In May 2019 the first fieldwork season took place at Tell Abu Habil, a Chalcolithic site on the Jordanian bank of the middle Jordan Valley. Although preliminary, the results indicated that during the early fourth millennium BC, a time when considerable amounts of archaeological literature claim that the entire Jordan Valley had been abandoned, Abu Habil was in fact a centre dedicated to a large-scale, workshop-based ceramic production. The aim of this paper is to reflect on how the ceramic chaîne opératoire approach, if applied from the outset of a research project can orient it by generating new archaeological questions. Subsequently, what kind of epistemological issues emerge from these chaîne opératoire-driven questions in general?

For several years, the chaîne opératoire has abandoned its niche status to become a shared approach across archaeology. Although the study of the manufacturing process is still rather new and rare in some disciplines (as it is in ceramic studies in the Ancient Near East), the chaîne opératoire no longer represents a sectorial method of analysis that only a few specialists undertake due to extremely specific skills and expensive technological means. The scientific success of ontologies and research about ancient technology (Dobres 2010), with the wide consensus on the effectiveness of their applications, has made the chaîne opératoire a relatively ‘en vogue’ concept (Lipo et al. 2006). Consequently, there exists a growing need to strengthen the link between increasingly innovative practical applications (Manclossi et al. 2019) and increasingly broad theoretical implications (Boëda 2013) of the chaîne opératoire.

This is not unusual for a notion enucleated over decades of debates (Roux 2003: note 1) and pertaining both to the making of, and to the studying of things, entailing both the process of transforming a single (or several) raw material(s) into a finished product (Cresswell 1976: 12), and to the analytical tool used for documenting such a process (Roux 2019a). The ways archaeologists deal with the chaîne opératoire allows this notion to progressively take issue with an expanding array of epistemological questions (Gosselain 2019; Shorter 2015). In other words, if there is the possibility of using the chaîne opératoire in new fields (from a methodological point of view, namely inherent to the way in which this analytical tool is applied), this could imply the possibility of asking new questions concerning the definition of the nature and consequences of the chaîne opératoire as a concept (Gosselain et al. 2009; Sennett 2009).

Obviously, this type of reasoning has no claim to be exhaustive. On the contrary, the transition from practical applications to more general and theoretical concerns could result in a series of disorganised reflections. To avoid this risk, this paper does not focus on epistemological issues but rather...
on a precise case study: Tell Abu Habil, a site in the Jordan Valley where fieldwork has recently begun.

The discovery of a workshop for ceramic manufacturing at Tell Abu Habil offers a rare opportunity to investigate production techniques and the evolution of ceramic technology during a very poorly documented phase. Furthermore, this allows—from the initial phases of a field project—to address questions about the sociality of technology in a research project through the chaîne opératoire framework. Both with regard to the specific case study of Abu Habil, and more generally, with regard to the intrinsic nature of the study of chaînes opératoires. Archaeological data is used to try to answer two questions:

1. How can the study of the ceramic chaîne opératoire orient future developments by broadening research perspectives when integrated from the outset of a project?
2. What can these technologically driven scientific questions reveal about the very nature of the chaîne opératoire?

RECENT FIELDWORK: QUESTIONS AND GOALS

Although the Jordan Valley has been intensively investigated for decades, the nature, organisation and relationships of its communities in the Chalcolithic, between the sixth and fourth millennia BC, remain little known (Lovell and Rowan 2011). Despite excavations at important sites in the western Jordan Valley such as Beth Shean, Tel Tsaf and Tell el-Farah, information on late prehistoric settlement pattern and social mobility is much more scattered than for the Negev such as at Grar (Gilead 1995) or Abu Matar-Safadi (Commenge Pellerin 1990), the coast (Rowan 2014) or Galilee (at Marj Rabba or at Peqi’in, Harney et al. 2018; Hill et al. 2016).

