. 1: *Composition of a tool. 1 structural composition of a tool after Leroi-Gourhan (1964; Boëda 2013, 46/40, fig. 4); 2 structural composition of a tool after Boëda (1991, 1997; Boëda 2013, 54/48, fig. 11); 3 specific example of hafting possibilities of a Levallois point after Bonilauri (2010; Boëda 2013, 48/42, fig. 7); 4 specific example of Techno-functional Units of a Hummalian blade (Boëda 2013, 85/79, fig. 32.4); 5 Techno-functional Units of composite tools (Boëda 2013, 121/115, fig. 221).*

as symbols with prominent colors (Boëda 2013, 80/74, fig. 29). For a better understanding of some of the divisions into different parts, a side view in drawings would also be useful (see Fig. 1.4).

Core types and production schemes

By trying to overcome typological criteria and to support the technological understanding, Boëda defines the structuring of the production by establishing different core types as well as their chronological attribution. Boëda's core type classification comprises six main types (A-F) that can be divided in up to three subtypes. These are either based on their production concept or on different blank types (flake, blade/bladelet or point) provided. According to Boëda, the individual types also show an evolutive character aspiring to more conceptual complexity (Boëda 2013, 97/91).

Before talking about these different core types in more detail, however, it is important to briefly summarize some superordinate features designating Boëda's classification. One of the main distinctive features in core technology is the division in *abstraites* (additional) and *concrètes* (integer) structures (Boëda 2013, 89/83 and 93/87). While the *abstraite*/additional structure divides the core into two subsystems, the useful and the non-useful core-volume where only the useful part is considered as core *sensu stricto* (Boëda 2013, 100/94), the *concrète*/integer structure only consists of the useful core volume obtained by complete shaping (*initialisation* and *configuration*) of the bloc (Boëda 2013, 138/132) (see Table 1).

The second feature of overriding importance is the dichotomy between homothetic and non-homothetic structures (Fig. 2). While the first is reserved to the *concrète* types, the latter is a common feature of the *abstraites* and some of the *concrètes* ones. In general, a homothetic structure is present, when only the size of the core changes but its main morphological aspects stay stable. Here we can further distinguish between homothetic structures with re-initialization/reshaping (e.g., preferential Levallois or maintaining a side scraper) and continuous homothetic structures, where the continuous *débitage* process without any necessary reshaping leads to volumetric diminution but stable core morphology (e.g., for some laminar productions; Boëda 2013, 94/88 to 95/89). Homothetic cores can produce very standardized blanks (for example punch blade cores from the Mesolithic, Magdalenian blade cores or the *livre de beurre* from the Neolithic, type F2). Non-homothetic cores can produce less standardized blanks because every removal will change the shape of the flaking surface and the morphology of the whole core. An example of an inter-type would be the discoidal reduction which can be, but does not have to be of homothetic structure.

The last thing to be clarified in advance is Boëda's understanding or definition of a core in general. For him the whole bloc is the core but it has to be prepared and shaped as that in its entirety (Boëda 2013, 148/142): "*Le bloc configuré dans son intégralité est le nucleus*". If not so, Boëda divides the piece into two distinct volumes: the *volume utile* and the *volume non-utile* (Fig. 3), where only the prepared and used part of the piece is understood as the core and the rest stays apart from the technological consideration (Boëda 2013, 108/102). In Boëda's (2013, 100/94) words: "[… L]*'utilisation d'une partie du bloc/volume utile appelé nucléus. Le reste du bloc n'ayant aucun rôle technique est le volume résiduel, non utile*".

Core type	conceptual structure	Used volume	Non-used volume	Transformative part of the removal	Handle or hafting part of the removal
A	*abstraite*/additional	indifferent	indifferent	indifferent	indifferent
B	*abstraite*/additional	recurrant débitage	indifferent	differentiated	indifferent
C	*abstraite*/additional	use of natural convexities in a recurrent form	indifferent	differentiated	differentiated
D	*abstraite*/additional	use of convexities and other recurrent managements	indifferent	differentiated	differentiated
E	*concrète*/integer	use of convexities and other recurrent managements	non-existent	differentiated	differentiated
F	*concrète*/integer	use of convexities and other recurrent managements	non-existent	differentiated	differentiated

Table 1: *Conceptual structure and characteristics of the core types proposed by Boëda.*

This distinction can be attributed to the *abstraites* core Types (A-D). The *concrètes* Types (E-F) show a complete configuration and thus are understood as cores in their entity (Boëda 2013, 138/132): "*Dans cet ensemble, le volume utile se confond avec l'intégralité du volume du bloc, alors appelé nucléus*".

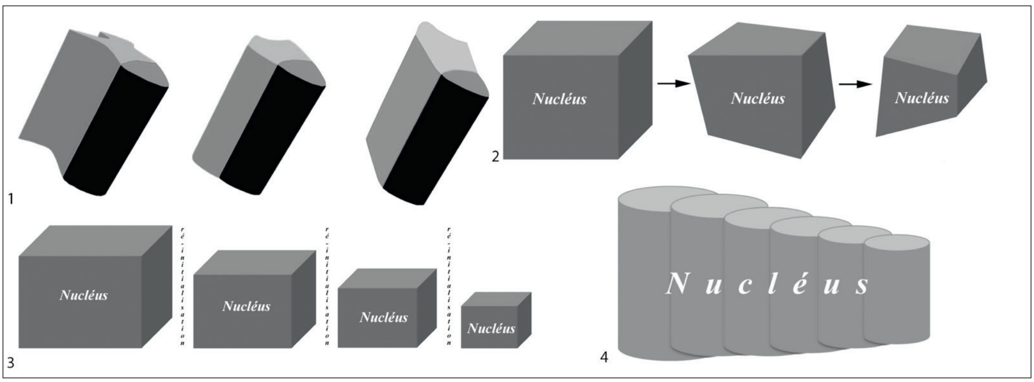


Fig. 2: *Homothetic and non-homothetic core structures. 1 general scheme of non-homothety (Boëda 2013, 91/85, fig. 36); 2 general scheme of non-homothetic core reduction (Boëda 2013, 96/90, fig. 43); 3 general scheme of homothetic core reduction with reinitialization phases (Boëda 2013, 95/89, fig. 41); 4 general scheme of continuous homothetic core reduction (Boëda 2013, 95/89, fig. 42).*

After this global view, we take to a closer look at Boëda's core classification approach. As already mentioned, he defines six main types, denominated Type A to F. While the Types A to D designate the *abstraites* core structures and are all non-homothetic, the Types E and F refer to the *concrètes* ones but only Type F is homothetic (E can be but does not have to, see Fig. 2).

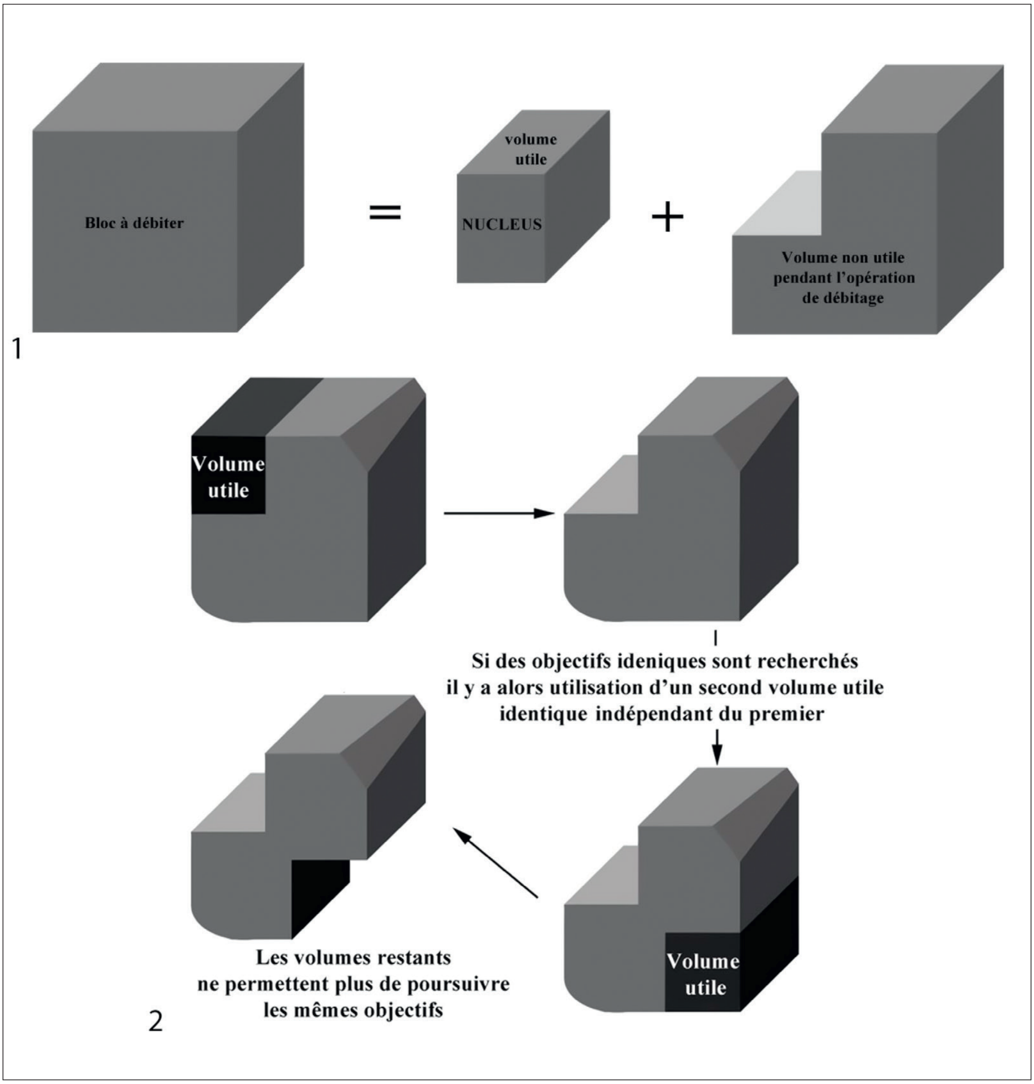


Fig. 3: *Differentiation of core volumes. 1 general distinction of a bloc into used (core sensu stricto) and non-used volume (Boëda 2013, 90/84, fig. 35); 2 general scheme of volume differentiation within distinct reduction sequences (Boëda 2013, 91/85, fig. 37).*

Type A and B

The core Type A (Fig. 4.1) as well as Type B (Fig. 4.2) are introduced without any subdivision. They represent the most basal and archaic *débitage* concepts, where no or nearly no additional investment is needed regarding *initialisation* or *configuration* activities. Flakes showing at least one cutting edge are the common and desired blank type. Criteria for Type B are that the bloc should have one striking platform that might be obtained by *initialisation*, allowing the detachment of a small flake sequence in a slightly more standardized form than Type A. On a chronological scale, they both are representative for very early lithic industries (see Fig. 4).

Type C

Core Type C (Fig. 5) also falls into the range of the very early lithic industries. It is characterized by natural convexities enabling the detachment of small series of more or less predetermined blanks – flakes for subtype C1 (Fig. 5.3) and blades for subtype C2 (Fig. 5.4) – varying from core to core. Especially C2 is the first representative of a volumetric blade production. Even in absence of *confection* (for C2), precise techno-functional criteria can be observed on the produced blanks (Boëda 2013, 113/107). Despite the technological evolution of the production schemes and the necessary knowledge of the whole assemblage (Boëda 2013, 119/113) one can also be confronted with a multitude of different core types (presence of evolved laminar knowledge F2 and presence of inferior blade production D2) in one assemblage (Boëda 2013, 126/120). Here, raw material quality and availability might be a reason for this (Boëda 2013, 138/132).

