Experimental production of lithic artefacts: Developing understanding; developing engagement

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Abstract:

This paper is reflective and discusses the results of a process experiment designed to develop understanding of a particular British Early Upper Palaeolithic stone tool technology. The technology in question is the Lincombian, and the discussion breaks down into three main parts. The first part argues that raw material availability and practitioner performance can be influential factors within the modern experimental reproduction process. When these issues were factored in for this experiment it became clear that early phase *debitage* materials reflected a process of interpretation, not replication. The second substantive part of this discussion focuses upon the final phase of the experimental process. Selection criterion for assessing finished artefacts was tightly constrained by archaeologically derived data. It is argued therefore that when finished artefacts fell within these assessment criteria the final phase of the process was akin to replication. Consequently, *debitage* associated with the final phase can provide useful analogue material to fill gaps in our understanding of this Lincombian technology. The final section is summative and returns to the issue of performance. It argues that practitioner performance facilitates audience engagement. Engagement is valuable for communicating understanding to both specialist and non-specialist audiences. The paper concludes by arguing that a rigorously evaluated experimental process can be used twice: firstly, as a tool for generating materials to develop our understanding; secondly, as an engaging performance to communicate understanding to specialist and non-specialist audiences.

Keywords: experimental archaeology; performance; engagement; Early Upper Palaeolithic; Lincombian

1. Introduction

This paper is reflective and discusses the results of a ‘process experiment’ (Outram 2008) involving a professional flint-knapper tasked with answering a particular research question, and focussed upon a British Early Upper Palaeolithic (EUP) stone tool technology. This introductory section is followed by a discussion that falls into three main sections. The first section introduces an argument that relates raw material availability to practitioner performance. This is followed by a detailed overview and evaluation of the final phase of the experimental process. A quantitative break-down is presented of the differing types of

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debitage produced when a blade is transformed into a blade-point. This is followed by a photographic explanation of how elements refitted, and is used as a strategy to recognise characteristic *debitage* types produced when transforming a blade into a blade-point. These characteristic micro-*debitage* elements are then contrasted with archaeological materials from two Lincombian sites to recognise particular aspects of blade-point production within the archaeological record. The third section is summative and returns to the issue of performance, and is then followed by a short concluding section. In relation to the stone tool technology that has been the focus of this process experiment, it is the Lincombian-Ranisian-Jerzmanowician (LRJ).

The LRJ is a pan-European stone tool industry dated to around 40,000 years ago. The predominant type-fossil for the industry has been termed a blade-point: a leaf shaped stone point produced using a blade technology (Figure 1). Type fossils dominate the available corpus with only a limited number of *debitage* collections available. Previous researchers have highlighted a predominance of LRJ sites within what now constitutes England and Wales (Flas 2011; Jacobi 2007) and this British material has been termed the Lincombian after examples recovered from Kent's Cavern, set in Lincombe Hill in Devonshire (Campbell 1986). The Lincombian blade-point corpus is not large comprising just over 100 mainly fragmented examples from 30 sites (Piprani 2016). Whilst carbon dating has situated this material within the Middle to Upper Palaeolithic Transition (Flas 2008: table 3) a lack of associated human fossil evidence makes it unclear if blade-points were produced by *Homo sapiens* or *Homo neanderthalensis*. Consequently, this material has been marginalised within overarching human transition debates (Flas 2006; Jacobi 1990). My own research has focussed on human behaviour via the medium of stone tool technology. The process experiment discussed here was developed to 'fill in the gaps' of our technological understanding built from a partial archaeological record.

Figure 1. Archaeological blade-points recovered from Glaston, Leicestershire (left) and Beedings, Sussex (right) (photographs by the author).

This project involved five days of experimental production explicitly designed to replicate this Early Upper Palaeolithic technological process. To facilitate and direct the experimental production of blade-points a technological model was developed based on a review of the literature produced by Roger Jacobi (1980; 1986; 1990; 2007) and Damien Flas (2006; 2008). Building on this foundation, I spent two days reviewing and recording key artefacts within the original (recovered ~1900 CE) Beedings collection at Franks House, British Museum. The stone tools and *debitage* from the Beedings plateau in Sussex form the largest Lincombian collection available and exceptionally, provide an opportunity for some technological insight.

Several blade-point characteristics emerged from this review process. The scarring evident on both cores and blades indicated the use of an opposed platform technology. A number of flakes and blades had large platforms with faceting and clear lips, suggesting removal by soft hammer. Some larger cortical blades bore transverse scarring appearing to be early removals. Jacobi recognised 36 un-recycled blade-points all worked upon the ventral and 19 also on the dorsal surface. Retouch was used to impose a symmetrical leaf shape on the dorsal, and to flatten the ventral face by removing curvature (Jacobi 2007). At this point, my understanding of production could be described as a model comprising three stages: nodule to core; core to blade; blade to blade-point.

Following Outram (2008), a process experiment was designed to answer a particular research question comprising two parts: how were blade-points made; and why were they made in the way they were? This process experiment was designed to provide a complete material expression of the above technological understanding. It was not possible to borrow materials from the British Museum, however, the above observations were discussed with the chosen flint-knapper, Karl Lee, and before our experimental work began a visit arranged so that he could examine the archaeological artefacts first hand. The project took place over five days in the summer of 2012 and all materials generated through one complete experimental production cycle were collected. Furthermore, the gestures and explanatory narrative of the knapper was recorded using a digital (video) camera. Lithic material was collected after each of my three conceptual stages and bagged separately, thus providing a relative chronology of removal. Gross weights of the nodule and large removals were recorded and noted before further reduction took place. As experimental blade-points were produced they were individually compared with the metric criteria derived from archaeological artefacts to assess the validity of their size and form. In this respect the blade-point production process was iterative, with Lee's methods and output developing over the five days production.

In relation to the flint-knapper's explanations, a dialogue was maintained throughout the process. I asked questions at relevant stages so that the logic behind his behaviour was made explicit to me. Information was recorded in note form as well as captured on the digital recordings. It is from these records (spanning all five days) that an understanding of the knapper's rationale and decision-making process was built. These were the data collection and recording methods used during the experiment. However, as the process unfolded some differing technological assumptions emerged held by myself as 'subject specialist' and Lee as 'production specialist'. Diverse perspectives on technological process can be valuable in allowing an exchange of ideas and through this process an overall development in understanding (see Aubry *et al.* 2008). Therefore, although un-planned, it became important to examine these differences critically. As a way into this discussion, I want to interrogate the flint-knapper's problems making blade-points within the metrical parameters drawn from archaeological examples.

2. Raw materials, performance and interpretation

In the first instance, the experimental blade-points Lee produced were assessed based upon their metrics for axial length, maximum width and maximum thickness, with boundary criteria drawn from extant archaeological examples. This allowed a binary assessment for each experimental artefact to decide if it was 'within' or 'outside' the archaeologically derived blade-point criteria established. Over five days the majority of the knapper's blade-points were metrically oversized in length, width or thickness and therefore fell 'outside' of the blade-point criteria used here. Flas (2011) in his study presented an average blade-point size of 90-100 mm in length, 30 mm wide and 10 mm thick based on both British and continental materials. However, the Beedings blade-points were generally larger than this average and it was these larger artefacts that the knapper had viewed. Some blade-point fragments at Beedings suggest the maximum size may have been bigger than the largest complete artefact from the site. The same is true for the smallest sizes. Consequently, fragments from Beedings were used to provide maximum and minimum thickness and width criteria, whilst complete pieces from Beedings and Glaston were used to define the upper and lower criteria for length (see Table 1).