Similar problems are also experienced on the Jordanian bank where Teleilat Ghassul, the eponymous site (Hennessy 1969) of the ‘Ghassulian’ phase of the second half of the fifth millennium BC represents the only extensive excavation (Bourke 2007). Meanwhile, Tell esh-Shuna (Bronk Ramsey et al. 2002), Pella (Bourke 2008) and Tell Fendi (Blackham et al. 1997), close to the river, as well as Tubna in the northern Jordanian highlands (Banning 2007), have only been investigated in relatively small trenches. French excavations at Abu Hamid (Lovel et al. 2004, 2007) featured relatively extensive exposures and collected essential data on a Chalcolithic village and its ceramic traditions (Roux et al. 2011).

Nevertheless, many documentary gaps persist about the Jordan Valley chronology, architectural traditions, organisation of production (Killebrew et al. 2013; Philip 2011), as well as local (Levantine) and supra-regional northern Mesopotamian exchange networks. Although a certain degree of regionalism is evident in material culture (Gilead 1988, 2011; Rowan and Golden 2009: 10-20), the Jordan Valley shows clear connections with other areas of the Levant and the Near East throughout late prehistory, especially during the Chalcolithic (Baldi 2016, 2017a, 2017b, 2019). This phase witnessed major changes in mortuary and ritual practices, settlement patterns, iconographic and symbolic expressions and craft production (Rowan and Golden 2009).
In order to establish a secure base regarding the long-standing debate on the degree of complexity of Chalcolithic societies (Gosic 2008; Kerner 2010; Levy 1998; Levy and Holl 1988), it is essential to have a precise understanding of domestic architectural traditions, their level of differentiation within the settlements, as well as the scale and organisational mechanisms of production systems.

These are the main aspects of focus for a new French-Jordanian expedition. The LaPJoB (Late Prehistoric Jordan Basin) project aims at obtaining new data on the occupation of the Jordan Valley during the Chalcolithic. It does this by conducting extensive excavations at Tell Abu Habil and developing further micro-regional investigations at the confluence between the Jordan and Yarmuk river.

In the 1950s, Abu Habil (fig. 1) was first explored by Glueck (1951) and sounded by Mel-laart and de Contenson (1960; Leonard 1992), yielding a series of superimposed dwelling pits. In 1975 it was surveyed once again by Ibrahim, Sauer and Yassine (Ibrahim et al. 1976; Kafafi 1982). In May 2019, the first fieldwork season was carried out at Abu Habil by conducting a survey of the tell and its surroundings, a wide stratigraphic section (trench B), as well as extensive excavations of two contiguous trenches (A-A2).

**OBTAINING INFORMATION BY TRADITIONAL MEANS: INITIAL SURVEY AND EXCAVATION RESULTS**

Despite the presence of modern features, such as buildings, an irrigation canal and a road around the tell, the surveyed area was divided into ten different zones (1-8, while A and B are respectively the areas where trenches A-A2 and B have

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1: This 1953 survey was carried out between the Yarmuk river in the north and the plains of Moab in the south (de Contenson 1960). The aim was to record archaeological sites threatened by the diversion of the Yarmuk River to the Tiberias Lake. In addition to surveying, some sites were sounded: Tell Abu Habil is one of the few sounded sites in the eastern Jordan Valley.
been excavated) according to the topography of the site. The survey combined the study of old maps and published research with satellite GIS images. Eventually, four different phases of occupation were recognised by cross-referencing data from both excavation and survey (fig. 2): Early Chalcolithic (sixth millennium BC; fig. 3, I-III), Late Chalcolithic (fifth millennium BC; fig. 3 IV-VI), transitional Late Chalcolithic-Early Bronze I (early fourth millennium BC; fig. 6) and late Antiquity-early Byzantine (seventh-eighth centuries AD). The archaeological site was much larger than the portions currently used (fig. 2). Areas A and B were the centre of the site since its earliest stages. Late prehistoric pottery is common, even if sometimes poorly visible in the central sector, which has been densely settled during all phases of occupation, and especially in the early fourth millennium and in the Byzantine era.

Trench A measures 17x10m and is oriented north-south. A2 is a 5x5m trench contiguous to the southwestern side of trench A (fig. 4). Although results are still preliminary, seven levels across three phases of occupation have been identified. This phasing was confirmed by the findings from trench B, at the northern side of the tell, where late Antiquity remains are well preserved (fig. 4, locus 66). Furthermore, a 10m wide section has been cut through modern, Byzantine and fourth millennium BC levels without reaching the natural geology.