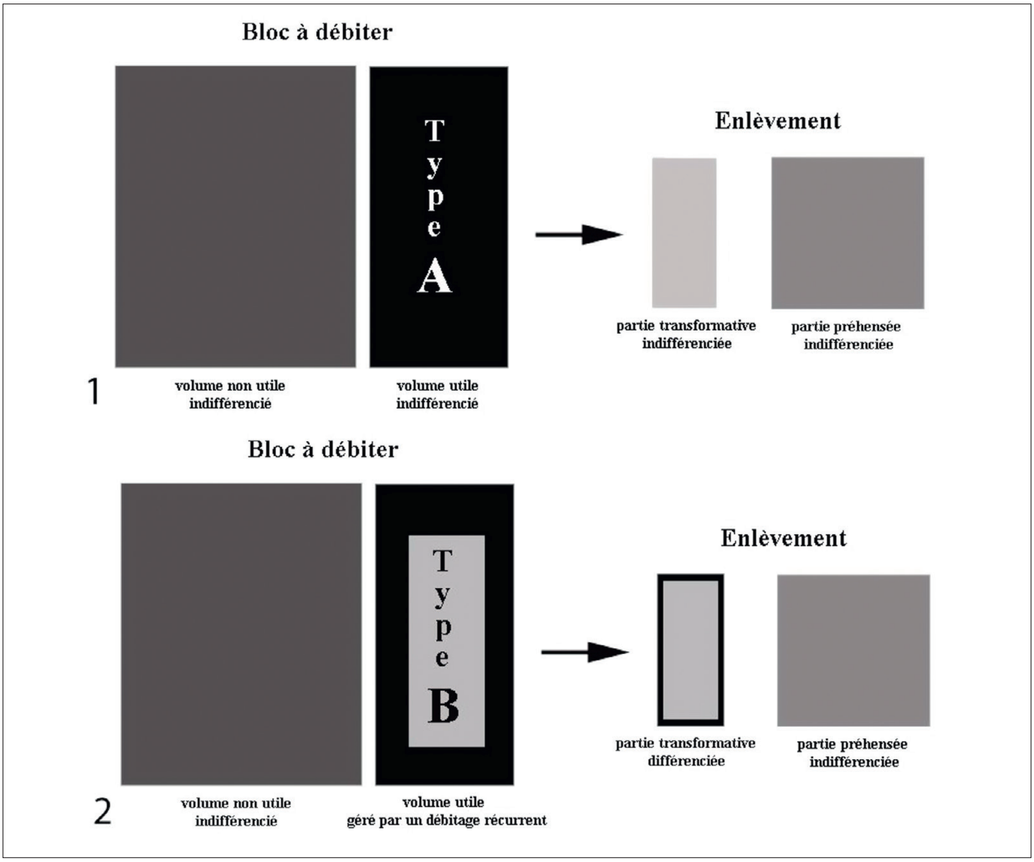


Fig. 4: *General scheme of core type A (1) and core type B (2) (Boëda 2013, 100/94, fig. 45 and 101/95, fig. 46).*

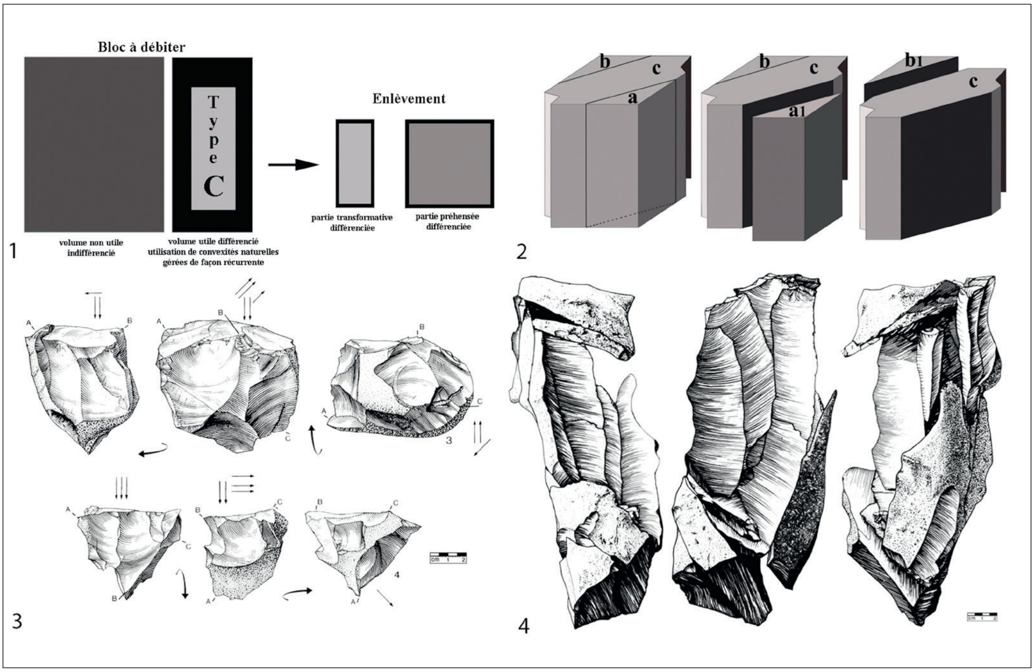


Fig. 5: *Core type C. 1 general scheme (Boëda 2013, 102/96, fig. 47); 2 core volume differentiation within distinct reduction sequences (Boëda 2013, 107/101, fig. 52); 3 specific example of core type C1 from High Lodge after Ashton et al. (1992; Boëda 2013, 108/102, fig. 53); 4 specific example of core type C2 from Saint-Valéry-sur-Somme after de Heinzelin de Braucourt and Haesaerts (1983; Boëda 2013, 110/104, fig. 56).*

Type D

Core type D is of volumetric conception and shows a higher but variable extent of *initialisation* and *configuration* (Fig. 6). It is characterized by either a preferential or recurrent production. According to the blanks produced, it is differentiated into type D1 for the production of flakes (Fig. 6.3), D2 for blades or bladelets (Fig. 6.4) and D3 for triangular blanks/points (Fig. 6.5). Each of the subtypes shows different schemes of initialization. The blank production D1 can be initialized by Kombewa, a Levallois like scheme or be of Victoria West style (Boëda 2013, 123/116 to 126/120). For Type D2 the initialization consists mainly in preparing distal and lateral convexities (Boëda 2013, 126/120). The triangular blanks (points) of D3 are obtained after an adequate initialization of the bloc, but there is no further specification given by Boëda. The obtained points either fall in the range of *typo pointes Levallois* or of *pseudo-typo pointes Levallois* (Boëda 2013, 132/126). In its chronological position, D1 precedes Levallois (F1). Core type D2 succeeds C2 but precedes F2 and can be found contemporaneous to E2 (Boëda 2013, 131/125). But the use of core type D can also be related to raw material economy, where it represents (for D3) a solution *ad minima* for the production of points (Boëda 2013, 132/126).

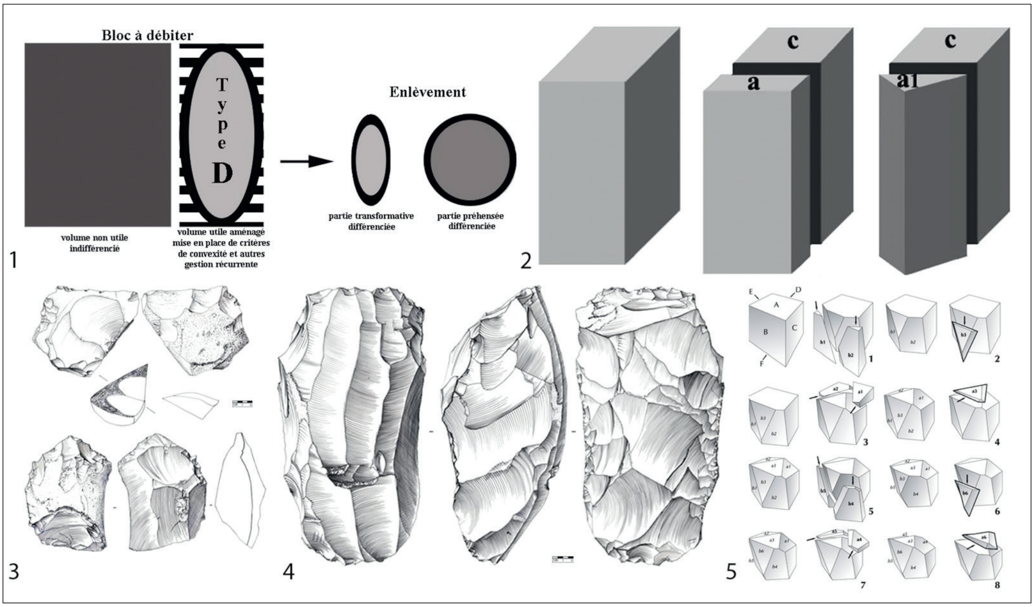


Fig. 6: *Core type D. 1 general scheme (Boëda 2013, 102/96, fig. 48); 2 core volume differentiation with configuration (Boëda 2013, 118/112, fig. 63); 3 specific example of core type D1 with Kombewa initialization from Barbas C'3 (Boëda 2013, 121/115, fig. 65); 4 specific example of core type D2 from Barbas II (Boëda 2013, 129/123, fig. 76); 5 schematic illustration of core volume differentiation (D3) within distinct reduction sequences from Villiers-Adam (Val d'Oise) after Locht et al. (2003; Boëda 2013, 135/129, fig. 83).*

Type E

Type E (Fig. 7) is the first of the *concrète* core types (*structure volumétrique dite concrète*), wherein Boëda distinguishes type E1 (Fig. 7.1) for the discoidal concept (Boëda 1993) and type E2 (Fig. 7.2) for pyramidal blade cores. Both are of volumetric conception, need investments of *initialisation* and *configuration* and allow a recurrent blank production. There is no more distinction between a used and an unused volume of the bloc, the whole bloc represents the core. The produced blanks show a high grade of predetermination and the negatives and scars left by them operate to predetermine further production. Herein lies the *auto-configuration* of this core type (Boëda 2013, 144/138).

The discoidal type E1 allows a heterogeneous production of four distinct flake types (Fig. 7.3): *Eclats débordants* and *pseudo-pointes Levallois* in cordal direction (along the plan of intersection) and rectangular or blade like flakes in centripetal direction (Boëda 1988, 1993, 1995; but see also Slimak 2004). The pyramidal core type E2 allows the recurrent production of blades or elongated points (Fig. 7.4).

Type F

The last group of cores is the core type F (Fig 8). In contrast to the types E, two distinct phases are necessary. Firstly, the phase of *initialisation* to configurate the core (as one used volume) and, secondly, the phase of *production* (Boëda 2013, 148/142). The core Type F is subdivided into three different subtypes (F1, F2, F3). F1 designates the classical Levallois concept for preferential and recurrent *débitage* (Fig. 8.4) with its multitude of blank forms, after Boëda's established five criteria (Boëda 1986), where he adds a sixth one, the *auto-corrélation* of the core (Boëda 2013, 165/159), responsible for the *homothétie* of this core type due to the hierarchy of its surfaces (Fig. 8.1). F2 is exclusive for the production of blades and bladelets (Fig. 8.2). As well as for F1 we find homothetic

