The French-Anglophone divide in lithic research: A plea for pluralism in Palaeolithic Archaeology

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Chapter 3

Mapping the French-Anglophone divide onto the analytic-synthetic polarity of world theories

> "*When a conception permeates a thought collective strongly enough, so that it penetrates as far as everyday life and idiom and has become a viewpoint in the literal sense of the word, any contradiction appears unthinkable and unimaginable* [...] *The same difficulty arises even today if such concepts as existence, reality, and truth are used in an absolute sense.*"
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> – Ludwik Fleck (1979 [1935]: 28)

> "*Cognition therefore means, primarily, to ascertain those results which must follow, given certain preconditions. The preconditions correspond to active linkages and constitute that portion of cognition belonging to the collective. The constrained results correspond to passive linkages and constitute that which is experienced as objective reality. The act of* ascertaining *is the contribution of the individual.*"
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> (*ibid.*: 40)

Abstract

Taking up the core insights of the preceding chapter, a new hypothesis is put forth about the nature of the French-Anglophone divide in lithic research and some of its cardinal characteristics are charted. It is argued that the division, on a macroscale, represents primarily a conflict between 'analytic' and 'synthetic' world theories. The attendant polarities in theory and practice are illuminated by drawing on Pepper's architecture of Western thought. The categories 'analytic' and 'synthetic' help clarify the logic of artefact recording; imperatives of research design and inference-making; the relationship between theory and data; and strategies of visualisation which underpin the dominant lithic approaches on both sides. In the final part of the chapter, two key themes in lithic inquiry – variability and complexity – are examined through a Pepperian lens in order to map some of the more tangible effects of the divide. The analysis elucidates that French and Anglophone approaches are based on oppositional premises, which are difficult to consolidate, integrate, or even compare. French technological research is 'whole-centric,' whereas Anglophone lithic inquiry is 'part-driven.'

3.1 **Pepper applied: a new hypothesis**

What can we learn from Pepper's construal of Western thought about the nature of the French-Anglophone divide? Most importantly, it allows us to recognise that irreconcilable lithic knowledge claims may have their origin in incompatible yet equally pregnant world hypotheses. The circumstance that French and Anglophone researchers regularly produce divergent interpretations of the lithic evidence can then be taken as an indication that their polarised readings are powered by different world theories or combinations thereof. This, in turn, suggests that the kinds of underdetermination we encounter at the French-Anglophone interface practically prohibit the independent selection of a particular world theory perspective. Clearly, this proposition deserves assessment.

We have also learned that the general structure of credible Western cognition generally predisposes scholars to either adopt an 'analytic' or 'synthetic' logic of world-making. Because French and Anglophone lithic research seem to uphold disparate discursive spaces and because there is a general interest of cultivating interpretive tension while still nurturing cognitive complementarity, the 'analytic'-'synthetic' polarity is thus expected to be a stronger organisational factor than, say, the 'dispersive'-'integrative' opposition among world theories. The resulting cognitive dynamics, mainly regulated by the 'analytic'-'synthetic' divide, would pre-structure the cognitive space that the two research traditions can fill. For these reasons, it has merit to approach the French-Anglophone divide in lithic inquiry as a clash of 'analytic' and 'synthetic' modes of cognition. Pepper's reconstruction of Western cognition, in other words, provides us with plausible arguments to surmise that the bifurcation of the lithic research landscape into French and Anglophone approaches is closely related to mutually exclusive world theory underpinnings. It furnishes a well-defined hypothesis that can be tested against the realities of lithic practice.

The hypothesis that the French-Anglophone divide represents a particular instance of the 'analytic'-'synthetic' thought-polarity comprises two additional expectations. We should not only be able to break down the variability of practice *between* the two research spheres, but also shed new light on the nature of their *internal* variability. If the 'analytic'-'synthetic' polarity accounts for some general features of the divide, some of the pertinent internal dynamics of French and Anglophone lithic research should be explainable in terms of the trade-offs between the two attributed pairs of world theories: French lithic approaches should rely on 'contextualistic' and 'organicistic' ways of marshalling the evidence; Anglophone inquiry, by contrast, should be characterised by 'formistic' and 'mechanistic' regimes of handling the evidence. This hypothesis, however, does not suggest that French and Anglophone approaches are necessarily successful in pursuing their cognitive ideal, nor does it imply that all practitioners will always be guided by 'pure' world hypotheses incarnations – we are, after all, dealing with *cognitive orientations* here. The hypothesised structural organisation of the French-Anglophone divide is outlined in **Figure 2**.

Importantly, this novel perspective on the French-Anglophone divide offers not merely a redescription of well-known differences, but clears the view for their *cognitive significance*. If the divide is the result of different world hypotheses at work, this would elucidate both its status and its stakes, enabling a more productive discussion of how it can successfully be navigated or bridged. Moreover, if the divide turns out to be powered by world theory dynamics, this would highlight the central role of research communities – or 'collectives of thought' – in lithic knowledge production, for only these are capable of developing and refining world hypotheses (see Chapters 2 and 6). Therefore, hypothesising that the French-Anglophone divide is generated by divergent world theory regimes involves an argument about the socio-historical nature of the divergence. The divide would then signify a true chasm of research communities occupying barely overlapping discursive spaces and cultivating their own cognitive tenacities (see Chapter 1). The divide, if reconstructed along these lines, would also come into view as a product of dissimilar historical efforts of rendering the available evidence intelligible. Through this prism, the clearly distinct historical trajectories of the two research spheres can be re-interpreted as an attempt to refine different sets of root metaphors (see Chapter 2), again suggesting that the epistemological grounds for lithic research have drifted apart.

The remainder of this chapter explores the first part of this hypothesis; it asks whether the general structure of the French-Anglophone divide can fruitfully be illuminated by drawing on Pepper's distinction between 'analytic' and 'synthetic' modes of world-making. I will refer to a number of case studies and discuss some key topics to examine this question. The analysis will remain rather general since the demonstration that the difficult relationship between French and Anglophone approaches in lithic research is created by a conflict between different species of world theories can only be the first step. The chapter is consequently a prelude of what follows. It seeks to chart the general organisation of the divide in order to legitimise a finer-grained analysis of its constitutive elements or building blocks. In other words, we first have to understand the basic logic of the divide before we can grasp the dynamics that guide particular cases of research within the two spheres. If the hypothesis is supported by the available evidence, this would not only shed new light on the nature of the relationship between French and Anglophone research traditions, but also substantiate the reality and epistemological weight of the division.

3.2 **The general structure of the division**

Can the general structure of the French-Anglophone divide be clarified by reference to the cognitive dichotomy between 'analytic' and 'synthetic' modes of reasoning? And if so, how exactly is the dichotomy implicated in lithic practice on both sides? In what way, precisely, does it structure the divide and sustains epistemological friction? In order to answer these kinds of questions, we need to recall that 'analytic' and 'synthetic' research are difficult to reconcile because they conceptualise the role and status of 'parts' and 'wholes' in an oppositional manner; they, in other words, reject each other's basic standards of knowledge formation and criticism. From an 'analytic' perspective, parts are seen as the primary building blocks of reality and wholes as composed or derived entities, inferable from part-configurations. From the vantage point of 'synthetic' inquiry, wholes instead legislate over their parts and are thus considered a necessary precondition for the respective parts to occur in reality – wholes are 'more than the sum of their parts' in some relevant sense. As a consequence, 'analytic' approaches typically rely on corroborative strategies in which parts are mapped onto hypothesised wholes in order to evaluate whether the two 'match' or 'follow' from each other; 'synthetic' approaches, by contrast, tend to promote corroborative criteria that emphasise the whole-qualities of the advanced knowledge claims.[225] In the context of the French-Anglophone divide, we therefore need to examine what the respective parts and wholes in lithic research are and what their function in the research process is. This task is not as easy as one may assume and requires a careful investigation of some basic features of French and Anglophone lithic inquiry.

I will start with a basic examination of how lithic assemblages are usually recorded and studied. What is the role of individual artefacts? And which type of information is gathered in order to reconstruct the assemblage-totality? I will then move to more general aspects of lithic research; the analysis will concentrate on the general quality of applied research designs and the adopted patterns of inference. What is the rationale that guides the architecture of lithic research? What is the general strategy of inference? This investigation leads me to the problematic relationship between theory and data. What can generally count as data in French and Anglophone lithic research? What is the status of theory and how does it relate to data-analysis? Is the distinction even significant? In a third step, we will explore whether, and if so, how 'analytic' and 'synthetic' research orientations are reflected in French and Anglophone visualisation practices. What is the nature and role of lithic imagery? Do French and Anglophone scholars adopt similar visual strategies or do they instead rely on distinct 'image-worlds' in order to interpret their evidence? In the last step, I will discuss two concrete case studies in order to illustrate how the 'analytic'-'synthetic' divide affects the basic character of the lithic discourse and empirical research. It is explored whether, and if so, how the divide is implicated in the treatment of lithic variability and the interpretation of technological complexity. In total, the exposition should provide a general introduction to the epistemological relevance of the 'analytic'-'synthetic' polarity in lithic knowledge production. It will set the scene for a more detailed investigation of lithic practice in both research spheres reported in Chapters 4 and 5.

3.2.1 ***Atomism and holism in lithic recording***

In the practice of lithic analysis, the difficult relationship between 'analytic' and 'synthetic' cognition can be expected to result in at least four sites of interpretive friction. These concern (i) the kinds and types of data which are to be retrieved from the source material; (ii) the localisation of the relevant bearers of information; (iii) the relevant unit(s) of analysis; and (iv) the preferred direction of inference. The example of recording lithic assemblages – a necessary precondition of analysing and interpreting the respective artefacts – illustrates some notable effects of policing these conceptual coordinates in a divergent manner. It is important to note that the differential handling of these four sites affects lithic inquiry already at the stage of processing the source material, before any proper method-guided data-analysis can be conducted. The resulting differences in the logic of research are bound to often poorly theorised, because taken-for granted, yet crucial practices of extracting information from the lithic assemblages under study. These practices respond to the question of how one can transform

[225] See Chapter 2 for a detailed discussion.

the artefactual evidence into a data-format that can be reliably digested in order to assess the general character of a given assemblage, ideally answering particular research questions. The key aspects of this process are so basic and so deeply ingrained that they are rarely explained in detail in the literature. The reason is of course that data construction is typically thought to respond directly to the chosen methodologies. In reality, however, preparing the lithic data and selecting the appropriate method(s) to investigate them are often not clearly separable. Both co-implicate each other and to ask which of them is primary is to ask the old chicken-or-egg question.[226] The basic kinds of information that are gathered from the lithic material constrain and respond to methodological needs at the same time. It is for this reason that an investigation of basic recording practices in lithic research is clearly warranted, promising some interesting insights into the nature of lithic inquiry on both sides of the divide.

What is the basic strategy of recording an assemblage in French and Anglophone lithic research? The straightforward answer is that Anglophone scholars tend to adopt a 'piece-by-piece' mode of recording, whereas French technologists typically favour an 'assemblage-based' strategy. But what does this mean exactly? It means that in Anglophone lithic research the relevant information is located in lithic 'parts,' which are defined as objects – individual lithic artefacts themselves – or parts of objects. The result is that the analysis is generally 'object-centred,' either transferring objects directly into discrete variables or documenting their parts as 'traits,' 'attributes,' and 'features' (e.g., Dibble 1995a: 103; Sackett 1999: 115; Armagan 2003: Appendix A, B [271-284]; Shea 2013: Appendix 2 [335-345]).[227] When Anglophone researchers speak about recording the whole of an assemblage, they normally mean to record every single piece individually (cf. Clarke 1968: 187; Binford and Binford 1966).[228] Of course, a size-threshold is sometimes introduced for practical reasons, but the present micro-*débitage* is typically not ignored. The important point is that the informational value of a lithic artefact is conceptually *independent* from the quality of the assemblage-totality:

> "The data of the discipline is the information observed about the attributes of these artefacts. [...] The total information from these sensory spheres of activity feed observations about all these attributes into the third sphere of synthesis and fit the best model or hypothesis to the observations for further testing. [...] Briefly, it is imperative to realise that 'perceived facts' or attributes are necessarily facts or attributes selected from a vast range possessed by every simple artefact. We may choose to perceive length, breadth, thickness and weight of a handaxe but we may not choose to perceive or to be aware of its chemical composition, its temperature, radioactivity, elasticity, refractive index and so on." (Clarke 1968: 14f.)

The reason is that the quality of the assemblage-totality is believed to be the result of the (accumulated) character of its parts. The assemblage is primarily recognised as a *compositional* entity – as a 'derived' feature of reality. This conception is directly reflected in the dominant practices of assemblage screening. The 'object-centred' approach does not rely on visual or physical inter-artefact confrontations. The typical procedure is to unpack a single artefact, inspect and document its features, perhaps assign it to a general class of objects, and then pack it away again.[229] This approach emphasises analytical redundancy – all objects are checked for the same traits and attributes – and the comparability of individual artefacts and recorded characteristics:[230]

> "Study of the artefact collection initially involved going through each artefact in turn, checking and recording its provenance, and recording the range of data identified at the outset as relevant for analysis." (Wenban-Smith 2017b: 325).

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[226] An important reason for the co-implication of data construction and the choice of research methodology is historical. Within a given research community, the two dimensions of inquiry are expected to develop in tandem and to adapt to each other in the course of disciplinary history. Because practices of data construction are 'inherited' to the same degree as, say, preferences for particular types of research methods, it becomes practically impossible to determine which of the two dictates the other. A more plausible scenario is that different research traditions *coordinate* their possibilities of data construction and their pool of preferred types of methodologies, so that the two can effectively support each other.

[227] This procedure is typically implied by the various trait- and type-lists provided in method sections or in extended appendices: they detail the kinds of artefact-level characteristics that are recorded and outline how they have been recorded (cf. e.g., Henry 1995: Appendices 8.1-8.17 [196-214]; Monigal 2002: 143-199; Scott 2011: Appendix; Tostevin 2012: 120-137 [esp. 120]; Byrd 2013: Wenban-Smith 2017a, 2017b; McPherron et al. 2018: 118-121).

[228] Historically important studies that have paved the way for an 'object-centred' approach to the lithic evidence in the Anglophone world are Spaulding (1953) and Sackett (1966).

[229] One may say that the confrontation of features and objects is already part of data-analysis. It is therefore not required at the data construction stage of lithic inquiry.

[230] Consequently, the recording process itself does not depend on the size or completeness of the studied assemblages.

In French technological research, by contrast, the relationship between 'parts' and 'wholes' is extremely dynamic. An isolated recording of individual lithic artefacts and their characteristics, without having established the assemblage-context first, is highly uncommon, some would certainly say unthinkable. The reason is that the signification of parts cannot be established without having grasped some whole-qualities. This is perhaps most clearly reflected in the widely-adopted habit of spreading the entirety of the studied assemblage on table boards for visual cross-reference and direct physical confrontation (e.g., Tixier 1978, 1988; Villa et al. 2005: Fig 5; Soriano et al. 2007, 2015).[231] In practice, this horizontal exposition of the artefact-totality is also used to pre-arrange and pre-sort the assemblage into potentially meaningful sub-groups (e.g., technical, functional, typological, mineralogical). This logic of research incentivises scholars to find effective groupings of artefacts before they actually decide which lithic features and characteristics they wish to document in detail, if any. The point is that each lithic artefact has an informational value only in terms of its relatedness to other artefacts. This condition already anticipates that the same artefact characteristics can have a fundamentally different bearing in different assemblage-contexts (cf. esp. Perlès 1992: 243, Note 22).[232] Whether and how they should be recorded is therefore ultimately decided by the 'whole,' and may thus differ from assemblage to assemblage.

It must be emphasised that this process of assemblage exposition, artefact sorting, and constant re-grouping appears to be a *necessary* precondition of lithic analysis in the French tradition.[233] It not only indicates that the determination of significant wholes and sub-wholes is an essential building block of French technological inquiry, but also makes clear that 'parts' cannot stand for themselves.[234] Primarily recorded are technical *relationships* and artefact-group *interactions* rather than discrete attributes, measures, or traits.[235] The informational value of an assemblage is therefore regarded to reside in the 'whole' of the assemblage rather than in its 'parts.' The assemblage, *qua* technological entity, is viewed to be 'more than the sum of its parts.' Lithic recording is not only a pre-analytical practice, it also furnishes some critical pre-understandings of assemblage-level qualities.[236]

An important consequence of this difference is that in French scholarship describing an assemblage does not necessarily imply to describe all of the associated artefacts. A complete description rather entails the adequate characterisation of the assemblage's 'wholeness,' specifying the place of as many individual artefacts as possible.[237] French technological research thus typically adopts an 'assemblage-centred' approach to the lithic evidence. Its mode of inquiry is *holistic*, lithic recording being

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[231] Note that this information is often deeply hidden somewhere in method sections, footnotes, or figure captions; it is often not even explicitly mentioned because it has become such a commonplace practice among French lithic experts. It is thus perhaps especially telling that Paola Villa, originally trained in the United States, began emphasising this dimension of *chaîne opératoire* analysis when she started working intensively with French technologists: "[…] An efficient technological analysis requires that all pieces be taken out of their separate packets, marked with square and level and/or catalogue number and spread out to speed up the process of grouping in discrete categories while also checking for consistency in classification" (Villa et al. 2005: captions Fig. 5).

[232] See the first part of Chapter 5 for a detailed discussion.

[233] It is for this reason that the practice of 'living and sitting with' both a visually and physically exposed lithic assemblage for days or even months is such a crucial process in French technological research.

[234] See especially Valentin (1995: Annexes [1-19]), where the author develops a specific vocabulary to tackle the problem of describing and interpreting whole-level characteristics; the latter are not directly observable, if you will, in individual artefacts. In the case of Valentin, these characteristics have to do with the *volumetric management* of core matrices (see esp. *idem*: Fig. 6). The various modes of 'volumetric management' always implicate multiple different artefacts and there is no direct artefact-level correlate for them.

[235] The circumstance that the confrontation with other artefacts is a primary operation in French lithic recording leads to the somewhat paradoxical situation that artefacts themselves, although they clearly constitute assemblage-parts, need to be observed in their 'wholeness,' only then can they be meaningfully juxtaposed with other artefacts. The reduction of artefacts to mere numbers and attributes is generally inconsistent with this requirement. Tixier (2012 [1978]: 122), for example, notes that "[…] perception – whereby sight plays the dominant role – and near simultaneous overall identification lead to a comprehensive, a sometimes syncretic, understanding. The overall identification is altogether faster if the observer has a long practice or experience of the dialogue which takes place between a prehistorian and flint, which consists of the semi-unconscious registering of a multitude of visual images and tactual sensations" (original italics changed to underlining). The key point is that the 'tactual' and 'visual' *Gestalt* of a lithic piece is indispensable information itself.

[236] Needless to say, Anglophone researchers sometimes also spread their material on a table board. The point, however, is not whether they do it or not, but whether this practice makes a *difference* in how they record and interpret the evidence. An example is raw material units whose determination often requires the 'horizontal examination' of the artefact-totality. Yet, this examination typically effects only a single attribute, namely an individual artefact's raw material association. The rest of the recorded traits and attributes remains independent of this examination. One can add that there is a recent trend to assign raw material categories on the basis of clusters of raw material traits – a symptomatic 'analytic' manoeuvre which does not require any inter-artefact confrontation.

[237] What this wholeness exactly means must remain open for now. The issue will be taken up again in Chapter 5 and analysed in detail.

no exception. This also holds true for the somewhat special case of technological tool analysis – now commonly referred to as 'UTF-analysis' (cf. Boëda 1997, 2001). Although UTF-analysis is not always based on an 'assemblage-centred' approach and primarily examines individual tool-infrastructures, it is clearly 'synthetic' in orientation. As a special case of *chaîne opératoire* inquiry, UTF-analysis operationalises individual lithic tools (e.g., bifaces or Quina scrapers) as 'micro-wholes' and examines their parts accordingly.[238] The latter are typically understood as functional units ensuring the performance of the tool-totality. Having said this, such tool-wholes are usually placed into even larger wholes, so that they effectively constitute 'sub-wholes' which can further be related to other wholes within the wider assemblage-context (e.g., production systems) (cf. Lepot 1992/1993: Planche 87; Soriano 2000; Bourguignon 1997; Boëda et al. 2013). The inclination therefore remains deeply holistic. Moreover, this configuration has some notable implications for how object-samples are drawn. Typically, the strategy is not to draw a randomised sample; instead, scholars tend to pre-establish meaningful 'sub-wholes' and draw the sample in accordance to them (e.g., Soriano 2000). Thus, even sampling, strictly speaking, presupposes a 'synthetic' take on lithic assemblages and is an interpretive operation. The example of UTF-analysis also highlights again that part-whole relationships are negotiated in a highly dynamic manner.