At present, level 7, associated with Late Chalcolithic (henceforth LC) fifth millennium pottery and representing the main focus of the LaPJoB project (fig. 3 IV-VI), has been reached in a deep test-sounding in the northwest corner of trench A2. Most architectural remains uncovered in trenches A-A2, as well as in the lower portion of the section in trench B, date to the LC-Early Bronze (henceforth EB) I transition of the early fourth millennium BC, (Hourani 2010). The discovery here of a large building devoted to ceramic production was completely unexpected. Indeed, this period has long been regarded as a phase of abandonment of the entire Jordan Valley and its surroundings.

More recently transitional LC-EBI assemblages have been identified at rare sites on both sides of the Jordan Valley (Braun 2016; Milevski 2013; Roux et al. 2013). However, evidence from Abu Habil is quite surprising because the size of the workshop (only a portion of which has been excavated, see fig. 4) clearly shows that it far exceeded the needs of a village community. The ceramic workshop was compartmentalised in production units separated by walls. Each production unit has yielded kilns, ash-filled ditches, potter’s tools (stone scrapers and sherds re-used for smoothing vessels), as well as pottery slag, overfired ceramics and fragments of vessels broken before firing. These suggest that pots were piled-up on the floor during the firing cycles of the furnaces, so as to exploit the heat for the drying processes.

The workshop underwent several internal renovations (as demonstrated by some kilns superimposed on each other or cut through previous structures in levels 6-3, fig. 4). However, it preserved its general structure. During its early stage, the

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2: This transitional phase, also called ‘Terminal Chalcolithic’ (Davidovich 2013; Lovell 2002: 90; Milevski 2013) has recently been dated to between 3900/3800-3700/3600 BC (Braun et al. 2013; Regev et al 2012).
Figure 2: Schematic results of the survey by areas © LaPJoB.
Figure 3: Tell Abu Habil: Early (I-III) and Late Chalcolithic (IV-VI) sherds © LaPJoB.
workshop was surrounded by a thick perimeter wall (locus/context 39), which included several separate, but communicating units, including several vertical-draught furnaces (with two superimposed chambers separated by a perforated floor, fig. 5 above). Later, after a transitory abandonment, the entire area was transformed (in level 2 of trench A and in the bottom level of trench B) with the construction of new circular structures (fig. 4, locus 69 and fig. 5 below). Evidence of this second phase of the workshop is limited because much of the surface of the tell has been bulldozed in recent times. However, the entire work area changes radically.

The new pyrotechnical installations were built on a layer of coarse sand deposited during an extreme weather phenomenon with violent rainfall during the momentary abandonment of the site. The reconstruction of the workshop did not imply a levelling of the area and the differences in groundlevel were used to support
some parts of the new firing installations, which are characterised by a stepped internal structure (fig. 5 below). In particular, these stepped circular facilities were built using (leaning on) the remains of the perimeter wall (39) of the first stage of the workshop (fig. 4). The furnaces of this second phase still contained large quantities of pottery slag and overfired pottery, but, compared to the kilns of the previous levels, they show less signs of firing. Despite abundant ash in the filling and some reddish fire-hardened marks on the bottom of both chambers, the inner surface of the mudbrick walls does not show many visible traces of fire exposure.

Yet, numerous fragments of melted or semi-vitrified ceramics, or remains of stone tools altered (semi-pulverised) by heat show that the temperatures achieved in these installations were considerable, even if apparently reached in a homogeneous way within the structure and without violent thermal peaks. All these features,
as well as the internal stepped structure of these facilities, seem to suggest that they actually represent the oldest Levantine attestation for a horizontal draught firing technology. Finally, the late Antiquity levels are represented by stone walls (trenches A-A2 level 1) and a building with a large stone threshold (trench B—fig. 4 locus 66) associated with early Byzantine ceramics and glass sherds.