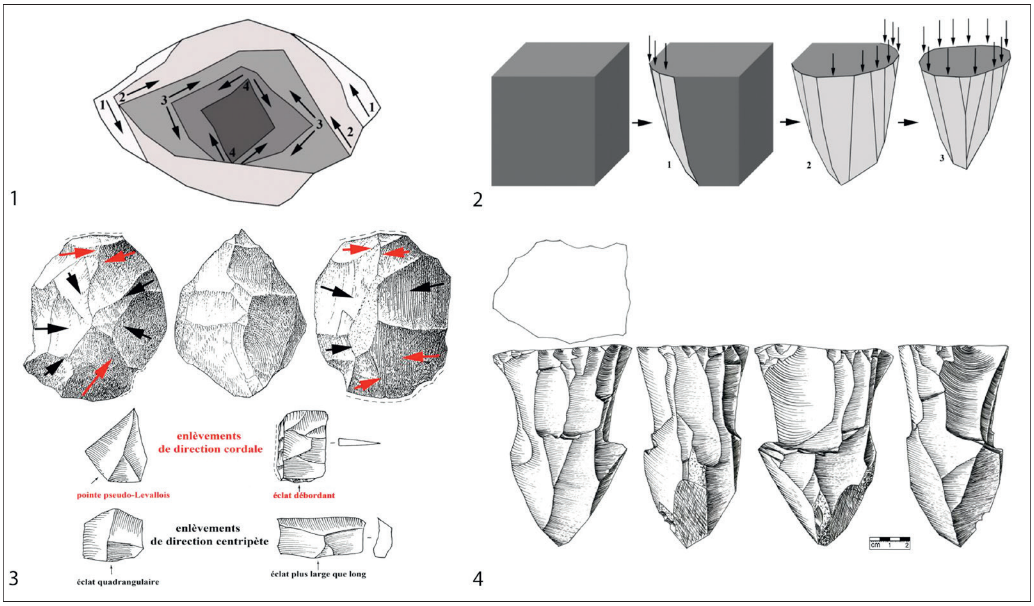


Fig. 7: *Core type E. 1 and 3 general scheme of discoidal reduction (E1) and example from Kůlna cave with different blank morphologies (Boëda 2013, 145/139, fig. 96 and 140/134, fig. 88); 2 and 4 general scheme of pyramidal reduction (E2) and example from Kaféine (Boëda 2013, 145/139, fig. 95 and 141/135, fig. 90).*

cores, but F2 has an auto-correlating character. Further on we find a very high and *concret* degree of standardization in blade production (Fig. 8.5) where a development from marginal direct percussion via indirect percussion to pressure flaking can be observed (Boëda 2013, 163/157). The subtype F3 represents a very special case and a *lignée* on its own because it is only attributable to pebbles, where only the *selection* is part of the *initialisation* (Figs. 8.3 and 8.6). Type F3 is obtained by the splitting of blocs via bipolar percussion, obtaining twin-flakes (Boëda 2013, 150/144 and 170/164). While the subtype F3 is the most specific and unique case in Boëda's whole conception, the products of F1 and F2 can also be obtained (morphologically and typologically) through other core types: Blanks similar to those produced with F1 or F2 can be produced with D, E or C as well. Blades are produced with types C2, D2, E2 and F2. Typological Levallois points can be produced with types D3, E2 and F2. Flakes similar to Levallois flakes (F1) can be produced with D1 (Boëda 2013, 151/145): "*Les techno-types produits par ces deux Types F1 et F2 n'ont rien d'original puisqu'ils peuvent être obtenus avec des débitages de Types D, E et C. Les lames peuvent résulter des Types C2, D2, E2 et F2 ; les typo-pointes Levallois peuvent provenir des Types D3, E2 et F2 et les typo-éclats Levallois de débitages de Type D1. Il ne semble donc pas exister d'adéquation entre un type de produit et la structure volumétrique du volume utile aux dépens duquel il est obtenu […]*".

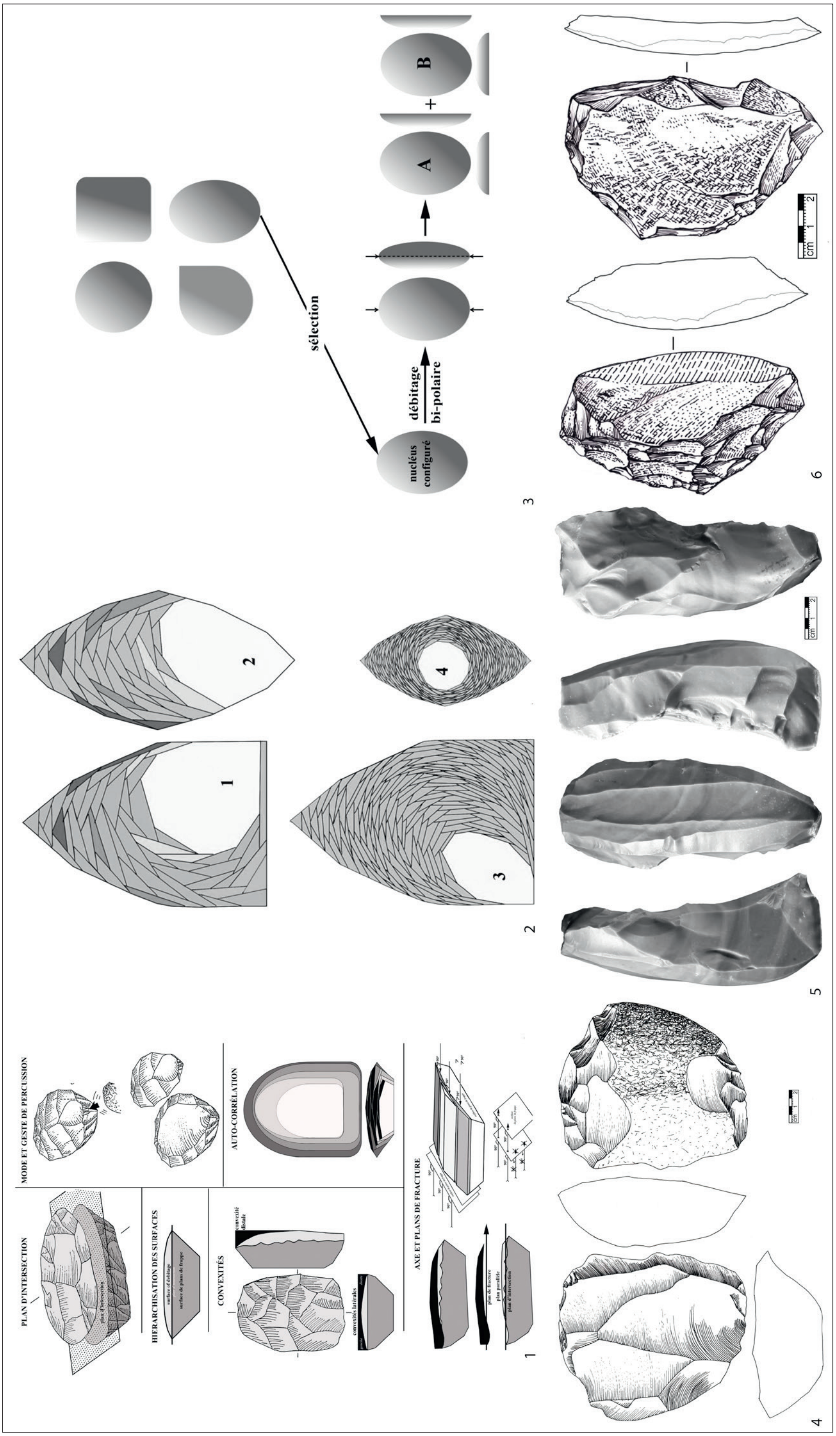


***Fig. 8:** Core type F. 1 and 4 general Levallois criteria (F1) and example from the Basin de Palmyre (Boëda 2013, 166/160, fig. 120 and 157/151, fig. 111); 2 and 5 general schemes of type F2 (blade and bladelet reduction) and example from Villazette III (Boëda 2013, 168/162, fig. 121 and 168/162, fig. 122); 3 and 6 general scheme of F3 (split flaking) and example from Maomaodong (Boëda 2013, 150/144, fig. 100 and 173/167, fig. 127).*

Review section three – Chronological phases and blade production in the Near East

In the third main and analytical section of the work (Boëda 2013, 175/196 to 222/116), Boëda uses the recently elaborated schemes and *lignées* on the Paleolithic record of the Near East and the blade based industries which are present there. Here, Boëda presents a chronological distinction of five phases (Amudian 300 – 200 ka; Hummalian 200 – 150 ka; sporadic laminar industries (with Levallois domination) 150 – 47 ka; transitional industries 47 – 36 ka; Ahmarian and younger industries 36 – 7 ka (Fig. 9 and Table 2).

At first, only the chronological and geographical setting is given (*le temps chronologique*) while naming some reference sites and their datation (Boëda 2013, 183/177 to 190/184). The reader is forced to accept these phases without any further

	reference name	chronological Position	geographical setting	production sheme	examples	laminar core types present
Phase 1	Amudian	300 - 200 ka	Levant (Lebanon, Israel)	first laminar industries	Tabun XI, Abri Zumoffen, Qesem	(C2), (D2)
Phase 2	Hummalian	200 - 150 ka	Levant, Syria	laminar (without retouch)	Yabrud 13 and 15, Hummal, Umm el Tlel, Tabun D	(C2), D2, F1
Phase 3	sporadic laminar	150 - 47 ka	Levant, Palmyre	laminar with or without Levallois	Rosh Ein Mor, Ain Difla, Umm el Tlel	(C2), D2, F1
Phase 4	Transition	47 - 36 ka	Levant (Lebanon, Israel)	laminar with some Levallois persistence	Ksar-Akil, Boker Tachit, Umm el Tlel	C2, D2, (E2), F1 (sporadic), (F2α)
Phase 5	Ahmarian (and younger)	(43) 36 - 7 ka	Levant (Lebanon, Israel)	fully laminar; change from abstract D2 to concrete F2	Kebara IV-V	D2, F2 (β,ɣ,δ)

***Table 2:** Summarizing Boëda's five phases of laminar production in the Near East. Core types in brackets appear only in some figures and are not mentioned in the corresponding text.*

techno-typological indications referring to this distinction. The main part of the section (*Paléo-histoire technique des modes de production et leurs outils*) deals more specifically with the five chronological phases in the Paleolithic record of the Near East. The goal is to combine chronological and evolutionary aspects focused on the production of laminar blanks, but also the break and change from one *lignée* to another (Table 2).

Phase 1 – The Amudian

This phase designates the first appearance of laminar blank production in its archaic and abstract form between 300 and 200 ka BP in the Levant (Lebanon and Israel). Concerning the production modes, Boëda describes a turn from the preceding bifacial Acheulean to mainly flake based industries. For blades (C2 and D2) there is an absence of retouched forms, which lets them stay in an *abstrait* state. The prehensile part (*partie préhensée*) shows a strong normalization. Following Boëda, two breaks are evident