Table 1. Artefacts and data used to define the maximum (top two lines) and minimum (bottom two lines) blade-point criteria. Abbreviations: NA –"Not available".

Source	Length	Width	Thickness
Beedings maximum	NA	41 mm	14 mm
Beedings complete	138 mm	39 mm	13 mm
Flas (2011) average	90-100 mm	30 mm	10 mm
Glaston complete	64 mm	27 mm	7 mm
Beedings minimum	NA	18 mm	6 mm

Over the five days 42 artefacts were produced of which 17 fell within the size parameters defined above and could, therefore, be used as analogues for archaeological examples. On no day did the flint-knapper achieve more than a 50% success rate (see Figure 2). This was almost exclusively because the majority of his experimentally produced pieces were metrically larger in one or more dimension than the largest museum pieces discussed here.

Whilst using the larger than average Beedings blade-points as a template may be part of the explanation, another factor that led to the experimental production of oversized blade-points was a debate regarding the stage at which a blade should be transformed into a blade-point. Early on in the process, it became clear that both the knapper and I had differing ideas on this issue. I was explicitly interested in core production and capturing the associated debris signature. However, the knapper tended to recognise and exploit opportunities for blade-point finishing early on in the nodule reduction process. When this occurred he shifted from producing a core that would generate blanks of the right size for this project, to manufacturing a blade-point. This approach resulted in large, sometimes cortical blade-points. Furthermore, it also disrupted the debris signature I was attempting to capture. Through discussion over three days we realised that I was approaching the issue from an assumption of mobility, whilst the knapper was working from the perspective of resource efficiency. I had assumed cores would be prepared in one location and then transported elsewhere to produce blades. Consequently, I had isolated core production as a discreet stage. The knapper argued that any removal that could be utilised to produce a blade-point would have been, regardless of at which theoretical stage it was produced. Thus, my three-stage reduction sequence needed reviewing. From a practical perspective we resolved this issue by producing blade-points both ways. Days four and five focused upon producing a core, and only after the core production debris had been collected did blade and blade-point manufacture go ahead, with blades removed directly from the prepared core. Days four and five provided clearly punctuated reduction sequences resulting in one complete debris collection. However, reflecting upon Lee's explanations for his resource-efficient approach has been useful.

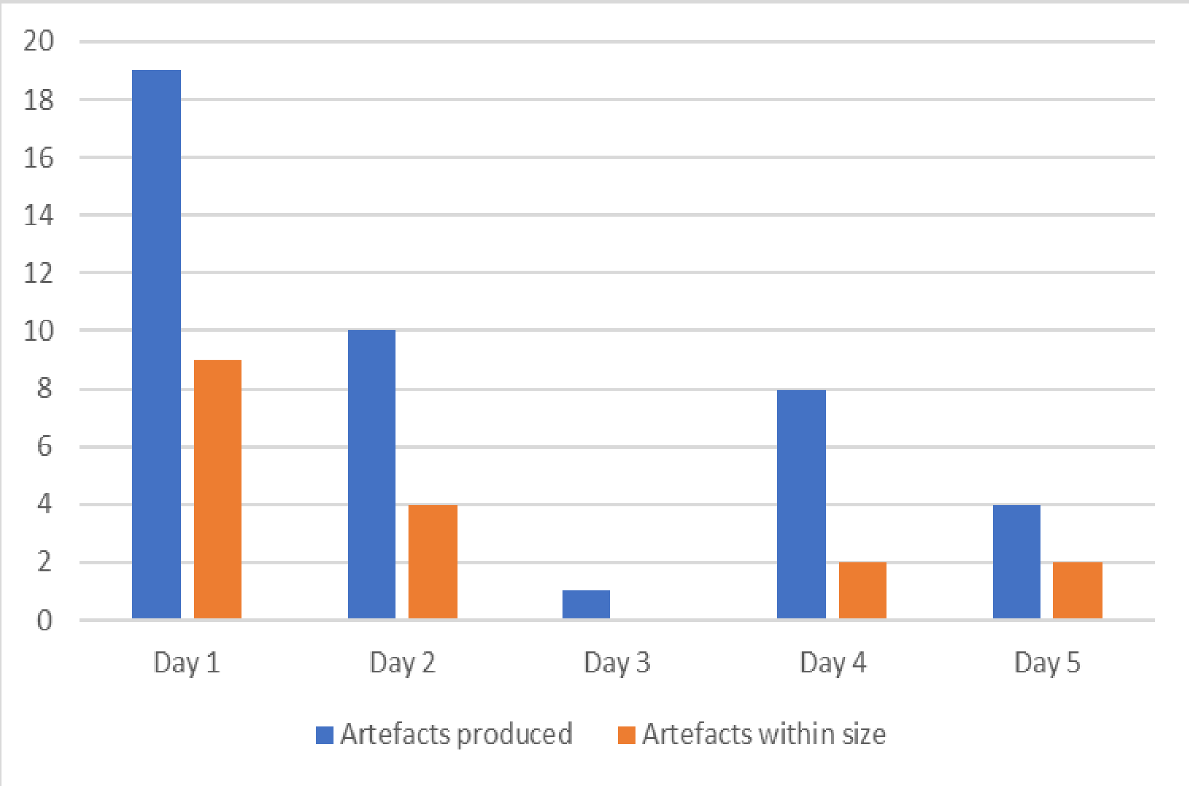

Figure 2. Total artefacts produced compared to pieces within the projects size parameters (chart produced by the author).

2.1. Different geographies, different approaches

I have worked with another flint-knapper, John Lord who lives in Norfolk, an area rich in flint. With easy access to good quality material Lord's explicit approach, when making a tool, was to address the most difficult aspects of production as early on as possible. If problems occurred he could abandon the piece and start again on a new nodule or flake, thus working in a time-efficient manner (personal communication with John Lord in 2006). When I discussed this approach with Lee he recognised an underlying logic, however, did not accept the assumption that people in the past would necessarily have had good access to raw materials. Lee lives in Gloucestershire in the west of England, not a flint rich area, and his preferred approach was to opportunistically develop early-stage removals and persist with these pieces, even when metrically unsuitable. Obviously both knappers' preferred tactics are valid in different contexts (see Binford and O'Connell 1984). What is interesting however is how their personal style and approaches correspond to their respective abilities to access good quality flint. In relation to this project, Lee continued to use large early-stage removals over the first three days, even after we had discussed how they were not metrically suited for purpose, and doing so disrupted the debris signature I was attempting to capture. The implication is that different experimental producers, with differential access to raw materials, may develop differing technological approaches when attempting to replicate the same archaeological artefact. In relation to this project I believe difficulty in accessing good quality materials may have been one factor that unconsciously contributed to the knapper's difficulty in moving away from a 'resource-efficient' approach. However, based upon my own subsequent experience working with him, I believe there was also a second factor that influenced Lee's use of earlystage removals.