The early fourth millennium pottery workshop provided most of the ceramic assemblage collected during the first season. Based on the morpho-functional repertoire, each production unit produced the entire assemblage needed by a settlement. Vessels can be divided into two groups. Some shapes are commonly associated with the previous LC phase and are widespread since the second half of the fifth millennium, as V-shaped bowls or holemouth jars with plain or slightly thickened rim (fig. 6.1-2, 4, 6). Close parallels come from LC levels at Teleilat Ghassul (Lovell 2001) and Abu Hamid (Dollfus and Kafafi 1993). Types generally associated with the beginning of the EBI are also attested, as indented rim jars, indented ledge handles and small bell-shaped vessels with slightly everted rims (fig. 6. II-III, 7-10). Furthermore, the transitional nature of the early fourth millennium assemblage is documented by the absence of some distinctive fifth millennium LC shapes (e.g. pithoi, pedestal bowls, churns or loop handles), as well as by the absence of typical EBI types, such as burnished or slipped containers, non-indented ledge handles and everted-rim bowls.

Very few sites and contexts have yielded this kind of pottery typology, so much so that this LC-EBI transitional repertoire has recently been cited as a ‘lost horizon’ (Braun 2016). Ceramics from Qatar Damiyah are not stratified (Kaptijn and de Vreeze 2008), while Wadi Feynan site 100 (Wright et al. 1998), Ashqelon (Baumgarten 2004), Afridar (Golani 2004) and Yesodot (Paz and Nativ 2013) have controversial stratigraphy and belong to quite distant horizons. Tell esh-Shuna North has been investigated in a limited trench for the beginning of the fourth millennium (Baird and Philip 1992, 1994; Philip and Baird 1993). Modi’in, in the Shephelah Valley, presents a very similar repertoire in a well-stratified context (Roux et al. 2013), while the Fazael cluster constitutes the only other large and well-stratified evidence in the Jordan Valley (Bar et al. 2015). Hence, results obtained without analysing the ceramic chaîne opératoire can be schematically summarised as follows. Firstly, the pottery workshop provides evidence that the LC-EBI transitional period does not correspond to any generalised abandonment of the Jordan Valley. Secondly, in this phase Abu Habil does not seem to have been a village, but rather a production centre used by artisans of different villages. In fact, according to the survey (fig. 2), early fourth millennium sherds are documented exclusively in the central sector of the site, occupied by the workshop, which probably was to make the area unhealthy and not suitable

3: The first horizontal-draught kilns in Mesopotamia date to the sixth millennium BC (Buccellati and Buia 1991: fig 6), but they are very rare. They are better documented in Syria and in the Levant from the second millennium BC, for instance at Qatna (MBI furnaces SU1574-1576), or MBII furnace in area J (Morandi Bonacossi 2003: figs 5, 11) or Tell Barri (Mitannian kiln 470, Pecorella 1998: 81).

4: More recently, a conference on changes in EBA Levantine material culture (Transitions during the Early Bronze Age in the Levant: Methodological Problems and Interpretative Perspectives – Jerusalem, 16-18 May 2018) has extensively focused on this LC-EBI intermediate phase due to the scarcity of sites with an uninterrupted sequence.
Figure 6: Tell Abu Habil: early fourth millennium (transitional Late Chalcolithic-Early Bronze I) ceramic sherds and shapes © LaPJjoB and JSB.
for a settlement. Finally, despite various renovations, the workshop has always been structured by distinct production units, suggesting that it was intended for different groups of craftspeople.

**INTRODUCING THE CHAÎNE OPÉRATOIRE APPROACH: TOWARDS NEW QUESTIONS**

Issues inherent to the early fourth millennium ceramic production are crucial at Abu Habil. Nevertheless, for the purposes of this paper, this is a mere coincidence. In fact, the study of the ceramic chaîne opératoire began in the early days of the first season, when the structures could not yet be interpreted as a craft area. Indeed, it would be a truism to show that the chaîne opératoire approach can provide interesting information about the way(s) of making pottery in a ceramic workshop. The focus here is rather on which additional questions the chaîne opératoire approach has raised: it is not a matter of knowing if it is useful, but in which sense, and why it is useful in that sense.

