tektorių naudojimą archeologijoje pažvelgta tik 8-ajame dešimtmetyje. Archeologų tarpe metalo detektorių naudojimas iki šiol tebekelia diskusijų. Žinoma daug sėkmingų metalo detektorių panaudojimo užsienio šalyse atvejų, kada, dirbant su jais, buvo aptikta monetų (5 pav.) bei paskirų metalinių dirbinių.

Lietuvoje pirmieji bandymai naudoti netobulus tarybinius karinius minų ieškiklius buvo 8-ajame dešimtmetyje. Tokie prietaisai naudoti Kavarsko vienkiemiuose, Vilniuje, Kernavėje. Išimtis iš negausių metalo detektorių panaudojimo atvejų tarybiniais metais buvo V. Urbanavičiaus 1983 m. Rytų Lietuvoje vykdyti Obelių ežero pakrantės tyrinėjimai. Čia dviem skirtingais metalo detektoriais šio straipsnio autorius tikrino iš ežero iškastas žemes su degintinių palaidojimų liekanomis. Per 44 darbo valandas buvo rasta daugiau kaip 300 įvairių metalinių XIII-XIV a. dirbinių. Maždaug nuo 1990 m. modernius metalo detektorius į Lietuvą įvežti pradėjo privatūs asmenys. Naujieji lobių ieškotojai pirmiausiai perkasė anksčiau rastų lobių vietas, išrinko ten pasilikusias monetas. Nuo 1993 m. metalo detektoriai keliose įstaigose pradėti naudoti moksliniams tikslams.

Šio straipsnio autorius metalo detektorius archeologiniuose tyrinėjimuose naudoja nuo 1992 m. Per ketverius metus detektorius panaudotas žvalgant bei tyrinėjant apie 20 archeologijos objektų iš geležies amžiaus–viduramžių laikotarpių. Eksperimentai, atlikti jau tyrinėtose archeologijos paminklų vietose, parodė, kad, kasant tradiciniais metodais, nepastebima dalies metalinių dirbinių (6 pav.). Ketveri intensyvaus darbo metai, atsižvelgus į užsienio šalių patirtį, leidžia apibrėžti tam tikrą metalo detektorių naudojimo specifiką bei galimybes Lietuvoje. Išskirtinis dalykas Lietuvoje yra labai didelis archeologijos paminklų užterštumas XX a. antrosios pusės metalinėmis šiukšlėmis. Dabartiniai metaliniai dirbiniai sudaro faktiškai 99% visų aptinkamų metalinių radinių (7 pav.). Palyginti nedidelis (paprastai ne daugiau kaip 20 cm) optimalus metalo detektoriaus darbo gylis lemia tai, kad sluoksnius metalo detektoriumi tenka tikrinti kas 10 cm, įskaitant ir išmestas bei atgal į tyrinėtą plotą supilamas žemes. Kiekvienas metalinis archeologinis dirbinys fiksuojamas tyrinėjimų plane. Šio straipsnio autoriaus išbandytas ir rezultatyvus yra piliakalnių tyrinėjimas su metalo detektoriumi plačiau jų nekasinėjant. Taip Ižiniškių piliakalnio pylime aptiktas XIII-XIV a. geležinis pentinis plačiaašmenis kirvis (8 pav.). Su metalo detektoriumi archeologinių tyrinėjimų metu, šio straipsnio autoriaus paskaičiavimu, galima aptikti iki 95-98 % visų metalinių dirbinių.

Paskutinis netradicinis lauko tyrinėjimų metodas yra biolokacija. Biolokacijos metodu gerai fiksuojami mūriniai pamatai arba perkasimai. Virgulė paprastai pasisuka jų riboje (9 pav.). Paties metodo veikimo principas nėra pakankamai išaiškintas. Biolokacijos panaudojimo užsienio šalyse žinoma vos pora pavyzdžių Lenkijoje ir Anglijoje. Kadangi šis metodas nėra pakankamai moksliškai pagrįstas, jis iki šiol Lietuvos archeologijoje plačiau netaikomas ir lieka diskusinis. Iki 1996 m. tik keli žmonės įvairiuose Lietuvos archeologiniuose paminkluose bandė panaudoti virgulę. Plačiausiai biolokacija išbandyta tyrinėjant Šeimyniškėlių piliakalnį Rytų Lietuvoje. Virgulės posūkio vietos buvo grafiškai fiksuojamos (10 pav.). Tyrinėjimai biolokacijos būdu Šeimyniškėlių piliakalnyje nebaigti, tad apie mokslinius rezultatus kalbėti dar anksti.

Gintautas Zabiela
Department of Archaeology,
Lithuanian Institute of History,
Kražių str. 5, LT-2001 Vilnius Lithuania

Refitting as a Method in Stone Age Archaeology: A brief Introduction

DAVID N. SIMPSON

Introduction

This paper provides an introduction to the method of refitting lithic artefacts. One of the strengths of the method lies in its potential to draw powerful conclusions from lithic debris, that is to say, that which often constitutes 90% or more of our recoveries on stone age sites, but which at the same time traditionally recieves not even 10% of our attention. In recent years the application of refitting has grown in breadth and scope, and it has gained recognition world wide as a means by which to evaluate stratigraphic integrity, and investigate human behaviour through the study of intrasite analysis and technology. Beyond this, refitting has played a central role in the development of a new approach to lithic studies, that of the *chaîne opératoire*. Examples will be drawn both from the author's own experience as well as from other, primarily Norwegian, research.