The mode of recording that prevails in the Anglophone research sphere, as we have seen, is overwhelmingly *atomistic*. The guiding idea is that the lithic world is made up by a number of small but well-defined parts whose configuration provides primary insight into this world. It is through a more reliable understanding of these parts that scholars hope to pave the way for robust lithic knowledge. The French approach is counterposed to this conception. French technologists tend to assume that an adequate grasp of lithic wholes will lead to a more reliable understanding of their parts, and not the other way around. We will see in the next section that this difference has an important bearing on inference-making and the nature of the adopted research designs. All of this clearly confirms that the basic treatment of lithic assemblages is guided by fundamentally different research imperatives.

This general disparity between French and Anglophone approaches leads to starkly opposed conceptualisations of the data-world interface (**Tab. 3**). I will continue to explore these vectors of conceptual incompatibility throughout the remainder of this study. The two basic modes of handling lithic data, however, are a direct consequence of the 'analytic'-'synthetic' divide and deserve some clarification here. Because Anglophone modes of handling the evidence seem to be atomistic, the standards for describing and reporting individual lithic artefacts are held as constant as possible. The criteria of recording, in other words, turn out to be largely pre-defined, and the documentation of a lithic piece is a question of adequately applying these criteria. We can therefore say that Anglophone lithic inquiry, for the most part, appears to be rooted in a *democratic conception* of evidence, supporting relatively flat data-landscapes and rather generic categories of analysis. A potential consequence of this configuration is that the reportable number of independent artefact features is naturally limited, and possibly rather small. 'Analytic' lithic research thus tends to continuously play with more or less the same attributes and traits, and discusses the status of dependent and independent data.

This 'equality premise' clashes with the French position, which is fed by a more *heterogeneous conception* of lithic evidence (e.g., Tixier 1987 [2012]: 129; Soressi and Geneste 2011: 338-340, 342).[239] We have already seen that lithic parts are not necessarily treated equally there and some parts may not even be measured or properly recorded at all (see *supra*). When different assemblages are compared, the same object-characteristics do not always possess the same informational value. The French approach thus focuses from the beginning on the identification of evidential asymmetries and hierarchies (cf. Langlais 2010: 39; Perlès 2016: 232).[240] These have to be newly discovered in each assemblage, and cannot simply be inferred from the analysis of generic lithic data.[241] The reason is that

[238] A detailed account of UTF-analysis and its epistemological background is provided in the second part of Chapter 5.
[239] As we will see later, the clash between these two conceptions of evidence is a major source of epistemic friction and explains why 'objectivity' is such a contested notion. For Anglophone scholars, 'objectivity' is primarily secured through evidential equality, while in the French tradition it is safeguarded by argumentation and the assessment of intelligibility (both featuring more prominently in later stages of the research process) (see *infra*; Chapters 4 and 5).
[240] Cf. Plutniak (2015: 46f.).
[241] 'Analytic' research can of course also take into account class, trait, and attribute hierarchies but these are typically constructed according to some general rationale (e.g., 'set-theory' or the 'Theory of Types'; see Chapter 2). This rationale is applied to all

these hierarchies and non-similarity relationships are thought to be modulated by the assemblage-whole, and consequently cannot be detected by a strictly 'object-centred' approach. They are not so much 'outcomes' of individual object-characteristics, but the inevitable result of particular wholes administering particular parts. We will return to this issue in Chapter 5.

Importantly, only the Anglophone conception of evidence relies on a 'predefined input grid,' be it a generalised spreadsheet or a complex database (cf. e.g., Monigal 2002: Table 6-2; McPherron et al. 2018: 118).[242] The grid specifies what needs to be recorded and ensures that all examined artefacts are treated as equally as possible (or according to pre-defined rule-sets of an 'if x then y' type). Anglophone researchers typically invest a lot of time and space into providing a full list of the criteria they use and try to provide a general rationale which legitimises these criteria. French technologists, conversely, do in principle not depend on such input grids. Practically, however, they often use them. The critical point is that a grid, according French research logic, can only be constructed if one has already understood what is important in the assemblage and what can be shown by reference to particular artefact-characteristics. Input grids, therefore, tend to be technology- or assemblage-specific. Soressi and Geneste (2011: 340), for instance, also point out that in *chaîne opératoire* analysis "[…] a grid cannot be established before an initial global observation of the assemblage has been made; this is usually done with the assemblage organized on tables […]." Input grids are therefore often used to explore highly specific consequences of particular whole-qualities, but French researchers remain generally sceptical about the explorative value of generalised spreadsheets and databases in establishing these qualities. Again, the reason is that their vision of lithic inquiry is 'synthetic' rather than 'analytic.'

What follows from all of this is that the artefacts themselves seem to play a differential role in French and Anglophone knowledge formation. From an Anglophone vantage point, lithic artefacts constitute the primary units of inquiry; they hold the totality of information required to set up a proper analysis, and they define both the starting point and the limits of an investigation. Artefacts can be data in themselves – as types, classes, or other categories – or they contain the relevant features, attributes, and traits to be transformed into continuous and discrete data points. It should be rather obvious that this conception of evidence lends itself to quantitative inquiry.[243] The result is that the evidential value of a lithic artefact is, *grosso modo*, determined by the nature of the same artefact. In French technological research, lithic artefacts may become data in more varied and less standardised ways. They assume the highest evidential value, however, if put into perspective by other artefacts, for example through grouping, sorting, or other forms of meaningful juxtaposition. The critical information about lithic assemblages, in other words, is carved out 'between' the lithic parts, not within them. This also means that key technological information always transcends the physical limits of the artefacts it concerns. Data, therefore, typically implicate multiple artefacts or entire configurations of such artefacts.[244] The artefacts themselves are only informative if they can successfully be calibrated against their assemblage-context. The result is that the evidential value of a lithic artefact is, *grosso modo*, determined by the assemblage in which it occurs (all other co-occurring artefacts).[245]

We are tempted to conclude that French lithic experts appear to underestimate the cognitive value of artefact-level features, whereas Anglophone scholars tend to undervalue assemblage-level characteristics. The French approach, on a general plane, is grounded in an 'emergentist' reading of the evidence insofar as it postulates qualities that are not fully reducible to the qualities of individual artefacts.[246] Anglophone modes of inquiry, by contrast, are 'reductionist' in orientation; they primarily seek to record the cumulative signatures of lithic parts and assume that assemblage-level qualities, if

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lithic artefacts with the same rigour. Even hierarchies are therefore established 'democratically' (cf. e.g., Clarke 1968: 188, Fig. 40).

[242] For a prototypical example of a generalised lithic spreadsheet, see Garrard and Byrd (2013: Appendices C-H [402-410]).

[243] See Shennan (1997 [1988]) for an introduction. Most quantitative strategies rely on a 'bottom-up' approach to the evidence, locating data primarily in object-characteristics.

[244] French technologists seek to identify and describe 'techniques,' 'technical processes,' and other phenomena that concern more than a single artefact. Therefore, the data that is required to analyse them must point to the relatedness of artefacts rather than speak of their 'self-sufficient' qualities. Lithic data in French technological research consequently always reaches out to multiple co-occurring artefacts; the data that is carved out from an artefact must somehow implicate other artefacts.

[245] Conceptually, this comes close to asserting that lithic artefacts form part of a wider artefact-ecology and that their technical role or function can only be elucidated only by understanding this ecology.

[246] For insightful introductions to 'emergentism,' see Kauffman (1993) and Chalmers (2006).

they exist at all, can be directly deduced from artefact-level qualities.[247] This discrepancy has, without any question, considerable implications for the architecture of the divide and should have a strong impact on the potential findings and cognitive achievements of lithic analysis on both sides.

All of this demonstrates that the French-Anglophone divide seems to implicate a clash of 'synthetic' and 'analytic' modes of handling the lithic evidence on the most basic level. What is ultimately put at stake is, first, whether lithic parts can be said to fully explain their wholes or rather the other way around; and, secondly, whether lithic wholes have accessible characteristics that illuminate their parts in ways that they themselves cannot. The first issue is for example touched upon by 'reduction sequence' approaches which seek to model the 'stream of reduction' (*sensu* Henry 1989b) directly through dimensional artefact-level variations. The second issue plays an important role for instance in the definition of any given *« système technique »*, which is typically considered 'more' than an amalgamation of the artefacts it hosts (e.g., Geneste 1991; Valentin 1995: 25). The 'analytic'-'synthetic' polarity is therefore likely a major driver of conflict between Anglophone research, grounded in various kinds of 'attribute analysis' and 'dimensional analysis,'[248] and French *chaîne opératoire* studies, rooted in a 'synthetic' reading of the evidence.

The exposition has also indicated that a distinction between 'recording,' 'analysis,' and 'interpretation' is crucial for 'analytic' lithic research, whereas the boundaries between the three tend to be blurred by 'synthetic' approaches. For example, the examination suggests that Anglophone lithic inquiry records lithic objects by taking into account attribute-analytical demands. At this stage, however, the procedure is still purely descriptive. It is only with explicitly interpretive approaches – such as 'reduction sequence' (i.e., McPherron 1994; Dibble 1995b; Shott 2003, 2005b) or the 'Organization of Technology' (i.e., Kelly 1988; Nelson 1991; Carr and Bradburry 2011; McCall 2015: 93-95), sometimes grouped together as 'behavioural-strategic' (Shea 2013: 13f.) – that interpretation enters the arena of inquiry. This clearly seems to differ in the French case, where recording poses many interpretive challenges and requires scholars to move beyond what is immediately given through individual artefacts. *Chaîne opératoire* inquiry (i.e., Tixier 1980; Geneste 1985; Boëda 1986; Pelegrin et al. 1988; Pelegrin 1990; Inizan et al. 1995), as it seems, is already holistic in the sense of integrating key operations of data-construction and data-analysis into a single conceptual framework.[249] At any event, this is clearly an issue that needs to be clarified and part of the next section is dedicated to it. The issue puts the spotlight on questions of research design and the structural rules of argumentation and inference in lithic research.

3.2.2 ***Research design and the structure of inference***

What are the effects, if any, of the 'analytic'-'synthetic' divide on general aspects of research design and inference-making? This question concerns foremost the mode in which uncriticised observation is transformed into criticised knowledge claims. It also touches upon the direction of inference and has implications for the role of rationalisation and argumentation in the lithic research process. All of these questions, as Pepper elucidates (cf. Chapter 2), can only be answered with recourse to cognitive values, showing that 'analytic' and 'synthetic' inquiry support different normative theories of science. This is perhaps best reflected in the overall character of reasoning tied to either of the two. As clarified in the previous chapter, 'analytic' approaches commonly subscribe to 'formal-logical' modes of reasoning and argument, whereas 'synthetic' approaches tend to adopt 'dialectic-dialogical' modalities of the same. This distinction has important consequences for the structure of inference-making, a feature of lithic research that can be examined in some detail with the help of case studies.

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[247] Some may counter that Anglophone research also musters assemblage-level qualities, most notably indices or other aggregate variables (i.e., the classic values 'IL,' 'IF,' 'IFs,' and 'Ilam'). While this observation is correct, these measures remain *fully reducible* to the artefacts in questions, meaning that they are directly inferable if one knows only the qualities of the individual artefacts on the basis of which they were constructed.

[248] See Ahler (1975) and Henry (1989b).

[249] This may mean that *chaîne opératoire* analysis relies on a logic of research, according to which a distinction between 'recording,' 'analysis,' and 'interpretation' plays a less important, perhaps even marginal role. In fact, this would not be particularly surprising given that *chaîne opératoire* approaches are likely underpinned by a 'synthetic' research paradigm (see *supra*). Distinguishing between 'recording,' 'analysis,' and 'interpretation' is, after all, a typical 'analytic' manoeuvre, assuming the research processes itself is analysable by well-defined parts. Because this assumption is not necessarily shared by 'synthetic' approaches, the research process may have a radically different character there (see the next section for an in-depth investigation).

'Analytic' cognition of the 'formal-logical' type organises research processes in such a way that the results seem to follow inevitably and 'automatically' from the data-input, given the accepted structural rules of cognition. This species of cognition is heavily driven by explicit methodologies which ensure the seamless digestion of evidence and control the pattern of reasoning. 'Analytic' inference therefore typically involves a high degree of formalisation, insists on maximally transparent deductions, and emphasises the directedness of inquiry. Argumentation primarily serves to guarantee that the transition from one stage of reasoning to another is really compulsory. The general structure of inference and argumentation is therefore well-defined and each operation, including argument, has a preordained function.

'Synthetic' cognition of the 'dialectic-dialogical' type, by contrast, is a more open-ended and multi-stranded endeavour; it rejects the idea of a fixed and somewhat stable structure of cognition. The solutions to cognitive problems are thought to be problem-specific and no general cognitive formulae can therefore be established. Inference in 'synthetic' research is always a struggle and multi-directional. The progression of reasoning is less rigorous and the evaluation of arguments is less straightforward since each argument needs to be evaluated contextually. This puts an even heavier burden on *rationalisation* and *argumentation* because only they can ensure that the cognitive constructions withstand further scrutiny.[250] The general structure of inference is therefore extremely flexible and favours more complex patterns of reasoning. Analysis and argumentation become a question of cross-adjustment – to arrange all parts in such a way that they satisfy their whole(s). Reasoning is less guided by formal-logical models and is conceptualised as multi-layered exchange of *pros* and *cons*. In *Méthode pour l'étude des outillages lithiques*, Tixier (2012 [1978]: 122) himself notes that there is a "dialogue which takes place between a prehistorian and flint." According to the 'synthetic' standpoint, it is this dialogue which delivers insights that can be carried over into robust lithic knowledge claims.

These general differences may already explain some of the recurrent kinds of criticism which are observable at the French-Anglophone interface (see Chapter 1). Given the outlined polarities, it is, for instance, no surprise that French lithic inquiry is often stigmatised as overly 'subjective,' 'intractable,' and 'non-reproducible.' Anglophone approaches, on the other hand, are unsurprisingly perceived as 'corset-like' and as giving voice to a 'tyranny of procedure,' in which methods often legislate over empirical data. Taking up again the insights from the previous chapter, this configuration is likely the result of a differential understanding of key conceptual coordinates such as 'objectivity' and 'rationality,' and may indicate that 'method' does a differential work in the two larger research frameworks, being designed to secure vastly different epistemological qualities.

The same differences, moreover, can clearly be recovered if we delve deeper into the three cases of interpretive conflict introduced in the second part of Chapter 1 (Biache Saint-Vaast IIA, Gouzeaucourt G, Micoquian layers of Kulna). A closer look into the adopted patterns of reasoning, the interaction between the construction of hypotheses and the mobilisation of data and methods, as well as the general progression of argument, including the logic of connecting different findings, confirms that the respective French authors (Boëda, Soriano) adhere to a 'synthetic' architecture of thought, whereas the involved Anglophone scholars (Dibble, McPherron, Tostevin) closely follow 'analytic' schemes of reasoning.

The latter group has authored highly-ordered, simplicity-favouring structures of inference, exhibiting a high-degree of inferential and argumentative redundancy (**Fig. 3**; see **Appendix III.1** for additional reconstructions and an explanation of the rationale guiding the conceptual analysis). The basic character of this pattern is that the analysis follows a semi-automated algorithm, resulting in a high degree of structural similarity between the approaches. Tostevin's (2012) comparative study of the Kulna lithic material slightly deviates from this pattern, but only with regards to the complexity and scope of analysis.[251] The reconstructed architectures of analysis clearly situate Anglophone lithic inquiry within a spectrum of approaches deploying 'inductive' and 'deductive' modes of reasoning in order to test explicitly formulated hypotheses. Even though both Dibble's (1995a) and McPherron's

[250] Cf. esp. Perlès (2016: 225).

[251] This finding only corroborates that the internal variability of 'analytic' lithic approaches should not be underestimated. In fact, Tostevin's (2012) more complex 'tree of analysis' (see **Appendix III.1: Figure III.3**) indicates that his investigation actively pursues the *proliferation* of fact and, accordingly, 'goes wide' in data-collection and -analysis. Together with a comparatively 'defused' hypothesis-testing approach and the generality of the finally offered explanations, this suggests that Tostevin's study responds to a broadly 'formistic' logic.

(1994) investigations are governed by a 'hypothetico-deductive' structure of reasoning, all three studies exhibit some degree of mixture between 'inductive' and 'deductive' inference-types. The key point is that the analysis is generally well-focused and directed, and that the evidence passes through a number of pre-defined stages of analysis before a knowledge claim is formulated. As a result, constructing the general theoretical framework from which the hypotheses are derived as well as specifying their test-implications structurally *precede* empirical data evaluation (cf. Clark 1991a). Basically, the 'rational' side of research, general theorisation and hypothesis-building, is well-separated from the 'empirical' task of data-analysis.[252] This bifurcation results in a well-ordered structure of inference, in which different operations serve their purpose within a specific, but largely generic chronological sequence (cf. Hill 1972).

Conceptualising rationalisation as a 'pre-empirical' procedure is important since it leads to a distinct character of arguments depending on whether they are used to develop theory and hypotheses or whether they serve to assess the degree of support the latter experience by the data. The evaluation of the actual 'match' between hypotheses and data is highly standardised, rooted in formal-logical calculus, and in all three cases heavily relies on statistical methods – it becomes a cognitive 'routine':

> "[…] the word *analytical* […] refers to the more general philosophical principle of using formal empirical observations in the building and testing of hypotheses. "Formal" in this instance refers to the use of quantitative data (be it categorical, ordinal or metric), to assess in a detailed manner the relationship (or otherwise) between a set of empirical phenomena and a particular model or hypothesis derived from theory or observation, the assumptions and predictions of which are made explicit. Such an approach can be contrasted with those of description and narrative." (Lycett and Chauhan 2010b: 3; original emphasis)

In general, the specific research designs and patterns of inference embraced by the Anglophone lithic researchers are clearly of an 'analytic' type. The structural exposition of reasoning reveals that they are either 'Hempelian' and therefore strongly influenced by the 'covering-law' model of scientific explanation (cf. e.g., Salmon 1967)[253] or at least subscribe to the basic principles of 'verificationism' and 'falsificationism.'[254] The distinction between 'empirical' and 'theoretical' operations thereby regulates the progression and logic of inference.[255] Because lithic inquiry in these cases is really hypothesis-driven, the structure of reasoning is that of a 'fork.' Typically, this means that a number of competing hypotheses is first outlined and then compared *independently* against the data. This strategy authors multiple individualised and largely self-contained pathways of inference, which only in the final stages of analysis contribute to the formation of knowledge claims. Again, this pattern is genuinely 'analytic' since different hypotheses or domains of inquiry (e.g., 'knapping domains' in the case of Tostevin's study) make up the 'parts' of the analysis which, through individual interrogation, allow for a synthesis of parts that clears the view for the 'whole.' In this scenario, the whole is nothing else then the outcome of analysis.

However, in a strictly hypothesis-testing approach, each hypothesis itself also defines a possible whole; the analysis simply checks whether the whole actually follows from the recorded parts (i.e.,

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[252] This separation closely follows the 'two context' conception of science advocated by Reichenbach (1938) and many other Logical Empiricists, but also by Popper (1965). The basic assumption of this distinction is that there exists a *general logic* of scientific justification, but no such general logic of scientific discovery. Accordingly, the logic of science becomes congruent with the 'scientific method.' Differentiating between the 'context of discovery' and the 'context of justification' typically implies to regard the construction of hypotheses and theories as creative acts which are by definition idiosyncratic and somewhat 'psychological.' This view, now deeply entrenched in many branches of science, conceives of the 'context of discovery' as an *exogenous* factor in scientific practice (cf. Nickles 2013).

[253] The perhaps most important account of the 'covering-law' model of explanation was provided by Hempel and Oppenheim (1948; see also Hempel 1942, 1945, 1965). This model of explanation takes up the idea that explanation requires one to show *how the explanation derives in a logical argument*. The 'covering-law' model adds that the premises of that logical argument must entail at least a single well-confirmed *law* or *regularity* of nature (cf. Godfrey-Smith 2003: 191). These must make a substantial contribution to the argument. Part of the motivation to introduce this model of explanation was to allow for the possibility of good 'inductive' arguments. In general, 'covering-law' explanations explain by showing that the *explanandum* (whatever is to be explained) was to be *expected*, that is, was no 'surprise,' given our knowledge about the basic regularities of nature.

[254] See Ayer (1936) for an influential theory of 'verification,' and Popper (1965, 1968) for an influential account of 'falsification.' Note that these accounts are 'analytic' insofar as the process of corroboration targets observational parts and compares them against the 'theoretical expectations' of a hypothesis (conceived of as the whole to 'end up with'). The corroborative procedure is *hypothesis-driven* and each hypothesis is considered to be testable independently.