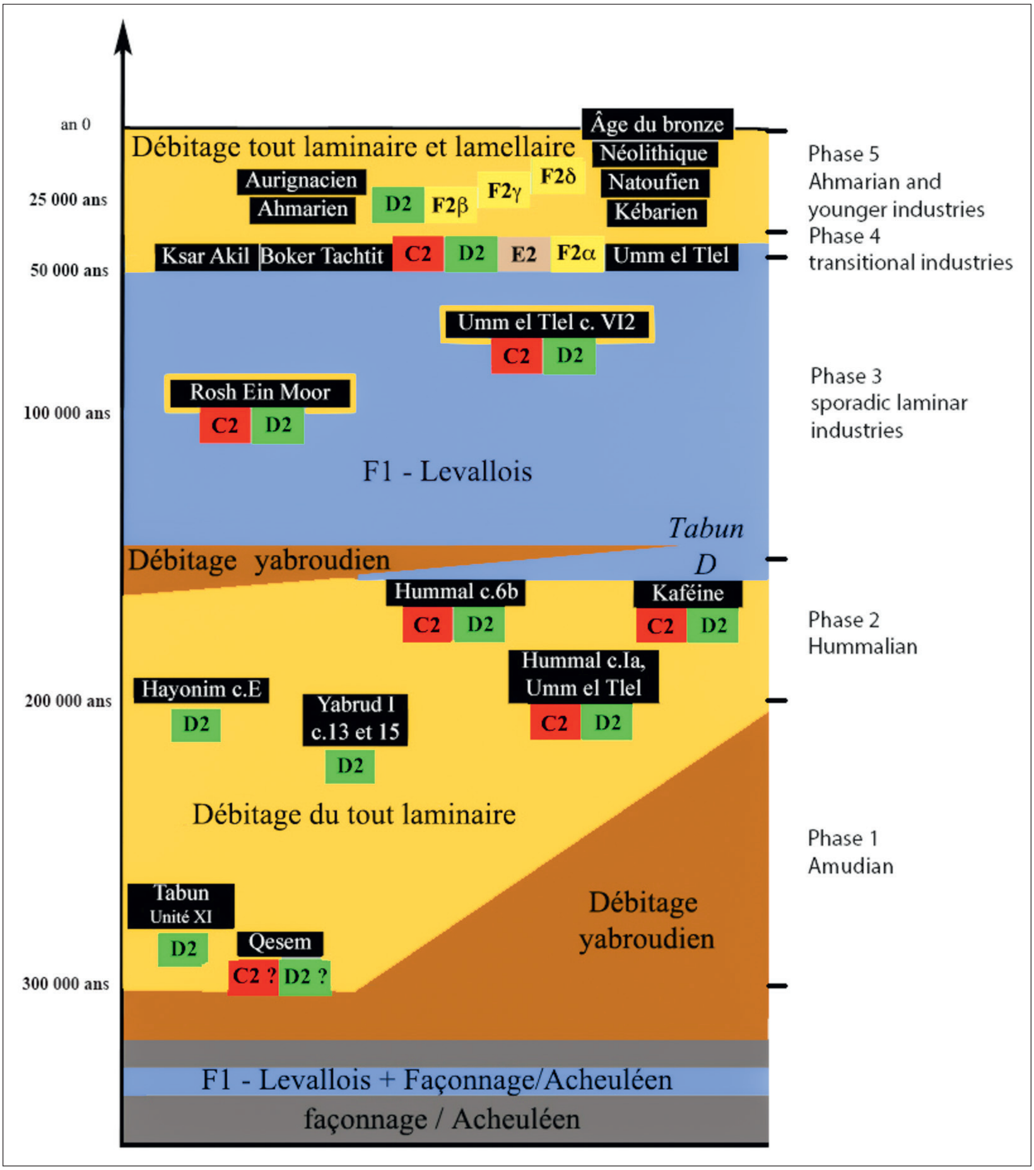


Fig. 9: *Chronological phases of laminar reduction in the Near East with reference sites and observed core types (modified after Boëda 2013, 197/191, fig. 132).*

during this phase. The break from bifacial Acheulean to the flake orientated Yabrudian is an expected one, because the normalized flake production and the resulting tools respond better and more adequately to current needs. However, Boëda does not further clarify this hypothesis. At the same time, the blade based Amudian sees its dawn as well.

Compared to the Yabrudian, it is more of a contemporaneous phenomenon completing the technical production schemes, and not a succeeding evolutionary state (Boëda 2013, 198/192). The blade based Hummalian succeeds both the Yabrudian and the Amudian.

Phase 2 – The Hummalian

During the Hummalian, a focus on blade production holds on in tradition to the Amudian, but flakes disappear nearly completely from the assemblages. Here, the differentiation and concretization of blade tools advances whereas the production schemes stay in the tradition of the Amudian (D2). Another transition towards a Levallois based production (F1) is observable during the Hummalian (Boëda 2013, 201/195), but the focus lies on laminar blanks and associated tools.

Phase 3 – sporadic laminar industries (with Levallois domination)

This phase is characterized by sporadic presence of Levallois concept (flakes and blades) as well as D2 blade production. Here we find numerous sites distributed over a large area. The chronological position ranges from 180 ka to 90 ka (Ain Difla) for the Levant and 110 ka to 70 ka (Umm el Tlel) for the regions of Palmyra (Boëda 2013, 188/182).

Phase 4 – Transition

The fourth phase designates the so-called industries of transition. It shows a massive focus on blade production (with only some sporadic presence of laminar Levallois points (Boëda 2013, 204/198). Even if the needs did not change fundamentally, the tool types show changes. It seems as if the producers tend to more standardized blank (blade) production which are modified afterwards to all kinds of different tool types (*sélection a posteriori*) (Boëda 2013, 205/199) instead of tool specific blank production (like endscraper versus sidescraper). In general, widespread changes mainly concerning the *partie préhensée* of the artifacts are observable. With this background, the quasi totally blade based production shows several structural advantages. In the first place, this affects the elongated *partie préhensée*.

Boëda summarizes the following structural advantages of blades and blade production. A specific zone of maintenance allows: 1. multiple modes of prehension, that creates new gestures, new functionalities and thus new functions; 2. new transformative parts that lead to new functions and new functionalities; 3. to multiply the potential energy, creating new techno-functional units, called *partie transmettrice de l'énergie*, which is situated between the *partie préhensée* and the *partie transformative* and; 4. new performing energies like the kinetic energy related to the length of the *partie transmettrice* and the functional mode. And, in general the possible maintenance of blades shows the same zones as for flakes (i.e. backed pieces) and the same types of *parties transformatives* (Boëda 2013, 206/200 to 207/201). In this phase, bladelet production is present, too – a phenomenon observable in all *tout laminaire* production industries (Boëda 2013, 213/207). Boëda claims that from a strictly evolutionary point of view, phase 4 could have succeeded phase 2 immediately (see Boëda 2013, 209/203 to 212/206).

Phase 5 – Ahmarian and younger industries

In phase 5 the *tout laminaire* is the only production scheme without any concurrence. It summarizes all kinds of industries after the transition. There is a change from the *abstraite* D2 blade production (Fig. 6) to the *concrète* F2 production of blades (Fig. 8). The products are highly normalized and through the invention of the pressure technique even highly standardized. Another important point lies in the widespread presence of tool hafting. The handle elongates the tool and leads to other relations of the three main parts of the tool (see Fig. 1.5). Here, the blade is used entirely or in fragments in composite tools (*artefacts lithiques multiples*). The artifacts become more specific. They can be a tool or part of one and are therefore submitted to a multitude of modification needs (Boëda 2013, 222/216).

Review of the conclusions

The last chapter (Boëda 2013, 223/217 to 236/230) entitled „*Conclusion*“ is not a conclusion in the strict sense of the word – as is clearly announced by Boëda himself (2013, 223/217). As mentioned in the introductive chapter, again Boëda emphasizes the loss of information, artifacts and assemblages through time. In fact, all this information from production technologies, functional aspects and, in the whole, cultural preferences are reflected in the artifacts. But through taphonomic processes, for example, this information becomes more and more scattered, though it is the archaeologist's task to reveal it as far as possible. Therefore, technological knowledge, as well as ethnographic comparison, is necessary to get back to the idea of the prehistoric reality. A simple typological analysis could never achieve this.

Following this theoretical introductive part, Boëda returns to the central theme again, closely related to these thoughts, the *lignée* and its relationship with the archaeological record.

If we accept the proposed techno-logical *lignées* in their evolutionary way as seen by Boëda (though this could be criticized), they can help with the understanding and interpretation of archaeological records concerning techno-cultural sequences, assimilations or breaks, and lead to further research questions. The four cases or situations introduced in this chapter are only examples of a multitude of further possibilities pointing in the same direction which can be encountered in the archaeological work. The examples show different situations of how artifacts belonging to two different *lignées* in different states or phases of their evolutionary cycle, can be found together on a single site. While the different *lignées* can be analyzed separately regarding their technological evolution on their way to conceptual concretization, this separation is not present in the assemblages itself, where we only observe a sequential change. That implies further questioning about the techno-cultural incidents in prehistoric times either external or internal or both (Boëda 2013, 231).

While seeing the *lignées* as evolutionary cycles, we can find artifacts of each phase of these different cycles as well as artifacts belonging to different *lignées* in their different phases (Table 3).

The archaeological implications resulting from these examples are as follows:

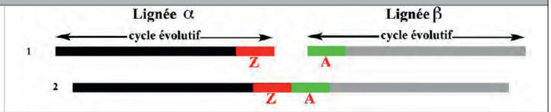
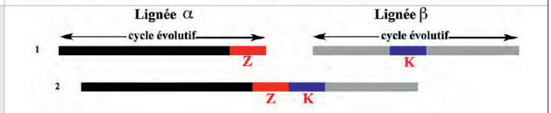
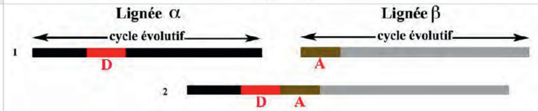
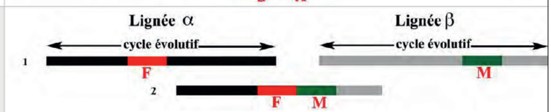
	Lignée *α*	Lignée *β*	Illustration 1) ontological genese 2) historical / archaeological succession present at site
Situation 1	object Z end of cycle	object A begining of cycle	
Situation 2	object Z end of cycle	object K middle of cycle	
Situation 3	object D middle of cycle	object A beginning of cycle	
Situation 4	object F middle of cycle	object M middle of cycle	

Table 3: *Summarizing of Boëda's four scenarios for appearance and succession of different* lignées *present in historical/archaeological record (Boëda 2013, 232/226, fig. 150; 233/227, fig. 152; 234/228, fig. 154 and 235/229, fig. 155).*

For situation 1 the change is logically awaited because *lignée a* is at its last concrete phase and *lignée β* starts in its abstract form. But from the archaeological view one has to prove if the other preceding phases of *lignée a* are also present at the site or in neighboring sites or not. If the answer is yes, one should take a local phenomenon into account, according to Boëda. If the answer is no, it could signify a migration or acculturation phenomenon.

For situation 2 one should also investigate the presence or absence of preceding phases of *lignée a*, but the abrupt presence of an already evaluated phase (*en cours d'integration structurelle*) of *lignée β* indicates its invention elsewhere and therefore represents an acculturation phenomenon (Boëda 2013, 233), where further research about the present course of *lignée β* is recommended. Thus, the presence or absence of subsequent phases of *lignée β* can either indicate a single event of occupation (no further phases present) or the arrival and ongoing occupation of a population (further phases are present).

Situation 3 is the opposite. One observes a rupture between *lignée a*, present in the middle of its cycle, and the advent of *lignée β* at its beginning and abstract phase. For Boëda, two scenarios can be seen here. The first one is related to one single population changing its technicity rapidly while adopting that new technological approach. In the second scenario, two different populations are involved, i.e., a new group arriving after the abrupt abundance of the preceding one. In any case, the necessity of clarification concerning possible phases present anterior to phase D (*lignée a*) is given, in order to answer questions like whether there has been a stable population or not.

In situation 4 the same conditions are present for *lignée a* as in situation 3. But for *lignée β* one observes the direct presence of an already evaluated phase. Here, the appropriate interpretation following Boëda would be a break of occupation with one population leaving and another one arriving, with both in the middle of their own different technological cycles (Boëda 2013, 235).

These examples might help to understand techno-cultural changes (in an inter and intra population way), due to internal or external factors like environmental changes. Boëda's interpretative implications given here are often related to different populations or acculturation phenomena due to migration that should nevertheless be taken into consideration.

Explanations, notes and comments

While reading Boëda's work, it turned out clearly that some approaches, ideas and explanations are missing or hard to understand. Here, we want to summarize and clarify the most important ones. The following tries to explain terms used by Boëda to describe core conceptions as well as the production and modification of a tool. All of these terms used to characterize steps in a lithic *chaîne opératoire* are spread all over the work and are defined differently in the literature. We would expect that they could be defined in a chapter at the beginning of the work. Our aim is to explain the idea behind Boëda's use of these terms and also to give alternative explanations if necessary.

Selection

In the approach of a lithic *chaîne opératoire* (e.g., Karlin et al. 1986; Boëda et al. 1990; Inizan et al. 1995), the term *selection* is used to describe the selective process of procuring lithic raw material. With regard to Boëda's (2013, 47/41) work, *selection* means the process of choosing raw material blocs of a specific morphology or the selection of specific surfaces to have the possibility to fulfill a distinctive lithic concept. The term *selection* is used 34 times in the whole book and is explained in the first part of section two (Boëda 2013, 53/47). It is separated into four schemes:

1. selection of a natural support that represents the general volumetric characteristics of the future tool, where a cutting edge is needed
2. selection of a bloc which has to be formed (*façonnage*) and where a cutting edge is needed
3. selection of a bloc which has to be knapped and where a cutting edge is needed at the support
4. a mixed variation with partial *façonnage*, *confection* (retouch) or *débitage*, partial *façonnage* and *confection* (retouch).