It is observed that the method can also be applied to materials other than lithics. It has been succesfully used with both ceramics and bone, and can potentially be applied to any materials that have been broken. However, it must be noted that when used with these other materials the method can not generally address technological questions as is the case of lithics. This is because the sequence of blows and flake removals involved in the production of lithic tools, which results in the "broken" pieces to be refitted, are in fact a record of specific technological behaviour, and the method of refitting can reconstruct this behaviour. Broken pot sherds, on the other hand, while they do form a record of how and where a pot is disposed of, do not reflect how the pot was manufactured. It is noted that while refitting could potentially identify sherds from a specific pot that have been re-used for some purpose and that this can be seen as a form of "technological" behaviour, there is irregardles a significant difference in the type of results achieved. In order to more clearly demark these significant qualitative differences in the nature of the results of the method as applied to lithic vs. non-lithic materials, it is preferred here to reserve the term refitting to lithic studies and apply the term mending to the analysis of other materials.

The Method of Refitting

Refitting is in principle a simple operation. It involves fitting struck or broken pieces back into their original form. The assumption is that each break is unique, such that the pieces will fit back only to the precise place from which they were broken or struck.

While simple in principle, refitting lithic materials can in practice be a complex and time consuming task. It is most effective if the practitioner has a good understanding of raw material classification, such that the pieces might be sorted into raw material groups that are more likely to fit together. Furthermore, competence in the field of lithic technology enables the practioner to organize the work process so that the innumerable "impossible" refits might be instantly recognised and ignored. A typical refitting session would, for example, involve arranging the pieces according to technological criteria such as: location of the butt (striking platform), orientation as to dorsal vs. ventral surface, type and location of negative flake scars, types of fractures, presence and location of cortex as well as criteria such as colour variations[1], the presence of distinctive fossils (in the case of flint), cracks and bedding planes. By working with these criteria one is thus able to focus on attempting to refit only those surfaces which have the potential to fit together and avoid wasting time pursuing such unfruitful combinations as dorsal to dorsal or ventral to ventral refits, incorrect orientions, or attempts to refit pieces with different types of fractures.

To summarize, and stress this point yet further, the process of refitting lithic artefacts should not involve a mechanical attempt to fit each piece to every other piece. To be most sucessful, it is a process requiring experience, imagination and a trained memory, where potential combinations are examined and evaluated, and where many specific pieces, the negative scars they might fit into and keys such as colour variations or fossils are memorized on order to expedite the analysis.

Practical hints

One practical hint that significantly eases the process of refitting is to arrange the pieces on a coloured background (Coulson pers. com.). The use of a white background is not advised as it has been found to cause eye strain. It is suggested that the analyst experiment to discover which background colours are most comfortable to work with in connection with different materials. In my own experience, for example, a green background is sucessful with black material, and several analysts in Norway have reported that a red background is advantageous when working with quarts crystal.

Related to this is the need for adequate lighting. This should be self evident to any who have worked with lithics, however, I must state that I have on one occasion observed students following an introductory lecture on refitting in the field work well into the night refitting by candlelight!

Since the process of refitting often involves taking apart refitted groups, is it stongly advised to use glue that is soluable. A variety of types of glue that are soluable acetone are available on the market. It is suggested that the analyst consult their conservation staff and test a glue before use to ensure that it is durable enough, and that it is indeed soluable and that it will not harm the lithics.

[1] To confound matters somewhat, it must be noted that post depositional processes can in fact selectively change the colour of some pieces struck from a block to such a degree that without refitting they would never otherwise be recognised as having originally "belonged" together. An extreme example of this is provided below.

I have found that glue that is slightly thicker and sets quickly is preferable to thinner glue that has to be held in place longer before it sets.

Documentation

Depending upon the purposes to which it is applied, refitting usually involves forms of documentation beyond that traditionally employed in lithic studies. This includes both documentation during the process of refitting as well as presentation of the results.

As a minimum, in the case of a field check of stratigraphic integrity, refitting might require only temporary marking of the pieces such that their context is not lost while removing them from their bags and taking brief notes as to which pieces from which contexts were found to fit together. For a more systematic analysis in the laboratory, however, each refitted piece should in principle be sketched and its catalogue number marked on the drawing. This is to ensure that its provenience will not be lost in the event the catalogue number marked on the piece is later obscured or removed by the solvent used to separate the pieces. Furthermore, it is observed that the process of refitting almost inevitably requires refitted blocks to be separated and reglued, sometimes many times, in order to place pieces "into" a sequence that has already been glued together, or to draw parts of a sequence for exploded views. Thus it is also advised to sketch the placement of each piece on a block as the pieces are refitted in order to facilitate re-construction of the block later.

The results of a refitting analysis can be presented in a variety of ways, again depending to a large degree upon the objectives of the refitting analysis. Focusing on description of a reduction sequence, line drawings of a block, embellished with exploded views, can be very effective (Figs. 1 and 2). The flow charts typical of more classical studies of reduction sequences have also been employed (Skar 1988 and Skar and Coulson 1987). A novel form of presentation is that of Volkman (1983), whereby the reduction sequence of a block is described in terms of a series of re-orientations of the striking platform (measured in terms of spin, tumble and roll) in combination with a form of flow chart indicating the type of removal at each blow.

Directed to problems in the field of intra-site analysis, refitting has significant potential. By plotting the pieces of a refitted group on a site plan, one has the potential to virtually follow in the footsteps of those who made, used, possibly reworked, and ultimately discarded a tool[2]. One can thus establish concrete links between independent artefact concentrations or activity areas which one could not otherwise argue convincingly were or were not part of a single phase of activity of a site. Fig. 3 illustrates four (of many possible) representations of refit plots: A) where all flakes from a core have lines back to the core, B) where lines are drawn between each contact surface, C) where lines are drawn between all pieces in a block and D) where the flow of the technological sequence is indicated (cf. Cziela 1990:23). Cziela (1990) proposes a set of conventions whereby different types of refit lines, that is, lines connecting contact surfaces, and the artefact types are represented by specific symbols. The types of refit lines referred to include

[2] Such an ideal situation is of course dependent on the analyst having adequate control of post depostional movement of artefacts.