[255] Note that this is precisely the concept of scientificity that was deliberately adopted and fiercely defended by Lewis Binford (1972, 1977, 1982) and the *New Archaeology* from the 1960s onwards (Spaulding 1968; Watson et al. 1984; cf. Trigger 2003: 9). The general 'mechanistic' orientation that the conceptual distinction between 'observational' and 'theoretical' implies is discussed in Chapter 2.

the available evidence) or not. Another facet of the same research logic is that a bigger problem, for example the reconstruction of lithic reduction dynamics, is broken down into a number of sub-problems, each investigated separately. This strategy is employed in all three Anglophone cases. It reveals a compositional structure of reasoning and shows that the 'compartmentalisation' of cognitive problems is an Anglophone hallmark. The basic strategy is 'anti-holistic' and presupposes the primacy of parts. 'Epistemological atomism' or 'methodological individualism' (see Chapter 2) are some of the common symptoms of this 'analytic' mode of lithic cognition. Binford's (2015 [1972]: 111) account of data-explication, for instance, provides a useful illustration here:[256]

> "Explication generally refers to some systematic description of observations. In this the archaeologist faces the task of breaking down a whole into parts, generally with the aim of elucidating its componential make-up, and the interrelationships among its components."

Although Tostevin's (2000, 2012) examination of the Late Middle Palaeolithic layers of Kulna cave, as noted earlier, seems to deviate from the generally deductive mode of inference employed by Dibble and McPherron, it nevertheless subscribes to explicit hypothesis testing, the primacy of theory in the construction of the research framework, and the maximally rigid evaluation of logically distinct relationships between 'theoretical' claims and 'empirical' evidence. A central goal, just like in the other two Anglophone cases, is to maximise *inferential transparency*. This is not only ensured through the *grosso modo* linear and well-defined structure of inference itself, but also through the application of highly standardised (statistical) procedures to compare expectations and findings. Inferential transparency is valued because it promises to assure a basic 'objectivity' of research, which, again, is thought to be indispensable for guaranteeing the 'replicability' and 'subject-independency' of inferences and conclusion (cf. Binford 1982; Marwick 2017). We will come back to the issue of subjects later in this section. What is perhaps most important is the structural rigidity exhibited by this approach. This rigidity leads to a high degree of operational redundancy, with different types of evidence handled in broadly similar terms.

Tostevin's *Seeing Lithics* (2012), just like McPherron's (1994) examination of bifacial shape-variability, further demonstrates that comparability among assemblages is primarily ensured by treating them *similarly*.[257] The resulting highly uniform analytical procedure facilitates one-to-one juxtapositions and makes sure that the exact same type of information is available for all of the studied assemblages. This, of course, clearly attests to an 'analytic' research orientation since the direct (i.e., unmediated) comparison of assemblage-parts in order to assess questions of similarity and difference on the level of assemblage-wholes only makes sense in an 'analytic' framework of inquiry. Since parts, from a 'synthetic' perspective, cannot stand for themselves, they also cannot be compared directly without knowing what their position, role, or function in a 'whole' is. At any rate, the epistemological 'principle of equality,' already encountered on the level of data-construction, seems to also apply to general questions of research design.

A final, yet important characteristic of the three Anglophone cases is that an explicit interpretation of findings is only offered *after* formal hypothesis-testing. All examined patterns of reasoning therefore evince a three-part structure, with a clear separation between theorisation and construction of hypotheses, primary data-analysis, and final data-interpretation.[258] The three parts are held together by a methodological framework. Typically, this general logic of inquiry is already signalled by the succession of headings and subheading that structure the papers, chapters, or books in which lithic research is reported. After outlining the general debate and the relevant research questions, these commonly describe the theoretical background of the taken approach and then introduce the methodology that is thought to help answering the research questions given the theoretical enumerations.

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[256] Note that the mere distinction between 'exploration,' 'explication,' and 'explanation' as suggested by Binford (1972b: 110) already indicates an 'analytic' approach. The well-differentiated role of these analytic 'activities' and their well-defined position within the sequence of reasoning supports this conclusion.

[257] This level of structural formalisation is of key importance for the nature of employed argumentative strategies. Only if highly formalised patterns of reasoning are employed is it possible to assess and criticise each single finding in the same way. The same basic arguments can then be mobilised again and again to inform the final conclusions. Therefore, structural and operational redundancy in this sense typically foreshadow argumentative and inferential redundancy. In the extreme case, examinations of this type appear to be driven by a 'cognitive machinery' whose results are inevitable and leave little leeway for interpretive creativity. Of course, it is precisely this general quality of scientific cognition that is deemed to be most 'reliable' by adepts of 'analytic' thought.

[258] Cf. e.g., Clarke (1972b).

Only then is the data introduced and analysed according to the selected methodology. The results are presented in a 'result' section. This section is usually kept separate from a 'conclusions' section in which the respective findings are placed into the larger debate and reflected upon in light of the chosen theoretical perspective. This general structure has in fact already become the norm in many of the field's leading peer-review journals, and has numerously been reiterated by various FAQs of 'how to write a scientific paper.' It can be found, for instance, in the guidelines of journals such as the *Journal of Human Evolution*, the *Journal of Archaeological Science*, and *PLoS ONE*. These are clearly 'analytic' journals, responding to the standards of inquiry which have been cultivated in the Anglophone research sphere.

In total, it is thus perhaps no surprise that Anglophone researchers increasingly identify themselves as *analytic* scholars (cf. Shennan 2004).[259] This general orientation of research was of course already addressed by David Clarke's epochal *Analytical Archaeology* (1968) and actively propagated by leading 'New' Archaeologists such as Lewis Binford. Within the same breadth, one could also mention the contributions of Glynn Isaac (1989) and many others. More recent Anglophone volumes that address theory and method in lithic research, for example *New Perspectives on Old Stones: Analytical Approaches to Palaeolithic Technologies* (Lycett and Chauhan 2010a), follow the same research trajectory.[260] In this light, it is probably uncontroversial to suppose that the vast majority of Anglophone scholars tends to conduct 'analytic' lithic research.

How does this compare to the examined French cases of lithic inquiry? Perhaps most importantly, there is no standardisation of the research process itself. Modes of argumentation and the followed pathways of inquiry, as a consequence, differ dramatically between the three cases. The main reason is that basic operations of inference are thought to be *case-sensitive*. Although the applied terminology and concepts are broadly shared, the way in which they are brought to bear varies. This suggests that the evidence itself exercises a much greater impact on how lithic inquiry is precisely done, including its direction and progression. A close inspection of the three French case studies (i.e., Boëda 1988, 1995a; Soriano 2000) in terms of research design and structure of inference further demonstrate that they violate key principles of 'analytic' thought, blurring the boundaries between some of the categorical distinctions that structure the research process there. The French cases, for instance, reject the structural and logical separation between 'rationalisation' and 'empirical corroboration' – the old Reichenbachian polarity between the 'context of discovery' and the 'context of justification' which has become a hallmark of 'analytic' inquiry (see *supra*). A tangible consequence of this repudiation is that a procedural and research-logical differentiation between hypothesis-construction and hypothesis-testing is no longer regarded to be effective. Rather than being independent operations that follow up on each other in a pre-defined temporal sequence, both form complementary parts of the process of data-analysis. Even hypothesis-construction therefore relies on a direct contact with the lithic evidence.

Boëda's (1988) approach to the lithic material from Biache Saint-Vaast level IIA illustrates this general condition. Here, the process of inference becomes manifest as a *cyclic structure*. We can identify multiple cycles and sub-cycles of hypothesis-formation, -evaluation, -rejection, and -reformulation, and these cycles are clearly embedded in primary data-analysis.[261] This process, as the comparison with the other French cases demonstrates, lacks structural formalisation. The analysis is driven not so much by formal-logical reasoning or inferential statistics, but is powered by *qualitative* arguments that seek to establish an interpretive 'dialogue' with the source material and between different parts of the source material (e.g., Boëda et al. 2013a: 194). The arguments are fashioned in such a way that they can be answered *relationally*, that is, with regards to other artefacts or already established assemblage-level findings supporting or disapproving particular readings. The result is a multilinear configuration of reasoning.

[259] See also Lycett and Shennan (2018).
[260] See esp. Gowlett (2010) and O'Brien (2010) in the same volume.
[261] Many French scholars have characterised their approach as relying on an 'inductive method' (e.g., Tixier 2012 [1978]: 125; Bon 2009: 120). As I try to show here, however, this is only adequate insofar as French technological research departs from the lithic facts and only from there develops theories and hypothesis. The procedure is not really 'inductive' in the strict sense because the inferential core is not so much based on formal or informal logic, but rather on *interpretation* (see *infra*). For clear rejection of the cognitive significance of the 'inductivism-deductivism debate' in French archaeology, see also Cleuziou et al. (1991).

In contrast to their 'analytic' counterparts, however, the resulting strands of analysis – individual cycles and sub-cycles – are critically *dependent* on one another. Their role is to focus and guide the analysis, not to deliver self-sufficient findings. These strands, in other words, have no independent say, but only through interaction, protrusion, and overlap with other strands provide insights into the lithic assemblage; they cross-configure each other in what they can contribute to the process of knowledge formation. The structure of reasoning, therefore, is generally elastic. There is a constant argumentative and inferential 'back and forth' between the constitutive elements of an individual cycle of reasoning, but also between all of the relevant cycles themselves. The analysis is holistic to this effect; no individualised strand of inquiry has significance without being responsive to the totality of significant strands. This is the 'synthetic' quality of Boëda's approach. The 'wholeness' of the account exercises authority over the 'partness' of localised findings and assertions.

An important consequence of this logic of analysis is that there is no 'natural' or 'logical' point of inferential departure. Where one starts the investigation – that is, what one studies first and what considerations one decides to throw into the mix first – does not really matter much. The reason is that anything which is said or argued needs to meet the standards of the whole, and this whole consists of the coming together of *all* parts. French lithic inquiry therefore comes into view again as a constant and highly dynamic cross-adjustment of parts and wholes. The point is that there is no necessity to start with the examination of a particular object class or to present individual findings in a particular order because they all need to be adapted to each other anyways. As a result, inferential pathways tend to be extremely *heterogeneous* and generally depend on the quality of the assemblage-whole. Some scholars chose to open up the investigation with an assessment of the core-technology, some opt for an assessment of the *débitage* first, and others, although this is more rarely encountered, start with a discussion of the toolkit.[262] The main reason for why there is a sequence at all is that one cannot, practically speaking, present all of these aspects at the same time. Much of the actual multi-linearity of reasoning that underlies French technological inquiry is masked by the constraints of producing a readable and legible paper.

These elucidations suggest that an important structural difference between 'analytic' and 'synthetic' reasoning at the French-Anglophone boundary is that the former shelters structural uniformity and cherishes general argumentative rule-sets, whereas the latter makes room for much more structural diversity and incentivises scholars to creatively devise case-specific arguments.[263] I would contend that this polarity leads to a critical trade-off: the Anglophone research structure, because of its separation between handling 'theory' and 'data,' encourages practitioners to diversify their theoretical repertoires and develop them independently; in the French case, creative diversification takes primarily place within data-analysis itself, leaving 'theory' behind as a somewhat problematic and mostly implicit dimension of research. We will return to these issues in the next section.

The cyclic structure of inference that seems to characterise French lithic inquiry is perhaps best reflected in the reconstruction of core-blank technologies. Again, Boëda's (1988) analysis of Biache-Saint Vaast IIA is a useful example here. In order to understand the signification of core variability, he examines the 'stigmas' of the cores and compares their spatiotemporal organisation with the technical features of the blank-population.[264] The goal is to determine groups of cores and groups of blanks which endow each other with meaning, and thus define a technological unit. The clue of this

[262] In practice, French practitioners often start the investigation with a detailed treatment of cores. This, however, has no structural or epistemological reasons, but simply responds to the fact that there is an asymmetry between cores and their flaking products. There are always multiple *débitage* products that 'belong' to a single core. This situation renders cores potentially richer in referencing other lithic objects in the assemblage; they are more pregnant in implicating other artefacts. This is why it is typically practical to begin with an analysis of cores rather than other types of lithic objects. In fact, however, this reasoning only underlines that there can be no 'natural' entry point of analysis. If cores are only chosen because of the many other artefacts they reference, this simply shows that no single artefact, not even cores, can be discussed in isolation and that it really doesn't matter where one starts – simply because one always has to discuss all lithic artefacts in light of their *entire* assemblage-context.

[263] According to a 'synthetic' understanding of science, heterogeneity tends to be regarded as an 'epistemic virtue.' It is usually highly valued among practitioners. For example, argumentative and inferential 'originality,' 'sophistication,' and/or 'elegance' typically carry positive connotations and scholars seek to realise them through their work. While 'analytic' approaches typically try to secure an epistemic 'democracy' by treating lithic objects in a similar fashion, 'synthetic' approaches instead value epistemic heterogeneity because it gives voice to the 'democratic freedom' of plural readings. In fact, analytical heterogeneity – the antithesis of epistemic rigidity and uniformity – can be viewed as a *precondition* for general intellectual creativity that is not restricted to methodological or theoretical innovation alone. The 'synthetic' understanding of scholarly 'ingenuity' is likely rooted is this valorisation.

[264] To be perfectly clear, the mobilisation of the term 'stigma' is not at all idiosyncratic here (cf. e.g. Inizan 1995: 25, 29, 34-36, 59, 73, etc.).

analysis is that the artefact features and their combination encountered in one artefact-domain are calibrated against the features in the other domain in order to isolate patterns of co-constitution. Only if most characteristics in the two artefact-domains can be shown to co-constrain each other – that is, to make sense in light of each other – can it be concluded that the two domains are also technologically related. This analysis also entails the necessity to show that the determined relationships help to resolve the entirety of the present lithic artefacts in a meaningful way.

Already the term 'stigma' implies this mutualistic logic of analysis. Technical 'stigmas,' in the sense of Boëda and others, are not just individual traits that leave a physical mark on their lithic objects. Stigmas are relational units of identification and generally refer to configurations of entities. A stigma on an object therefore already implies other objects. Goffman (1963, 1974), for example, who provided one of the most influential characterisations of the concept to date, defines a 'stigma' as the status of a person as assigned to that person by other persons in that person's social field. Processes of 'stigmatisation,' according to Goffman, are therefore sociologically significant. They tell us something about the position of the person in her/his social field. Analogously, technical stigmas tell us something about the status of a technical object *as assigned by other objects* in that object's technological field. The 'technological field' thereby simply refers to the technical 'sub-whole' to which the stigmatised object contributes (i.e., a particular core-blank technology, a technical structure, a technical system). An analysis of technical stigmas, conversely, allows one to determine which other lithic objects in the assemblage are relevant for the explanation of the stigmatised object.[265] We can conclude that a technical stigma, according to Boëda, is *technologically significant*; stigmas are qualities that reference other qualities and thus always encapsulate 'more-than-the-stigmatised-artefact.' Stigmas, in other words, 'reach out' to the assemblage context. The mobilisation of the notion of a technical 'stigma' is consequently indicative of the anti-atomistic orientation of French lithic analysis.[266] It clearly testifies to a 'synthetic' approach to the lithic evidence.

Boëda's (1988) reconstruction of the various core reduction methods, including unidirectional and bidirectional 'Levallois recurrent' (*Schéma A*, *B*), is therefore comprehensible as a continuous inferential movement 'back and forth' between varying lithic parts and their potential lithic wholes, in the process of which both are mutually adjusted to each other until global intelligibility is reached. This pattern of reasoning is 'dialectical' at its core. It clarifies what it means to 'bring the lithic artefacts into dialogue.' We may then also better understand why the process of reasoning itself tends to be of a 'dialogical' nature. The interrogation of, say, a core leads to an initial interpretation, which suggests a set of possibly related artefacts; the interrogation of this set, in turn, may confirm the initial interpretation or, more likely, leads to new interpretive perspectives on the core. It may of course also lead to a re-adjustment of the initial interpretation. Typically, the initial confrontation of potentially meaningful artefact-subsets of an assemblage leads to new strands of investigations pertaining to all subsets, often resulting in a reshuffling of at least some of these sets.[267] In the extreme, re-adjusting an interpretive claim therefore requires one to also adjust all connected assertive claims. This inferential cyclicality, which is open-ended, results in a basic condition of *holistic testing*.[268] Interpretations cannot be evaluated individually, but rise and fall as a function of the total set of currently held interpretations. To 'test' a single inference thus always means to test the entirety of current inferences. If intelligibility cannot be reached, the inquiry must start anew. It should be clear that a publication conveys on the final and ultimately successful pathway of reasoning.

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[265] The concept of a 'technical stigma' therefore already expresses the aspiration to arrange lithic assemblages, understood as 'wholes,' into various 'sub-wholes' in order to illuminate the role and status of each single lithic artefact therein.

[266] The point is that a 'technical stigma' defined in this way usually implicates technical relationships which are not based merely on (dis-)similarity. Rather, the sought-for relationships – those that can be defined as *technical* in the strict sense – are typically based on *complementarity* and *transience*. A 'transient tie' describes a technical relationship between two or more lithic objects or processes involving no direct interaction, but some 'intermediator(s).' Such *indirect relationships* are generally difficult to track by 'analytic' inquiry, especially if the guiding root metaphor is 'similarity.'

[267] This interpretive 'sorting' includes the possibility of rejecting the explanatory relevance of particular groups of artefacts for other groups of artefacts, and *vice versa*.

[268] 'Methodological holism' has been prominently defended by thinkers such as Pierre Duhem and Willard O. Quine. In epistemological terms, the key idea is that the *whole* of a theory or an entire set of propositions is the *smallest unit of confirmation*. Quine (1951b: 42) even posited that "[t]he unit of empirical signification is the whole of science." An important consequence of this view is that a failed prediction does not necessarily refute the hypothesis on which it was based. The point is that the confirmation of a hypothesis always depends on more general background information and the relationship of the hypothesis to other hypotheses. In holistic modes of inquiry, therefore, a hypothesis typically loses both its status as the smallest unit of confirmation and its epistemological independence.

We have already seen that the general character of 'synthetic' cognition is open-ended and that 'synthetic' modes of argumentation typically embrace the lurking incompleteness of their knowledge claims. This, again, is linked to the cyclic nature of inquiry and its weakly defined structure and directionality. Because argumentation and rationalisation are 'dialogical' and serve primarily to connect disparate pieces of knowledge, they cannot settle a problem once and forever. In 'synthetic' science, whole-part dynamics are always puzzling, delivering a vision of scientificity that emphasises ongoing effort rather than the fruits of knowledge. It can be argued that this general cognitive orientation is directly reflected in a 'rhetoric of provisional results.' This rhetoric not only rejects ultimate answers to thorny questions,[269] but also motivates a practice in which preliminary syntheses are flagged by denominations such as *« essai »* ('essay') and *« jalon »* ('milestone'). These terms are used to name books, chapters, and papers, and thus denote a central mode of reporting the interconnection of certain findings. They are rather omnipresent in the French expert literature, especially in more recent instantiations (cf. e.g., Leroi-Gourhan and Brézillon 1972; Schmider 1988; Pigeot et al. 1991; Valentin 2008a: 47; Mevel 2017: 253ff.). In Anglophone research, by contrast, such terms tend to be shunned because of their undesired 'narrative' connotations (cf. Binford 1968c: 11; Lycett and Chauhan 2010b: 3 [op. cit.]; Shea 2013a: 295).[270]

We have also seen that French lithic inquiry is really the product of an interpretative tradition of stone artefact analysis. 'Interpretation' is thereby not just a question of giving a final verdict after data-analysis has been conducted, but plays a role on almost all stages and levels of the research process. Each 'act' of re-organising one's judgements after a cycle of inter-artefact confrontation has been passed through involves at least a single interpretive decision. In practice, this often blurs the second stronghold of 'analytic' rigidity: the structural distinction between 'observation' and 'interpretation.'[271] Furthermore, interpretation is a key operation since it helps to bridge parts and wholes and to navigate through the unsteady cycle of inference.[272] This 'dialectic-dialogical' pattern of reasoning supports a *hermeneutic* logic of inquiry,[273] in which the emphasis clearly lies on 'understanding' [*Verstehen*] rather than 'explanation' [*Erklären*] (cf. e.g., Von Wright 1971; Schurz 1988; Corbey 2005: 122-134). 'Understanding,' as defined here, can be recognised as a species of knowledge which centres on 'piecing together disparate pieces of knowledge' (e.g., de Regt and Dieks 2005; de Regt 2009; Gijsbers

[269] A clear symptom of this 'open-endedness' of inquiry is the presence of many explicitly formulated questions within the interpretative part of research. An example is Marchand's (2014) attempt to bring together various lines of investigation in order to understand the historical trajectory from the Late Palaeolithic to the Neolithic in Brittany. His account is extremely 'thick' and puts forth many unanswered questions while trying to connect the various pieces of evidence he has collected.