2.2. Performance and audience satisfaction

Knapping today has primarily an educational role, and a key component of the knapper's toolkit is the ability to engage with an audience, be it academic researcher, museum visitor or bush-craft enthusiast. A key skill within this audience engagement is linking the production process with an explanatory dialogue. Importantly, the successful manufacture of an end product provides a conclusion to the dialogue, a happy ending. Our own Archaeology Department at the University of Manchester has capitalised upon this aspect of the process. We have used Lee for a number of years to provide our third-year students with just such an engaging introduction to the subject of stone tool technology.

As discussed above, within my experimental project the flint-knapper was keen to produce blade-points from early stage removals. This allowed him to achieve outcomes earlier in the prescribed technological process, and fitted well with how I have observed him work within his demonstrations at Manchester. However, this approach meant that his blade-points were variable in size as illustrated by the low proportion of within-parameter pieces produced. It would seem that working through the prescribed technological process did not fit easily with the performative aspects of artefact production. The fact that I was filming throughout the experimental project may not have helped. It seems obvious that the social and 'economic' context of a modern flint-knapper and Palaeolithic hunter are very different. Observation, discussion and reflection have helped me to understand the particularities of a modern knapper's 'economic' context and the implications of issues such as material availability, audience engagement and practitioner performance within it. Through dialogue over a number of days we made a shift towards technological exploration with less import placed upon immediate outcome. However, I believe that the knapper's initial drive to manufacture blade-points from very early removals was in part related to an underlying desire to produce results as part of this modern performative process. Having the opportunity to review the material results of the five days in detail within a laboratory context, I found a number of differences between the experimental and archaeological blade-points. Consequently, I believe that the early blade production stages of the experimental process can be better described as interpretation rather than replication. In this respect, the overall production process outlined here can be better understood as a pre-experiment, useful for highlighting issues in need of further consideration and exploration. However, this is not the whole story. I present the above example to highlight some of the potential problems of my approach to using experimental production to un-critically 'fill in the gaps' within our understanding of a past technological process. Nevertheless, based upon the same analytical criteria I would argue that the final phase of transforming blades into (within-size) blade-points is more akin to replication than interpretation. If so then aspects of the blade-point production process discussed here can be of real value for new analyses of archaeological collections of Lincombian materials that do have a micro-*debitage* component. To support this argument, I want to use the next sections of this paper to present a detailed summary of four blade-points produced, and then relate the associated micro-*debitage* to example materials recovered from two Lincombian sites.

3. Replication and developing understanding

Four within size blade-points produced on days four and five were selected for refitting and analysis. They all metrically (size), typologically (zones of retouch) and formally (shape and proportion) fell within the criteria established, although one example was an outlier in form being slightly flatter than any archaeological example recorded. Micro-*debitage* for each blade-point was collected and comprised flakes, shatter and two 'long flakes' as well as sand and dust created by abrasion. All this material was important when calculating relative weights. However, the research focus was on materials above 4 mm as these components can have some analytical value in relation to current collections that do have a micro-*debitage* component (*e.g.*, Beedings, Glaston). Consequently, it was materials above 4 mm that were used for refitting and metrical and formal analysis. A detailed review of this process is presented here, followed by a summary of the results.

3.1. Quantitative data on the production of blade-points from blades

Four blade-points offered the opportunity to record the weights both as blades and then after production as blade-points with associated *debitage*.

3.1.1. Blade-point to *debitage* weight

For the four blade-points under discussion overall weights were recorded before and after reduction from a blade. Consequently, the weight of materials removed from each blade could be calculated and from this data averages were derived (Table 2).

Table 2. Summary of original blade weight and percentage of material removed in relation to the resultant blade-point produced.

Number	Blade	Debitage	Blade-point
4.2	31g	4g (13%)	27g (87%)
4.3	33g	3g (9%)	30g (91%)
5.14	41g	7g (17%)	34g (83%)
5.19	36g	9g (25%)	27g (75%)
Average	**36g**	**6g (17%)**	**30g (83%)**

Although slightly differing in metrics, blade-point 5.14 provided a proportionally good example of an average (n=4) experimental blade-point. Based upon this example it can be stated that on average the knapper had to remove 17% of material (by weight) from a blade in order to produce a blade-point metrically, formally and typologically analogous with archaeological examples from the site of Beedings.

3.1.2. Break down of *debitage* by size

The two blade-points manufactured on day four were analysed to provide data on the proportion and type of *debitage* produced, in particular, materials above and below 4 mm. Blade point 4.2 (27g) produced 2.5g of *debitage* over 4mm and 1.5g below. Similarly, blade point 4.3 (30g) produced 1g of *debitage* over 4 mm and 2g below. This provided an average of 2g above 4mm (Figure 3) indicating that when micro-*debitage* was generated from blade-point production approximately half the weight of this material comprised pieces of a size likely to be of analytical value.

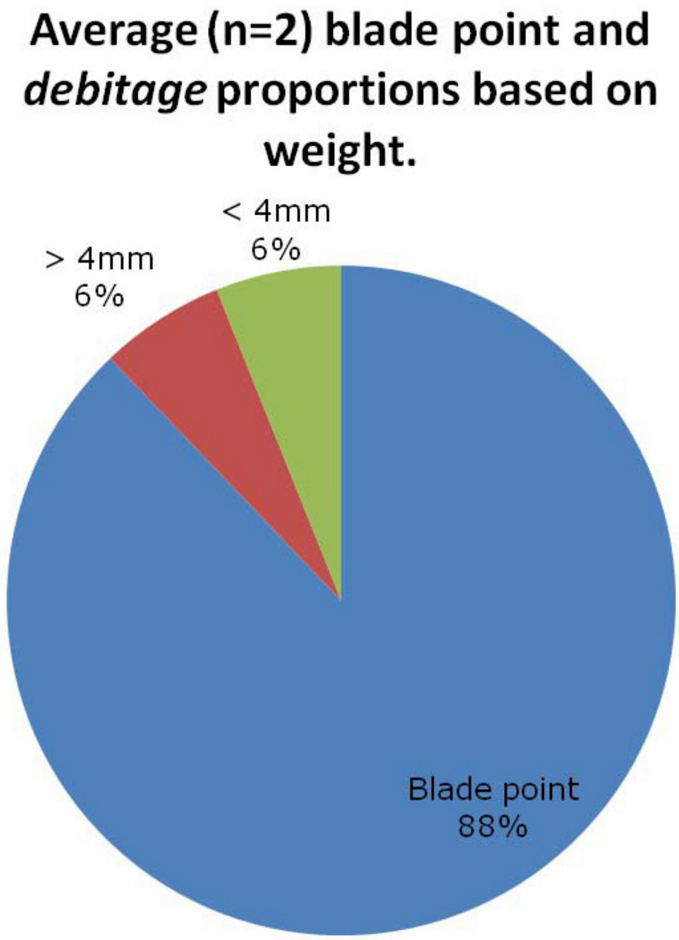

Figure 3. Average weight of blade-point in relation to *debitage* as a percentage.