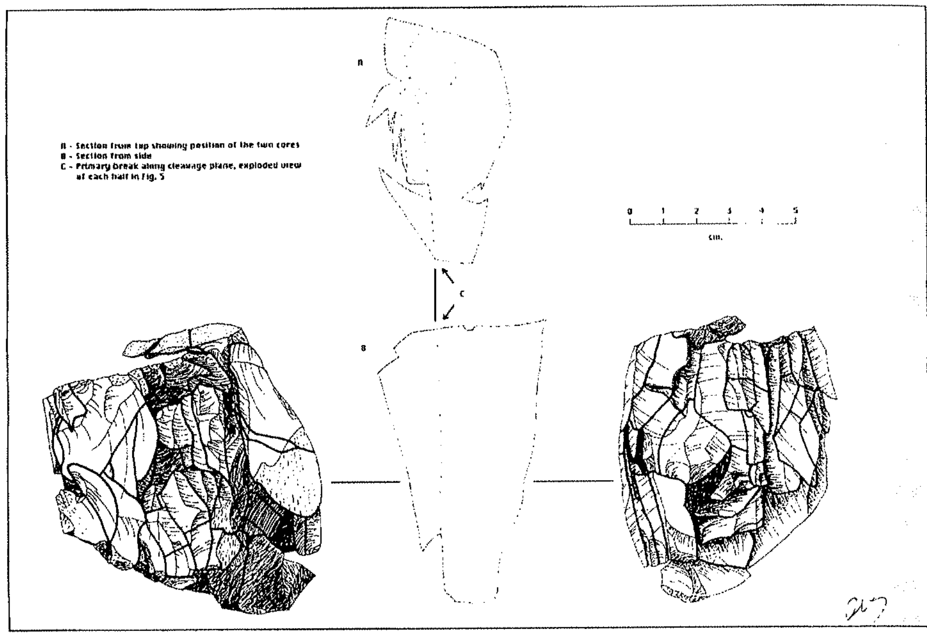

Fig.1. The black block, Krossnes locality 6 (*drawing by David Simpson*)

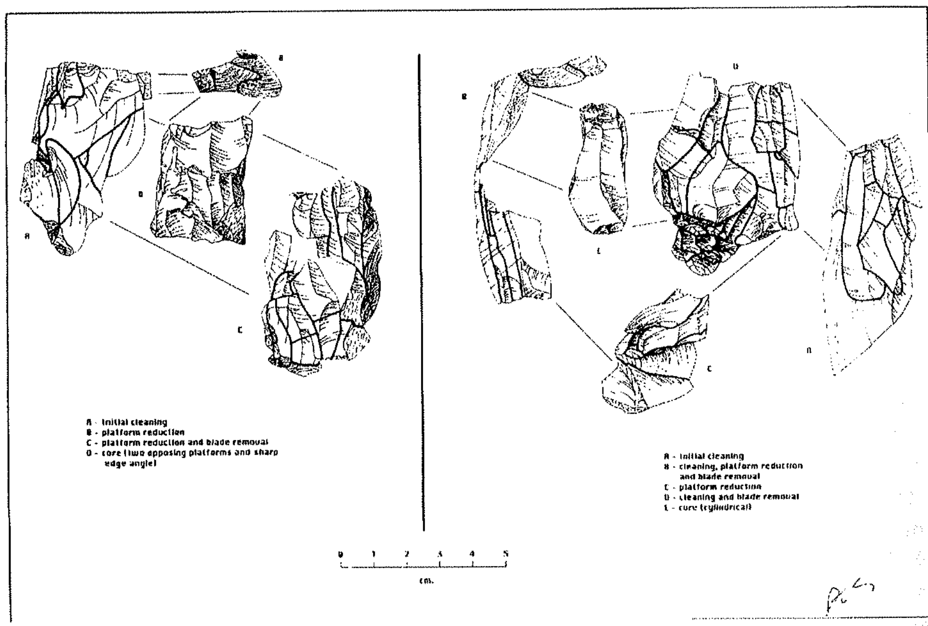

Fig. 2. Exploded views of the two halves of the black block (*drawing by David Simpson*)

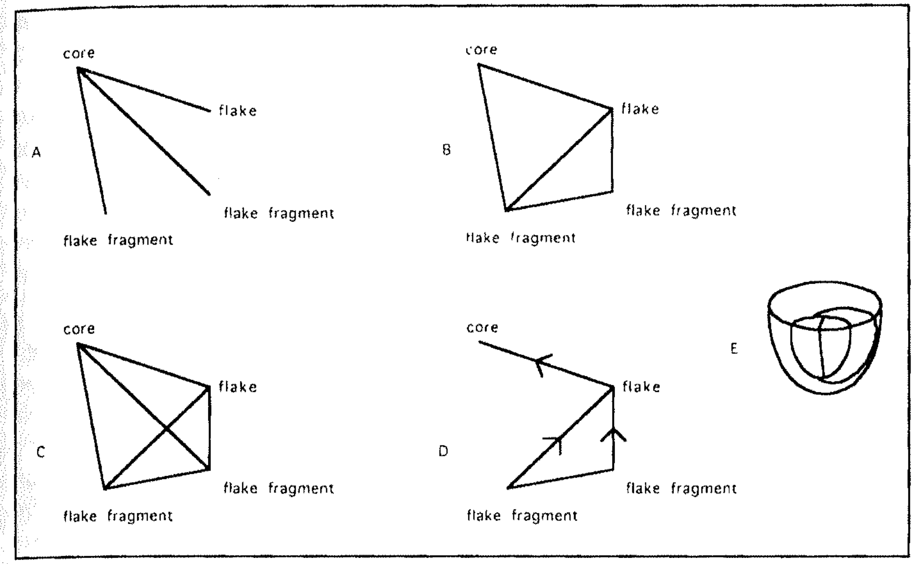

Fig. 3. Different methods of plotting refitted data. A) Lines connecting each piece back to the central core. B) Lines connecting contact surfaces in the refitted block. C) Lines connecting all pieces in a block to all other pieces of that block. D) Lines showing the technological sequence, plain line connecting the two halves of a broken flake, lines with arrows indicating the sequence of removal of individual flakes. E) Schematic representation of a core and flakes used in this example (*drawing by David Simpson*, adapted from Cziela 1990:23)

those representing technological sequences, breaks, and artefact modification. He further addresses a form of simplified plot in which only the technological flow is indicated by "connection lines" as opposed to refit lines (see Fig. 3d).