Since the seminal studies of Franken at Tell Deir ‘Alla (Franken and Kalsbeek 1969, 1975), focusing on pottery as the product of complex material-social interactions, research in ceramic technology has a long tradition in the Jordan Valley (Chesson 2000; London 2011; London et al. 2008) and the Dead Sea area (Beynon et al. 1986). Later, relevant technical analyses have focused especially on the late prehistoric ceramics from Abu Hamid (Ali 2005; Roux 2003; Roux and Courty 1995, 1997, 2005, 2007). Instead of stressing compositional or raw material-based approaches, these studies focused on reconstructing the chaîne opératoire according to a methodology that has recently been adopted for other sites in the central and southern Levant (Baldi 2013, 2017b, 2017c; Baldi and Roux 2016). Therefore, it seemed entirely logical to use the same methodology at Tell Abu Habil, which is located in the immediate vicinity of Abu Hamid.

The operational sequence of technical gestures carried out during the manufacturing process of a pottery vessel (e.g. the chaîne opératoire) has been reconstructed by examining the sherds both on a macroscopic and microscopic scale. First, examinations on a macroscopic level or at low magnifications have been conducted on the whole assemblage (5607 sherds). Then, as large a sample as possible (414 fragments), representative of all technical and petrographic groups identified with the naked eye, has been analysed under a stereomicroscope (1 to 40x magnification) and a microscope. Diagnostic macro- and microscopic traits have been interpreted by reference to significant surface features and microfabrics highlighted by ethnographic or experimental studies (Baldi 2012; Gelbert 2003, 2005; Livingstone Smith 2007; Roux 2019). Different passages of the chaîne opératoire can be reconstructed.

**SHAPING METHOD**

The only shaping technique documented at Abu Habil continues the traditions of the previous Ghassulian (LC) period, as documented in the whole southern Levant (Roux 2019b: 27-35). Using a lump of clay, the base was modelled into a disk whose edges were raised up over around 1cm in order to start coiling the body. Then, a peripheral coil was placed against the internal surface of the raised edges of the base (fig. 6.1). The body was built by superposing 1.5-2cm thick coils
with inward-oriented oblique joints (fig. 6.3). The rim was shaped by pinching it between the fingers when the clay was still wet, as shown by frequent sub-parallel striations (fig. 6.4). Once the consistency was leather-hard, another external coil was added to reinforce the junction between the body and the base (fig. 6.2).

**FABRICS**

Three distinct fabric groups have been identified (fig. 7). Group A is represented by brownish, slightly reduced fabrics fired in vertical up-draught kilns. Their composition is coherent with ferruginous and basaltic fifth millennium samples attested in the entire Jordan Valley (about 20% of mineral inclusions). They differ from ceramic pastes documented at Abu Habil in the LC because they contain quartz and crushed shells.
Group A\textsuperscript{1} is fired in horizontal kilns and appears in level 2 of trench A and in the lowest layers of trench B (after the temporary abandonment of the site). These slightly vitrified pastes are a very close variant of A fabrics (same composition with relatively rare basalt and frequent inclusions of shell and quartz) and replace them, but with a significant innovation: for the first time they systematically contain grog. Group B fabrics are rose-reddish pastes fired in vertical kilns in oxidising conditions. They appear in the early fourth millennium as the A Group, but they are coarser, with 25-30% of calcareous and basaltic large-sized (up to 1.5mm) inclusions.

Table 1: Tell Abu Habil, evolution of early fourth millennium chaînes opératoires by level. Dashed line between level 3 and 2 indicates abandonment and reconstruction of the workshop.

<table>
<thead>
<tr>
<th>Chaîne opératoire</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td>A+VK*</td>
<td>38%</td>
</tr>
<tr>
<td>A+HK**</td>
<td></td>
</tr>
<tr>
<td>B+VK***</td>
<td>62%</td>
</tr>
</tbody>
</table>

\* A+VK; fabrics A fired in vertical kilns
** A+HK; fabrics A fired in horizontal kilns
*** B+VK; fabrics B fired in vertical kilns