3.1.3. Broken or complete

The total micro-*debitage* available for analysis from all four blade-points comprised 40 pieces above 4 mm of which 23 were broken and 17 complete

3.1.4. Numbering and micro-*debitage* types

Refitting was attempted for all micro-*debitage* associated with each blade-point. Six elements were found to conjoin and therefore treated as three pieces. This reduced the overall total to 37 units of micro-*debitage*. Based upon colour and patterning, pieces were located to blade-point faces and some probable, and 14 definite refits were found relating to three blade-points. All definite pieces were numbered and recorded. The numbering system included information on the blade-point, removal face and the probable order of removal. Any notes or comments (such as 'conjoin') were added after the number. The face and number (*e.g.*, v3) was recorded directly on the piece itself, whilst the complete code was input directly into an Excel spreadsheet; this is summarised in Tables 1 and 2 and in the descriptions of the debitage in sections 3, 4, 5 and 6 (see also Piprani 2016, 153). Measurements were taken using non-digital callipers and rounded up or down to the nearest millimetre. The large majority of pieces were classified as either flakes (n=29 or 78%) or shatter (n=6 or 16%), however, two pieces (6%) could be termed 'long flakes' as they were twice as long as wide with approximately parallel sides.

3.1.5. Micro-*debitage* character

Of the 29 flakes produced 22 were complete and analysis of these indicated an average size of 11mm length, 10mm width and 1mm thickness. Fourteen refits were found from three blade-points (nos. 4.2, 4.3 and 5.19) comprising 11 flakes; 2 long flakes and one piece of shatter. Of these nine came from a ventral surface and eleven from a proximal part.

3.2. Blade-point micro-*debitage* summary

By relating four experimentally produced blade-points to their associated *debitage* a number of general observations can be made. To make a blade-point, approximately 17% of a blade's weight will be removed in the form of micro-*debitage*. Approximately half this weight will be made up of pieces above 4 mm and therefore is likely to be of analytical value. A large majority of this above 4 mm material will comprise mainly complete and broken flakes with an average complete flake measuring around 11x10x1 mm. Refitting for three blade-points suggests that most material is removed from the proximal end and the ventral face. Whilst small in sample size, this quantitative summary fits comfortably with previous descriptions (Jacobi 2007), emphasising bulbar reduction and blade straightening. This is unsurprising as it was this same data that was used to structure experimental production. This comfortable fit suggests that the quantitative data generated here should be a useful complement to these previous technological understandings derived from museum collections. Building upon the above observations, these experimentally produced materials can be used to develop a more nuanced understanding of relationships between micro-*debitage* quantities, form and the actual process of blade-point production. This was achieved through refitting.

4. Refitting micro-*debitage* to experimentally produced blade-points

What follows is a detailed break-down of the refitting process for each experimentally produced blade-point.

4.1. Blade-point 4.2

Blade-point 4.2 had seven refitting units including one conjoin with the majority of refits coming from the proximal end (86%, no.=6) and ventral face (71%, no.=5). Refitting allowed a relative order of removal to be recognised which began with a series of ventral removals and the long flake v2a.

4.1.1. Long flake v2a

This long flake was complete and measured 15x7x1 mm (Figure 4). Refitting showed it to be a ventral removal from the right-hand side of the proximal end. It had an intermediate External Platform Angle (EPA) of ~70˚. EPA was measured where the platform intersected the dorsal face (Lin *et al.* 2013: 729). In plan it was asymmetrical with a slightly larger left side. In relation to the platform it had a twisted transverse profile with the left-hand side lower than right. The platform was angled in relation to the blade's transverse section and the twisted transverse profile was seen to be due to the flake having travelled around the original blade's bulb of percussion. The flake's dorsal surface appeared to be the ventral surface of the mother blade with two scars (red arrows) cutting into this original surface.

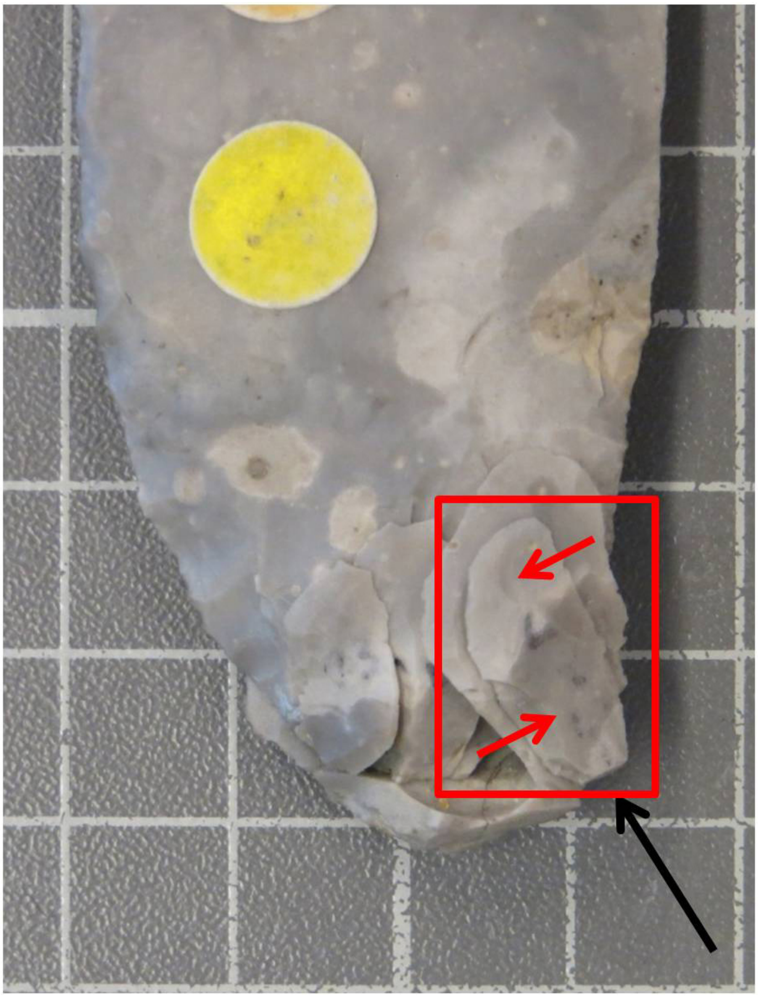

Figure 4. Blade-point 4.2, long flake v2a with red arrows indicating direction of dorsal scars and black arrow indicating direction of removal blow (photograph by the author). Gridlines on this image are 10mm apart.

4.1.2. Flake v2d

V2d underlay v2a and was the second refitted piece to have been removed (Figure 5). This complete flake measured 20x13x2 mm and was again from the ventral surface, proximal end and right-hand side. It had a high EPA (~90˚) and in plan was asymmetrical with a relatively straight and narrow right-hand dorsal surface, and an expansive lunate left. The characteristic feature of this flake was a pronounced transverse twist with the dorsal left-hand edge much lower than the right. Refitting indicated that this was again due to the flake accommodating the bulbar prominence. The dorsal surface showed the central removal scar from flake v2a and highlighted how this flake was one component in a removal sequence from a single point on the blade.