It is no doubt evident to the reader that refitted groups of even modest size will result in "alarmingly" complex plots, especially if one chooses to plot more than one group on a single plan. One method of dealing with such complexity is the use of color to indicate seperate groups, and/or types of refits, although the cost of publishing these may be restrictive in many cases. One possible practical aid here would be to "link" databases containing artefact types, coordinates and refit types to a CAD (Computer Aided Design) program such that plots could be automatically generated. Alternatively, given adequate resources, tailor made programs could be developed (cf. Lindenbeck 1990 and Wansleeben 1990). In this context it is also appropriate to note that in 1995 a student in the Institutt for Informatik, University of Bergen, completed a dissertation addressing the use of computers as an aid in refitting (Sætherø n.d.). While I have not yet completed my own evaluation of this work (I recieved a copy only within a few days of finishing this article), I am able to relate that the intention of the work was to develop computer tools that might aid in the refitting process itself (3D representations of knapped pieces that could be "refitted" manually on the screen), visualization of a knapping sequence (taking apart a 3D representation of a refitted block on the screen) as well as the plotting of refitting data on site plans.

With regard to refitting data and site plans, practical difficulties may be experienced when attempting to plot refitting data whose precise provenience has not been recorded, for example, for data collected by square meter or quarter square meter. One solution includes plotting refit lines from symbols placed at convenient locations within the grid unit (cf. Skar 1988). If it is of interest simply to demonstrate the horizontal extent and/or density of a refitted group, any number of means are available. Classical expressions of artefact density include surface contour plots (topographic maps for artefact density), the use of grey scale gradients or symbols of varying sizes where symbol size is proportional to artefact density.

Requirements

Before continuing to an examination of specific applications and examples, it is appropriate to address some of the requirements of the method. In terms of data requirements these range from very little to "total excavation", depending on the goals of the analysis. A field test of context integrity, for example, makes no special demands on the data aside from temporarily marking the pieces selected for refitting to ensure that their provenience is not lost. A fully developed intrasite analysis on the other hand requires that all pieces be marked and generally requires extensive to total excavation of a site. Total excavation is recommended not only to provide more "pieces for the puzzle", but more importantly to provide a degree of assurance that any missing pieces are in fact missing from the site (carried away by the prehistoric inhabitants) as opposed to the pieces having not been excavated or lost during excavation. Note that total excavation is in fact a relative term. It is more an ideal goal than something that can be achieved in practice with any certainty, as it is ultimately rarely possible to know that a site is in fact completely excavated and that no pieces remain in the deposits beyond the limits of the excavation.

Regarding the demands placed on the analyst, beyond an understanding of lithic raw materials and technology as discussed above, a good measure of time is often required. Refitting is generally understood to be a very time demanding method. However, it must be pointed out that this again depends on the goals of the analysis, and of course on the experience of the analysist. While some have devoted years of effort to refitting a site, at the other extreme, a field evaluation of a specific stratigraphic context could require as little as one analyst and one or two afternoons. A more common situation might be that represented by the re-analysis of the Rørmyr II site in Norway (Skar and Coulson 1987). This study involved an investment of two analysts six weeks each (Coulson pers. com.). The examples drawn from my own research reported below (Krossnes Localities 2, 3 and 6) are the partial results of roughly eight weeks of analysis. It is noted that once the process of refitting is well underway, for an experienced analyst the most time consuming aspect may well be that of documentation.

Cautions

Whereas the data resulting from refitting could be described as the first truly objective knowledge available to archaeologists (inasmuch as a piece will either fit or it will not[3]), *the interpretation of the meaning of refitted material is as much a matter of subjective evaluation as any other archaeological analysis*.

Among the leading questions that have been raised with regard to refitting are 1) the degree to which one can assume that material refitted to a single block is from the same phase of activity or occupation (i.e. has there been re-use of material from a site in later periods?) 2) the degree to which one can assume that artefacts of different raw materials in the same "concentration" represent a single activity/ phase, and 3) whether "missing" artifacts are truly missing. These and additional points have been addressed by others in a variety of overview works (Adamsen 1986, Ballin 1992, Cziesla 1990 and Hofman 1992). For the purpose of this brief introduction, it can be said in general that it is necessary to evaluate each case independently and that if an analyst has not adequately addressed the types of issues noted above, then his or her conclusions should probably be subjected to close scrutiny. For example, with regard to the question of whether activities are contemporary, a single refit between two areas of a site is not likely to constitute a convincing argument as the refit could well represent post depositional processes instead of cultural activity. On the other hand, multiple refits, especially with movement back and forth between two areas of a site that are also meaningful in terms of which specific artefacts have been moved, may well be argued to reflect contemporary activities.

Missing or "shadow" artefacts can easily be identified on the basis of holes or gaps in refitted groups[4]. The value of shadow artefacts is very much dependent upon objective of the study and the thrust of arguement of the analyst. The point is often raised that such missing artefacts may in fact have not been recovered by the archaeologist (not collected or that they remain in unexcavated portions of a site), as opposed to having been transported from the site by the prehistoric inhabitants. If the point of the analyst is that the shadow artefacts *were* transported from the site, then any further conclusions building on this interpretation will be subject to varying degrees of critique unless the missing artefacts are in fact recovered from another site and refitted[5]. On the other hand, the mere recognition of such shadow artefacts could greatly enhance a site study in the event that the artefact type in question is not otherwise represented in the site inventory. In this case, the shadow artefact data constitutes an extremely valuable source of information that is not otherwise accessible. Coulson (1986) provides a classic study in which the results of refitting have required significant reinterpretation of previously excavated material (this example, the refitting of the outer case of a Neolithic cylindrical core from material earlier interpreted as Mesolithic, is more fully described below).