Although very variable temperatures and firing conditions can be achieved by managing the same type of firing installation in different ways, whether up-draught or horizontal-draught (Baldi 2006; Gosselain 1992). At Abu Habil, the correlation between fabrics and types of furnaces is not accidental. Containers with A and B pastes, attested since the early phase of the workshop and associated exclusively with up-draught kilns, were produced through firing cycles radically different from those of A\textsuperscript{1} pastes, which appear in the late phase of the workshop and are always associated with horizontal kilns (table 1).
**SURFACE TREATMENT**

All vessels are coated with clay whatever their shape and size (fig. 7.5-6). Surfaces are lumpy, with floating mineral inclusions covered by overlapping layers of viscous clay irregularly applied starting from the rim, that is often overthickened. Since the shaping method and the surface treatment are the same for the entire assemblage, it is possible to identify three different technical traditions according to fabrics and firing techniques (fig. 8, table 1): 1) coiled and clay coated vessels in A fabrics fired in vertical kilns; 2) coiled and clay coated vessels in A¹ fabrics fired in horizontal kilns and 3) coiled and clay coated vessels in B fabrics fired in vertical kilns. Differences in pastes are certainly not due to chronological factors because A and B pastes are attested since the construction of the workshop, while A¹ group is documented in the later phase (table 1). However, it is surprising to note that, starting from a certain moment, (not so different) fabrics are used to make pottery by the same manufacturing sequence, but are fired in completely different structures.

From a functional point of view, the slightly vitrified fabrics of A¹, fired at high temperatures in horizontal draught kilns could have allowed the walls of most containers to be quite thin by preventing lime spalling. On the other hand, for B fabrics, spalling after rehydration was prevented by lower quantities of iron oxide and firing cycles at lower temperatures in vertical kilns. Therefore, both production techniques allow the same problem to be solved in an equally effective manner. At the same time, this evidence could be interpreted as the expression of different groups of artisans using disparate fabrics (the one with shells and grog and the other without added inclusions) and distinct firing technologies.

**WHAT NEW QUESTIONS AND WHY PRECISELY THOSE?**

The central issue is whether a single community of craftspeople manufactured this kind of assemblage using divergent firing techniques depending on functional/practical reasons, or whether this assemblage is the expression of different groups of potters. High temperatures in slightly reduced atmosphere (fabrics A¹) and lower temperatures in oxidising conditions (fabrics B) both avoid lime spalling. However, physical reactions of matter are a fact, not an explanation of social organisation. Especially because any *chaîne opératoire* implies an ‘isochrestic’, arbitrary and traditional choice between two or more functionally equivalent solutions (Sackett 1977, 1990).

Consequently, the application of the *chaîne opératoire* from the very beginning of our research directs the research itself towards specific questions. The adoption of the *chaîne opératoire* as an analytical tool leads to (or rather implies) questions about the organisation of the ceramic production in the Jordan Valley at the LC-EBI transition, with implications for social and economic complexity of...
the local communities.⁵ If traditions (and especially firing technologies) diverge for reasons inherent to the clay, what may be its physical characteristic requiring such different firings? Alternatively, if (as it seems more likely)⁶ distinct chaînes opératoires correspond to different craftspeople, where were these different groups of artisans located and what spatial relations did they have? Of course, this makes it necessary to survey the area in the vicinity of Abu Habil to identify the presence of possible villages and to compare ceramics from different settlements with those produced according to the chaînes opératoires documented in the workshop of Abu Habil.

From an anthropological viewpoint, it is crucial to understand the nature of the ‘difference’ between groups of artisans having used different furnaces and firing methods. This is a major issue for any study focusing on craft communities of practice (Wenger 1998). But compared to ethnographic or anthropological surveys (Gosselain 2019; Herbich 1987; Patton 2008; Stark 2003; Stark et al. 2008), which serve as interpretive basis as they can access nuanced technical diversities emerging from different identities (geographical, ethnic, or concerning gender, age, kinship, etc.), prehistoric archaeology can only assume the extent of social diversity on the basis of the degree of distance between technical traditions (Castro Gessner 2008; Greenberg et al. 2014; Iserlis 2009; Wendrich 2013).