[270] Even though such small details should perhaps not be over-interpreted, they show that French attempts to endow a historical sense to *apriori* isolated observations often leads to quasi-narrative procedures (e.g., Valentin 2008a; Bon 2009), imposing a certain 'textuality' onto the palaeo-archaeological record (cf. de Beaune 2016: Chapitre VIII, 279-282). I would not go so far as to infer that this already exposes a tacit reliance on the idea of 'material culture as text,' but it certainly transports a hermeneutic undertone. It at least seems to be no coincidence that 'textuality' has been a key term for many French post-structuralists (as they are labelled in the Anglophone world; for a critique of the term from a French perspective, see Angermuller 2015). Propelled by what is sometimes called the 'linguistic turn,' these scholars began to re-conceptualise texts in the most abstract sense *as by necessity incomplete entities*. A text in this sense is always partially 'hidden.' This incompleteness was then regarded as the main obstacle for 'understanding,' therefore requiring specific interpretive procedures to be successful. Narration is one such procedure of holistically making sense of textual incompleteness. For French *« Paléohistoire »*, the analogy seems particularly striking since the Palaeolithic record also presents itself as an inherently fragmentary and 'dis-membered' object of study.

[271] Admittedly, the key point here is not only how 'synthetic' science makes sense of the distinction between 'observation' and 'interpretation,' but also what can *count* as either of the two. Pepper (1942: 48) clearly anticipates this problem. According to Pepper (*ibid.*: 100), what can count as 'pure' fact may vary dramatically among world theories. It is therefore likely that some of the 'pure' facts of French technological research are regarded as 'highly interpreted facts' by Anglophone analysts. Although Pepper (*ibid.*: 51) notes that within world hypotheses 'data' are typically refined in such a way that their 'purity' can be defended, they nonetheless tend to be 'loaded with interpretation.' We will return to this issue in Chapter 6.

[272] Valentin (2005: 148), for instance, explicitly calls for a more 'interpretive ambition' in devising artefact typologies. These typologies are not just required to say something substantial about the lithic objects themselves, but have to 'restore the place of the facts in the respective technical system.' These 'interpretive typologies,' in other words, have to serve the technical wholes under consideration. For a detailed discussion of the role of typologisation in French technological research, see the first part of Chapter 5.

[273] In the context of hermeneutic understanding, the cyclic structure of inference is mirrored by what is widely known as *the hermeneutic circle* (cf. Bolten 1985). With Norris (2005), one can say that the latter is concerned with "the fact that comprehension can only come about through a tacit foreknowledge that alerts us to salient features of the [objects of study] which would otherwise escape notice. Yet it is also the case that every [object of study] (and every reading of it) in some way manages to pass beyond the 'horizon of intelligibility' that makes up this background of foregone interpretative assumptions. The debate is joined between those (like Gadamer) who think of understanding in terms of a dialogue or ongoing cultural conversation, and those – Habermas among them – who wish to maintain a more independent role for the exercise of critical thought." Hermeneutic reasoning, accordingly, typically bespeaks of a mode of argumentation that I have characterised as 'dialectic-dialogical' (see Chapter 2 for a discussion of hermeneutics and general 'synthetic' argumentation).

2013) rather than proceeding from a well-defined set of premises to the conclusions in a controlled, directed, and broadly pre-conceived formal-logical manner (e.g., Trout 2007).[274]

All of this suggests that French lithic inquiry, in contrast to the vast majority of Anglophone lithic research, is neither governed by 'deductive' nor by strictly 'inductive' modes of reasoning – both of these species of cognition are 'analytic' insofar as they presuppose that parts are the primary units of analysis and, after careful examination and comparison with other parts, directly result in the sought-after wholes. Instead, French approaches seem to be based on a cognitive strategy in which the *coordination* of parts and wholes is essential. In this strategy, overarching directions or generic patterns of inference cannot be predicated. The lithic evidence tends to be handled 'bottom-up' and 'top-down' at the same time: French technologists analyse lithic parts in order to grasp possible wholes and whole-characteristics, but they similarly examine whole-qualities in order to better understand the signification of parts. Nonetheless, the primary points of reference are always whole-categories since they ultimately legislate over the interpretation of the lithic parts. The result is a 'looping' quality of reasoning in which the level of analysis constantly shifts between parts and wholes, both being subjected to an ongoing process of re-definition and mutual adjustment. We may therefore perhaps more adequately term this mode of reasoning 'transductive.'[275]

Altogether, the examination of the three pairs of assemblage-based case studies in terms of research design and structure of inference has demonstrated that the 'analytic'-'synthetic' polarity plays an important role in organising the French-Anglophone divide. It seems clear that French lithic inquiry is founded on broadly 'synthetic' premises, whereas Anglophone lithic research is imbued with an 'analytic' understanding of science. The identified structures and morphologies of lithic reasoning, but also the nature and role of the mobilised arguments support this view. Some of these differences appear to resonate with the classic distinction between 'explanation-based' and 'understanding-based' projects of research. This is certainly interesting since French and Anglophone approaches, for this reason alone, may then be differentially capable to harness the cognitive resources of particular cognate disciplines. The very definition of a 'cognate' discipline may in fact vary because of it. [276] This, in turn, might at least partly explain why Anglophone research endeavours are often strongly influenced by the natural and life sciences, whereas French technological research tends to draw more heavily on the interpretive branches of the humanities and social sciences[277]. This split, moreover, seems to partly run in parallel with the well-recognised separation between 'analytic' and 'Continental' strands of philosophy and their corresponding conceptions of scientificity (cf. e.g., Friedman 2000; Levy 2003; Chase and Reynolds 2010). The 'parting of ways' between French and Anglophone lithic inquiry is therefore likely to reflect the relative position of the two in the wider landscape of Western intellectuality.

Lastly, the distinction between 'analytic' and 'synthetic' science, but even more so the conflict between 'explanation-based' and 'understanding-based' approaches, implies a deep-running discord of the status of the human subject in the quest for lithic knowledge. We have already touched upon this issue in the context of 'uniformity'-'heterogeneity' trade-offs pertaining to the structure and logic of reasoning at the French-Anglophone interface. While 'analytic' research in the 'explanatory' mode usually promotes an 'objectivist' conception of lithic knowledge and thus seeks to eliminate or at least minimise the human factor, 'synthetic' approaches in the 'understanding' mode tend to crucially rely on human judgement and interpretation. The latter consciously exploit the ineluctable 'horizon' of human subjectivity in order to grasp the complexity of lithic realities.[278] The implied view of science emphasises the irreducibility of human involvement in processes of inquiry, re-casting the human

[274] Proponents of 'nomothetic' conceptions of science, those who want to give an 'objectivist' account of scientificity, have typically conceived of 'understanding' and 'intelligibility' in rather pragmatic terms, potentially varying from person to person and context to context. This status that is of course at odds with the 'universalist' aspiration of 'objective' research in these circles (see e.g., Hempel 1965: 413, 425f.).

[275] See **Appendix III.2** for a schematic comparison of 'transductive' and 'inductive'-'deductive' modes of reasoning.

[276] A detailed account of the relevant extra-disciplinary resources in French and Anglophone lithic research will be given in Chapters 4 and 5.

[277] See e.g. Betti (1962) for a classic attempt to ground all of the humanities [*Geisteswissenschaften*] in hermeneutic method and reasoning. Classic hermeneutic perspectives have been provided by Habermas, Ricoeur (for philosophy), Weber, Oevermann (for sociology), Geertz (for interpretive ethnology), Dilthey, and Rickert (for historiography and history). For a more general discussion including the potential role of the 'hermeneutic mode of reasoning' in 'synthetic' inference and corroboration, see Chapter 2.

[278] For a conceptual account of this inclination, see de Regt (2014: 379).

factor as an enabling condition of knowledge production. Each researcher's subjective background of knowledge – her/his 'hermeneutic horizon' – is considered an interpretive asset rather than something that potentially hinders insight. Understanding, in this view, critically depends on various forms of *pre-understanding*.

The perhaps most obvious example in French lithic inquiry is the role of knapping experience and the importance of knowledge about fracture mechanics, including an understanding of general principles of convexity management (cf. Pelegrin 2006b: 40; Perlès 2016: 225).[279] These axes of pre-understanding are indispensable for evaluating how wholes and parts co-constrain each other and what the possible consequences of particular knapping operations are. The point is that these pre-understandings guide the entire process of reasoning and potentially inform each interpretive claim. 'Synthetic' approaches are much more susceptible and open to individual lithic expertise than their 'analytic' counterparts.[280] In the Anglophone case scholarly expertise of course also plays a role, but it is typically important in the context of mastering particular analytic tools (i.e., various computer programmes), specific methodologies (i.e., statistical procedures and tests), and in the construction of testable hypotheses from well-selected bodies of general theory.

The Anglophone position reflects the proclivity to safeguard the subject-neutrality of lithic analysis and interpretation. The human subject is typically regarded as a knowledge-distorting factor, only accentuating the problem of lithic knowledge by adding another layer of artificial interpretive variability. The standardisation and 'automatisation' of inferential procedures and argumentative figures has consequently to be understood as an attempt to render lithic knowledge claims as *independent* as possible from individual and at best variable scholarly judgements. The Anglophone stance towards the treatment of lithic evidence can thus be characterised as broadly 'etic.' French technological research, by contrast, is often regarded to provide a level of understanding that can be qualified as 'emic' in the broadest sense (cf. esp. Pigeot 2005).[281] An important consequence of this configuration is that Anglophone scholarship widely promotes computer-aided applications and robotic facilities in order to study lithic technology in maximally 'human-devoid' fashion (cf. e.g., Clarke 1968: Chapter 13; Dibble and McPherron 1988; McPherron and Dibble 2002; Dibble and Rezek 2009; Brantingham 2010),[282] whereas the French research tradition encourages its representatives to cultivate their personal qualities of inquiry, for instance object-matter experience as well as argumentative and interpretive skill (see *supra*).[283] That these differences help to make sense of the French-Anglophone divide at least supports the idea that the conflict between the two parties is related to basic difficulties of navigating the 'analytic'-'synthetic' boundary.

3.2.3 ***Role of theory and data***

If there is anything we can learn from Pepper's enunciations of Western thought, it is probably that 'theory' can come in many guises. Just as there is conflict among world hypotheses about what can legitimately identified as 'pure' fact or even 'data' (cf. Pepper 1942: 51-59, 63-70), theoretical enterprises may vary vastly between them. Theoretical work in science does at least not only concern 'grand-theories,' grounded in more or less well-founded regularities, but theory, for instance, plays an equally important role in the miniscule comprehension of historical events – although the latter is

[279] Personal and qualitative lithic experimentation is a core practice in the French tradition and there is a huge body of literature that reflects this condition (cf. e.g., Tixier 1978 [2012]; Roche and Tixier 1982; Binder and Pelegrin 1983; Boëda and Pelegrin 1983).We will see in Chapter 5 that one can add a certain subject-based quality of being 'skillful' in *reading* lithic artefact and assemblages (frz. *lecture*); typically, this entails experience and proficiency in practices of physical and 'mental refitting'. General dimensions of experience with the source material, for instance knowledge about similar and different assemblages, are similarly important.

[280] Cf. **Appendix III.2: Fig. III.4: A**.

[281] For the distinction between 'etic' and 'emic,' see esp. Harris (1968: 571f., 575-578). For an explicit critique on 'emic' tendencies in French Palaeolithic archaeology, see for example Boissinot (2011: 299-301) and Tostevin (2011b: 354f.).

[282] See also Binford and Binford (1968) and the well-developed branch of Anglophone simulation-driven research (e.g., Grove 2008; Barton and Riel-Salvatore 2014; Premo and Tostevin 2016). It is notable, and appears not at all to be coincidental, that such simulation-driven research is virtually absent in the French scene, it is even unclear how such inquiry would contribute to the current lithic discourse(s) there.

[283] A telling example of the central role of first-hand experience in French lithic analysis is Boëda's recent book *Techno-logique & Technologie. Une Paléohistoire des objets lithiques tranchants* (2013), in which the author seems to deliberately rely only on those lithic assemblages which he himself has studied and/or at least examined in some detail to construct his arguments and develop his general narrative.

often discredited as 'atheoretical.' Theories cannot only be found in "explicit explanatory systems of propositions but also in analytical, interpretive, methodological, and argumentative choices" (Abend 2006: 6). The question is therefore not whether theoretical activity is an essential part of lithic research, but rather what the status and role of theory in different epistemological endeavours is. Pepper's expositions call our attention to the basic fact that all facets of research, including the most primitive categories such as 'theory' and 'data,' are subjected to world-theory interpretation. The point is that these epistemological footholds are variables in themselves, their character depending on the type of world hypothesis that motivates them. This section asks whether French and Anglophone theory-use in lithic research actually differs, and whether the kinds of theories brought to bear relate dissimilarly to the available evidence and to other pieces of theory. If there is a general difference, it should reflect some of the pertinent features of the 'analytic'-'synthetic' divide among world theories.

In the Anglophone lithic discourse, 'theory' plays an extremely important role. Theory-building is an explicit, independent, and well-delineated area of scholarly activity (cf. e.g., Binford 1964, 1977; Binford and Binford 1968; Clark 2002).[284] Theory seems to serve two primary purposes: first, it organises and systematises the general repertoire of ideas and understandings about the world in order to facilitate the extraction of *testable* and *highly specific propositions* (i.e., hypotheses); second, theory is an important tool of *explanation* and it is hoped that empirical findings can be illuminated by linking them effectively to theoretical insights. The two are obviously complementary. The general lesson, consistent with the previous section, is that practices of 'theorisation' are *exogenous* to practices of empirical data-analysis; they are the logical entry point of an investigation and motivate the formulation of particular research questions as well as the collection of specific kinds of data. Data without theory are typically seen as rather 'hollow' and 'meaningless.' Some authors would certainly go as far as to argue that data cannot even exist without a theoretical underpinning (e.g., Clark 2001: 139). This epistemological primacy of theory-making and the dependence of data on theory is a classical tenet of 'analytic' modes of investigation. 'Analytic' research thereby acknowledges the 'theory-laden' nature of most of the available data.

Because 'theory' is at the centre stage of the Anglophone research enterprise, scholars have developed a rich and diversified taxonomy of theories, acknowledging that different types of theory have a different function in the research process. 'General' theory, for instance, specifies general principles of nature, general relationships between two or more variables, or law-like behavioural dispositions which may have led to the observable patterns in the archaeological record. 'High-level' theory is sometimes also used to designate this species of theory. 'Low-level' theories, by contrast, have a different role in the reasoning process. Rather than guiding the explanatory endeavour, they tend to provide the needed clues of how to prepare and connect disparate pieces of evidence in order to render them interpretable. The most attention, however, is typically paid to 'middle-level' theories since they are thought to connect the strictly observational realm with the domain of potentially explanatory 'high-level' or 'general' theories.[285] The striking impact of Binford's (1977, 1978, 2001) 'Middle-Range-Theory' (MRT)[286] programme on the development of Anglophone research in Palaeolithic archaeology provides a telling example of this general logic of theory-use.[287] The key task of 'theories of a middle range' is to provide *independent* guidelines – e.g., the specification of relevant observable variables and their interrelationships – on how one can reach out from a 'static' record to a 'dynamic' past (cf. Shott 1998). The important point is that the call for MRT spawned a *separate branch of research*, highlighting the central role of theory-building in shaping the entirety of the Anglophone research architecture:[288]

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[284] See esp. Tostevin (2012: 27-41) for a useful summary of important axes of lithic theorisation in current American archaeology.

[285] See Bernbeck (1997: 65-84) for a useful summary.

[286] The basic concept of MRT, although never acknowledge by Binford (1983a: 19, Note 5), is borrowed from sociologist Robert Merton (1949). See Raab and Goodyear (1984) and Shott (1998).

[287] Schiffer's (1972, 1976, 1983) 'behavioural formation theory' falls of course into the same category.

[288] This is the birthplace of Anglophone 'ethnoarchaeology' as a *frame of reference* for archaeological reasoning (Yellen 1977; Binford 1978; McCall 2012; cf. Trigger 2007: 399). It is important to recognise that this specific understanding of 'ethnoarchaeology' is strictly opposed to the French idea of 'prehistoric ethnography' (*Ethnologie préhistoire* or *Palethnologie*), which seeks to maintain a high degree of interpretative intimacy with the archaeological facts and focuses on the description of 'quotidian' particularities (e.g., Leroi-Gourhan 1971; Leroi-Gourhan and Brézillon 1972). For a more recent sceptical voice against ethnoarchaeological theory-building and 'analogising,' see Perlès and Vanhaeren (2012).

> "The conclusion should be clear: Middle-range research, with particular emphasis of theory building, is crucial to the further development of archaeology. We cannot "know" the past without it, and we cannot evaluate our ideas about the past and why it was the way it appears to have been without means of monitoring the conditions or variables believed to be important. Both of these tasks are dependent upon the development of middle-range research." (Binford 1981b: 30)

This highly differentiated theory-scape and the critical role of MRT-research therein further underlines that the structural principles of knowledge corroboration are clearly 'analytic.' With Pepper (see Chapter 2), we can say that the respective theories of truth mobilised to evaluate and criticise reasoning are based on 'correspondence' or 'causal-logical necessity.'[289] Again, the goal is to compare the 'observational' with the 'theoretical,' and to climb up various levels of theory if needed. This comparison between 'data' and 'theory' proceeds either in terms of *analogy* or *similarity*. Clarke (1972a: 643), for instance, tried to capture this basic strategy by noting that "[h]ypotheses are developed to relate observed properties to one another by means of a structural concept." It is equally reflected in Binford's (2015 [1972]: 110f.) insistence on the importance of first 'describing similarities and differences' in archaeological parts and then 'explaining them by means of theory-informed hypotheses.' The categorical distinction between 'theory,' 'hypothesis,' and 'data,' characteristic of science in the 'analytic' mode (see the previous Section), is therefore clearly a hallmark of Anglophone approaches.

The result of this research logic is a layered framework of inquiry, describable in terms of a 'superstructure-substructure' configuration. Dennell's (1983) juxtaposition of the traditional Continental European research configuration, which he describes as essentially 'culture-historic' and non-layered, with the "new" layered architecture of research he and his Anglophone colleagues are working with exemplifies this condition (**Fig. 5**). Only the latter supports well-defined levels or scales of inquiry and the discrimination between 'general' and more 'specialised' bodies of theory. It should be recalled here that much of the 'anthropological' re-orientation that Anglophone Palaeolithic research experienced from the 1960s on was motivated by the tantalising prospects of bringing to bear general theory and to learn more about the invariables of past human behaviour (e.g., Binford 1962, 1965; Yellen 1977). This ties in with conceptualising 'knowledge,' 'findings,' or 'facts' in layers (e.g., Potts 1988: 297-300) and representing the process of knowledge production as a 'ladder of inference' (Hawkes 1954) with different aspects of past behaviour being differentially challenging to reconstruct (cf. Clark 1952, 1989; Clarke 1968: Fig. 49).[290] Together with the mobilisation of well-delineated levels of theory (cf. Schiffer 1988; Tostevin 2011b: 353f.), all of this reflects a conception of worldly-order emphasising *verticality* and *hierarchy*. This, in turn, nicely captures the already outlined epistemological trade-off between data-conception and world-conception which characterises Anglophone inquiry.[291]

The recurrent call for 'model-building' that prevails in Anglophone research circles (e.g., Clarke 1972a, 1977; Hammond et al. 1979; Lycett and Chauhan 2010b: 8-12) is a comparable attempt to close the gap between the theoretical and observational dimensions of research. Models can be understood as conceptual devices that break down a piece of theory into its most basic elements and operationalise it with regards to specific test-conditions and the kind of evidence the case provides. By "making a series of simplifying – but precise and explicit – assumptions, such that parameter values taken from empirical data can be compared for goodness-of-fit against those precisely laid out assumptions" (Lycett and Chauhan 2010b: 10), models help relating theories to data. Alternatively, models may assist in theory-building since they enable the *direct* assessment of particular theoretical assumptions or sets of assumptions in terms of their archaeological consequences. Model-building is then an independent operation that can inform theory-building. In any case, the very notion of a *mod-*

[289] Cf. e.g. "Clearly if we can isolate causal relationships between things, and if we can understand such relationships in terms of more general principles of necessity, such as the theories of mechanics or some other basic science, then we have a strong warrant for the inference of the cause from the observed effects. We would be building a strong theoretically informed bridge between properties of the contemporary archaeological record and characteristics of the dynamic past" (Binford 1981b: 26).