In Boëda's (2013, 52/46) understanding, the process of *selection* corresponds to an act of predetermination, or in other words, the producer and user of a tool will select a bloc (raw piece), a core or a support (or a retouched piece) that fits into a specific scheme of how a piece should be formed to produce a support or a tool or to use it as it is. For Boëda (2013, 147/142 and fig. 98) it is also possible to select just a part of a raw piece to form a core. The act of raw material procurement from a source is never mentioned in the work. Only aspects of raw material availability and knapping properties are put into consideration at some point (e.g., Boëda 2013, 111/105).

Initialisation

The *initialisation* describes the transformation of a raw piece (*bloc*) into a core (Boëda 2013, 87/81): “*Le bloc de départ fait subséquemment l’objet d’une initialisation aboutissant à un nouveau volume, le nucléus*”. It describes how volumetric shaping of different surfaces predetermines the morphology of the blanks to be produced (Fig. 10). In the section of the different core types (Boëda 2013, 94/88 to 168/162), specific ways of *initialisation* are imaged for each type of core reduction. The *réinitialisation* corresponds to the rejuvenation of a core (Boëda 2013, 87/81) and is important for maintaining specific core types (like Levallois or laminar cores). In the whole work, the term *initialisation* is used 15 times and the term *réinitialisation* 12 times.

Configuration

The term *configuration* can be found 27 times in the work. In the descriptions of the terms *configuration* and *initialisation* they are melted together. It is not obvious

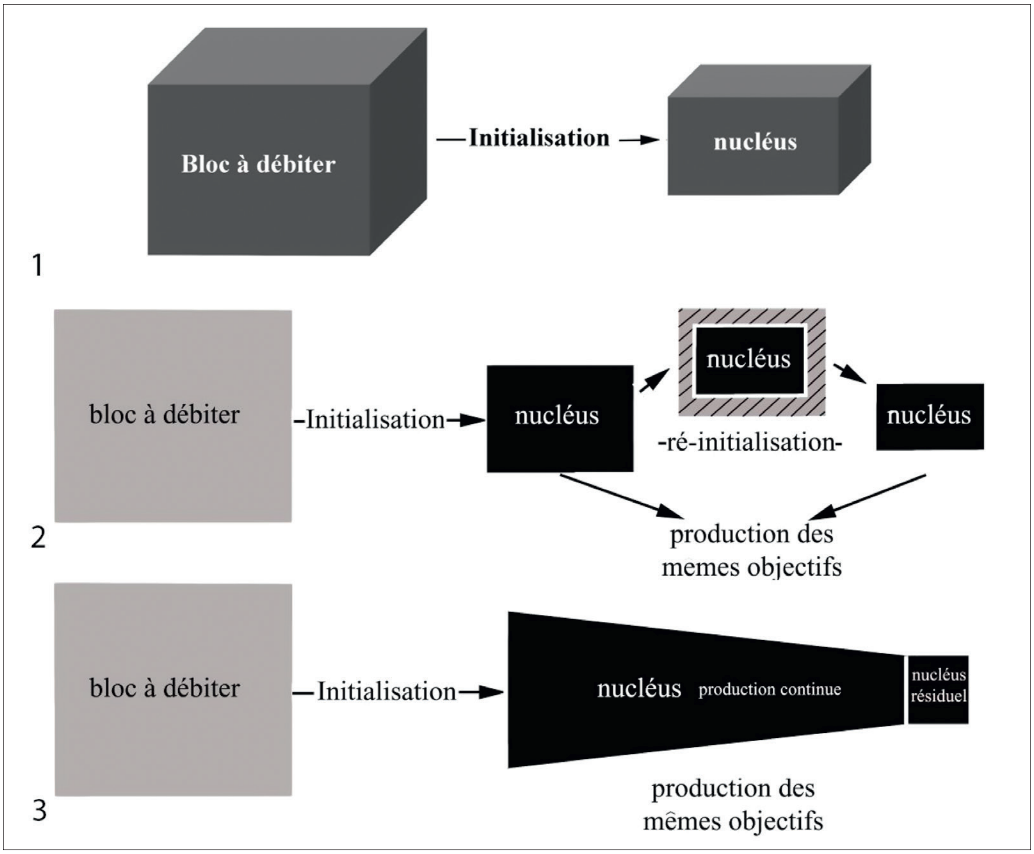


Fig. 10: *General scheme of core initialization. 1 simple initialization of a bloc (Boëda 2013, 93/87, fig. 39); 2 core reduction with primary initialization and reinitialization (Boëda 2013, 94/88, fig. 40.1); 3 continuous core reduction with primary initialization (Boëda 2013, 94/88, fig. 40.2).*

how they differ from each other. On page 148/142 the *configuration* is a phase of the *initialisation*. On the same page, Boëda distinguishes the two terms for other core types. For Levallois (F1) and laminar cores (F2), the *initialisation* forms a core which is called "*nucléus configuré*" (Boëda 2013, 149/143). In our comprehension, the confounding of the terms *initialisation* and *configuration* leads to misunderstanding, which needs to be clarified by a definitional separation of these terms. Therefore, according to our understanding, we would like to propose the following distinction:

1. *initialisation* – the first knapping steps on a raw piece, mostly the decortication, the building of a first striking platform and the forming of an edge angle which fits for the used technique.
2. *configuration* – the following steps, forming a core in a specific manner by removing shaping flakes to fulfill the criteria of a litho-technological concept (for example to produce a crested edge or convexities).

Production

The term *production* appears 345 times in the work. It integrates two modes: the *débitage* (production of a blank) and the *façonnage* (production of a tool with massive surface modification, like a bifacial element) and is used in the sense of Inizan et al. (1995).

Homothétie

The term *homothétie* derives from mathematics, where it designates a centric dilation around a center with a cycle modification factor. Boëda uses this geometrical description to explain two variations of core reduction (Fig. 2):

- First, a homothetic core and its reduction will not change its geometrical and morphological characteristics with continued reduction (Boëda 2013, 95/89).
- Second, a non-homothetic reduction process will change the geometrical and morphological characteristics of the core (Boëda 2013, 96/90).

The term *homothétie* is used three times, *homothétique* 19 times and *homothétiques* six times.

Auto-corrélation

The term *auto-corrélation* is used seven times and is first mentioned on page 40/34 in an evolutionary sense to describe the internal relations of different functions of an object. Boëda compares this with pressure flaked cores or bipolar splitting (Boëda 2013, 41/35). The next time the term is mentioned in the section where Levallois reduction (core type F1) is described (Fig. 8). Here (Boëda 2013, 165/159), the synergy of the criteria for Levallois is called *auto-corrélation* and is linked to corrections of knapping accidents and the predetermination of blanks. The term *auto-corrélation* has its origin in statistics and signal processing. It describes how similar a function or signal is to the original one. The third time (Boëda 2013, 167-168/161-162) the term is used to describe the mostly continuous reduction process for leptolithic cores (core type F2). Maybe the term *auto-corrélation* is not the best term to describe these lithic phenomenon. For us it seems that the term *continuité* fits much better. For example, preferential and recurrent Levallois reduction are non-continuous reduction processes on a convex surface. After every series of blank production, an intensive configuration step is necessary to restore a core. The succession is as follows (see for example Boëda 1994): raw piece (a bloc) > initialization > pre-core > configuration > core > production of predetermined blanks > reduced core > re-configuration > restored core > production of predetermined blanks > ... .

Very often, the laminar production of blanks on non-Levallois cores (Boëda 2013, 168/162, fig. 121) is mostly a continuous reduction process. If no knapping accidents happen, it is possible to reduce the whole usable (or active) volume of a core without massive re-configuration effort (only marginal dorsal reduction or abrasion to restore the edge angle are necessary). Examples for this process are the production of Châtelperronian blades (Roussel 2011, 2013) or the production of bladelets from carinated pieces (Le Brun-Ricalens et al. 2005).

For Levallois cores (F1), Boëda describes the volumetric configuration with criteria he defined in 1986 and published in 1994 (Boëda 1986, 1994). Notably, in these and other publications he defines six (!) criteria (e.g., Boëda 1995a), but sometimes in another succession. In an article about Chinese lithic technological behavior (Boëda et al. 2013) he defines seven (!) criteria. In the current work, Boëda establishes six criteria again (sic!), combining two criteria to one (and adding *auto-corrélation*). For illustration, these criteria are shown in Table 4.

Criteria	Boëda (1994, 255)	Boëda (1995a, 46-53)	Boëda et al. (2013, 195)	Boëda (2013, 165/159)
1	two surfaces are separated by a plane of intersection	two surfaces are separated by a plane of intersection	two surfaces are separated by a plane of intersection	two surfaces are separated by a plane of intersection
2	hierarchization of the surfaces, one is the flaking surface and one is the striking platform	hierarchization of the surfaces, one is the flaking surface and one is the striking platform	hierarchization of the surfaces, one is the flaking surface and one is the striking platform	hierarchization of the surfaces, one is the flaking surface and one is the striking platform
3	flaking surface is formed convex to predetermine the shape of the blanks	flaking surface is formed convex to predetermine the shape of the blanks	flaking surface is formed convex to predetermine the shape of the blanks	exclusively, direct percussion with a hard hammerstone
4	preparation of the striking platform	fracture plane is parallel to the plane of intersection	fracture plane is parallel to the plane of intersection	flaking surface is formed convexe to predetermine the shape of the blanks; preparation of the striking platform in that way that the strike hits in a 90 degree angle
5	fracture plane is parallel to the plane of intersection	preparation of the striking platform	preparation of the striking platform in that way that the strike hits in a 90 degree angle	fracture plane is parallel to the plane of intersection
6	exclusively, direct percussion with a hard hammerstone	exclusively, direct percussion with a hard hammerstone	exclusively, direct percussion with a hard hammerstone	auto-correlation
7	-	-	auto-correlation	-

Table 4: *Boëda's criteria to define the conception of Levallois in different publications.*

Confection

The *confection* is preserved for tool terminology and describes the formation of a tool, the cutting edge itself and the restructuring of an artifact (Boëda 2013, 58/52); it appears 75 times. The *confection* can either be part of the production (*débitage* and *façonnage*) or is the setting or modification of a cutting edge. In the case of the Near East, Boëda uses this multivariable understanding to explain the differences between a Levallois industry and the industries made in the Umm el Tlelian, the Yabrudian and the Hummalian. In the former, the shape of a tool is dominated by the predetermination of the support produced with a Levallois conception, the latter produces a high diversity of supports with a highly standardized *confection*, i.e., the retouch of the cutting edges (Boëda 2013, 71/65). The *confection* can affect and therefore transform every techno-functional unit of a tool (transformative part, transmitting part and the hafting part), as explained on pages 77 to 83/71 to 77.

There is no direct correlation between retouch and *configuration*. For example, the shape of the flaking surface predetermines the shape of a blank. If the shape of this blank is very close to the shape wanted, only little parts of the blanks need to be retouched (i.e., confected). So most of the *configuration* was done while producing the blank. Conversely, if a simple flake should be formed into a point, intensive retouching is necessary.

Cores, used and non-used volumes

One of the main divisions in the section of the core types is the differentiation of a raw piece (*bloc à débiter*, a bloc of raw material which is designated to be knapped) into specific volumes (Boëda 2013, 95/89 to 102/96) (Fig. 3):

1. *Volume utile*, usable volume i.e., the core, the active volume or the reduction volume

2. *Volume non utile*, non-used volume, the passive volume or the grasping volume.

From a theoretical point of view, they act independently. The *initialisation* transforms a bloc into a core (e.g. Boëda 2013, 100/94, fig. 40).

Boëda's distinction between bloc volumes might be useful in a technological view, but provides confusion in the terminological understanding. And even from a technological point of view we are confronted with a crucial distinction because on the one hand the denomination of core only refers to one production sequence and on the other hand, the so called *volume non utile* nevertheless might play an important role at least for the knapper to hold the piece. At this point, we do not agree with Boëda's definition. This approach seems confusing and leads to misunderstanding, when dividing the piece into a core part and a non-core part. In analogy to the tool parts it seems more convincing to divide the core-piece into a modified volume of production (*Abbauvolumen*, active volume, *volume utile*) and a grasping volume (*Haltevolumen*, passive volume, *volume non-utile*) emphasizing the importance of the piece as a whole (see also Frick 2010). In another publication (Boëda et al. 2013) these volumes are already called active and passive, which describes the function of these volumes much better.