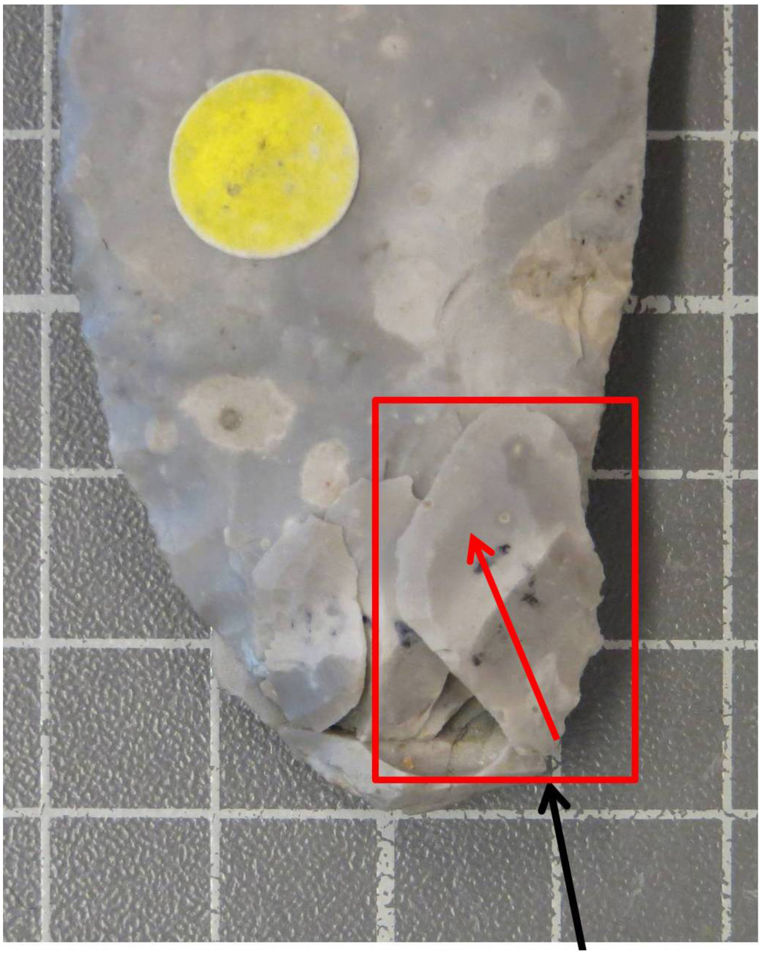

Figure 5. Blade-point 4.2, flake v2d with the black arrow indicating direction of removal blow and the red arrow showing the direction of dorsal rippling (photograph by the author). Gridlines on this image are 10mm apart.

After this bulbar thinning episode the knapper seems to have turned the blade over to begin a sequence of dorsal reduction.

4.1.3. A dorsal reduction sequence

The first refitted piece to be removed from the dorsal surface was d1+, a broken flake measuring 7x12x1 mm and taken from the proximal right-hand side of the blade (Figure 6). The flake's platform had been removed and it was asymmetrical in plan with more surface area on the dorsal right-hand side and only a slight transverse twist. The flake's dorsal surface had two parallel removals scars travelling in approximately the same direction as the ventral rippling. These factors indicate this to be one removal in a series from the same point on the blade.

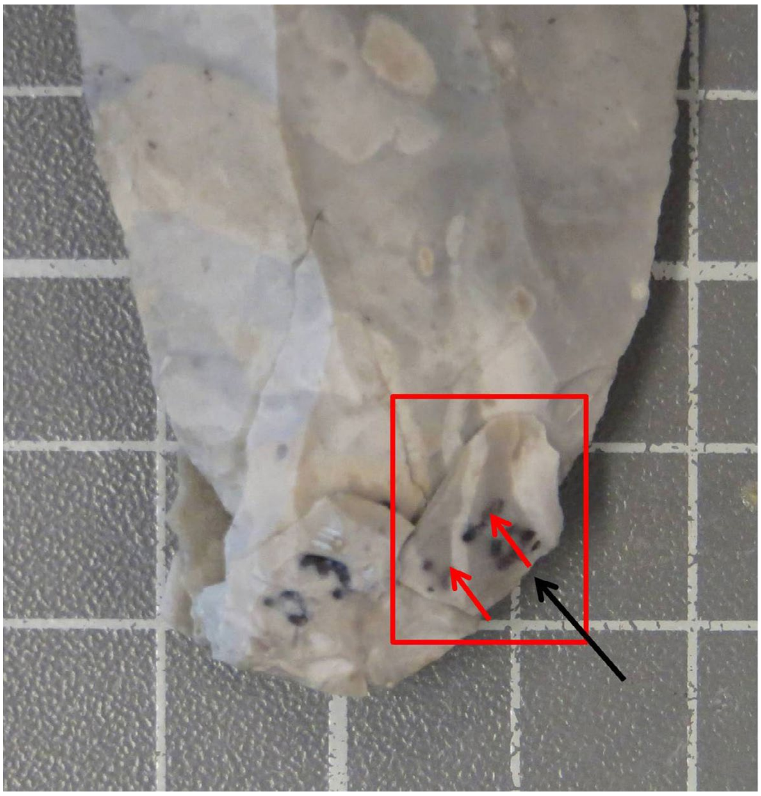

Figure 6. Blade-point 4.2, broken flake d1+ with red arrows indicating direction of previous removals and the black arrow the direction of the flake removal blow (photograph by the author). Gridlines on this image are 10mm apart.

4.1.4. Conjoined shatter d3c + d1

The next removal created two pieces that could be conjoined (Figure 7). d3c fits with d1 and in doing so reforms a striking platform. This suggests they were both removed by the same blow. The platform had a high EPA (~85˚) and the complete conjoined piece measured 25x16x6 mm and had been struck from the central section of the proximal end of the dorsal surface. It was asymmetrical in that the dorsal surface veered slightly to the left of the striking platform. In doing so the longitudinal axis followed the dorsal ridge of the blade from which it was removed. This conjoin has only a slight transverse twist. The dorsal scar pattern was complex but could be divided into two parts. Whilst the proximal was heavily worked the distal end indicated removals trending in the same direction as the blades dorsal surface. A characteristic of d1 was a longitudinal curved ventral surface which gave it overall thickness. This thickness may be one factor signalling how it overhung the completed blade-point showing it to be part of an initial shaping process. With the removal of this overhanging piece, the knapper seems to have turned over the blade and returned to the ventral face.