[290] There are two dimensions to this: first, the old Baconian idea of the 'pyramid of knowledge' and 'levels of intellect' provides the prototypical example of the 'formistic' conception that knowledge about the world is typically gained in different *qualities* – that there is a *ladder of knowledge* (see Chapter 2); second, 'mechanism' introduces layers of 'facts' or 'insights' in order to account for the *differential relevance* of information for answering particular research questions (*idem*). Because such questions are specified with the help of orientating theories, the world is rendered a hierarchical place with different layers of information only being significant for solving certain problems.

[291] See again **Tab. 3**.

el is already 'analytic' since a model's purpose is always to evaluate whether or not particular combinations of parts given particular conditions could have produced the sought-for whole(s).[292] The use of computer-based 'simulations' serves a similar purpose. Quite often, *simulation* is simply a method to explore the properties of a model when traditional analytic methods are not available or if one wants to explore more complex problems that require the modulation of multiple parameters (cf. Grüne-Yanoff and Weirich 2010: 21-26). The implementation of both formal-mathematical models and computer-driven simulations is therefore a testimony of 'analytic' thought (Aldenderfer 1981, 1991). The fact that both play an important role in current Palaeolithic research in the Anglophone world,[293] but are virtually lacking within mainstream Palaeolithic archaeology in France suggests that the 'analytic'-'synthetic' separation is of some significance here:[294]

> "What is a model? Models are pieces of machinery that relate observations to theoretical ideas, they may be used for many different purposes and they vary widely in the form of machinery they employ, the class of observations they focus upon and the manner in which they relate the observations to the theory or hypothesis. It is therefore more appropriate to describe models than to attempt a hopelessly broad or a pointlessly narrow definition for them. Models are often partial representations, which simplify the complex observations by the selective elimination of detail incidental to the purpose of the model. The model may thus isolate the essential factors and interrelationships which together largely account for the variability of interest in the observations; in this way the model may even share a similarity in formal structure with the observations." (Clarke 1972b: 1)

This important role of 'theory' in Anglophone research makes it in principle possible that scholars can concentrate almost exclusively on theoretical inquiry and try to advance the theoretical discourse rather than doing a lot of fieldwork or primary data-analysis – periodicals such as the *Journal of Archaeological Method and Theory* testify to this situation.[295] The same research configuration also explains why secondary data – that is, data collected from the literature – may be as important as primary data and continues to delineate a lively field of scholarly activity and debate.[296] Because theoretical matters are negotiated *explicitly* and are widely recognised as crucial for the development of the field, practitioners tend to specialise relative to taken-for-granted 'theory'-'data' dichotomies and to devise expert areas of inquiry mirroring these dichotomies. Overviews of Anglophone, especially U.S. American Palaeolithic archaeology are therefore often organised according to theoretical orientations (cf. Clark 2008: 54-59). Ecological theorists (e.g., Butzer 1982; Kelly 1988; Torrence 1989c; Kuhn 1995; Shea 2011b, 2017a) are for example contrasted with reduction theorists (e.g., Dibble 1987, 1995b; Henry 1989b; McPherron 1994; Iovita 2008; Olszewski 2016), cognitive theorists (e.g., Gowlett 1984; Mithen 1996; Stout 2011; Wynn and Coolidge 2016), design theorists (Bleed 1986; Bousman 1993; Bamforth and Bleed 1997), style theorists (e.g., Sackett 1973; Wobst 1977), formation theorists (e.g., Isaac 1967; Binford 1979; Toth 1985; Bunn and Kroll 1986; Stern 1993, 2008), or scholars working within the confines of Neo-Darwinian evolutionary theory (e.g., Dunnell 1989; Lyman and O'Brien 2000; Shennan 2002; Kuhn 2004a) – to name but a few of the relevant theoretical orientations propelling Anglophone lithic inquiry. The diversification of approaches relative to 'high-level' theories is sometimes described with the concept of 'paradigms' (e.g., Clarke 1972b: 1.1, 1.16).[297] A paradigm in this sense defines a general theoretical inclination, pre-organising the rich theory-scape in order to narrow down the range of operational theories that may be selected in the context of a particular re-

[292] Model-use is also 'analytic' in terms of its truth-conditions. Clarke himself (1972b: 1) notes that "[t]he relation between the model and the observations modelled may in general be said to be one of analogy, or in the case of logical and mathematical models more usually one of isomorphism [...]." Again, some to be specified *analogy* or *similarity* relationships (isomorphism is a special case of similarity) are exploited to corroborate knowledge claims that derive from model-based approaches. See Chapter 2 for an exposition of the 'formistic' and 'mechanistic' theories of cognitive criticism underlying this mode of corroboration.
[293] Recent examples of simulation-based research in the Anglophone world are Mithen (1990), Steele (1994), Shennan (2001), Powell et al. (2009), Romanowska (2015), and Barton and Riel-Salvatore (2016).
[294] Compare, for example, the mentioned simulation-authors in Lake (2014) for a rough indication.
[295] The work of Clive Gamble (1986, 1998, 1999, 2007) exemplifies a broadly theory-oriented career. Gamble's theoretical contributions have framed many discussions in the field and sparked often-controversial debates. Although his views were regularly met with criticism and scepticism, they certainly shaped the Anglophone discourse – if only as a *contrastive foil*. The more recent cooperation between Clive Gamble, John Gowlett, and evolutionary psychologist Robin Dunbar has resulted in the integration of some of the most important strands of British Palaeolithic archaeology under the umbrella of the 'social brain theory' (cf. Gamble et al. 2011, 2014; Gowlett et al. 2012).
[296] The re-assessment of the classic question of interassemblage variability in the Western European Mousterian by Szmidt (2003) offers a prototypical example of the productive usage of secondary data in Anglophone lithic research.
[297] See also Isaac (1972b: 193, Note 1).

search problem. A research 'paradigm' sits at the summit of the epistemological pyra -mid, reinforcing the layered character of theorisation in wider Anglophone research.[298]

This overwhelmingly 'analytic' signature of theory-mobilisation is met by a much more ambivalent use of 'theory' in the French research context. It has to be said from the start, however, that theoretical considerations *have* always played a role in directing French inquiry – even within Bordian 'straight archaeology' (*sensu* Sackett 1991). In the context of lithic analysis, this is for example well-illustrated by Geneste's (2010 [1991]: 420-429) extensive discussion of the various theoretical currents and thinkers that have contributed to the conceptual orientation of the *chaîne opératoire* approach. He mentions primarily the 'History and Anthropology of Techniques' including what in France is called *« Technologie culturelle »*, philosophy of technology, cybernetics, and general systems theory.[299] Similar theoretical discussions can for instance be found in Bon (2009: Chapitre IV, 223-240), who draws on ethnology and sociology, and Valentin (2008a: Chapitre 1), who examines in detail the relationship between history and prehistory and tries to reinvigorate Furet's (1975) vision of 'problem-history.' Yet, the way in which theory is debated and made use of in these works clearly suggests that 'theorisation' is not regarded as an analytical operation in the narrow sense of the word. Theoretical considerations mostly remain in the 'background' and are rarely formalised or made overly explicit in terms of their consequences.[300] This utilisation of theory as 'background theory' serves to guide and orientate analysis, contextualisation, and interpretation – it is neither explicitly tied to the logic of discovery, nor is theory regarded to have a distinct explanatory value. Moreover, theory is typically 'historicised' in France and considered to be intimately bound to the evolved disciplinary fabric of Palaeolithic archaeology (e.g., Audouze et al. 2018).[301] Theory is therefore to a much lesser degree negotiable independently of broader intellectual developments.[302]

In her recent review of the French technological approach, Perlès (2016: 231f.) also stressed that theories are usually mobilised *implicitly* by practitioners and that the latter typically feel no need of 'labelling their approach, theory, or method.' The first aspect is illustrated by the case of Leroi-Gourhan – the *« Patron »* of the Parisian research trajectory – whose major works *Évolution et techniques* (1943/1945) and *Le geste et la parole* (1964/1965) are characterised by a practice of implicit reference-making (e.g., Martinelli 1988; Sigaut 2010; Delage 2017: 164). This practice, putting forth a radical form of 'intertextuality' (*sensu* Genette 1982), deals with a broad range of theoretical sources, often in somewhat idiosyncratic ways, without citing or mentioning the respective authors or primary works.[303] Audouze (2002: 292), for instance, notes that Leroi-Gourhan's thought was "like an octopus, sending tentacles in many directions, but all ultimately connected." The point is that theorisation is often considered a rather 'mundane' and perhaps even 'un-exciting' undertaking, which naturally takes opportunity of its wider intellectual context without elaborating too much on this context. Influential theoretical perspectives do not need to be named or addressed specifically since they belong to everybody's broader 'horizon of knowing.' Explicitly dealing with them would un-necessarily complicate the train of thought, often hindering the readability of scholarly productions. This becomes especially apparent in the *œuvre* of the 'Early' Leroi-Gourhan, which is rather complicated in its conceptual structure and benefits from many different, but often *prima facie* non-connected ideas.

Another reason for this rather 'intangible' mode of theorisation is that theory is developed 'on the way,' that is, in the process of dealing with a particular problem, rather than beforehand (cf. Audouze 1999). Theories are regarded to be useful only if they help to illuminate particular problem-

[298] An interesting consequence of this research configuration is that intergenerational theory change is often modelled in terms of a Kuhnian *change of paradigms*, the implication being that disciplinary advancement suddenly depends on theoretical novelty and the ability of a new generation of scholars to contribute something substantial to the theoretical discourse.
[299] For similar points, see e.g. Julien (1992), Schlanger (2004), Perlès (1991a, 2016), and Audouze et al. (2018).
[300] See Cleuziou et al. (1991) for an illuminating discussion of the apparent 'atheoreticality' of French prehistoric archaeology.
[301] See Olivier (1999: 99) for a similar argument which, however, differs in its details from the perspective outlined here.
[302] It may be possible to argue here that 'theory-building' is therefore less of an individual task but concerns the research community as a whole. Accordingly, the guiding, one could say 'founding,' theories of the discipline are incrementally built up by multiple generations. If this reading is appropriate, it would show that even theory-building follows a 'synthetic' logic in France and really concerns the whole of the research process rather than its effective parts (i.e., individual scholars).
[303] This mode of referring to the wider intellectual sphere is typically intertwined with a particular *mode of scholarly self-enactment*. Tendencies of 'intertextuality' seem to be particularly strong if 'erudition' is considered a cognitive virtue and when scholars identify themselves as *intellectuals*. Arguably, intellectuality is of a much lesser importance in the Anglophone research enterprise, which tends to emphasise the 'scientific' qualities of researchers rather than their intellectualism.

contexts – the concept of a 'general theory' has little meaning here.[304] This suggests that 'theory,' for the most part, cannot stand for itself. It is useful not because of its essential content, but because of its possible relationships to other theories and the interpretive perspective it provides on particular sets of evidence.[305] Theory, therefore, is in principle not treated differently than data.

The second aspect – the question of 'naming practices' – is linked to the logic of specialisation and disciplinary persuasion in France. Practitioners indeed do not seem to identify themselves and what they do in terms of 'theory-related' labels. They, for instance, define their place in the research community by referring to long-standing or developing umbrella approaches specifying certain 'agendas,' 'visions,' or 'ambitions' of research (cf. Ramírez Galicia 2016). Examples are *« Ethnologie préhistoire»* or *« Palethnologie »*, *« Technologie préhistoire »*, and *« Paléohistoire »*. The important point is that these approaches are defined by a certain theoretical matrix and adopting them implies also to adopt the corresponding theoretical orientation. Because these umbrella approaches are essentially historical entities, the theoretical matrix that comes with them is a product of particular *disciplinary traditions*. This again suggests that the French conception of 'theory-making' is grounded in the idea that ongoing research and theoretical inquiry inseparably go together, i.e., co-enable each other. Theorisation is therefore certainly not regarded to be primary, nor to be a distinct arena of scholarly engagement. Moreover, rather than specialising relative to theoretical positions, lithic practitioners usually specialise relative to well-attested differences in the stone artefact record: researchers usually consider themselves experts in Magdalenian, Solutrean, Aurignacian, Mousterian, or Acheulean lithic technology; they may equally specialise into broader periods such as the Lower, Middle, or Upper Palaeolithic and in particular kinds of technology (i.e., *façonnage*, *débitage*). This again signals that matters of theorisation are subordinate to perceived differences in the object-matter at hand.

A particular detail of implicit theory-mobilisation may be of importance here. As for example illustrated by Valentin's (2011: 56-59) short discussion of concepts of 'culture,' 'tradition,' and 'currents of culture' (*courants culturels*), individual terms such as 'gesture,' 'technique,' 'habitus,' and 'social morphology' actually stand for larger theoretical discourses in which they continue to have a specific meaning.[306] They are, in other words, *pars pro toto* and reflect more general theoretical insights. This is quite critical because it demonstrates the 'synthetic' take on theory that prevails in the French tradition. It also confirms Coudart's (1999) suspicion that instead of speaking of 'theory-building,' we should probably talk about *conceptual work* in the French context. This *prima facie* somewhat subtle difference in fact explains what theoretical activity in French lithic research amounts to. Above all, theorisation refers to the development and refinement of *interpretive concepts* that help interrogating the primary lithic evidence.[307] The classic contributions which continue to define the theoretical foundations of lithic inquiry such as Inizan (1976), Perlès (1980), Pigeot (1983), and Pelegrin (1995) coined at least one important research concept. Conceptualisation is also the key operation when scholars develop new ways of describing and interpreting the modalities of core management (e.g., Ploux 1988; Valentin 1995: Annexes). A more recent example of a similar practice is the conceptual distinction between 'integrative' and 'additive' structures of core exploitation (Boëda 2013: 89-102).[308] All of this clearly indicates that the construction and implementation of interpretive concepts geared towards the specific problems of lithic analysis proves to be one of the most potent loci of theoretical innovation in current French lithic research. Theorisation is considered a conceptual business *embedded* in data-analysis. It supports meticulous and highly-differentiated terminological systems in order to facilitate empirical research. Theoretical work therefore always resonates with the 'whole of the research process, it does not contain or define that whole.'

We can conclude from this that 'theory' is really handled 'synthetically' in French technological research. The various practices of bringing it to bear generally question whether any meaningful dis-

[304] Note that the rejection of 'general theorising' is also the consequence of an initial research focus on 'how-questions' rather than why- or what-questions (e.g., Tixier 2012 [1978]).

[305] Cf. "As Guille-Escuret recalls, Leroi-Gourhan was such a prodigious professor because, in his approach, observation and theory were associated in an insoluble whole. Each served to correct and consolidate the other as the work progressed (Guille-Escuret, 1994, p. 10)." (Audouze 2002: 298)

[306] The term *chaîne opératoire* is no exception here.

[307] To be more specific: most of the time, these interpretive concepts help to delineate and characterise 'sub-wholes' in the investigated lithic assemblages (see *infra* and Chapter 5 for a more detailed discussion).

[308] A complementary but not entirely alternative distinction is between the 'partial' and 'total configuration' of a core matrix (e.g., Carmignani et al. 2017: Fig. 16). For a detailed discussion of these concepts within the context of the 'techno-genetic' approach, see the second part of Chapter 5.

tinction between 'theory' and 'data' can realistically be made. Rather than embracing theory as a distinct field of inquiry, French scholars tend to engage in conceptual activity to alter their 'exposure' to the lithic evidence. This already implies a somewhat dialectic relationship between the 'theoretical' and 'observational' aspects of research. At the same time, the link between more general pieces of theory and explanations of the evidence is much 'looser.'[309] This is because the primary role of theory is to put lithic observations *into perspective* and because scholars typically agree that no simple or one-to-one relationship between theory and data exists. Neither theory nor data can therefore legislate over each other. Theory therefore typically serves an interpretive 'crutch' and becomes just another vehicle of argumentation and, potentially, narrative enrichment.[310] Because theory seems to be subjugated to *interpretive ends* rather than the other way around, theoretical considerations are typically 'weaker' than in most Anglophone research contexts. Yet, they are often much 'thicker.' This is because theory rarely comes in the singular and there is little concern for theoretical purity. This adds to the already raised issue of implicit theory-use in the French scene.

On a general level, one can therefore agree with Tostevin (2011b), who has recently noted:

> "One reason for the absence of a discussion of the theoretical differences between the [French and Anglophone] approaches in the present debate is the fact that the explicit espousal of high-level theory is considerably different in each context (Bleed 2001). Archaeological theory is not conceived of exactly the same way by proponents of the two approaches. This frequently results in explicit statements of theoretical orientation by American reduction sequence proponents and implicit orientations within methodological discussions by *chaîne opératoire* proponents." (*ibid.*: 353; original emphasis)

The comparative examination of French and Anglophone theory-use indeed shows that 'theory' serves a vastly different purpose in both research contexts. Not only are the 'theoretical' and 'empirical' domains of research unequally articulated in both cases, the way how theory is understood and conceptualised fundamentally differs. This divergence reproduces Pepper's epistemological division between 'analytic' and 'synthetic' modes of thought. The crucial point, therefore, is not only that French and Anglophone practitioners typically call upon dissimilar bodies of theory, but that they would mobilise even the same body in different ways.[311] An 'analytic' understanding of theory, characteristic of Anglophone lithic research, emphasises the role of theory as a well-defined part of the research process and calls for a precise formal analysis of theories themselves, whereas a 'synthetic' grasp of theory, found in large parts of the French scene, leads to the recognition that theory is always transgressive and has to be developed in close dialogue with specific sets of evidence. The 'synthetic' view rejects the idea that practices of theorisation can be separated from the overarching logic and trajectory of specific lithic inquiries. All of this strongly indicates that French and Anglophone lithic approaches are fuelled by different kinds of world hypotheses and that the 'analytic'-'synthetic' distinction plays an organisational role in this.

3.2.4 ***Styles of visualisation***

Chapter 2 has taught us that empirical research can profit tremendously from visualisation and that different strategies of 'making visible' are likely to be deployed by varying research programmes. Generally speaking, pictures and images are non-textual elements of inquiry that not merely 'result' from the interrogation of evidence, but can *actively* contribute to the process of reasoning and knowledge formation (cf. e.g., Lynch and Woolgar 1990; Rheinberger 1992; Topper 1996; Bredekamp et al. 2008).[312] Tactics and strategies of scientific visualisation aid scholars in handling the available data –

[309] Leroi-Gourhan's general scepticism towards the direct use of analogies – anthropological or otherwise – illustrates this point (cf. Valentin 2015: 176). Taking up this point, Cleuziou et al. (1991) contend that "[t]he major weakness of French archaeology in this respect is that the scepticism expressed – by Leroi-Gourhan, for example – concerning the construction of cultural models or the notion of culture itself, leads to the use of notions which are even more dangerous because they are implicit."

[310] An example of this 'argumentative function' of theory is provided by Renard and Ducasse (2015). Their approach to mobility and techno-economy is discussed in detail in the first part of Chapter 5.

[311] The recognition that different standards of theory underpin French and Anglophone Palaeolithic archaeology also defuses the allegation of 'atheoreticality' which has regularly been brought forward by a number of U.S. American practitioners (e.g., Binford and Sabloff 1982; Straus 1987, 1991; Clark and Lindly 1991; Clark 1993, 2001; Conard 2009; cf. Wargo 2009: 110, 114-119).