In our understanding and with the idea of separating the terms *initialisation* and *configuration* we would explain it this way: It is possible to separate a used bloc of raw material into an active volume (the volume which can be successively reduced by blank production) and a passive volume (the volume which is necessary to hold the core in hand or in an implement, the volume which is not used actively to produce blanks).

Production concepts

Boëda reduces lithic production concepts (the idea behind how to reduce a core and how to produce blanks in a certain way) to the discussed core types (Figs. 4 to 8). This approach is a try to establish a taxonomic classification of cores with explicit rules how such a core needs to be produced and exploited, in some aspects similar to the approach of Conard et al. (2004).

But there are problems with such classifications. One is explained by Richter (1997): In core reduction, at the end of blank production, cores often are reduced more or less opportunistically or randomly, so the original reduction concept is not always visible anymore. A good example is a formerly unidirectional Levallois core with recurrent production series, where the last one is centripetal to get some last small oval flakes or a core reduced within a specific concept with last removals in an opportunistic manner. In these (and other) cases, only the last reduction series is visible. The former sequences are either visible if refittings are possible or if there is a holistic overview of the assemblage present, as Boëda points out (Boëda 2013, 119/113).

Another problematic aspect is that knapping stones is a handcraft, which needs to be learned (Shea 2006; Stapert 2007) and they are produced by humans. Therefore, if the physics provide a specific framework what is possible, humans could use this continuum to produce artifacts. In some cases it is impossible to find the idea (lithic concept) behind. Such assemblages or knapping sequences would be classified as opportunistic. A good example in that way is discoidal technology. It lasted until the year 2003 that lithic experts were able to give an overview of the entirety what a discoidal technology could be, how it works and what could be produced (Peresani 2003).

In the description of the production structure of the core types (Boëda 2013, 95/89 to 180/174), Boëda integrates so so-called secondary production concepts. For example, in core type D he describes ventral removals (Kombewa) as a *configuration* step for cores (Fig. 6.3) and describes these Kombewa flakes as blanks for tools, too. He mentions the Kombewa production from Les Tares à Sourzac (Geneste 1991) but all other known Middle Paleolithic concepts of flake-core removals are not mentioned (e.g., Tixier and Turq 1999), nor are the so-called ‘ramification’ and other secondary flaking concepts (e.g., Delagnes 1993; Geneste and Plisson 1996; Bourguignon et al. 2004). Likewise, secondary production concepts like the production of bladelets on carinated pieces or all kinds of burins are left out. The reduction of Quina type is completely missing (Bourguignon 1996, 1997). It is only mentioned once on page 34/28 in the introduction of the work.

From a general point of view, we appreciate Boëda’s technological core classification attempt because he tries to combine different technological parameters (e.g., *initialisation*, *configuration*) and conceptual ones (e.g., volumetric, surface hierarchy). The big advantage of such an approach is, as indented by Boëda, to overcome typological

Core type	Quina	Barrenförmige Kerne	Ventral face flaking	Dorsal face flaking	Edge flaking	carinated pieces
Concept	flaking along two reference planes	bidirectional removal of blanks from lateral of a flaking surface	removal of blanks from the ventral face of a blank, Kombewa	removal of blanks from the dorsal face of a blank, Kostenki, Nahr Ibrahim, truncaded-faceted pieces	removal of blanks from the edge of a blank, burin, para-burin	removal of bladelets from a carinated piece
Sites or distribution	Western Europe	Germany	all over the world	all over the world	all over the world	western Eurasia, Levante
Literature	Turq 1988; Bourguignon 1996, 1997; Hiscock et al. 2009	Bosinski & Sitlivyj 1990	Owen 1938, 1940; Tixier & Turq 1999; Frick 2012	Tixier & Turq 1999; Klaric 2000; Frick 2012	Tixier & Turq 1999; Jöris 2001; Klaric 2003; Frick 2012	Hahn 1988; Chiotti 1999; Le Brun-Ricalens & Bordes 2007
Selection of used and unused Volumens and surfaces	selection of a convexe flaking surface and a fitting striking platform	selection of a long convex flaking surface and two opposite striking platforms	selection of a convexe flaking surface and a fitting striking platform	selection of a convexe flaking surface or a crest and a fitting striking platform	selection of a crest, the lateral edge or a truncation	selection of a thicker piece
Initialization	unidirectional along two surfaces	initialization of a convexe flaking surface and two fitting striking platform	production of a blank as core			
Configuration	configuration of interchangeable flaking surface and striking platform	configuration of flaking surface and striking platforms	flaking surface and striking platform are not interchangeable	configuration of a striking platform		preforming the flaking surface
Rhythm	continuous	continuous?	production of single pieces	production of single pieces or small series, sparse configuration, production of single pieces or small series		production of a large series
Homothety	possible	yes	no	no	no	yes
Auto-correlation	yes	yes	no	no	no	yes
Auto-configuration	with beginning of the production	yes	no	no	no	yes
Used Volume	the whole bloc is used		only a part is used			
Volumetry	exploitation of two surfaces	exploitation of one surface			exploitation of one surface (edge), possibility to use other, too	exploitation of one surface
Hierarchy	no	yes	yes	yes	yes	yes
Direction of production	unidirectional	bidirectional	unidirectional, bidirectional, centripetal		unidirectional, possibly bidirectional	unidirectional
Production sequence	small series	large series	single pieces	single pieces or small series		large series
Premiss	alternating of striking platform and flaking surface	convexity of the flaking surface	convexity (bulbe)	crest, scars	long edges	round flaking surface
Aim	elongated cutting edges	circular cutting edges		elongated cutting edges		
Confection	blanks can be retouched					
Predetermination	for transformative and prehensile parts					
Produced blanks	oval and rectangular flakes		oval flakes with two „ventral faces“	elongated flakes, bladelets	bladelets	
Used raw material	everything that can produce a cutting edge, raw material should be more or less homogenous					
Technique	direct-hard-straight			direct-hard-straight or direct-soft-tangential		direct-soft-tangential
Identification in archaeological context	good visible					
Chronology	Middle Paleolithic	Middle Paleolithic	Lower Paleolithic to Neolithic	Middle Paleolithic to Neolithic	Middle Paleolithic to Neolithic	Mostly in the Aurignacian

Table 5: *List of some missing reduction concepts summarized with Boëda's conceptual criteria.*

nomenclature by systemized categories. But it seems to us that the criteria grouping the production schemata are not standardized enough. As mentioned before, some production types are missing (see Table 5).

In our understanding, there is a dilemma in the description of these production structures. If we try to avoid typological schemata, it must be clear, that the reduction and production structures (or litho-technological concepts) are ideal and standardized ideas, but there is overlap between these structures. We would suggest that there are possibilities to get rid of this dilemma. One would be to explain each of these production structures as a combination of criteria related to one removal or a series of removals (one active volume that produces a blank or a series of blanks), which Boëda did for Levallois (Boëda 1986, 1994) or for bifacial discoidal reduction (Boëda 1995b).

Tables 6 to 8 try to summarize the criteria used to separate and define these types of cores, because such a cross correlation is not part of Boëda's work. They are separated in concepts, sites and literature (Table 6), preparation and production (Table 7) as well as theoretical aspects and production aims (Table 8).

Products, techno-type and typo-type

Another thing that is missing is a section that explains so called techno-types (Boëda 1997). These techno-types were the aim of production. The only short mention of one techno-type is the definition of a blade as such (Boëda 2013, 72/66). The description of techno-types would fit into the section of the explanation of what a tool is. So it seems the only differentiated explanation of techno-types is in the dissertation thesis from H. Koehler (2009) at Paris X-Nanterre.

Regarding a proper terminology to clearly express what is meant by which term, Boëda names existing grievance referring to Levallois or the *débitage bipolaire* terminology (Boëda 2013, 119/113). The patchy terminology is mainly due to the embedded history of research attached to typological schemes and comparative classifications. Boëda advocates a stringent and proper use of terms and tries to overcome the existing descriptive and suggestive terms in favor of a more technological approach. Thus, the nomenclature used for points and the Levallois concept should be more precise.

Boëda suggests to use the term of *techno-pointe Levallois* for points produced within the Levallois concept, and the term of *typo-pointe Levallois* for points produced within non-Levallois concepts (Boëda 2013, 187/181). At first glance this follows his established terminology of techno-types (Boëda 2013, 34/28 and 136/130, fig. 84), he also adds (Boëda 2013, 120/114): "*Mais, rappelons qu'il faut distinguer Types et techno-types, en particulier dans le cas des pointes Levallois. En effet, une pointe Levallois peut très bien être produite par un débitage de conception non Levallois. La pointe est alors de type Levallois, mais n'est pas le techno-type pointe Levallois. Pour cela, il aurait fallu qu'elle soit produite par un débitage de conception Levallois*". For the diversity of production concepts to make lithic points, see also Boëda (1991, 54).

Core type	A	B	C1	C2	D1	D2	D2	D3	D3	E1	E2	F1	F2	F3
Concept	unknown, „expedient“	*unknown*	*opportunistic surface exploitation*, System par surface de débitage alterné (SSDA)	laminar	Victoria West, Proto-Levallois, Para-Levallois, Tabelbala-Tachenghit, Kombewa, Type Rocourt,…	laminar	lamellar	centripetal, discoidal for axial (symmetric) triangular flakes	centripetal, discoidal for non axial (asymmetric) triangular flakes	Discoidal	Pyramidal	Levallois	laminar and lamellar	reduction of rounded pebble stones
Sites or distribution	no	Lokalalei	High Lodge (UK), Point aux Oies à Wimereux; Montsaugeon en Haute-Marne (F); Monte Poggiolo (I); Gimpo, Guanyindong, Guizhou (CN)	Barbas, Saint-Valéry-sur Somme, Tourville-la-Rivière (F); Kaféine (SYR); Kapthurin (EAK)	Fejej (ETH); Korlolevo (UA); Barbas, Cagny-la-Garenne, Tares à Sourzac, Villiers-Adam-Val d'Oise, Ault Onival, Hermies (F);	Europe, Levant; Barbas (F); Kaféine, Umm el Tlel (SYR);	Europe, Levant; Umm el Tlel (SYR);	Villier-Adam-Val d'Oise (F); Umm el Tlel (SYR)	Villier-Adam-Val d'Oise (F); Umm el Tlel (SYR)	All over the world; Queyssac (F); Kůlna (CZ)	Amudien, Tabun, Zumoffen, Boker Tachit, Kaféine, (SYR, IL), Leiliras (AUS), Saint-Firmin-des-Prés (F)	Europe, Africa, Asia, Australia, South America	All over the world	South America, China (Longgupo, Bose), South East Asia (Hoabinien) and Italy
Literature	this book [Boëda 2013]	Roche et al. 1999; Delagnes & Roche 2005	Ashton et al. 1992; Forestier 1993; Peretto et al. 1998; Li 2011	Boeda 1997; de Heinzelin de Braucourt & Haesaerts 1983; Guilbaud & Carpentier 1995; Johnson & McBrearty 2010	Owen 1938, 1939; van Riet Lowe 1945; Tixier 1957; Bordes 1961; Otte et al. 1990; Boëda 1996, 1997; Boëda et al. 1996; Lumley et al. 2004; Vallin et al. 2006	Boëda & Bonilauri 2006	Karlin & Ploux 1994; Nespoulet 1999; Bon 2002; Schmider 2002; Boëda & Bonilauri 2006; Bordes 2006; Bordes & Shidrang 2009;	Boëda 1991; Texier 1995; Bourguignon & Turq 2003; Locht et al. 2003	Boëda 1991; Texier 1995; Bourguignon & Turq 2003; Locht et al. 2003	Boëda 1993, 1995a	Spencer & Gillen 1912; Garrod & Bate 1937; Garrod 1956; Garrod & Kirkbride 1961; Jelinek 1975, 1981, 1982, 1990; Mulvaney 1975; McCarty 1976; Bordes 1977; Marks & Volkman 1983; Meignen 1993, 1994; Lhomme et al. 1999	Boëda 1986, 1988, 1993, 1994; Boëda et al. 1990; Nami 1992; Morello 2005	Dauvois 1976	Colani 1927, 1929; Lai Pannocchia 1950; Hou et al. 2000; Zeitoun et al. 2008; Boëda and Hou 2011; Boëda et al. 2011
Identification in archaeological context	difficult to impossible	difficult	good visible	good visible	difficult	good visible, very often, together with C2, E2 and F2	good visible, very often together with C2, E2 and F2	good visible	good visible	good visible	good visible	good visible	good visible	difficult
Chronology	Early Lower Paleolithic	*Early Lower Paleolithic?*	Late Lower Paleolithic	pre Saalian blade industries	Late Lower Paleolithic, Middle Paleolithic, before Levallois	OIS 8 to 3, after type C2, before type F2, contemporaneous to E2, Transitional industries, Aurignacian,	OIS 8 to 3, after type C2, before type F2, contemporaneous to E2, Transitional industries, Proto-Aurignacian, Gravettian, Magdalenian, Bardostien ancien (Zagros)	Middle Paleolithic	Middle Paleolithic	Acheulian, Middle Paleolithic, sometimes in Upper Paleolithic and later	Amudien, *Middle Paleolithic*	widely spread from around 300 ka on until 40 ka, in the holocene also in South America	beginning way more than 200 ka in Europe, Africa, Near East	all times