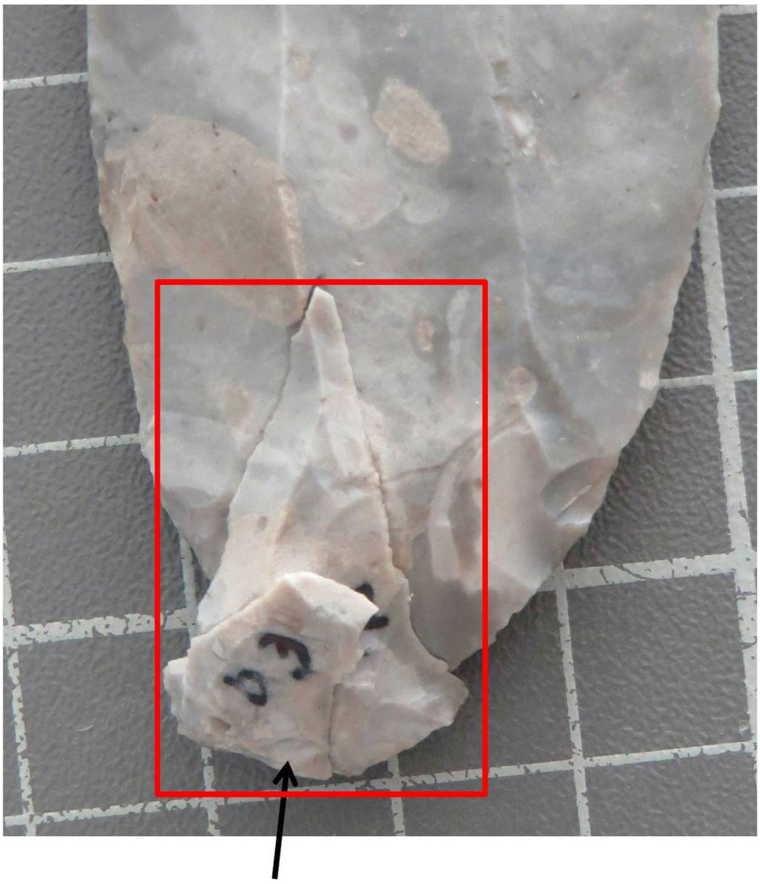

Figure 7. Blade-point 4.2, two conjoining pieces of shatter d3c and d1 with the black arrow showing direction of removal blow (photograph by the author). Gridlines on this image are 10mm apart.

4.1.5. Flake v3

This was an almost complete flake (distal tip missing) that measured 10x10x2 mm and had been removed from the proximal ventral surface (Figure 8). The EPA was difficult to read but appeared to be high (~90˚) and the flake was markedly asymmetrical. When the dorsal surface was viewed in plan section the main body of the flake veered to the left. This piece also had a dramatic transverse twist. Viewed from the platform the dominant left-hand side was high whilst the right seemed flat. Using the platform as an indicator of direction of strike showed how this piece had started off headed towards the bulb, but veered around the bulbar mass resulting in its marked asymmetry. The flake's dorsal surface had scarring showing evidence of earlier removals from the same point and there also seemed to be evidence of the blades original ventral surface remaining on the distal left-hand edge of the flake.

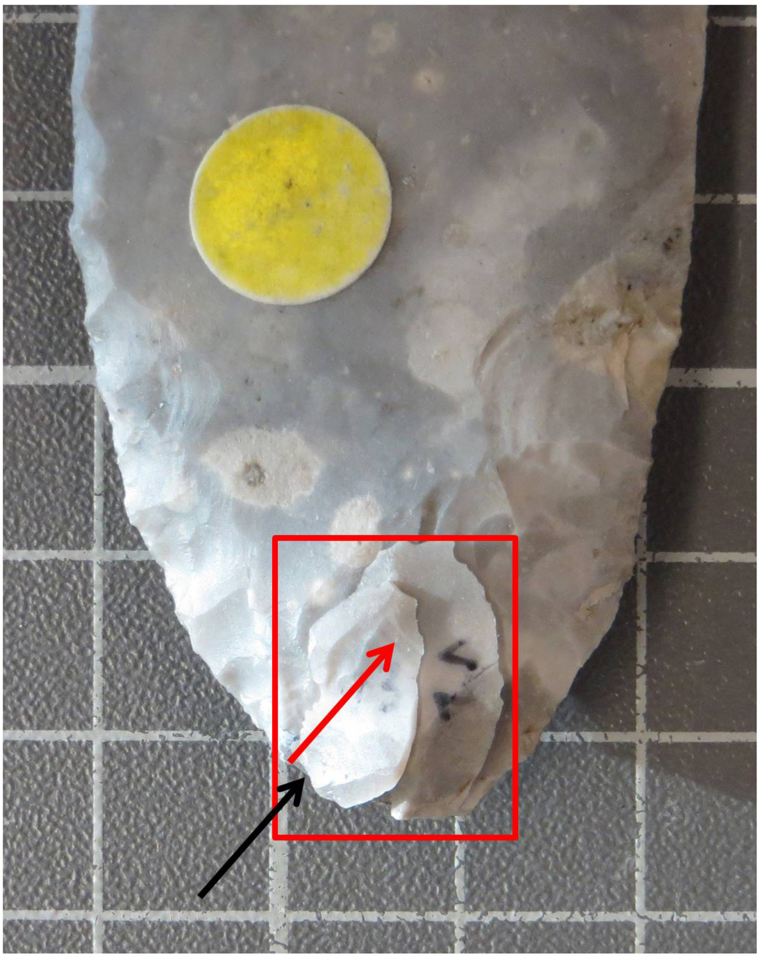

Figure 8. Blade-point 4.2, flake v3 with the black arrow showing direction of the removal blow and the red arrow the dorsal scar pattern (photographs by the author). Gridlines on this image are 10mm apart.

4.1.6. Flake v2c

Flake v2c (Figure 9) underlay the previous twisted removal (flake v3) and in many ways was more straight-forward. This was a complete flake measuring 15x8x2 mm. It was from the proximal end of the ventral surface and the EPA was high (~90˚). In relation to the platform the flake was asymmetrical, trending to the left when the dorsal surface was viewed in plan. It had only a slight transverse twist and dorsal scarring was on both sides of a central ridge, trending in the same direction as the flake's ventral rippling. This indicated it to be one element in a vertical reduction sequence on the same point of the blade. The final refit was from the ventral distal section.