[312] For a general discussion of the increasingly evident 'more-than-representational' status of scientific imagery, see Daston (2014).

they can guide interpretations, mediate cognitive operations such as 'analogy-building' or 'metaphor-exploration,' and provide independent arguments for or against whatever claim one wishes to defend. Rendering research problems or specific data-configurations 'visible' is therefore often equally important as, say, conducting a statistical test (e.g., Latour 1986; Daston 2008; Suchman 2014). After all, many of the research operations that are now commonly used in Palaeolithic archaeology have a visual component and the *manipulation of visual evidence* becomes an increasingly important domain of scholarly activity (e.g., Magnani 2014).[313] Some scientific publishers, for example, have already begun to promote the employment of 'graphical abstracts.'[314] Any analysis of scientific practice should therefore not only focus on the latter's structural and 'written' aspects, but also take into consideration the unique 'rhetoric of images':

> "After some twenty years of remarkable work on visualization in science, it is now astonishing to recall how blind historians of science once were to anything but words: scientific texts were purely textual; when we came to an image (a drawing, a graph, a table, a diagram, a photograph, it was all one), we just flipped the page. Illustrations in history of science monographs, insofar as there were any, consisted almost exclusively of portraits of past scientific luminaries. Pick up almost any recent book or article in the field now and it is likely to be peppered with images, many of which are as essential as the well-chosen quotation is to making the author's point. Images have come into their own as a source for the history of science, even if we are still learning how to interpret them and to emancipate ourselves from text-centered analogies such as 'reading images' and 'visual literacy'." (Daston 2014: 319)

Images are important footholds of reasoning because they are considered to enable an 'immediate' access to the phenomena under consideration, as well as to enshrine a 'tangible objectivity' of knowing that words can never hope to match (cf. Daston and Galison 1992). Visualisations may indeed say 'more than thousand words' and often appear to satisfy, by means of their clarity and visualisability [*Anschaulichkeit*] enhancing capacities,[315] the old ideal of 'direct scientific observation' (Daston 2008). Because of these qualities, scientific imagery can provide a shortcut to the key message of the scholarly production(s) in question and greatly facilitates the identification of peers and other like-minded practitioners. To put it simple: similar 'image worlds' typically indicate that scholars work on broadly similar problems, utilise similar methods, and share some basic or at least cognate assumptions (cf. Lynch and Woolgar 1988; Bueno 2012, 2016).[316] This last point is of particular importance in an age in which scientific knowledge seems to be disseminated at ever-accelerating speeds and the full range of scholarly outputs has become almost unmonitorable. All of these aspects can be exploited in order to analyse the specific role of images in a given research context. Are particular approaches distinguished by particular types of images? Do different research communities cultivate disparate sets of images or incompatible modes of image-use? And if so, can these help us in understanding the logic of research regulating the interpretation of evidence in these contexts?

This section will explore the 'visual signature' of French and Anglophone lithic approaches. The investigation thereby mainly focuses on the assemblage-based case studies introduced in Chapter 1, yet also takes into account some more general features of lithic visuality in both research spheres. The central question is whether there is a substantial difference in the logic of image-use when French and Anglophone lithic approaches are compared, and if so, whether this difference can be accounted for by the conflict between 'analytic' and 'synthetic' world hypotheses. Lithic practice appears to be particularly well-suited to answer these questions since there is a long-standing tradition of drawing and photographing stone artefacts or organising them in diagrams (e.g., Dauvois 1976; Laurent 1985; Addington 1986; Martingell and Saville 1988; Adkins and Adkins 1989). The importance of visualising both objects and data in lithic research is only increasing as we speak and recent years have witnessed a vast surge of new technologies for processing, manipulating, and representing various kinds of visual information. Shott (2014), for instance, even argues that the field is currently undergoing a true 'visual revolution.' A Pepperian perspective should help us to better understand the general role of these im-

[313] For discussions of the role of visualisation in wider archaeology, see Shelley (1996) and Kavanagh (2007).
[314] See for example the special entry on 'graphical abstracts' on the Elsevier webpage: "A Graphical Abstract is a single, concise, pictorial and visual summary of the main findings of the article. This could either be the concluding figure from the article or a figure that is specially designed for the purpose, which captures the content of the article for readers at a single glance." (webtext accessed on the 7th of July 2018)
[315] Cf. e.g., de Regt (2014: 378).
[316] It may therefore be argued that scientific imagery, in a perhaps unique manner, makes *explicit* what otherwise remains sedimented in the opacity of textual discourse.

ages in lithic knowledge production.[317] Moreover, the results can be expected to complement the previous findings of this chapter and, if necessary, serve as a corrective measure.

With Lopes (2009: 6), we can distinguish between three axes of pictorial practice, along which lithic imagery is expected to vary. The first is the deployed *image-type*, with drawings, schematisations, pictorial diagrams, photographs, tables, or graphs being examples of different kinds of lithic images.[318] The second is the *imaging task*, which is the purpose of the image broadly conceived – the question here is for instance whether the image is used to illustrate an argument, present data, perform an inference, specify hypotheses, or conduct some sort of proof. The third axe is the *image context* or 'context of use.' This dimension of scientific imagery is the disciplinary, topical, and/or 'working' context of individual visualisations. It is linked to broader questions about the role and function of particular media (e.g., research monographs, field reports, specialised journals) as well as to the design and focus of a specific study (e.g., highly focussed, comparative, synoptic, mono-specific). The three axes of image-use are often interconnected (cf. Gooding 2004: 551-555) and to understand the respective relationships can be imperative in order to expound different modes of visualisation. Methodologically, keeping constant the 'image context' enables a more effective comparison of visualisation practices between distinct research communities, even though it has to be said that both research design and focus of inquiry are often variables in themselves when such research communities are contrasted (see previous Section). It is therefore usually unpractical to fixate the 'image context.' A more promising strategy, especially for the present purpose, is to compare the overall character of image-use, which is simply a function of all three aspects of visualisation. By examining the spectrum of 'image-types' and 'imaging tasks' in a given 'image context,' it should be possible to extract the general *logic* of employing lithic imagery. It is this logic that can then be compared.

Because images, as argued before, can to a certain extent 'speak for themselves,' it is also possible to investigate what an image silently *presumes* about its object matter. This opens up some important angles of interrogation. How do lithic images conceive of part-whole relations in whatever they visualise? Do they primarily show parts or wholes? What are the relevant parts and the effective wholes in the images, if any? And what can this tell us about what is considered to be lithic data in the first place? All of these questions resonate with basic features of Pepper's epistemology and examining them should therefore help us assessing whether image-use at the French-Anglophone interface reproduces 'analytic'-'synthetic' antagonisms. Drawing on Pepper, we can even ask more specific questions, for example whether the 'imaging task' is completed by putting the spotlight on 'particulars,' 'characters,' 'classes,' 'types,' 'relations,' 'qualities,' 'fragments,' or 'nexuses.'[319] Since these categories have specific world theory implications, we can gain some additional and potentially complementary insights about the French-Anglophone divide. I will begin with a quantitative examination of the lithic imagery employed in the three pairs of assemblage-based case studies.[320]

Table 4 captures the generalised 'visual signature' of the lithic approaches in the three paired case studies. The first striking difference is that French scholars seem to pay much more attention to representing lithic artefacts themselves than their Anglophone colleagues and tend to mobilise a variety of abstract pictorial schemas or interpretive diagrams. The latter type of imagery is completely missing in the examined Anglophone cases.[321] The Anglophone approaches, by contrast, rely more heavily on different tables and quantitative-statistical graphs. The degree of standardisation across the employed tables is fairly high. This contrasts with the relatively low level of inter-table standardisation in the French cases, where table design and table content appear to be somewhat idiosyncratic. Furthermore, the comparison of image-use reveals that in the respective French studies lithic artefact depictions always feature prominently in the principal part of data-analysis, whereas the positioning of such

[317] In particular, approaching lithic images through Pepper's lens would help in accomplishing Lopes' (2009: 5) two central tasks, to "understand imaging as a type of representation with distinctive capabilities (by contrast, in particular, with language" and to "understand the diversification of different kinds of images across different scientific contexts."

[318] One may argue that tables, some diagrams, and most graphs are not really images. Quite often, they at least do not depict lithic objects, but rather summarise aspects of data-analysis. However, the here adopted perspective on lithic visualisation is fairly pragmatic and 'inclusive' (the sum of non-textual elements in a scientific production; see *supra*), also because the analysis is guided by the informed suspicion that the importance of depicting the lithic objects themselves may vary greatly in French and Anglophone approaches.

[319] See Chapter 2 for an explanation of these structural categories.

[320] For a general description of these three cases of interpretive conflict, see Chapter 1 (esp. second part of Section 1.2).

[321] As we will see below, abstract diagrammatical reasoning is not completely absent in the Anglophone world, but tends to serve different purposes than similar image-types in French technological inquiry.

image-types, if they are present at all, is more variable in the Anglophone examples. Compelling is also the opposition between the virtual non-existence of technical symbology to supplement artefact representations in the Anglophone research context and the relatively strong reliance on similar pictorial elements in the French cases. It is certainly interesting that such a clear disparity in image-use becomes already apparent on a general level of analysis, suggesting that the logic of research producing them is indeed vastly different. But how can these differences be explained? What do they indicate and how do they interact with what we have already learned?

The differential status of artefact representations in French and Anglophone lithic research may be significant for a number of reasons. Most importantly, it suggests that the informational value of lithic *objects* is perceived unequally. The central issue is the role of objects in constructing the argument and in guiding the course of reasoning. In the Anglophone cases, images of lithic artefacts are either entirely lacking – as in the case of McPherron (1994) – or confined to the introductory section or a supplementary part (i.e., appendix, addendum, electronic supplement) – as in the case of Dibble (1995a) and Tostevin (2000, 2012). Artefact drawings, in other words, only feature 'outside' of the data-driven core sections of the analysis.[322] This, in turn, suggests that object visualisations have little to contribute to the actual processes of reasoning determining the interpretive results of the studies in question. Lithic object visualisation appear to serve an 'illustrative' rather than 'demonstrative' purpose. In Dibble's (1995a) study of the material from Biache-Saint-Vaast IIA, detailed artefact drawings help introducing the site and giving the reader a general overview of the kinds of artefacts found there. In Tostevin's (2012) study of the Kulna layer 7 assemblage, there is not a single in-text reference to the artefact illustrations provided in the appendix, indicating that they are largely dispensable for the advanced knowledge claims and are provided mainly to satisfy the curiosity of those who care what the actual artefacts look like. It is not far-fetched to attest a 'documentary' function of the respective artefact-images here – they are intended to provide a 'visual record' of the assemblage. In both cases, artefact visualisations depict 'types,' 'classes,' or 'particulars.' The fact that all of these depictions, although of course being technical drawings, emphasise the 'realism' of the lithic objects and lack additional aspects of encoded visual information, affirms the mostly *illustrational* purpose of object imagery in the Anglophone case studies (**Fig. 5**).

All of this provokes the question of 'data.' Are lithic artefacts considered lithic data at all? The visual evidence at least suggests that this question must be answered in the negative. The representation of lithic objects points to a conception of artefacts as *evidence* rather than primary data. The idea would be that lithic objects of course possess informational value – they are evidence for something – but in order to become 'data' the information they register needs to be transposed into an adequate data-format. It is only in this format that 'evidence' is turned into 'data.' With Pepper, we can understand this process as the transformation of uncriticised observation into reliable scientific 'fact.' The circumstance that lithic object representations hardly play a role in the 'context of justification' hence indicates that 'data' is typically provided in another visual format. This format is tables and quantitative-statistical graphs. We can therefore assert that the 'imaging task' of object-images is *non-analytical*. They do not specify any hypothesis, nor do they present data in the strict sense or catalyse any proof or inference. Instead, this is overtaken by the tables and graphs that showcase the lithic data, typically in numeric or digit form, and perform inferential statistics in order to provide the needed arguments, often by means of some kind of 'pattern visualisation.' The 'data' – whether provided as 'continuous' or 'discrete' variables – is always data about parts. It concerns object-particulars but also 'traits,' 'attributes,' or 'ties' (i.e., indices and other relationships between traits and attributes).[323] The general logic of image-use is therefore clearly 'analytic.' It is also evident that data-construction as reflected in imaging practices responds to requirements of *quantification*. Since the depiction of lithic objects is always ineluctably 'qualitative,' it may thus not be surprising that this 'image-type' only plays a marginal role in the examined Anglophone cases of lithic analysis.

In the French cases, the situation is somewhat different. Lithic object representations are central *argumentative devices*. Not only can they be found throughout the entire paper, some of the 'tex-

[322] See also, for example, Yellen et al. (2005: Appendix C [Figures 4-33]).
[323] Especially in Dibble's (1995a) study, lithic artefacts are grouped together in a relatively 'loose' manner. There is either no apparent selection of artefacts except for the fact that they, as *individuals*, instantiate a set of predefined and supposedly *diagnostic classes* of Mousterian artefacts, or artefact-groupings are based on broadly shared morphological characteristics or attributes (*ibid*.: Fig. 7.4-7.7). Object-images therefore clearly represent 'particulars' or 'types.'

tual' arguments are simply not comprehensible without referring to the corresponding figures. This suggests that showing objects is at least as important as talking about them. Many arguments have a textual *and* an 'object-visualisation' side to them, and both are indispensable to the construction and persuasiveness of the argument. The relationship between text and image is not only complementary and mutually reinforcing, but also of a dialectical nature. In order to retract an argument, even the reader sometimes has to move back and forth between the relevant written and pictorial parts. Both aspects of reasoning therefore seem to form an inextricable 'whole':

> "Drawings should not be considered as a prop for words and definitions, but as a genuine informative technological writing, and this is what we have attempted [...]. Far from being mere reproductions of stone artefacts, the drawings and diagrams presented here were conceived at the same time as the text and can even substitute for it, the symbols used being equivalent to a terminology. If a clear sentence is better than a vague generic term, an accurate technical drawing can usefully replace a vague description." (Inizan et al. 1999 [1995]: 17)

The important point, however, is that individual artefacts are no longer considered as evidence, but assume a status as *data*. Why is this the case? Boëda's (1988: 199-202) reconstruction of the relationship between different reduction stages and Levallois products may serve as an illustration here. The author uses schematic images to specify why and how particular core configurations and particular blank configurations inter-constraint each other (*ibid.*: Fig. 18.15-18.17; **Fig. 6**).[324] The 'imaging task' of these images is to outline and 'explore' local hypotheses and possibilities of core-blank interaction under specific technical conditions. The associated textual train of thought develops the rational arguments that link particular groups of artefacts to the outlined technical relationships. The object-images that group artefact which are interpreted to belong to the same context of lithic reduction (cf. *ibid.*: Fig. 18.18-18.20) are then presented on distinct panels in order to establish that the derived expectations are confirmed by the data. The 'imaging task' of these depictions is both 'inferential' and 'demonstrative.' The visualised lithic artefacts are data in themselves – they are shown to convince the reader that the suggested reading of the evidence *makes sense*.

A whole range of pictorial features support this view. The perhaps most significant aspect is the evident search for a 'visual match' between two or more lithic artefacts that are believed to bring forth each other, for instance specific cores and their associated blanks.[325] This 'visual match' is then further analysed in order to assess whether or not the technical and morphological characteristics of the involved lithic objects explain each other. A key point emerges from this: the corresponding logic of image-use affirms that individual artefact-features are always examined in terms of how they contribute to the 'wholeness' of the artefact insofar as this wholeness can be related to other artefact-wholes. The resulting 'synthetic' interpretation of lithic objects forbids a full reduction to 'atomistic' data-formats and partly explains why the status of numerically encoded information becomes ambivalent at best (see *infra*). Primary lithic data, in other words, must always be artefact-wholes and not their parts. Another side of this 'synthetic' orientation is the organisation of lithic objects into meaningful technical groupings. These groupings – and this iterates some of the points made in earlier sections – do not just establish (dis)similarities and correlative relationships among artefact-parts. Rather, the 'imaging task' of these object panels is to place individual artefact-wholes into larger technical wholes which, in turn, are rendered significant through their technical relations with other technical wholes. The respective imaging practice therefore typically involves considerations about *morpho-technical complementarities* and the assessment of *transitive linkages*.[326] Strictly speaking, these object-images do not represent 'particulars,' but seek to capture 'relations,' 'contexts,' 'qualities,' and 'nexuses.' The question is always how parts reach out to their significant whole(s). Parts are therefore usually *pars pro toto* and the ultimate goal of visualisation is to render the corresponding whole(s) intelligible – object-images provide *visual insight*.[327]

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[324] 'Inter-constraining' here simply means that specific core configurations have particular blank consequences, and specific blank removals have particular consequences for the resulting core configuration. In order to relate cores and blanks technologically, one has to take both directions of technical amendment simultaneously into consideration.

[325] As we will see in the first part of Chapter 5, practices of *visually matching* lithic artefacts generally resonate with the idea of « *lecture* » and the 'mental refitting' approach which continue to occupy a central place in French technological research.

[326] A 'transitive' tie is an *indirect relationship* between two or more entities which entails at least one other, intermediating entity.

[327] For an important discussion of 'visual abduction' in archaeology, certainly relevant in this context, see Shelley (1996).

A general symptom of this mode of image-use is the increased selectivity of object representations and the heightened mobilisation of technical symbology. The first aspect results in the reduced realism of object-images, emphasising only technical features which are important to drive home the argument. The second aspect is reflected in the trend to enrich the provided pictorial information by introducing technical symbols to record different technical operations, or by colour-coding and pattern-coding artefact surfaces in order to indicate differential surface treatments and surface functions.[328] Both aspects are especially evident in the work of Boëda (1988: esp. Fig. 18.3-18.6) and Soriano (2000: esp. Fig. 108, 111-112, 114-115, 126-134, Annexe 2 [Fig. 138]). Practices of symbolic coding clearly exemplify a domain of lithic research in which considerable pictorial innovation has been made in recent years (cf. e.g., Inizan et al. 1995: 106-127; Nicoud 2011; Chevrier 2012: Annexe 3.1-3.5; **Fig. 7**).[329]

Given these findings, a closer look at the role of tables and quantitative graphs in French lithic inquiry is warranted. What is their purpose and how do they relate to object-images? I will use Boëda's (1988) study as an illustration again. The first point to note is that the few quantitative graphs that this study features represent a follow up of the qualitative examination of the main core reduction schemes. This positioning is not at all coincidental. The 'imaging task' that they perform, namely to quantify metric values of cores, is *dependent* on the preceding technological analysis (cf. *ibid*.: Fig. 18.13-18.14). Quantified are simply the categories that have been established before (*Schémas A-C*, *Indifférencié*). In contrast to the Anglophone case studies in which quantification is clearly a primary operation, quantitative analysis is secondary and serves to investigate category-internal dynamics, as well as the quantitative effects, if any, of these categories.[330] The design and content of tables follow a similar logic. Here also the goal is to analyse and cross-tabulate the distribution of 'synthetic,' that is, already established whole-categories in order to learn something about their interconnectedness (cf. *ibid*.: Tabl. 18.I-18.V [Table 5 *sic!*]), for example to provide insight into the 'infrastructural' details of a *given* technical system.[331] This operation is diagnostic rather than prognostic; it proceeds from wholes to parts and not the other way around. Therefore, most non-object visualisations *presuppose* whole-categories. The respective graphs and tables demonstrate that the significance of parts is determined by their place in a whole – a classic tenet of 'synthetic' thought.

This configuration of visual practice may also explain why there is so much heterogeneity in terms of using different graphs, tables, and object representations in French technological research. The images called upon vary because they have to express different arguments and different kinds of technical relationships depending on the assemblage-level context in question. In other words, to highlight the relevant technological relationships may require to summon different 'image-types' and to adapt them specifically to the argumentative and inferential demands of particular contexts of inquiry.

The last aspect of French visual practice that requires some attention is the deployment of relatively abstract diagrams and schemas – in particular because this 'image-type' is often completely missing in Anglophone scholarly productions. The 'synthetic' quality of this type of imagery is immediately evident. The 'imaging task' is to visualise the *technological functioning* of a lithic whole in question. The respective images may for example specify the volumetric 'working principles' of a prepared Levallois core (Boëda 1988: Fig. 18.1) or bifacial shaping (Boëda 1995a: Figure 1-4), how a core is transformed in terms of its morphology and surface configuration as a function of particular blank

[328] This type of additional, symbolically encoded visio-technical information seems to be very rare in the Anglophone lithic literature. Even simple technical arrows indicating the direction of removals are sometimes missing, especially when plain *débitage* or tools are concerned (cf. e.g., Shea 2013a, 2017a; Stutz and Nilsson Stutz 2017: Fig. 32.2). This exclusive focus on artefact *outline* suggests that the images serve a purpose other than showcasing these features or that these features are generally not regarded to capture important information – it again indicates that object imagery primarily serves dispensable, 'illustrative' purposes.

[329] But see Dauvois (1976: 129-139). Already Dauvois (*idem*), the father of the *schéma diacritique*, speaks of "dynamic and structural drawings." His vision of drawing is thus already 'synthetic.' Drawing a lithic object always implies to interpret the object in the light of its parts and its parts in the light of the object's 'wholeness.' A 'dynamic and structural drawing' captures the insights gained through this process. Note also that devising a *schéma diacritique* essentially *requires* to visualise the target object. Some form of visualisation is therefore indispensible for this type of technological inquiry.

[330] In a more recent paper, Boëda et al. (2014: 955) explicitly note: "[…] [t]he underlying and more significant question concerns the concept of cobbles – their form and volume, and the ways in which natural features of the raw material may have been incorporated in reduction sequences leading to tool production. This is essentially a qualitative question that requires technological and technical analysis that cannot be reduced to simple numbers and graphs."