Discussion of Applications

In the following I will address and provide examples of some of the main areas of application of refitting. My is coverage by no means complete but is intended to give an indication of the breadth of possible applications.

[3] This statement must be qualified insofar as I have heard of or observed two examples where pieces did not in fact "click" together (Coulson pers. com.). One example was where a flat surface of a small piece was fitted onto a large flat surface of another piece on the basis of colouration (a distinctive fossil) and another where the extremely small distal ends of two blades struck from opposing platforms were found to refit. In the latter case there were "solid" refits connecting the blades through other pieces.

[4] In a related matter, it should also be noted that "missing" tool types might actually be reconstructed from otherwise unidentifiable fragments.

[5] Several incedents of inter-site refitting have been reported in the literature, see, for example, Singer (1985) and Schaller-Åhrberg (1990).

Evaluation of Context Integrity

Stratigraphy can be characterized as one of the pillars of archaeology. At the same time, from a critical perspective, it could be considered as one of its greatest banes. The crucial question to be asked is the degree to which we can trust that the artefacts recovered from a specific stratigraphic context do in fact "belong" to that context.

It has been argued that archaeologists sometimes inappropriately appeal to the "Pompeii Premise" (Ascher 1961:324; Binford 1981a:420;1981b; Hoffman 1992:3), that they assume an assemblage from a given stratigraphic context represents an in situ deposit without adequately evaluating potential sources of mixing. So much has in fact been written regarding sources of disturbance/artefact movement that one might begin to consider that the only in situ contexts existing might in fact be those "frozen" by a rain of volcanic ash. I must admit to being partial to this train of thought. At the risk of making an unsubstantiated claim, it has been my experience that artefacts often move after they were deposited – sometimes they move a lot – and to assume otherwise is probably to assume in error.

Another side to this problem is the presumption of continuity between stratigraphically distinct assemblages (Villa 1983; Hoffman 1993:4). Assuming that some, if even minimal, mixing does occur between adjacent stratigraphic units, then an analysis of these units which does not take the potential of mixing into account would automatically assume a degree of continuity between the assemblages. Stated another way, a conclusion that a set of adjacent stratigraphic units represents technological or cultural continuity may well be measuring post depositional disturbances, rather than true diachronic cultural processes!

At the same time, once having recognized the potential effects of post depositional disturbance, I assert that rather than abandoning "poor" contexts, a better approach would be to examine them and exploit their potential. The questions at hand then are: is the site I am working on disturbed, how much and in what ways is it disturbed, and how can refitting contribute to solving potential problems?

Among the first applications of refitting in Norway was that of Bjørgo (1981). Here refitting was used to test the stratigraphic integrity of a group of sites on the island of Flatøy, Western Norway. The analysis resulted in the successful refitting of fragments of numerous large artefacts, primarily axe and grinding plate fragments, on several sites. The case of Flatøy XII is particularly enlightning.

The culture layer was excavated in five layers where layers II-IV represent the darkest portion of the culture layer.... The profiles gave the impression that the locality was undisturbed.... Among the recoveries were 11 grinding plate fragments that could be refitted to in all three different grinding plates (Bjørgo 1981:47 [my translation]).

According to the profile illustrated by Bjørgo (1981:48), layers II to IV varied in thickness from ca 5 to 40 cm each. The horizontal and vertical distribution of the refitted fragments are indicated in table 1. Faced with refits between layers IB, II and III Bjørgo concludes that:

Because an artefact from layer IB has the same age as parts of the same artefact in layer III, it is posible that distubance of the layer sequence has occurred that could not be observed within the area where these were found (1981:49 [my translation])

This simple though classic example is included to demonstrate the difficulty in recognizing post depositional distubance based exclusively on the observation of stratigraphy.

Table 1. *Grinding plates refitted from Flatøy Locality XII (Bjørgo 1981)*

Grinding plate	Grid square (1 m^2)	Layer	Fragments refitted
A	DD11	IB	2
	DD11	II	2
	EE12	III	1
	uncertain	uncertain	1
B	EE11	IV	2
	EE12	IV	1
C	FF15	III	1
	EE14	IV	1

(adapted from Bjørgo 1981)

Table 2. *Vertical sorting of black rhyolite in the bog deposit*

Layer	Max. thickness (cm)	Black Rhyolite	Period
recent bog and intrusive hearth	30	5	
VX*	15	409	Early Neolithic
Bc**	5	2	
Bd	5	126	
Bj (EN)	5	11	
Bj (LM)	10	2	Late Mesolithic
Bh***	43	1	

* Artefacts were recovered almost exclusively from the bottom 5 cm of layer VX
** Layer Bc is discontinuous and interpreted as a hiatus
*** Artefacts were recovered from only the top 5 to 10 cm of layer Bh (adapted from Simpson 1996)

More recent excavations on Flatøy (Simpson 1992) involved a refitting analysis of several sites. Those addressed here were "totally excavated", and one (Krossnes Locality 6) was situated in a small bog. One of the interesting recoveries from this site was a dense concentration of black rhyolite. Approximately 550 pieces of this material were recovered, of which over 350 were from a single 0.25 m^2 grid square. Table 2 provides an indication of the vertical spread of this raw material through the deposit.

The question raised by table 2 is thus whether the use of black rhyolite at this site began in the Late Mesolithic, gradually increased to a maximum in the layer VX phase of the Early Neolithic, then went rapidly out of use again, or if the black rhyolite stems originally from one phase of activity – that of layer VX – and the vertical spread is the result of post depositional effects.