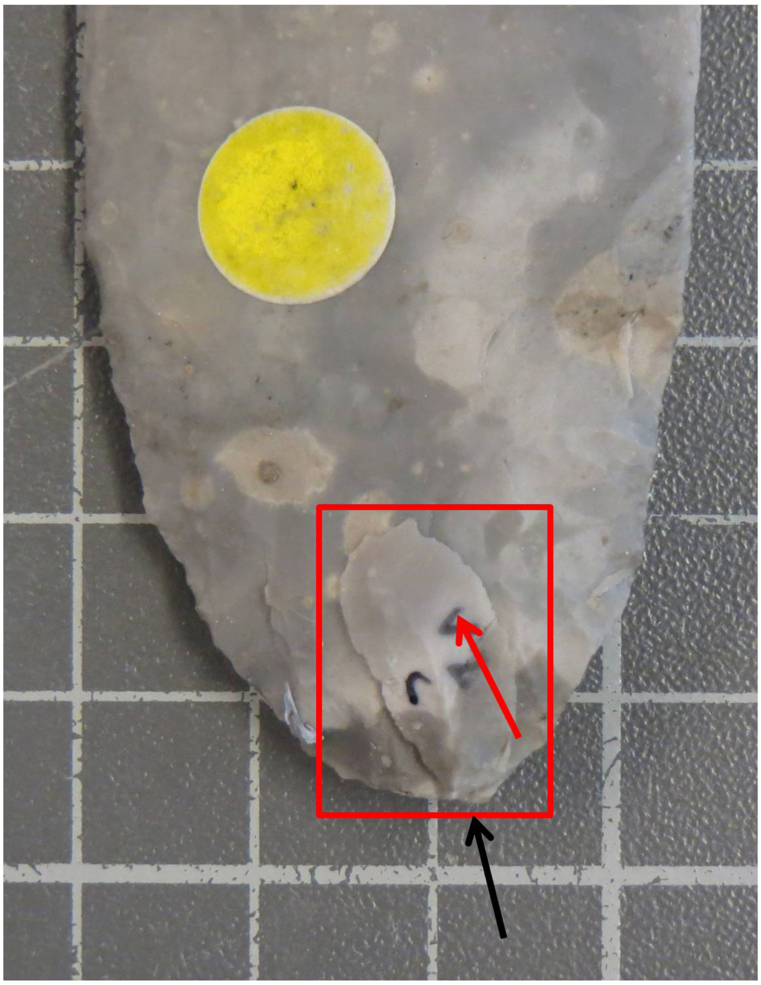

Figure 9. Blade-point 4.2, flake v2c with the black arrow showing direction of removal blow and the red arrow the direction of an earlier removal on the dorsal right (photograph by the author). Gridlines on this image are 10mm apart.

4.1.7. Flake v1

It is not a simple matter to discern at which point this ventral removal was struck. However, the knapper did have an explicit method, dealing with the proximal mass first and then the distal. If this protocol was followed flake v1 would have been the last of the refits to be struck. Prominence from the edge suggests it was perhaps early in a series of removals from this section and therefore used to shape the point (Figure 10). This complete flake measured 11x7x1 mm and was from the ventral distal left-hand edge. The EPA was high (~85˚) and the flake relatively asymmetrical with more material on the dorsal right-hand surface. The complete flake was relatively flat with no observable twist. On its dorsal face there are indications that the blade's original surface has been cut by a removal on the left-hand side, showing it to be one in a series of linear sequential left to right removals. This 'cutting' also explained the flake's asymmetry.

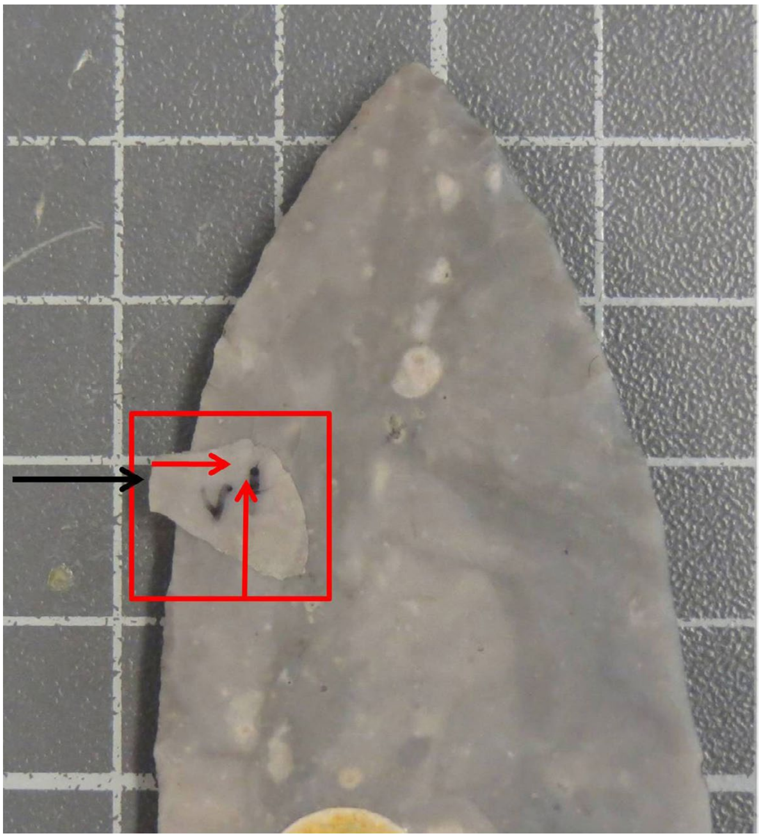

Figure 10. Blade-point 4.2, flake v1 with the black arrow showing direction of removal blow and the red arrows the dorsal scarring (photograph by the author). Gridlines on this image are 10mm apart.

4.2. Blade-point 5.19

Seven pieces were able to be refitted to blade-point 5.19 and four of these pieces conjoined making a total of five refitting units. Of these a majority (60%, no.=3) were from the ventral face and all were from the proximal section. Refitting suggested that for this blade the dorsal surface was reduced first. This is because two of these flakes extend beyond the finished blade-point and seem to have been initiated directly from the mother blade.

4.2.1. Flake d2

This first removal was a complete flake measuring 19x16x1 mm (Figure 11). It overhung the blade-point and had been struck from the left-hand edge removing it from the dorsal surface. The EPA was low (~45°) supporting the idea that this was struck from a blade edge. The flake was asymmetrical in plan with the dorsal surface veering to the left. Refitting indicated that this asymmetry was caused by the flake following the main line of the dorsal ridge. This flake had only a vaguely discernible transverse twist. The dorsal scar pattern was confused but could be divided into two parts. The proximal end had removals trending in the same direction as the flake's ventral ripples indicating it was one removal in a series from the same point. In this respect, it was also similar to the conjoined shatter from blade-point 4.2 (d3c+d1) showing intense working on the proximal section. The flake's distal section comprised the beginning of the original blade's dorsal ridge showing clearly how the change in direction followed the trend of the original blade.