[331] This notion of 'infrastructure,' certainly central to some strands of 'synthetic' technological thought in France, will be explored in more detail in the first part of Chapter 5.

detachments (cf. Boëda 1988: Fig. 18.2), or how different reduction stages are orchestrated and what kind of lithic products each of them supplies (cf. *ibid*.: Fig. 18.22).[332] These visualisations involve a certain degree of abstraction and idealisation and seek to capture the *systemic articulation* of various technological elements. This can result in hybrid images where idealised exploitation schemes are juxtaposed with object-particulars in order to demonstrate that the latter form a unified technical whole (cf. Soriano 2000: Fig. 99-100); it can equally result in complex diagrams, often also hybrid in character, which specify the system-level relationships between different lithic artefacts and their features (**Fig. 8**).[333] More abstract and 'diagrammatical' images may for instance represent the relationship between different lithic production systems within an assemblage without comprising any iconic component (cf. Boëda 1995a: Figure 20).[334] All of these images depict something that cannot directly be observed in the examined assemblages. There exists no spatiotemporal physical object that corresponds to them. We have to conclude that they are purely *conceptual images*. The fact that they play such an important role in all of the three case studies thus further supports the claim that French technological research can be understood as a *conceptual practice*.[335] The goal of conceptual images is to provide conceptual 'understanding.'

It has to be said, however, that 'diagrammatic reasoning' –that is, the understanding of concepts and idea by means of visual devices (e.g., Kulpa 1994; Anderson et al. 2002) – is not completely foreign to Anglophone approaches. Already Clarke's *Analytical Archaeology* (1968) musters a whole range of abstract diagrams and Shennan's *Quantifying Archaeology* (1997 [1988]) also includes such imagery. Yet, the difference is that these images are *theoretical entities* in the sense of 'theory' specified in the previous section. They serve a rather different purpose than the conceptual images found in the French discourse. Their 'imaging task' is to formalise and simplify theory-derived expectations (e.g., Clarke 1972b: Fig. 1.4, Figs. 1.9-1.11, Fig. 1.17; Ambrose and Lorenz 1990: Fig. 1.1, 1.2) or to provide an overview of the various causal or otherwise constitutive relationships that hold together different domains of reality (e.g., Binford 1980: Figure 1, 3; Rolland and Dibble 1990: Fig. 13; Nelson 1991: Figure 2.1; Jochim 1992: Figure 1; Hoffecker 2002: Fig. 1.6; Steenhuyse 2007: Fig. 1.1). Theoretical quantitative-statistical images represent 'ideal' patterns and data-behaviours against which empirical findings can be compared. Theoretical images of worldly-order typically legitimise correlative thinking and the explanation of certain phenomena (e.g., lithic technology) in terms of other phenomena (e.g., climate change).[336] Alternatively, abstract imagery may serve to explain measuring procedures; it may also be deployed in experimental lithic research in order to describe the study design or the specific causal-determinative factors investigated. In all of these cases, however, diagrammatic reasoning serves or prepares empirical data-analysis, it is almost never an active part of this analysis.[337] Moreover, these images almost always 'theorise' parts and their configurations, co-variations, and transformations – their goal is 'explanatory.'

How images are *produced* is no less informative. Automated image-production by specialised expert software, for instance, seems to be a hallmark of Anglophone lithic practice (e.g., Braun and Harris 2001), especially when complex statistical procedures are employed or a geometric morphometrics approach is followed (cf. Shott and Trail 2010; Archer et al. 2017; McPherron 2018). An important aspect of this imagery is that the distance between data-input and data-visualisation is fairly small.[338] The visualisation typically follows by necessity from the data-input. All of this is thought to secure an 'objectivist' analysis of the evidence (cf. McPherron 1991; Lycett and Cramon-Taubadel

[332] This, conversely, also means that this 'synthetic' imagery serves to specify which parts of the assemblage are *relevant* for the reconstruction of particular sub-wholes such as tool-systems, reduction systems, and various significant artefact-groupings. Thus, the lithic wholes determine explanatory 'relevance,' not the parts.

[333] 'Hybrid' here simply means that drawings, photographs, and/or more conceptual diagrams and schemas are combined within a single image.

[334] See also Boëda et al. (1990), Geneste et al. (1997), and Bourguignon et al. (2004) for the utilisation of similar 'image-types' with broadly similar 'imaging tasks.'

[335] See the previous section for a similar point.

[336] If systemic 'imaging tasks' are chosen, the outlined systems typically specify *external* relationships, not so much the internal configuration of lithic technology.

[337] Certain types of 'digraphs' which are sometimes used to analyse lithic reduction trajectories (e.g., Kuhn [2014] 1995: Fig. 4.11) may be an exception here since they appear to 'summarise' empirical findings. I will address this issue in the second part of Chapter 5, when various versions of the 'reduction thesis' are scrutinised.

[338] This is because the software produces imagery based on *mathematical formulae*, *calculi*, or other principals of transposition, so that the relationship between the input and the output is well-defined.

2013),[339] even though some subsequent visual manipulation may nonetheless be necessary in order to render the image intelligible. The increasing use of 3D-rendering technology to display lithic objects is another case of a quasi-automated practice of visualisation (e.g., Bleed et al. 2017). But as Magnani (2014: 285) for example readily admits, the resulting images, for the most part at least, serve illustrative purposes and provide a precise 'visual record' of the objects in question. In the case of geometric-morphometrics imagery, a similar point can be made. These images, strictly speaking, do not specify primary data since this data is also provided in digits and other numerical measures.[340] In the French case, pictorial diagrams and even artefact-plates are also increasingly constructed with the help of graphic applications. But this process appears to be comparatively non-automated. Instead, the process of constructing images, depending on their pictorial and interpretive complexity, typically involves *tinkering* with different arrangements and pictorial elements until a satisfying image-composition has been established.[341] This image-making practice leaves room for personal idiosyncrasies, but also epitomises the 'synthetic' need to adapt visualisations to specific assemblage requirements. French lithic scholarship, especially the latest generation of researchers, indeed often puts much effort into designing lithic imagery. The latest monographs in the *CTHS* series exemplify this trend[342] – the pictorial investment they embody at times even rivals text-writing.

This increasing significance of the 'rhetoric of images' in French lithic inquiry is also echoed by a recent controversy between Sylvain Soriano and Ludovic Slimak about supposedly 'aestheticised' lithic object-imagery and its seductive potential (Soriano 2010; for the response, see Slimak 2010). The debate certainly indicates that the persuasive power of lithic imagery cannot be taken lightly anymore. Grégor Marchand (2017: 10), for example, has recently also evoked the epistemological importance of 'imaging practices' in Palaeolithic knowledge production:

> "I belong to the rarity of archaeologists who think – and hope – that one day, a good portion of the work on prehistory can be exclusively presented in images, in drawings, and in schemes." (my translation [for the original French quote, see **Appendix Q.7**]) (Note his omission of graphs and tables here!)

Taken together, the evidence clearly suggests that the visualisation of objects, concepts, and data constitutes a key practice in lithic research. The detailed examination of visualisation trends in French and Anglophone approaches has thereby established that image-practice follows a vastly different logic in the two camps. While lithic image-use in the latter is guided by 'analytic' imperatives, the construction and implementation of imagery in the former serves to facilitate a 'synthetic' understanding of lithic technology. The revealed differences reproduce many of the fault lines between the two research spheres that have been identified and discussed in the previous sections, confirming that we are dealing with a robust and coherent pattern. One can thus conclude that the difficulties of bridging the French-Anglophone divide are likely related to the complications of negotiating between 'analytic' and 'synthetic' visions of science. Although the issue appears to be fairly general from this perspective, it should have also become clear that these two general research orientations are *realised* in rather specific ways, acknowledging the unique questions and problems of lithic inquiry in Palaeolithic archaeology. A short excursion into the realm of empirical discourse will provide sample material to better understand some of these more tangible ways in which the 'analytic'-'synthetic' divergence continues to impact Palaeolithic research.

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[339] Lycett and Taubadel (2013: 1509), for example, emphasise that morphometric approaches provide 'far more than merely an image capturing technique' and offer "an automatic method of analysis." See also Archer et al. (2015, 2016: 61) for an accentuation of the importance of 'automated approaches' in lithic studies.

[340] To be more specific here, the 3D-image is used to extract the sought-for data. This, just like in the case of physical lithic objects, suggests that the images are considered evidence rather than data. They first have to be transposed in a normalised data-format in order to become data.

[341] I would in fact argue that this process of image-construction cannot be separated from the process of data-analysis since the construction of the image may provide insights which are otherwise difficult to gain and deepen the investigators understanding of the assemblage-whole. Working with and constructing images becomes therefore another means of holistically making sense of a particular lithic context. This inseparability of understanding and image-making affirms the 'synthetic' quality of inquiry in the French scene. I do admit, however, that an 'ethnography of lithic image-making' would be necessary in order to substantiate this perspective.

[342] Some recent studies published in the *Éditions du Comité des travaux historique et scientifique* monograph-series suggest that image and text are increasingly seen as equally important in French lithic research. These monographs are extremely well illustrated and the image quality is extremely high. Langlais' *Les Sociétés Magdaléniennes de L'Isthme Pyrénéen* (2010) and Mevel's *Des Sociétés en Mouvement. Évolution des Sociétés Magdaléniennes et Aziliennes des Alpes du Nord Françaises* (2017) are revealing examples of this trend.

3.2.5 ***Two key sites of lithic conflict: variability and complexity***

Variability and complexity are the subject of lithic research since the field's inception. Their investigation can be regarded as part of the core business of Palaeolithic archaeologists, and insights into these two aspects of lithic technology generally promise to make an important contribution to our knowledge of the deep human past. It is therefore not surprising that both French and Anglophone lithic researchers have always endeavoured to tackle questions of variability and complexity. Both would agree that progress in the field to a certain extent depends on our ability to better comprehend and disentangle these two key coordinates of the lithic record. Lithic variability and technological complexity thus present themselves as excellent candidates for a comparative conceptual analysis. How are these two terms usually understood and examined in the two research spheres? And how does this effect what we can know about the Palaeolithic and its technological evolution? What follows in this last section is an attempt to address these questions and to investigate to what extent different answers may be explained with reference to Pepper's divarication between 'analytic' and 'synthetic' cognition. The foregoing analysis clearly suggests that such an investigation should be both worthwhile and clarifying.

Variability: the "oligarchic' vs. the 'democratic' point of view

How is the variability of lithic technology conceptualised? How is it measured and monitored in order to determine its significance? In general terms, variability describes how closely related or spread out a set of data is. The concept seeks to capture to what degree a particular entity can vary as a function of different variables. It is therefore obvious that empirical measures of lithic variability depend upon the mobilised kinds of data and the technological entities considered to vary. The question of variability is therefore interwoven with questions about data-concepts and the appropriate unit of analysis, issues which have already been covered in the previous sections. For this reason, it seems appropriate to begin with a survey of terms and concepts invoked in the literature to approach or assess lithic variability in particular research contexts. What is their presumed level and focus of analysis?

In the French case, variability is usually assessed on multiple levels. It can be discussed on the level of lithic assemblages, significant sub-units of these assemblages, or on the level of particular technical objects, for example bifaces. The central point, however, is that the variability discourse is anchored in the identification and discussion of entities that have no direct physical or artefactual correlate. When variability is debated, French lithic experts typically conjure concepts such as *chaînes opératoires* (e.g., Pelegrin et al. 1988; Boëda et al. 1990; Julien 1992; Pelegrin 1995; Geneste et al. 1997) 'technical systems' (*systèmes techniques*) (e.g., Perlès 1987: 22; Boëda 1991; Inizan et al. 1995: 14f.; Bodu et al. 2001; Geneste 2010 [1991]; Valentin 2011: 46),[343] modalities of volume-management (*conceptions volumétriques*) (e.g., Boëda 1993, 1994; Bodu 1994; Valentin 1995: Annexes; Bourguignon 1997; Delagnes and Roche 2005), gestural systems (e.g., Pigeot 1987; Le Brun-Ricalens 2005: Fig. 9, 14; Koehler 2011: Fig. 11; Valentin et al. 2014; Marchand 2014: Fig. 37), 'technical logic' (*logique technique*) (e.g., Perlès 2009; Brenet and Folgado 2009; Chevrier 2012: 769f.),[344] *schémas opératoires* (e.g., Boëda 1986, 1994; Pelegrin 1990, 1995; Boëda et al. 1990; Karlin and Julien 1994), or 'knowledge' (i.e., *savoir-faire*, *connaissance*, *vouloir-faire*, skill, and technical competence) (e.g., Pigeot 1983, 2004; Ploux 1988, 1991; Karlin 1991; Pelegrin 1991, 2000; Audouze 2010; Ploux and Karlin 2014; Leroyer 2016). More recently, 'tool systems' have been faithfully added to this list (e.g., Boëda 1991, 1997, 2013; Lepot 1992/1993; Soriano 2000; Bonilauri 2010; Nicoud 2011; Chevrier 2012). Even if scholars wish to study lithic variability on the level of social and economic strategies (e.g., Perlès 1980, 1991b, 1992; Bon 2002, Pelegrin 2011; Renard and Ducasse 2015), these strategies are reconstructed with reference to some of the listed categories.

What emerges from this general enumeration of terms and concepts is the recognition that variability in the French scene is interrogated on some *higher level* of lithic organisation. Most of the

[343] See already Mauss (1947: 29). [cited in Inizan et al. 1999 [1995]: 14, footnote 14]
[344] See also Boris Valentin in [*Devenir Archéologue*] *Les outils en pierre préhistoriques*, uploaded to the YouTube network by the University of Paris I-Sorbonne on the 9th of February 2016 [URL = https://www.youtube.com/watch?v=MB4CD145z40].

time, the relevant variability is even located within *virtual* properties of lithic technology – that is, properties that refer to an 'ideal' aspect of technical reality that is nonetheless real.[345]

There are two immediate consequences of this discursive configuration. The first is that one is not only prompted to examine the variability within these categories, but also the variability *between* them – that is, how the various categories are interconnected and linked in a given technical context, i.e., in a particular lithic assemblage. The distinction between 'technique,' 'method,' and 'concept,' introduced during the 'technological revolution' (cf. Tixier et al. 1980; Perlès 1991a), resonates with this ambition. The classic preoccupation of French technological inquiry to reconstruct 'operational schemes' and to relate them to their corresponding 'conceptual schemes' in order to retrace distinct 'knapping projects' can similarly be regarded as a symptom of this basic understanding of variability (cf. Schlanger 1994; Pelegrin 1995; Inizan et al. 1999 [1995]: 15). Variability, in this view, is always a multi-scalar and multi-dimensional phenomenon (cf. Forestier 1993: Fig. 1):

> "Because lithic variability is not exclusively typological, but simultaneously conceptual, technical, and economic, it is also likely that the underlying factors are themselves of a varied nature. Although most archaeologists would assent to this proposition, few actually apply it to their analyses of lithic industries. Instead, most diachronic and synchronic studies postulate single "explanatory" factors – e.g., functional needs, seasonality of occupation, cultural traditions, etc. – and account for all observational data in light of these "hypotheses." Such approaches are necessarily at the methodological level to the extent that they demonstrate the *potential* relevance of a given factor. On the other hand, these approaches lack the capacity to discriminate among various causal factors. Such arguments cannot establish either that the factor under consideration accounts for *all* of the observed variability or that it *alone* could produce it. Consequently, these approaches are too restricted for an efficient analysis of archaeological contexts in which lithic industries, their variations, and their transformations result, as do all human phenomena, from the interaction of multiple factors." (Perlès 1992: 24; original emphasis)

The second consequence is that artefactual variability cannot be compared without reference to these higher-level categories anymore.[346] The goal of technological analysis is to resolve the variability of lithic artefacts *internally*, that is, in terms of reconstructing effective technical groupings or contexts, so that the higher-level categories can be filled with technological content. To resolve the variability of Levallois assemblages, for instance, not only implies to show how many different varieties of Levallois reduction can actually be found in the respective assemblages, but also demands one to enquire whether apparently disparate sets of lithic artefacts (in terms of frequency distributions, metrics, present tool-types, etc.) may nonetheless 'belong' to the same technological variety.

All of these observations suggest that French researchers tend to study lithic variability through the prism of 'synthetic' categories. Newer attempts to chart aspects of variability in terms of abstract 'technological structures,' for instance, equally testify to the fact that the subject is approached from the perspective of wholes rather than parts (cf. e.g., Boëda 1997, 2005; Forestier 2000, 2010; Nicoud et al. 2016). These technical wholes are thought to have properties of their own and it is these properties that constitute the primary focus of analysis. With Pepper, we can say that variability turns out to be question of 'relations,' 'qualities,' and 'nexuses.' The resulting 'synthetic' understanding entails the concession that 'knowing the variability of lithic parts may mean nothing without knowing how it relates to the variability of the corresponding wholes.' As a result, the variability discourse in French Palaeolithic archaeology appears to be directed by an *oligarchy of wholes*.

This oligarchy of wholes is countered by a *democracy of parts* in Anglophone lithic research. In the latter, variability is assessed by charting and, if possible, quantifying part-based 'attributes,' 'traits,' and other directly observable variables. Variability is understood foremost as a non-stable pattern or structure of lithic data, fluctuating in relation to some relevant independent variables – it is primarily seen as a *quantitative* phenomenon. Variability, in other words, is the *result* of the various interactions, combinations, and associations of the relevant lithic parts and their features – it is the *outcome* of part-centred analysis. Lithic variability is therefore simply defined as a consequence of

[345] This findings clearly hints at the important role of *interpretive idealisation* in French lithic research. Although I cannot provide an in depth analysis of this research operation here, we will touch upon this issue again in Chapter 5.

[346] In other words: artefactual variability, that is, the variability found in the lithic artefacts themselves, cannot be taken as an *absolute* measure. It needs to be 'calibrated' against their technical whole or at least 'put into perspective' by this whole.

varying constellations of 'particulars,' 'characters,' 'ties' or other 'primary' and 'secondary' part-qualities. This conception is overwhelmingly 'analytic.'

Anglophone scholars typically map different types of variability depending on the type of data they harness. We may for example distinguish between *typological variability* (e.g., Freeman 1966; Wymer 1968; Sackett 1973, 1999; Rolland and Dibble 1990: 492; Dibble 1987; Coinman and Henry 1995; Mellars 1996; Szmidt 2003; Wenban-Smith 2004; McPherron 2006; Olszewski 2016), *morphological variability* (e.g., Sackett 1966; Roe 1968; McPherron 1994; White 1998; Iovita 2008, 2011; McPherron and Iovita 2011; McNabb and Cole 2015), *raw material variability* (e.g., Rolland 1977; West and Montet-White 1990; Ambrose and Lorenz 1990: 21-24; Jelinek 1991; Dibble 1991b; Kuhn 2004b, 2011: 100-102), and combined or other more specific axes of trait-based variability (e.g., Barton 1988: 105-110; Kuhn 1995; Tostevin 2000, 2012; Marks et al. 2001; Henry 2003; McCall 2006, 2015; Wragg Sykes 2009; Scott 2011; Culley et al. 2013; Ruebens 2014; Monnier and Missal 2014: Table 2; Scerri et al. 2014; Conard and Will 2015; Jones 2016; Ruebens and Wragg Sykes 2016; Rezek et al. 2018). There is no general hierarchy between these axes of variability, and they, as a result, may be analysed as parts themselves – the aim is then to examine their *external* relatedness and, if possible, to detect patterns of co-variation and (statistical) correlation. Contrary to the French conception, the idea here is that 'knowing the variability of the whole is largely identical with knowing the variability among lithic parts.' A key precondition for studying variability on an inter-assemblage level is thus to keep the analytical part-categories constant. The result is a strong analytical reliance on well-defined and standardised systems of object classification and similarly formalised trait-lists.[347]

On the assemblage-level, variability is generally examined as the degree of similarity or affinity. There are a number of schemes for organising variability at differing scales, but all of them organise the data according to some logic of increasing or decreasing affinity, analogy, or resemblance among parts. The perhaps most well-known scheme of this type is Clarke's (1968: 187-189, Fig. 40) 'hierarchical model of archaeological entities' – a model that is still frequently used today (e.g., Gamble 2001: 52; McNabb 2007: 7-9; Shea 2013a; 37f.). Clarke discriminates between 'attribute,' 'artefact,' 'type,' 'assemblage,' 'culture,' 'culture group,' and 'technocomplex.' While one climbs up this hierarchical ladder of categories, the relevant part-affinities decrease (which means that their variability increases), but the spatial and temporal coverage of the categories simultaneously increases. Clarke' model for organising lithic variability is often used in a simplified version, distinguishing merely between 'assemblage,' 'assemblage-type,' and 'assemblage-tradition' (cf. McNabb 2007: 7-9). An 'assemblage' is here defined as a shared set of significant attributes, an 'assemblage-type' consists of a series of assemblages that share these significant attributes, and an 'assemblage-tradition' is encountered when assemblage-types persist through longer timespans. Drawing on Pepper, this understanding of the general structure of variability can be said to imply 'The Theory of Types' and/or set-theoretical premises.[348]

Williams' (2003: 92-95) framework to assess lithic variability in the Levantine Early Upper Palaeolithic follows a similar logic. Based on the classic work of Henry (1989a: 81-89) and Marks (2003), he differentiates between three lithic entities – 'complex,' 'industry,' and 'phase/facie' (**Fig. 9**). Again, these categories are thought to capture different levels of variability, the relationship between the categories being defined as decreasing inter-assemblage affinity measured by the individual characteristics of the lithic artefacts that take part in the assemblages (cf. Williams 2003: 94f.).[349] The logic of determining variability and organising it is clearly 'atomistic.' The basic strategy is to start with the smallest elements and gradually built up ever larger groupings of such elements – the regulative idea is the 'law of association' (see Chapter 2). The 'smallest' parts are examined in order to detect robust patterns or other new wholes; these patterns or wholes are then 'turned' into parts themselves and analysed in order to establish new patterns and wholes, and so on. The structure of variability is reconstructed 'bottom-up' and the higher levels remain in principle reducible to the basic elements that generate them.