To date, 171 pieces of the black rhyolite have been refitted, the largest single block containing 150 pieces (hereafter referred to as the black block). The black block contains extensive refits between layer VX and and the underlying layers. In fact, only ca. 80% of the pieces in the black block were recovered from layer VX. That is, some 20% came from the other layers[6]. Furthermore the cross-layer

[6] Note that as more pieces are refitted to the black block, the precise proportions of how many pieces are derived from different layers will change.

refits within the black block are "interlaced", for example, sequences have been identified where a piece from layer VX was struck, followed by one or more pieces from layer Bd, followed again by pieces from layer VX. Such a "back and forth movement" of the knapping sequence is *not* possible through the time scales indicated by the independently dated stratigraphy here, thus, it must be concluded that at least the pieces that have been refitted to the black block relate to a single phase of occupation, in all likelihood that represented by layer VX. While it might be technically possible to "totally refit" the black rhyolite from Krossnes 6 in order to absolutely demonstrate that all of it relates to the same phase of occupation, the point here is that it has already been demonstrated that post depositional disturbance *does* account for at least some of the vertical spread of the material and it is not in fact unreasonable to assume that it might account for all of the vertical spread.

The recent work at Flatøy (Simpson 1992) also provides an example where the potential impact of agricultural disturbance on the horizontal distribution of lithic materials could be evaluated. At Krossnes Locality 2 the upper 11 to 40 cm of a 60 cm thick relatively well drained gravel deposit containing stone age artefacts had been affected by recent agricultural disturbance (most likely spading as opposed to plowing). Here a refitting analysis has demonstrated an average refit line length of 1.8 m (n=6) in the deeper undisturbed deposit as opposed to an average refit line length of only 1.3 m (n=18) in the agriculturally disturbed zone. This type of data could thus be drawn into an argument for the "defence" of the integrity of the disturbed agricultural zone, that is, that the agricultural disturbance has not likely resulted in significantly greater horizontal displacement than in the underlying deposit.

However, in this specific context such a conclusion is problematic. The material refitted here, the same rhyolite as in the previous example, contains numerous natural fault planes and once it has been "dried out" is subject to chemical erosion along these flaws. Given sufficient time under the right micro-environmental conditions, this material is understood to fragment along these fault lines. Note that it is a simple matter to distinguish this type of post depositional fracturing from knapping removals as they are heavily eroded and do not have attributes characteristic of human induced fracture such as point of percussion, bulb of percussion, radial fissures, erailleur scars or ripples. The difficulty in this case is that many of the rhyolite refits from locality 2 are in fact "natural" breaks along fault lines. Coupled with the mechanical effects of agricultural activity, the rhyolite here may have become more fragmented in the upper disturbed layers as a direct result of agricultural activity, thus biasing the refit line length data reported above. It should also be noted that similar results could be expected for other raw materials as a result of burning (forest clearance, hearths or natural fires) as thermal alteration of many lithic materials will result in the formation of weakness in the material and/or direct fragmentation. Thus a more conclusive evaluation of the effect of agricultural disturbance on the horizontal patterning of the lithics from this locality is pending further refitting studies of other types of raw materials. The point being made here, however, is to outline a direction of investigation that might assist others in interpreting their assemblages.

Typology/technology/chronology

For the puposes of this paper, typology is seen as a *communicative tool* used by archaeologists, a set of definitions that allows us to know what artefact the other

is talking about. Technology is a broader concept, to which a variety of definitions might be applied. The study of technology is seen here to ask questions such as how, where and why tools were manufacured, what they were used for, and how this type of information might be used to improve our understanding of prehistory. Chronology then, is a framework into which specific types and/or technologies are placed on the basis of their presumed ages. For the stone age archeologist in general, the themes of typology, technology and chronology are inextricably inter-related. For a refitting analyst, the interplay between these can become even more complex, with the study of technology through refitting often serving as a "corrective" influence on presumptions within and between the fields of typology and chronology. A fully developed discussion of the points raised here is beyond the scope of this paper, however, in the following I will present a few examples in which refitting has provided technological insights that were otherwise not possible to achieve; examples which to varying degrees also illustrate the interplay between typology, technology and chronology.

Coulson's (1986) re-analysis of the Vesle Berousen II site, Norway, using refitting provides a classic example whereby the identification of "shadow" artefacts has required a dramatic re-interpretation of a site's chronology. Here ca. 1000 lithic artefacts were recovered and the site was radiocarbon dated to 6100 +/- 140 bp. This Mesolithic age was also reflected by the typological characteristics of the stone tools in the assemblage (Hagen 1963:131 in Coulson 1986:17). The re-analysis of this site resulted in the refitting of a flint nodule that contained the negative impression of a *Neolithic* cylindrical core. That is to say, it demonstrated the presence of a previously unknown (and otherwise unknowable) phase of occupation of the site.

The black block (Figs. 1 and 2) from Krossnes locality 6 addressed above is of relevance in another context. By way of review, this group was argued to relate to layer VX, a layer representing an Early Neolithic phase on the site – the Early Neolithic of Western Norway dating to the period 5200–4700 BP (Olsen 1992). The black block did in fact contain a cylindrical core, a typical Early Neolithic trait in Western Norway. It also, however, contained a core of another type, one with a single face, opposing platforms and acute platform edge angles. This type of core is typologically dated in Western Norway to the Early Mesolithic, that is before 9000 B.P. (Bjerck 1983:120). The observation that this block contains two cores that according to a traditional typological approach have an age difference of some 4000 years clearly requires some form of explanation.

It has been argued elsewhere (Simpson 1996) that the black block was in fact knapped in the Early Neolithic (i.e. not first used in the Early Mesolithic and then re-used in the Early Neolithic) and that the difficulty in this case lies in the typology and chronology employed. The specific arguments employed will not be addressed here, but rather it will be stated that this case is presented as an example whereby it has become necessary to review typological and chronological relationships on the basis of refitting data.