At Tell Abu Habil, the chaînes opératoires recorded in the early fourth millennium workshop have a clearly homogeneous core and, during the entire early stage (phases 6–3), they are distinguished only by the presence of two (slightly) different recipes for fabrics A and B (table 1). This indicates that the manufacturing techniques during the transition to the EBI were entirely consistent with the tradition attested throughout the southern Levant during the LC (Roux 2019b).

Nevertheless, technical changes in the late stage of the workshop (phase 2, table 1) are particularly intriguing. Despite the stratigraphic gap caused by the temporary abandonment of the site, the presence of B fabrics (documented since the construction of the workshop) and the appearance of A₁ pastes (sharing the same compositional petrographic basis of previous A fabrics) constitute clear technical continuities. Moreover, the shaping method does not change, suggesting that craftspeople of the late phase of the workshop belonged to the same social group as the previous occupants (attested throughout the Ghassulian southern Levant during the Chalcolithic, Roux 2019b).

5: Even limiting parallels to the ancient Near East and ceramic workshops functionally comparable to Abu Habil, studies show very divergent orientations. For instance, in northern Syria, the kilns and work areas of Tell al-‘Abr and Kosak Shamali (second quarter fifth millennium, Hammade and Yamazaki 2006; Nishiaki and Matsutani 2001) have been studied from a purely typological point of view. Namely, as contexts able to offer complete evidence of the ceramic repertoires precisely because they were areas intended for the manufacture of all shapes. The workshops and kilns of Tell Feres (same period, Baldi 2014) or Sabi Abyad (middle Assyrian, Duistermaat 2008), studied from the earliest stages of the excavation through the lens of the chaîne opératoire, were used as proxies for the organisation of production and society.

6: If one considers in particular the last phase of the workshop, A₁ and B fabrics are distinguished by the presence (or absence) of voluntarily added inclusions. Moreover, the respective temperatures and firing conditions could be obtained in any type of furnace not dependent at all on the use of vertical- or horizontal-draught kilns, but rather on specific traditional ways of using them (Baldi 2006; Cuomo di Caprio 1972; Licka 1988).
Yet, the systematic use of grog, an inclusion requiring specific preparation, is far from an accidental step in the framework of the chaîne opératoire, showing that the fabrics in A¹ are not a mere variant of the older A pastes.

Similarly, adoption of new firing methods, in kilns completely different from the previous ones, indicates a substantial difference with respect to the first stage of the chaîne opératoire. In other words, if during the early stage the socio-technical panorama is definitely homogeneous, the current evidence (to be confirmed during the next campaigns) seems to reveal that, after the abandonment, there is a fairly clear social difference between two groups of craftspeople, each linked to a distinctive firing technology (table 1).

The group characterised by the use of B pastes are attested at Abu Habil since the earliest phase of the workshop: it does not change any of its techniques, but in the late stage represents only a minority of the ceramic assemblage. The other group (with A¹ pastes) is characterised by the ordinary shaping method of the Ghassulian Jordan Valley, but also by clear technical discontinuities (Roux and Courty 2013), as if, compared to the first phase of the workshop, this second group had adopted recent innovations or allogeneic techniques.

If the next fieldwork seasons indeed confirm the existence of groups having manufactured ceramics in the same ways but firing them by very different structures and technologies, this would pose a wider question: do horizontal-draught kilns (never before documented in the late prehistoric Levant) constitute a local innovation or have they been adopted as a result of external technical borrowings? And, in this case, where would they come from? If horizontal-draught kilns were a local innovation, the end of the LC would appear as a phase of technical ‘instability’, characterised by quite volatile choices (Roux and Gabriellini 2018), before the beginning of proper proto-urban development in the EBI. Otherwise, if horizontal kilns were the result of contacts with foreign populations, this would confirm that the very end of the Chalcolithic, especially in the Jordan Valley, was characterised by strong social and geographical mobility (Braun 2016; Milevski 2013).

Obviously, at this stage of the research, these are unresolved or even completely hypothetical questions. However, they arise because of the early use of the chaîne opératoire, which, in this case, implies a ‘spatial turn’ for the entire research project. These scientific questions depend on the fact that the chaîne opératoire as an analytical approach pertains to archaeological practice, but the notion of the chaîne opératoire concerns archaeology as a way of thinking. It focuses on processes shaping societies (Barker et al. 2017; Guildi and Armitage 2014) by giving insight in human behaviour and by approaching production (namely craft) as a skilful human-material entanglement (Hodder 2012).