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[347] See the Section 3.2.1.

[348] See Chapter 2 for a discussion. See also Pepper (1942: 156-162).

[349] This logic of mapping lithic variability enables the discrimination between multiple levels of organisational hierarchy. These levels are typically referred to as 'higher-order groupings': "[h]igher-order groupings of stone tools consist of a hierarchy of technological and typological characteristics, artifact-types, assemblage-groups/industries, and industrial complexes." (Shea 2013a: 37)

These short enunciations are enough to reveal that French and Anglophone approaches to lithic variability appear to be informed by opposite ends of the 'synthetic'-'analytic' spectrum. The survey of the various terms and categories that form the bedrock of studying variability in both camps has demonstrated that not only the mustered categories themselves differ, but also the ways in which they are put to practice. It has become clear that these differences have a strong impact on how the lithic record is perceived and understood, with important implications for the possibilities of lithic interpretation and knowledge formation. The exposition has therefore clarified some of the stakes of the French-Anglophone divide and further ratifies that Pepper's epistemological categories are likely well-suited to unpack it.

Complexity: compositionality vs. systemic emergence

How is technological complexity defined and assessed? What are the key differences between a 'more complex' and a 'less complex' technological make-up? What are the relevant units and the preferred focus of analysis to examine complexity? The term 'complexity' is typically employed to characterise an entity with many components interacting in multiple ways. These interactions 'create' complexities of various sorts. It is therefore the relationship between parts, their linkages, and the 'complex' whole they delineate that is central for any understanding of complexity as a phenomenon. Various notions of complexity are thus likely to favour their own definitions of these elements and their connections. If we wish to investigate the key concepts that guide the empirical examination of complexity in France and the Anglophone world, we consequently have to pay attention to these three aspects. We have to ask how lithic complexity is build up, what its building blocks and what its consequences are.

The basic orientation of Anglophone complexity research is expressed by Perrault et al. (2013), who assert that

> "[…] the complexity of a technology can be measured by counting the number of elemental building blocks associated with it." (*ibid.*: 398)

The strategy is almost always to determine the boundaries of whatever one wants to analyse in terms of complexity, decompose it into its relevant parts and then re-assemble these parts again. The 'Golden Rule' employed by many of these approaches can be summed up in the following manner: 'the more relevant parts can be observed, the more complex the phenomenon under consideration appears to be.'[350] Whether the respective parts are identified as 'procedural units,' 'tool categories,' or 'concept traits' may of course differ, yet in all cases complexity is considered an *aggregate property* of technological wholes, especially lithic assemblages (cf. Bousman 1993; Torrence 2001: 78).[351] Rather importantly, the complexity of the whole thereby follows without loss from the whole's compartmentalised part-structure. The result of this research configuration is a strong predisposition of picturing the evolution of lithic complexity either as a story of qualitative changes based on the presence or absence of certain key traits (e.g., Ambrose 2001, 2010; Brooks et al. 2006; Coolidge and Wynn 2009; Shea 2009; Shea and Sisk 2010) or primarily in quantitative terms, so that a continuous evolution of more or less complex technologies becomes conceivable. Examples for the latter approach are Isaac (1972, 1976), Dennell (1983), Mellars (1989, 2006: xii), McGrew (1992), Gowlett (1996: 154, Fig. 5.9), Per-

[350] This orientation is also reflected in the general definitions of complexity employed to direct the 'human modernity' discourse: "Behavioural complexity is defined relatively as the accumulation of 'more parts and more connections between parts' in cultural systems (Price 1995, 140), whereas symbolic thought can be defined as 'the ability to represent objects, people, and abstract concepts with arbitrary symbols, vocal or visual, and to reify such symbols in cultural practice' (McBrearty & Brooks 2000, 492). Combining both of these definitions, we define complex behaviour here as that which requires successive cognitive components that demand the actor to plan several consecutive steps (such as those used in the manufacture of multi-component artefacts) before the execution of the first step, or which require deep understanding of the operation of variables and their complex interplay as well as their reactions to deliberate manipulations by the actor. This last part of the definition refers to understandings of environment and the operation of the natural world that facilitate, for example, catching deep water fish, making repeated sea crossings and navigating between islands or intentionally influencing the natural reproductive cycles and productivity of plants and animals." (Langlais et al. 2008: 291)

[351] Torrence (2001: 78), for instance, defines 'complexity' in tandem with other composite properties of lithic assemblages: "Tool assemblage structure is described in terms of the particular mix of tool types (*composition*); number of types (*diversity*); and number of parts of each tool (Torrence 1983) or the average number of parts per tool in an assemblage (*complexity*) (Bousman 1993, Bamforth and Bleed 1997)." (original emphasis)

reault et al. (2013), Gamble et al. (2014: Fig. 3.4), or Hoffecker and Hoffecker (2018).[352] Most of these approaches are implicitly or explicitly inspired by common definitions of complexity in biology (e.g., Bonner 1988) or the behavioural sciences (e.g. Cochet and Byrne 2015). Some of the reasons for this conceptual affinity are historical. Anglophone scholars, especially those engaged with the 'behavioural modernity' debate, have tended to use complexity arguments in order to negotiate the boundary between 'animality' and 'humanity,' as well as between 'nature' and 'culture' (cf. Corbey 2005).[353] An important epistemological ideal of all of these definitions is that they aspire to be 'objectivist' and to facilitate an *absolute* understanding of lithic complexity that is valid independently of the context of inquiry or the technology in question.

Furthermore, and as Kuhn (2011: 104) for instance also notes, most discussions of lithic complexity refer to or depart from the seminal work of Wendell Oswalt (1974, 1976). Based on ethnographic observations and parallels, Oswalt proposed that technological complexity can be assessed by comparing the number of 'technounits' that different technologies host. A 'technounit' is thereby defined as an "integrated, physically distinct, and unique structural configuration that contributes to the form of the finished artefact" (Oswalt 1976: 36). A simple wooden digging stick, for example, has only a single 'technounit,' whereas composite harpoons and other hunting weapons usually consist of multiple 'technounits' (cf. Kelly 2013: 120). Measuring technological complexity with reference to 'technounits' enables, on the one hand, to obtain a rough measure for the overall complexity of the assemblage – what Oswalt termed the *elaborateness* of technology – and, on the other, to assess the complexity of individual tools. The latter provides insight into the variability of tool-complexity *within* a given assemblage. 'Simple' tools, according to Oswalt (1974), have parts that do not change their position relative to other parts during use, whereas 'complex' tools do alter the position of their parts during utilisation. It is easy to see that this account of complexity is 'analytic' – it revolves around lithic parts, potentially relates and counts them. Moreover, a 'part' may consist of multiple parts itself. It is generally sufficient to assess the configuration of these parts in order to gauge the complexity of the technological whole to which they contribute. The complexity of the whole, in other words, is always reducible to the characteristics of the relevant parts. As a result, Anglophone scholars who draw on Oswalt's theory typically inherit his 'analytic' conception of complexity (cf. e.g., Torrence 2001: 78f.; Kelly 2013: 116-128; Hoffecker and Hoffecker 2018: 203-206, 222f.).

It should also be noted that Oswalt's focus on 'food-getting technology' laid the groundwork for a whole suite of *Human Behavioural Ecology* (HBE) approaches which conceive of technological complexity as an expression of forager adaptations to northern latitudes (e.g., Hoffecker 2001, 2005; Reed 2008). Through this prism and in line with Oswalt's original considerations, technological complexity is seen to "reflect the complexity of the problems that it was designed to solve" (Hoffecker and Hoffecker 2018: 217). This view is compatible with 'optimality' and 'risk-centred' approaches which play an important role in the current Anglophone discourse (cf. Bleed 1986; Torrence 1983, 1989c, 2002; Jochim 1983; Bamforth and Bleed 1997).[354]

Even though the scope of this survey is certainly limited given the importance of the complexity question in Anglophone debates, the discussion nevertheless demonstrates that there exists a strong tendency to reconstruct complexity in 'analytic' terms and to regard the object of complexity as a *compositional entity*. The analysis of complexity tends to focus exclusively on parts and part-properties. In general, the applied definitions thereby seem to cover only a small fraction of the possible spectrum of complexity definitions (but see Hoffecker and Hoffecker 2018).[355]

In French technological research, by contrast, questions of complexity are typically pursued on the level of significant technical wholes. This means that complexity is either gauged relative to some

[352] The recent paper by Muller et al. (2017) falls into the same category of approaches, even though the authors cannot be considered here.

[353] Because of this focus on significant evolutionary transitions, many workers have in fact adopted what Vaesen and Houkes (2017: 1246) call the 'complexity thesis,' which holds that "cumulative technological complexity is a distinctive characteristic of human cultural evolution."

[354] See the second part of Chapter 4.

[355] The comparison of the discussed Anglophone understandings of complexity with Vaesen and Houkes' (2017) Table 1 shows that only three, perhaps four, of the nine listed conceptions of complexity (definitions nr. [1] and [2], perhaps nr. [3] and [6]) are currently applied to the empirical data (cf. **Appendix III.3: Table III.1**). It should be noted that Anglophone research also relies on omitted definition nr. [10], which was originally termed 'adaptive complexity.' Even though some of the listed definitions are difficult to operationalise within a strictly 'analytic' framework of inquiry, others could have easily been adopted. This at least indicates the potential of future conceptual work in this domain.

(higher level) properties of the whole which its parts lack, or as a function of interconnections between parts that cannot be discovered by an analysis of patterns among part-properties alone. The examination of technological complexity, in other words, is guided by the intuition of strong *systemic emergence*. Complexity, in this view, is a property of wholes that cannot be reduced to the properties of their parts – an 'emergent' property resulting from 'non-additive' and 'non-predictable' processes.[356] Discussing the concept thus reveals important parallels with the French understanding of variability.[357] In a now largely forgotten paper on the issue of *chaînes opératoires* in the animal kingdom, Beyries and Joulian (1990: 23) for example emphasise that one cannot meaningfully talk about complexity in the singular, because in reality one always deals with *multiple complexities* simultaneously. The same authors also stress that complexity is about the 'integration and level of management of functional, technical, economic, ecological, and cognitive factors' of behaviour (*idem*).[358] All of this mirrors what we have found previously, foreshadowing a relational approach to technological complexity. While introducing the problem of applying the *chaîne opératoire* approach to animal behaviour, Beyries and Joulian (*ibid*.: 17) also indicate that *chaînes opératoires*, and *a fortiori* their complexities, 'cannot be described or analysed in an absolute manner.' Already on a general level, therefore, they reject an overly 'objectivist' account of technical complexity.

The first important axis of investigating complexity in the French research context is the study of varying modalities of managing a volume-matrix. This, for instance, may involve questions about the relationship between preparation and reduction, the technical demands of 'navigating' a particular core architecture or adapting to certain local rules of reduction, the need of altering technical gestures, the requirements of rotating cores or reorganising their volumetric structure, the level of redundancy or 'cyclicity' involved in the reduction process, or the dependency on technical anticipation (cf. e.g., Binder and Perlès 1990; Boëda 1991, 2005, 2013; Mourre 2003; Pigeot 1991; Bourguignon et al. 2006; Valentin et al. 2014). In most cases, the goal is to determine the co-constitutive relationships that exist between some or all of these factors. The important point, however, is that none of these factors can be examined by interrogating lithic parts in isolation. Rather, all of the mentioned factors describe qualities of 'operating' technical systems. They result from the dynamic interplay of technical knowledge, reduction methods, and knapping techniques. Whether one of these factors renders the system 'complex' and in what respect *depends* to a large degree on the system itself (i.e., its organisation).

The second axis of researching complexity concerns the structure of the *chaîne opératoire*. The idea here is that different ways of organising the knapping process lead to different 'infrastructures,' that is, different articulations of groups of artefacts and technical operations. Geneste (2010 [1991]: 429-432, Fig. 1, 2), for example, distinguishes between 'linear,' 'scalariform,' and 'ramified' reduction structures (**Fig. 10**). These may also be combined to form 'hybrid' reduction structures and the respective structural qualities may be expressed to varying degrees (cf. Boëda et al. 1990; Geneste et al. 1997; Bourguignon et al. 2004). Brenet (2011: esp. Fig. 8), in a similar vein, discriminates between 'independent' operational sequences (*chaînes opératoires indépendantes*), 'successive' operational sequences (*chaînes opératoires successives*), 'simple ramified' operational sequences (*chaînes opératoires ramifié simple*), 'mixt ramified' operational sequences (*chaînes opératoires ramifié mixte*), and two different types of operational sequences 'combining' *débitage* and *façonnage* (*chaînes opératoires combinée débitage/façonnage*). All of these categories delineate whole-qualities – they concern the globality of the technical processes which define a *chaîne opératoire*. The underlying conception of complexity is consequently 'synthetic.' Perlès' (1980, 1991b) and Boëda's (1991) concept of 'complex' operational sequences (*chaînes opératoires complexes*) supports this view: a 'complex' reduction trajectory is thought to follow relatively rigid and non-redundant rule-sets, whereas a more 'simple' system of reduction is typically characterised by a limited number of highly versatile technical rules.

The third axis of examining complexity concentrates on the nature of the wider 'technical milieu' in which specific technologies make their appearance. Instead of paying attention only to the internal constitution of particular *chaînes opératoires*, the various relationships between them come to fore here. Researchers can for example investigate the number of co-occurring technologies and

[356] See esp. Hodgson (2000) for a discussion of the history and significance of the concept of 'emergence' in the social sciences.
[357] See the previous sub-section.
[358] This provisional definition of complexity is consistent with definitions nr. [5] to [8] of Vaesen and Houkes' (2017) Table 1 (cf. **Appendix III.3: Table III.1**), indicating that we should expect little overlap between French and Anglophone concepts of complexity (see previous footnote).

whether or not they serve similar functional, economic, or social purposes (cf. Bourguignon et al. 2006).[359] The variability of reduction systems can therefore already be a potent proxy for the technological complexity of the assemblage in question. Another angle of inquiry focuses on the interactions and potential complementarities between broader categories of lithic technology – i.e., *débitage*, *façonnage*, and tool-technology (e.g., Boëda 1991, 1995a, 1997; Soressi 2002; Montoya 2004: Fig. 134; Boccaccio 2005: Fig. 159; Renard and Geneste 2006; Brenet and Folgado 2009; Ducasse 2012: Fig. 4). The objective is to determine inter-technology 'synergies' as well as the reality and extent of a technological 'division of labour' (e.g., Soriano 2000; Brenet et al. 2014). Asking broadly similar questions, other researchers have started to examine the link between particular production systematics and the utilisation of their associated non-retouched products (e.g., Soressi and Hayes 2003; Lazuén and Delagnes 2014). All of these perspectives highlight that technological complexity can only be understood adequately if the dynamic interplay between lithic parts and wholes is taken seriously.

More generally speaking, French technological scholarship exhibits a strong tendency to assess the various ways in which different dimensions of complexity appear to condition each other. An example is Roche and Texier's (1991) mediation of a possible link between the *conceptual complexity* and *operational simplicity* of *chaînes opératoires* – whether and, if so, under which conditions the two presuppose each other. Delagnes' (1995) classic discussion of trade-offs between simplicity and complexity at the interface of 'operational schemes' (*chaînes opératoires*) and 'conceptual schemes' (*schemas opératoires*) follows a similar logic of research. Complexity, therefore, is really understood as a multidimensional phenomenon that needs to be approached holistically.

Due to this multidimensionality of complexity, there is also no way of settling the complexity question once and forever. Moreover, complexity cannot even be defined in general terms and French scholars are typically somewhat sceptical whether net differences in complexity between different technological contexts can be established reliably. As a consequence, practitioners either establish complexity as a *relative* property or discuss how complexity is *organised* within a well-defined technical context and what this may mean in terms of human behaviour (e.g., Delagnes 2010; Delagnes and Rendu 2011). Bourguignon et al. (2006), for instance, argue that it makes generally little sense to invoke a binary opposition between 'simple' and 'complex' production systems to understand the nature of technology in the French Mousterian. If one compares different reduction systems and investigates their socioeconomic repercussions, one usually finds that different aspects of these systems turn out to be 'complex' or 'simple.' This, in turn, suggests that complexity is a *dependent* property and that investing one dimension of complexity may have potential implications for its other dimensions (cf. Brenet et al. 2014). Although different techno-economic systems may therefore turn out to be 'complex' in rather different ways, every system will maintain a certain 'complexity equilibrium' – the total sum of a system's complexity will rarely change. The question, therefore, is not anymore how 'complex' a wider technical system is, but rather how its complexity is *distributed*. Clearly, this understanding motivates the default view that technical systems *are always complex in a certain sense*.

Technical complexity may be unequally distributed in a technical system because of social factors. It can for example be expressed as some kind of 'skillfullness.'[360] The latter may vary within a technical system because of reasons related to social learning and lithic apprenticeship (cf. e.g., Tixier 1976; Ploux 1983, 1988; Pigeot 1988a, 1988b; Karlin and Pigeot 1989; Ploux et al. 1991; Karlin et al. 1993; Delagnes and Roche 2005; Leroyer 2016). Different levels of complexity may consequently be the product of different levels of 'technical competence,' 'procedural knowledge' (*savoir-faire*), or 'conceptual knowledge' (*connaissance*) (Pelegrin 1991; Karlin and Julien 1994: 154). This perspective continues to be influential in French *« Palethnologie »*, which has traditionally endeavoured to expose and study 'micro-slices' of time.[361] Alternatively, complexity may be unequally distributed because of evolutionary reasons (cf. Pigeot 1991). Within the framework of Boëda's (1997, 2005, 2013) 'techno-genetic' paradigm, the character of technological complexity may considerably change in the course of long-term developments.[362] The basic idea is that lithic technologies organise themselves in 'technical lineages' when they navigate evolutionary time. In the earlier stages of technical development, tech-

[359] Note that the quantification of technical wholes remains a secondary operation since the wholes first need to be constructed by qualitative technological research.
[360] See definition nr. [4] in Vaesen and Houkes' (2017) Table 1 (cf. **Appendix III.3: Table III.1**).
[361] See the first part of Chapter 5 for a more detailed discussion of some of these issues.
[362] The generalities of the 'techno-genetic' approach are outlined and discussed in the second part of Chapter 5.

nologies are typically characterised by highly 'differentiated' and 'heterogeneous' structures – the relevant parts tend to operate independently from one another. In the later stages of technical evolution, by contrast, more and more 'integrated' structures emerge and these develop increasingly beneficial and mutually supportive inter-part relationships at potentially ever higher densities.[363] The character of this discourse is clearly 'synthetic.' Complexity is always analysed with reference to a technical whole, which appears to 'dictate' the terms under which something may be called 'complex' or 'simple.'

Altogether, the conceptual analysis of French and Anglophone complexity research can complement our previous findings. Complexity is mainly investigated from an 'analytic' point of view in the Anglophone world, whereas the majority of French technologists seems to adopt a 'synthetic' perspective. This recognition further substantiates the significance of Pepper's world theories for understanding the French-Anglophone divide and warrants an even closer examination of lithic practice on both sides. The question is now not only whether Pepper's 'analytic'-'synthetic' distinction has a general bearing on the divide, but rather whether the variability of approaches *within* both the French and Anglophone research enterprise can be illuminated by referring to Pepper's full spectrum of four world theories – 'formism,' 'contextualism,' 'mechanism,' and 'organicism.' We will explore this question in detail in the subsequent chapters.

[363] This conception of complexity is consistent with definitions nr. [7] and [8] of Vaesen and Houkes' (2017) Table 1 (cf. **Appendix III.3: Table III.1**).