The nature and quality of the raw material used by prehistoric folk is an important aspect of the study of typology and technology. In terms of the classification of raw material into geological types the criteria of colour is often employed. An additional example from the Krossnes locality 6, however, constitutes a "cautionary tale" with regard to raw material classification based on colour. Here a block was refitted which contained pieces of such varying colour that they would otherwise have been classified as four different raw materials (Fig. 4, table 3). The raw material has been identified as rhyolite (Milnes 1994, pers. com) and the extreme colour variation is interpreted as being the result of differences in post depositional weathering dependent on the water content of the deposits and in two cases (the olive green pieces) possibly thermal alteration (Simpson 1996). I feel that little more needs be said with regard to this example; I leave it to the reader to ponder the implications of figure 4 and table 3.

Intrasite analysis and Human Behaviour

Refitting not only allows one to follow the "life history" of a given tool, from its manufacture, through use, perhaps also resharpening, breakage and re-use, to its ultimate discard, but by plotting the locations from which the pieces from specific blocks are recovered we can virtually follow in the footsteps of the individuals who made and used these tools. This constitutes a type of data invaluable in the study of intra-site analysis. Beyond this, close examination of refitted sequences has led some analysts to assert that they have been able to identify and distinguish individual knappers on the basis of how the cores were prepared, worked and how errors were (or were not) corrected (Cahen and Lawrence 1980, Pigeot 1990, Skar and Coulson 1986 and 1987).

Skar and Coulson (1986 and 1987) provide a valuable re-analysis of the site of Rørmyr II, Norway which addresses these issues. The site was near totally

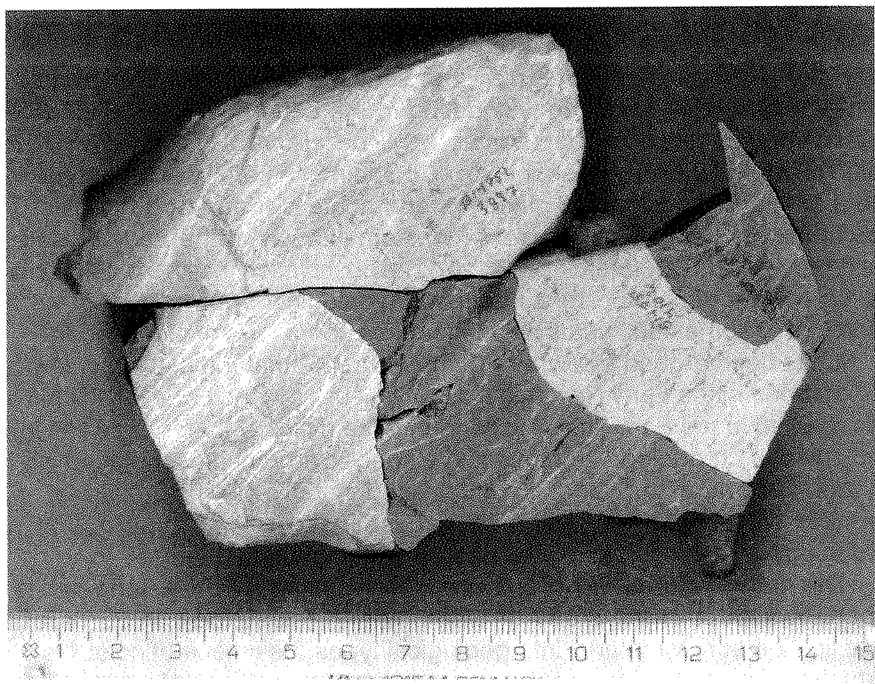

Fig. 4. Multi coloured block, Krossnes locality 6. The olive green pieces are not visible in this view (*artefact scan by David Simpson*)

Table 3. *Colour variants of the multicoloured block using the standard Rock Color Chart (Geol. Soc. of America 1994)*

Variant	Colour		Number refitted
1) black:	'greyish Black'	(N2)	2
2) dark grey:	banded: 'dark grey/greyish black' and 'dark greenish grey'	 (N2.5) (5 G Y 4/1)	3
3) light grey:	'light grey'	(N7)	7
4) other:	'olive grey/olive black'	(5Y 3/1)	2

(previously published in Simpson1996)

excavated and 613 artefacts were recovered, these distributed between three main concentrations (Areas I, II and III). Some of the main conclusions that the analysts very convincingly argued (based wholly or partly on refitting) include:

- the three lithic concentrations on the site were "contemporaneous"[7]
- Area I was a manufacturing location, Area II was a retooling station and Area III was a special task location, probably used for butchering
- the lithics represent the activity of two knappers
- the work of these two individuals could be distinguished from each other
- the artefacts were brought to the site as partially prepared nodules
- projectile points were manufactured on the site, used and damaged in a hunt, and returned to the site and discarded during retooling.
- the site is interpreted as a short term hunting camp

Approaches to stone age research: The *chaîne opératoire*

As indicated in the introduction to this paper, refitting has played a role in the development of a new approach to lithic studies, that of the *chaîne opératoire* (operational sequence). This approach was formulated and is widely used by researchers in France (Bodu, Karlin and Ploux 1990, Pelegrin 1990, Pigeot 1990, Ploux, Karlin and Bodu 1991 see also Edmonds 1990, Grace 1996). The *chaîne opératoire* has been defined as "the different stages of tool production from the acquisition of raw materials to the final abandonment of the desired and/or used objects" (Bar-Yosef et al. 1992:511). While this definition may at first glance seem rather "innocent", it does in effect involve a series of reorientations of perspective from traditional approaches.