Table 6: *Table showing litho-technological concepts, sites and literature used by Boëda to define his core types. Words in italics are our additions.*

Core type	A	B	C1	C2	D1	D2
Premises	no	one striking and one flaking surface	natural convexity	natural convexity	natural convexity	distal and lateral convexity
Used raw material	*everything that can produce a cutting edge*	*everything that can produce a cutting edge*	*everything that can produce a cutting edge*	*everything that can produce a cutting edge, raw material should be more or less homogenous*	*everything that can produce a cutting edge*	*everything that can produce a cutting edge, raw material should be more or less homogenous*
Selection of used and unused Volumens and surfaces	no	no	selection of a convexe flaking surface	selection of a convexe flaking surface	selection of a convexe flaking surface and a fitting striking platform	selection of a convexe flaking surface and a fitting striking platform
Initialization	no	no	shaping of a striking platform or using of a natural striking platform	shaping of a striking platform or using of a natural striking platform	Ventral exploitation, unidirectional parallel, centripetal	unidirectional parallel, unidirectional convergent, crested
Configuration	no	striking platform	striking platform	striking platform	configuration of a flaking surface and sometimes of the striking platform in different styles (Kombewa, Victoria West, „Levallois“)	configuration of flaking surface (lateral and distal convexity, sometimes with crests) and striking platform
Rhythm	production of single pieces	continuous	alternating, exchange of flaking surface and striking platform	continuous	continuous	continuous
Direction of production	*unidirectional*	*unidirectional*	unidirectional, bidirectional	mostly unidirectional, sometimes bidirectional	preferntial, unidirectional parallel, centripetal	unidirectional parallel, unidirectional convergent, bidirectional
Production sequence	single piece	small series of similar pieces	single pieces or small series	single pieces or small series	preferential single pieces or small series	preferential single pieces or small series
Technique	*direct-hard-straight*	*direct-hard-straight*	*direct-hard-straight*	*direct-hard-straight*	direct-hard-straight	direct-hard-straight or direct-soft-tangential
Produced blanks	non-standardized flakes	non-standardized flakes	more or less normalized flakes	more or less normalized blades	oval flakes of different sizes	more or less normalized blades

Table 7: *Table showing preparation and production schemes attributed to the core types by Boëda. Words in italics are our additions.*

D2	D3	D3	E1	E2	F1	F2	F3
distal and lateral convexity			removal secant to the reference plane (centripetal) or along to it (cordal)	plane striking platform and convex flaking surface	removal parallel to the reference plane	plane striking platform and convex flaking surface	split fracture
everything that can produce a cutting edge, raw material should be more or less homogenous							*rounded pebbles, raw material should be more or less homog-enous*
selection of a convexe flaking surface and a fitting striking platform							selection of biconvex pebbles and two fitting striking plat-forms
Ventral exploita-tion, unidirec-tional conver-gent, crested	unidirectional convergent	Ventral exploitation, unidirectional convergent	Ventral exploita-tion, centripetal	unidirectional parallel, unidirectional convergent	unidirectional, bidirectional, centripetal		bipolar split fracture of pebbles
configuration of flaking surface and striking platform					configuration of a flaking surface (production of a lateral and distal convex-ity) and a convex striking platform	configuration of a flaking surface (use of a natural crests, produc-tion of a bidi-rectional crest and a distal convexity) and a plane striking platform	no
continuous					short flaking series, con-figuration, short flaking series	long flaking series, configura-tion, long flaking series	splitting and confection
unidirectional parallel, unidirectional convergent, bidirectional	preferential	preferential, unidirectional convergent	preferential, cen-tripetal, cordal	unidirectional parallel, unidirectional convergent	preferential, unidirectional parallel, unidirectional convergent, bidirectional, centripetal	unidirectional and bidirectional	unidirectional
preferential single pieces or small series							preferential twin pieces
direct-hard-straight or direct-soft-tangential	direct-hard-straight	*direct-hard-straight*	direct-hard-straight	direct-hard-straight, *direct-soft-tangential?*	direct-hard-straight	direct-hard-straight, direct-medium hard-straight, direct-soft-tan-gential, indirect-soft-straight, pressure	direct-hard-straight
more or less normalized bladelets	axial (symmet-ric) triangular flakes, éclats débordants	points, non-axial (asymmetric) triangular flakes, éclats débor-dants	*centripetal direc-tion (long or rec-tangular flakes, triangular flakes), cordal (éclat débordant, crested flakes and blades), see Terradas 2003, Slimak 2004*	long flakes and blades, triangu-lar flakes and blades	elongated, oval and rectangular flakes, triangu-lar flakes, blades, éclats débor-dants	blades in very different shape and dimension	split flakes

***Table 7** (continued)*

Core type	A	B	C1	C2	D1	D2
Homothety	no	no	no	no	no	no
Auto-correlation	no	no	no	no	no	no
Auto-configuration	no	no	no	no	no	no
Used Volume	only one part of the bloc is used		only one part of the bloc is used, the used volume is independent from each other used volume		only one part of the bloc is used	
Volumetry	surface exploitation			a possible surface exploitation, but not structural; volumetric exploitation	surface exploitation	a possible surface exploitation, but not structural; volumetric exploitation
Hierarchy	*no*	*no*	flaking surface and striking platform are interchangeable	flaking surface and striking platform are constant		
Predetermination	no, random shape of the blank	only for transformative part	for transformative and sometimes for prehensile parts	partial for transformative and sometimes for prehensile parts	for transformative and prehensile parts	
Aim	cutting edge at a blank	normalized cutting edge at similar flakes	cutting edge, mostly retouched	cutting edge, mostly unretouched	cutting edges on *(more or less normalized)* blanks	elongated cutting edges
Confection	no	no	often retouched	no	*no information*	

Table 8: *Table showing the litho-theoretical aspects and production aims pointed out by Boëda. Words in italics are our additions.*

<table>
<tr><th>D2</th><th>D3</th><th>D3</th><th>E1</th><th>E2</th><th>F1</th><th>F2</th><th>F3</th></tr>
<tr><td>no</td><td>no</td><td>no</td><td>no</td><td>no</td><td>yes</td><td>yes</td><td>no</td></tr>
<tr><td>no</td><td>no</td><td>no</td><td>no</td><td>no</td><td>yes</td><td>yes</td><td>no</td></tr>
<tr><td>no</td><td>no</td><td>no</td><td colspan="2">with beginning of the production</td><td>no, after removing a series a configuration step is needed</td><td>with beginning of the production</td><td>no</td></tr>
<tr><td colspan="3">only one part of the bloc is used</td><td>the whole bloc is used, two volumes are separated by a reference plane (plan of intersection)</td><td>the whole bloc is used</td><td>the whole bloc is used to form the core, a flaking volume and residual volume are separated by a reference plane (plan of intersection)</td><td>the whole bloc is used, the flaking surface can rotate around an axis (reference axis)</td><td>the whole bloc is used</td></tr>
<tr><td>a possible surface exploitation, but not structural; volumetric exploitation</td><td colspan="2">surface exploitation</td><td colspan="4">a possible surface exploitation, but not structural; volumetric exploitation</td><td>volumetric exploitation</td></tr>
<tr><td colspan="3">flaking surface and striking platform are constant</td><td>flaking surface and striking platform are interchangeable</td><td colspan="3">flaking surface and striking platform are constant</td><td>no</td></tr>
<tr><td colspan="5">for transformative and prehensile parts</td><td colspan="2">normalization of transformative and prehensile parts</td><td>for transformative and prehensile parts</td></tr>
<tr><td colspan="3">elongated cutting edges</td><td>cutting edges on heterogeneous products</td><td>cutting edges on heterogeneous and homogeneous products</td><td>planoconvex blanks, diversity of blanks</td><td>planoconvex blanks, very similar blanks</td><td>planoconvex blanks</td></tr>
<tr><td colspan="5">no information</td><td colspan="2">can be retouched</td><td>circular retouch</td></tr>
</table>

Table 8 *(continued)*

However, at a closer look we are faced with a very confusing variety of terms while talking about Levallois points and Levallois-shaped points including all possible variations especially concerning products of non-Levallois *débitage*. Starting with a *typo-pointe Levallois,* which generally defines a Levallois-shaped point produced within another concept, we also find terms such as:

- *pseudo-typo pointe Levallois*,
- *typo-pointe pseudo Levallois*,
- *pointe pseudo-Levallois*,
- *techno-pointe pseudo-Levallois*,
- *typo-pseudo-pointe Levallois* and
- *pointe dite Levallois*.

This multitude of terms is very confusing. Summarizing Boëda's explanation given to some of the terms, we could conclude his understanding as follows (see Table 9):

term	meaning	example	concept
techno-type	blank produced with specific concept	techno Levallois point	Levallois
typo-type	blank produced with any concept but resembling a specific one which it is not	typo Levallois point	other than Levallois (looks like but is not)
pseudo-type	blank produced with identifiable concept, but resembling another specific one	techno / typo pseudo Levallois point	discoid

Table 9: *Summary and meaning of Boëda's terms of techno-, typo-, and pseudo-types for points.*

The *techno-types* (Boëda 1997; Koehler 2009), like the *techno-pointe Levallois*, follow a concrete and defined scheme of production concept (Boëda 2013, 34/28). The *typo-types*, like the *typo-pointe Levallois*, show the typologically relevant criteria (i.e., of a Levallois point), but are produced within other concepts (Boëda 2013, 136/130): "*Une typo-pointe Levallois peut être produite par trois types de structures volumétriques distinctes: F2, E2 et D3*". Among this general category of *typo-types* we can also place the set of pseudo-Levallois types. According to Bordes' understanding of pseudo-Levallois points (Bordes 1961), this group refers mainly to points produced within the discoidal concept (Mourre 2003) or in Boëda's (2013, 136/130) words: "*Ce type de débitage se retrouve sous plusieurs appellations : débitage centripète (Texier 1995), débitage convergent, voire débitage Discoïde […]. Ce dernier est évoqué lorsque la production est clairement orientée vers l'obtention d'une typo-pointe pseudo Levallois. Dans certains cas, malgré la présence de ce type d'objectif, on préfère parler de débitage centripète. Il s'agit, pour l'essentiel, de la production d'une petite série de deux à trois enlèvements dont le dernier présente des bords convergents. Cette notion de convergence est à notre avis importante, car ce mode d'exploitation permet d'obtenir ce caractère sans tenir compte de la morphologie globale de l'éclat*".