In the same way, the chaîne opératoire investigates past ways of thinking. The very notion of the chaîne opératoire tackles human-matter interactions from the specific point of view of craft, seen not just as a production process, but also as a heuristic device. Craft is far more than making: it explores and constructs
alternative (and material) ways of experiencing and understanding reality (Boivin 2008; Gosselain 2019) by thinking through skilfully handled materials (Roux 2003; Sutton 2008).^7

Like science and art, craft opens new perspectives and forges future progress: its specific methodology is based on the essential empirical truth of experience about what works and what does not (Kuijpers 2018: 36-63). This implies that approaching a product (in this case ceramics) manufactured by different techniques (in this case vertical or horizontal-draught kilns) through the lens of the chaîne opératoire inevitably leads to questions about the perception of reality, interactions with the material world and the reciprocal social interactions of the craftspeople using these techniques.

In the case study of Abu Habil, further investigations on the adoption of horizontal-draught kilns are crucial. If this is an innovation that was spreading (Manzo et al. 2018), it has undoubtedly been evaluated and tested through the technical expertise and the perception of reality of the different groups that have adopted it by means of borrowings crossing technological and social boundaries. As recently demonstrated for the adoption of kilns (Roux et al. 2018), this is a complex process implying that the habit of a craft practice is overcome by new skills assimilated to and transformed by what remained of past experience to form a new whole.

CONCLUSIONS: FOCUSING ON THE ENTANGLEMENT BETWEEN THINGS AND PEOPLE

During the first season of the LaPJoB project, a pottery workshop was discovered at Tell Abu Habil: it is divided into several production units and dates back to the beginning of the fourth millennium BC, a phase in which the entire Jordan Valley was long considered abandoned. This data, collected through somewhat usual archaeological approaches, are significant in themselves.

However, the study of the ceramic chaîne opératoire from the outset of the fieldwork has allowed the identification of three variants of one technical tradition which shared the shaping method and clay coating of the surfaces but were distinguished both by the fabrics and the ways they were fired. In particular, during the last stage of the workshop, two traditions differed from one another through the use of distinctive fabrics fired at different temperatures and conditions in vertical or horizontal-draught kilns.

These very preliminary results definitely need further investigations. However, the early analysis of the chaîne opératoire raises the question whether these differences were due to technical constraints or rather to cultural differences between distinct groups of producers. In the latter case, this would compulsorily orient future research towards a broader spatial approach, to learn where the groups characterised by such different traditions lived and to what extent they interacted.

Ultimately, the early analysis of the chaîne opératoire has suggested new research perspectives, which would not have been open in any way through other approaches.

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^7: According to Renfrew (2007: 199): “weight has first to be perceived as a physical reality—in hands and arms, not just in the brain within the skull—before it can be conceptualised and measured”. 
The nature of these questions and perspectives intimately depends on the very notion of *chaîne opératoire*, which broadens current archaeological thinking both as an analytical tool orienting research towards the study of ancient ways of crafting, and as a heuristic device offering insight in past ways of conceiving and handling the world.

Since experiencing material realities is part of the construction of cognition (Schlanger 1994), as demonstrated by any study that goes beyond Cartesian theories, cognition is not a purely cerebral process (Sutton 2008; Renfrew 2007; Bril 2002). Archaeology is obviously drawn to this emphasis on the role of material culture. The case study of Abu Habil highlights in a very basic way how the *chaîne opératoire* allows interactions between present and past ways of cognising the world by enhancing current archaeological thought on the cognition of past craftspeople. This focuses on the deeply entangled nature of (present and past) humans and things (Hodder 2012; Roux 2003) living in a material world explored by material (archaeological or craft) means (Boivin 2008; Brinkman and Tanggaard 2010; Lehmann 2012). Since, actually, we are the ongoing outcome shaped by these entanglements (Morris 2015), I think the *chaîne opératoire* can be defined as a trigger of an epistemology of materiality.

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