In my view, one of the more fundamental of these reorientations is that from the *artifact* as primary focus, to that of the set of *decisions and actions* a set of

[7] More precisely, there were "direct connections" between Areas I and II, Areas I and III, but not between Areas II and III, implying that Areas II and III were not used at exactly the same time, or that the activities that took place in them did not involve any direct contact between them (Skar and Coulson 1986:93).

artifacts represents as the object of study. Also involved is a shift from using a modern western concept of technology – where one is thought to first plan or design a tool, then in a separate step implements the manufacture of that tool – to a model where design and implementation are inextricably inter-related, a model of technological practice as a handcraft or craftsmanship (Ingold 1990). The difficulty with the former, the modern western model of technology, is that experience has shown that the actual "steps" taken in the manufacture of stone tools is exceedingly more complex than the simple flow charts resulting from the traditional approach (Wyckoff 1992). The model of lithic technological practice as craftsmanship, on the other hand, more reasonably accounts for the range of variation that has been observed in lithic reduction sequences as illuminated through refitting.

The black block from Krossnes locality 6 described above can be used to illustrate the different implications of these two models. According to the traditional approach, the presence of two cores that are supposed to be from different periods in a block that was in all likelihood reduced in a single knapping session can be seen only as an anomaly, and has little interpretive value. However, from the perspective where knapping behaviour is seen as craft one might:

... view this example as a matter of an Early Neolithic knapper who probably sat down to produce blades from a cylindrical core, but when faced with a flaw in a piece of raw material that resulted in an undersized unusually shaped block inappropriate to the cylindrical core method, the individual exploited the unusual piece and produced what appears to us to be an Early Mesolithic core type....That is to say, the knapper is seen as a craftsman who had in mind a plan consisting of a goal and a set of methods by which to achieve it. However, in the course of execution of that plan there was feedback between the "steps" of design and implementation. Pending, for example, the quality of the raw material at hand, the body of knowledge (cultural baggage) available, and the skill of the practitioner, the methods applied or the results themselves might deviate significantly from the original intended plan (Simpson 1996).

The model of lithic technological behaviour as craftsmanship thus allows us to *understand* what may have happened, rather than simply to write it off as an anomaly.

Finally, it has been argued that through the *chaîne opératoire* one has the potential to identify different types of knowledge in action in prehistoric settings, that is, *connaissances* and *savoir-faires* (Pelegrin 1990). The former corresponds to knowledge that can be transmitted, for example, orally or in written form, the latter relates to knowledge such as motor skills which must be learned through practice. Some studies have in fact been "witness" to the process of teaching apprentices the techniques of stone tool manufacture (Pigeot 1990, Bodu, Karlin and Ploux 1990).

Refitting and the *chaîne opératoire* as a Cross Theoretical Approach

It should be stated that refitting can play a role in yet higher levels of inquiry than have been addressed in this paper. Western archaeology has been witness to a series of theoretical debates through the last 50 years, culminating in the recent processual vs. post-processual or structural vs. post-structural debates. In this context, Ian Hodder provides an eloquent commentary that I have chosen to draw this presentation to a close:

[The chaîne opératoire addresses] issues at the heart of contemporary archaeological theory such as the relationships between theory and practice, meaning and material, society and individual. The study of technology allows many of these abstract issues to be brought down to earth and be brought to account. It allows many of us to do what we have long wanted to do – that is face the general theoretical questions with the mundane details of archaeological data. In addition, technology allows what are normally seen as opposed theoretical camps to explore their differences in relation to concrete data than simply in terms of theoretical posturing (Hodder 1990:157).

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Skaldytinių rekonstravimas kaip archeologijos metodas: trumpas įvadas

DAVID N.SIMPSON

Santrauka

Šis darbas skirtas skaldytinių rekonstravimo metodui akmens amžiaus tyrinėjimuose. Aprašomas metodas ir įvairūs jo taikymo būdai, pradedant nuo to, kad jis panaudojamas kaip priemonė įvertinti archeologijos kompleksų vientisumą. Aptariama metodo įtaka tipologiniams, technologiniams ir žmogaus veiklos tyrinėjimams, apibrėžiamas jo santykis su nauja akmens dirbinių tyrimų kryptimi – technologine grandine (*chaine operatoire*).

David N. Simpson
Department of Archaeology, Bergen Museum,
University of Bergen
Haakon Sheteligspl. 10, 1007 Bergen Norway

The Analysis of Materials from Papiškės IV Site Using Computer Databases

DŽIUGAS BRAZAITIS

Our knowledge of the Lithuanian stone age is in many cases based on data recovered from very large sites. The areas excavated sometimes extend over several thousand square meters and some assemblages contain more than 100 thousand artefacts. As a rule, most of the large sites contain more or less mixed materials from different periods. Nevertheless, these archaeological monuments remain very significant for prehistory studies, because they can provide unique and sufficiently reliable information about the past. The development of methods and techniques to work with materials from these mixed sites is a very important goal.

Large bodies of archaeological data provide the potential to address particular questions using quantitative methods. The problem is, that large amounts of data require enormous numbers of calculations and considerably slows the progress of the investigations. The volume of data has especially increased in Lithuania in recent years since the introduction of the method of exact point recording. This method improved the quality of documentation, but time expenditures for spatial distribution analysis became very significant. The only way to make research proceed more quickly and effectively was to employ computerized databases using personal computers.

The site of Papiškės IV, located in the Vilnius district, was excavated in 1989-1991 and was chosen for this case study. The site contains materials from at least three periods: Mesolithic, Middle Neolithic and Early Bronze Age, and might be referred to as mixed (Brazaitis 1992). The main goal of the investigations was to characterize the features of the assemblages from each period using computer databases. Since a standardized system for the recording of archaeological materials from the Stone Age has never been established in Lithuania, another, and probably the most important goal of the study was to find a suitable form to record and store the data in electronic memory and to find appropriate methods for further analysis that would be useful for working with multi-component sites containing large amount of data.

Papiškės IV is situated along the upper reaches of the Vokė river, approximately 20 km south west of Vilnius. The site occupies a small sandy-gravel hill in the river valley. The cultural deposits were covered by a layer of peat which preserved organic materials such as bone and amber.

The excavations were started using a very traditional method of documentation. Artefacts were recorded according to observable stratigraphic layers and collected from 4 m² grid units. The exact positions of flint tools and other