This terminology can be attributed to both points and general blank types. Apart from the confusing use of different terms (which could be reduced to three), as mentioned above, we can criticize the still widely spread fixation on the distinction between Levallois and non-Levallois (e.g., Dibble and Bar-Yosef 1995) and its typological determination that goes along with it. Instead of using these determinations, Boëda himself talks in favor of an adequate use of conceptual terms in a technological classification approach (Boëda 2013, 118/112): "*Il ne faut oublier que cette détermination à créer des types est à visée comparative. C'est l'essence même de la typologie. D'ailleurs, notre propre travail aboutit aussi à la création de types, en essayant de s'approcher au plus près des caractères structurels de chaque objet*".

We appreciate Boëda's technological approach, but we would await a clear and stringent terminology that enables us to discuss lithic technology clearly on the one hand, and helps to overcome the, in some ways outmoded, typological terms in a synthetical way, on the other.

Laminar development in the Near East

The main problem in understanding section three concerning the laminar development in the Near East is the very abrupt introduction of five chronological phases (Fig. 9 and Table 2). Starting with a kind of introductive part to the *lignées*, Boëda starts characterizing the different laminar production schemes of the Near East in a general way. Then he fixes the chronological frame of the five phases (not mentioned before). After that he talks about the blade products ("*Les produits lames*"), where he first distinguishes two tendencies in blade production.

Although techno-functional aspects are treated and the developed core type terminology is used, the essence of this section is difficult to understand. Here we would have expected a more synthetic overview and more precise distinctive features while introducing the five phases. We missed the systematic and consequent techno-typological differentiation leading to this phases. Likewise, the geographical setting concerning the phases is slightly scattered. Except for two overview tables, we missed further figures here (especially on Boëda 2013, 192/186) to help with the comprehension.

The last point to mention is the comparison given by Boëda at the beginning of the section concerning evolutionary *lignées*. It seems to us neither right nor necessary, especially using a product placement (Boëda 2013, 178/172): "*De façon plus triviale, quelles que soient les lignées d'objets nous ne connaissons pas « d'invention à l'envers », qui irait de l'objet concret vers l'objet abstrait. Encore aujourd'hui, dans notre monde moderne, la 2 CV ne précède pas la dernière C6 de Citroën : une techno-logique existe*".

Layout critique

By thumbing through the work, we observed leaks in a consistent layout. One of the first things to realize is that the figures are not made in one style. Different stroke width, fonts and font sizes are used. Sometimes, the font size is that small that it is really hard to read (e.g., Boëda 2013, 64/58, fig. 16). It seems that originally this figure was designed in a horizontal format as well. Likewise, there are figures where the font is running vertically, with very tight letters, which is also hard to read (e.g., Boëda 2013, 76/70, fig. 25). In the same manner, figure 28 on page 79/73 shows an added hand made line. In some of the figures, features are colored but not explained (e.g., Boëda 2013, 80/74, fig. 29) or there are greek letters (α, β, γ or δ; see Fig. 9) in figures for the core type F2 (Boëda 2013, 196/190, fig. 131 and 197/191, fig. 132) but no explanation in the section of the core type F (Boëda 2013, 148/142 to 174/168). Greek letters are only used in the text to differentiate *lignées* in the so called conclusion (Boëda 2013, 223/217 to 236/230) (Table 3). The figures, which illustrate the core types and their reduction are very schematic. Dealing with lithic technology and breakage mechanics, more realistic sketches would have been more instructive (e.g., Boëda 2013, 106/100, fig. 49; 107/101, fig. 52 or 118/112, fig. 63). As seen in many figures, subfigures are not consequently labeled with sub-numbers (e.g., Boëda 2013, 81/75, fig. 30 or 114/108, fig. 59). Most of the figures look like they were copied from other publications and/or presentations (without proper citation). This is illustrated in the use of different scales for artifacts and different stroke width for drawing. The resolution of some of the figures is very low, which is the case for illustrations of artifacts (e.g., Boëda 2013, 117/111, fig. 62) as well as tables (e.g., Boëda 2013, 147/141, fig. 97 or 191/185, fig. 130) and schematic illustrations (e.g., Boëda 2013, 207/201, fig. 136; 219/213, fig. 143 or 226/220, fig. 147). The low resolution of most of the figures contributes strongly to the hard readability of the texts therein.

Further on, we see changes in font color (e.g., Boëda 2013, 132/126), also listings and paragraph titles appear in a non-consistent and confusing manner (e.g., Boëda 2013, 206/200 to 207/201). Very often the footnotes are way to long, covering nearly the whole page (Boëda 2013, 61/55). In some cases, they provide important information to understand Boëda's discussion and topic.

The complete work shows that it is not designed with a specific design program. As the metadata of the pdf version indicates, the work was completely written and illustrated in msWord©. If this is correct, this would explain the low resolution of most of the figures and the position of many figures in the text flow. Some mistakes in the citation of other works indicate also that the book was made without the help of a citation program. We would have expected that such a work of considered importance would have passed more attentive lectoral and editorial proceeding.

Conclusions

As stressed at the very beginning of Boëda's work, it can be seen in its entirety, among others, as the adoption of Simondon's thoughts of technological objects to Paleolithic stone artifacts and their production technology as well as their techno-functional and chrono-cultural genesis. But there is also a perceptible background referring to other philosophers like Gilles Deleuze, Yves Deforge, Bernard Stiegler or Pierre Rabardel, who, in return, are all influenced by André Leroi-Gourhan. Especially Simondon's strong influence on Boëda's work can be seen not only in the references made by Boëda himself but also in the vocabulary used. This is directly observable in the idea of the steps of concretization of technological objects, which is seen as a progress to more and more perfection, due to needs and desires, thinking and inventing. Boëda also reflects Simondon's way of thinking in the relationship of mental realization and cultural information (metadata) incorporated in material, physical objects. At last the simple but important understanding of tools as physical extension of the human body and its action – the idea of instruments that help to enhance and complete the human perception – is based on Simondon's model.

In our opinion the transmission and analogy of philosophical thinking about modern technical objects, here related to prehistoric mankind and their produced objects and technological behavior is unique and unusual on the one hand, and logical and necessary on the other. The work represents the effort of combining broad French philosophical humanistic traditions of thought with modern Paleolithic stone technology and production analysis. Here, Boëda pushes back Simondon's approach to human Paleolithic history in trying to " […] *réintégrer les techniques dans l'humain et dans la culture, et pour les comprendre en partant de leur genèse*" (Sigaut 1991). Seeing the objects and their way of production with their makers and societies to which they belong and from whom they emerge in their spatial, temporal and cultural continuity and variability is the great contribution Boëda's work provides to the reader.

But as mentioned earlier, the problem lies in trying to comprehend this insight, due to the sometimes confusing way of writing, especially if one is not familiar with the different interdisciplinary approaches. In this case we fully agree with Françoise Audouze's statement in her foreword (Boëda 2013, 15/9 to 19/13).

The work can be seen as a very engaged and profound attempt of litho-technological fundamental research. Nevertheless, it shows distinct weaknesses with regard to the internal structuring of the text. This tends to result in difficulties regarding its understanding, at least for non-native readers, and those who are not that familiar with the philosophical and theoretical approaches the work is based on. Therefore, it can only be recommended to readers familiar with the subject – but it is definitely worth reading. This is so particularly because of Boëda's long lasting and strong contribution to lithic analysis and therein, especially concerning the structure of tools and, of course, their production.

Towards a holistic view of lithic artifacts

In general, every artifact should be considered as a momentary glimpse in time of its object biography. For Boëda it is important to explain that we should stop using typological schemata to explain artifact variation. In a technological and a techno-logical view, an artifact can change its shape with every use and every (re-)confection. Thus, a typological determination only describes the last stadium of an artifact or gives a name for a production step (see, e.g., Floss 2012). A holistic litho-technological view tries to explain the used raw material and its provenience (where is it from?), the breakage mechanical properties (how are the physics?), the production (how was it made?), the import and export (how was it transported?), the modification (how was it changed?), the usage (how was it used?), the distribution of sequences (how is it related?), the discard (how was it buried?) and the find situation of an artifact as well (Fig. 11).

In addition to macroscopic morphological analysis, microscopic analysis can aid to find cutting edges and hafting zones (e.g., Rots 2009; Rots and Plisson 2014). It seems to us that only a fruitful combination of macroscopic technological analysis, microscopic use wear, hafting and residue analysis (as well as experimental data) can advance our

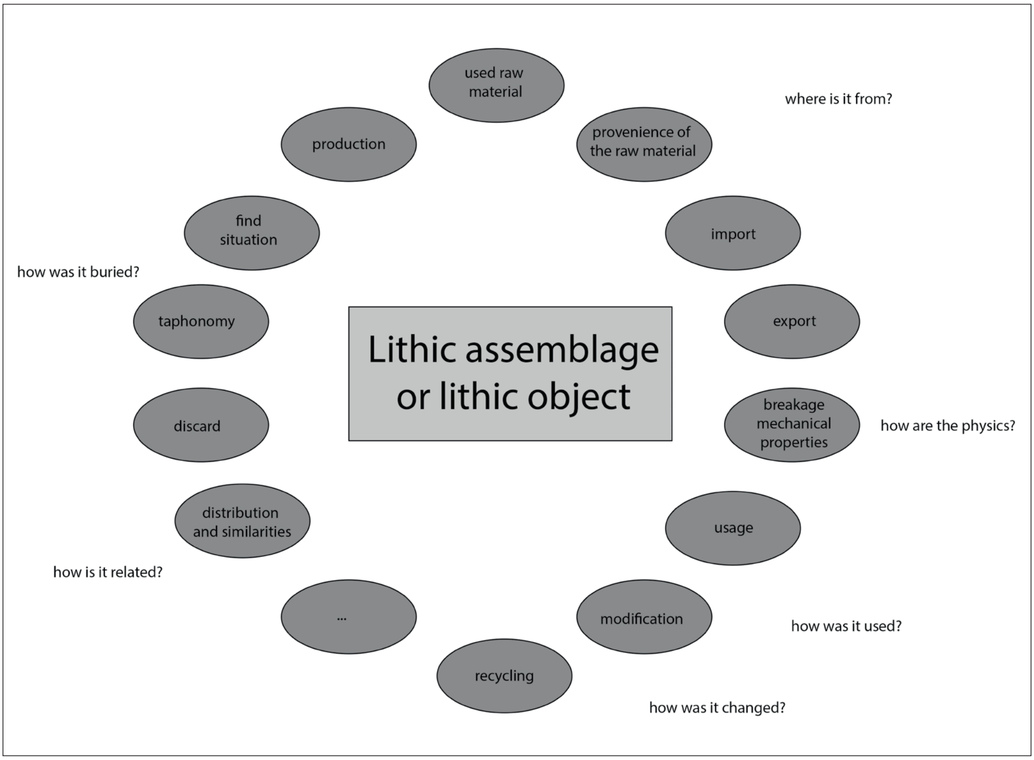


Fig. 11: *Aspects of a holistic view of object biography and artifact analysis*

understanding of tools, their production and use. Roux and Bril (2005, 2) even argue for a much broader range of interdisciplinarity because „[…] the interpretation of artefacts requires that knowledge external to archaeology should be drawn upon (Gallay 1986)." This is particularly true due to the strong interrelation of the structure of tools and what they have been used for. *„Les „Préhistoriens" ne s'y sont pas trompés. Seuls ceux qui recherchent l'homme et ses activités à travers ses outils entendent se prévaloir de cette appellation*" (Tixier 1978, 23). According to this, the fact to be kept in mind is, that every artifact represents a man made and used object, which is one of the main reasons why it becomes of archaeological interest to us in order to reveal and understand Paleo-history.

Acknowledgements

We would like to express our gratitude to those who have contributed to the realization of this article. First, we thank the editors M. Bolus and N. Conard who proposed the topic and permitted it in a very open-minded range. Furthermore, we say thank you to S. Steigerwald and D. Rose for their patient and careful revision of the text regarding grammar and language. We also say thank you to G. Porraz and H. Koehler for their help in improving the paper. We are very grateful to both for providing helpful comments and constructive annotations, helping to make the article adequate for being published.

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