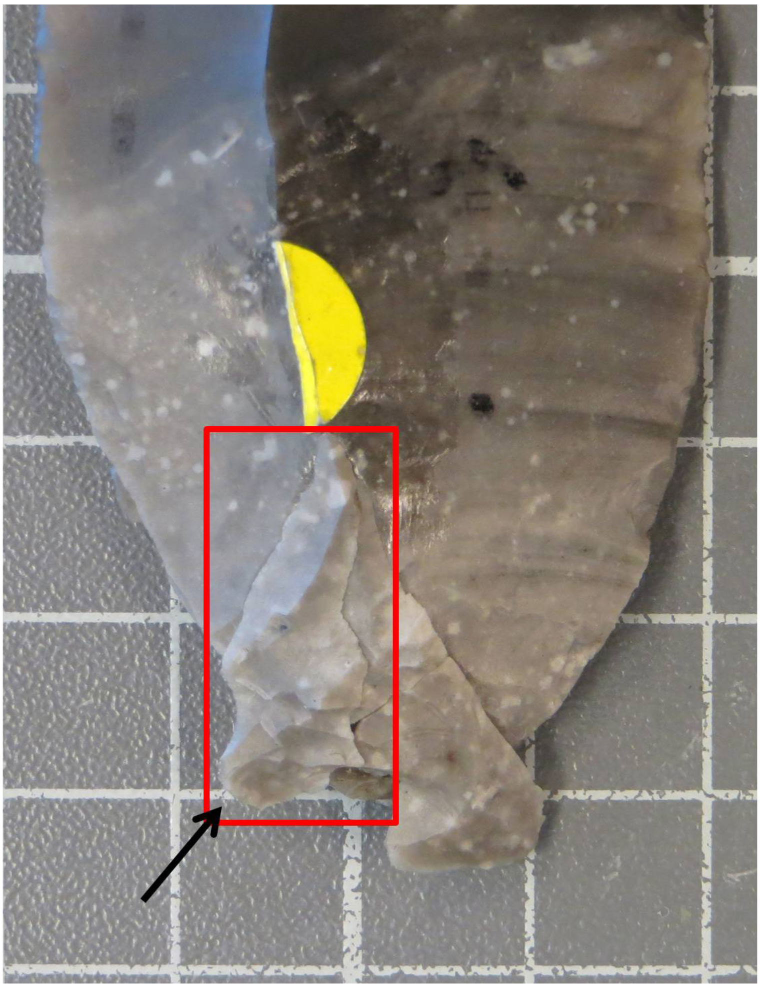

Figure 11. Blade-point 5.19, flake d2 with the black arrow indicating direction of the blow of removal (photograph by the author). Gridlines on this image are 10mm apart.

4.2.2. Conjoin flake d6+d4

Broken pieces d4+d6 conjoined to form one complete flake and so have been discussed as one unit (Figure 12). This unit measured 20x20x2 mm and underlay d2 but was from the dorsal proximal right-hand side. This flake extended beyond the finished margin and comparison with the recorded shape of the original blade showed it was struck from the edge. This was supported by the low EPA (~45°). The flake was asymmetrical as the distal section veered to the right when viewed in plan. Asymmetry with both this and its overlying piece seemed to be related to the dorsal ridge acting as a barrier to direct progression of the removal. This piece had only a marginal transverse twist. The dorsal surface bore a flake scar trending in the same longitudinal direction as the mother blade. After these removals the blade seems to have been flipped over and worked on the ventral surface.

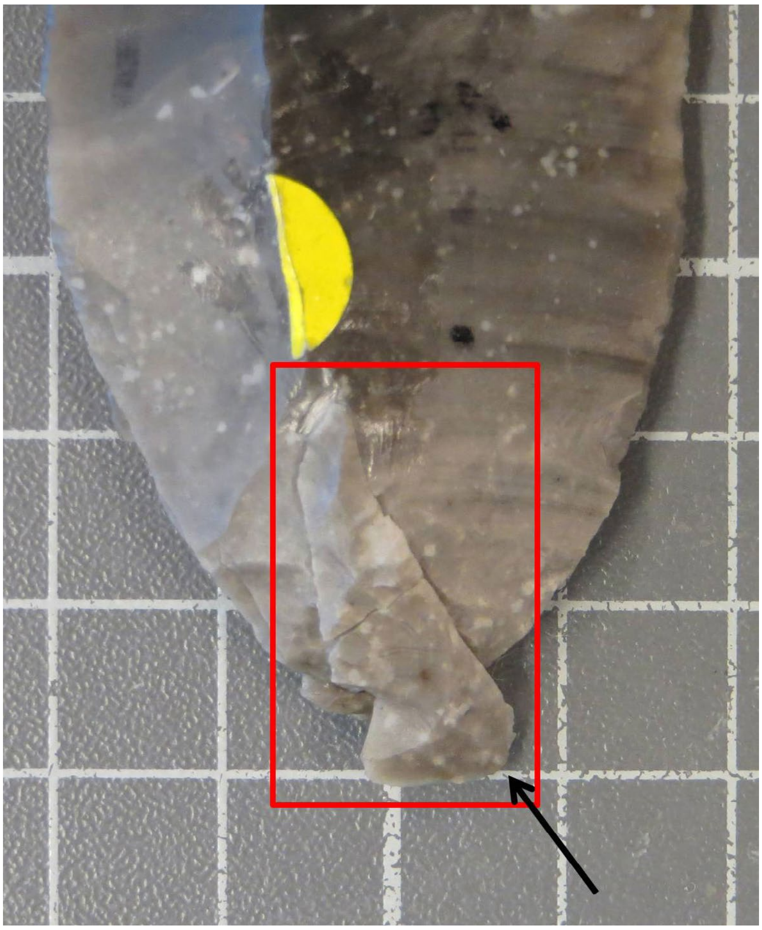

Figure 12. Blade-point 5.19, flake d4 and d6 with the black arrow indicating direction of removal blow (photograph by the author). Gridlines on this image are 10mm apart.

4.2.3. Flake v2

The next removal appears to have been flake v2, a complete flake measuring 10x7x1 mm (Figure 13). Refitting showed it to be struck from the proximal ventral right-hand edge of the blade. This was supported by its low EPA (~45˚). It was approximately symmetrical with no transverse twist apparent. The left-hand proximal section of the dorsal surface had a dipped area and bore a scar showing an earlier removal trending in the same direction as the ventral surface. This indicated it to be one removal in a linear sequence moving from left to right along the right-hand edge of the ventral face. The underlying scar pattern on the edge of the blade-point confirmed this sequence.

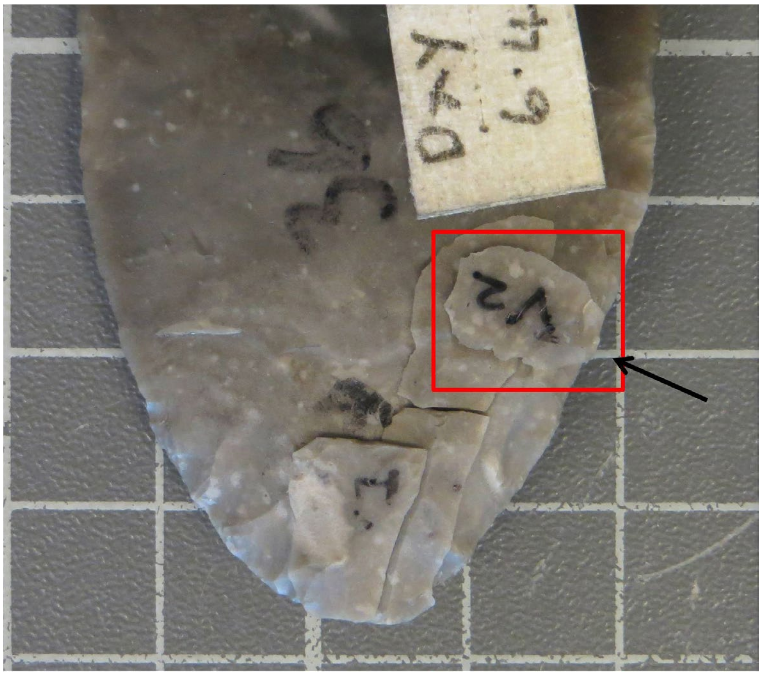

Figure 13. Blade-point 5.19, flake v2 with the black arrow indicating the direction of removal blow (photograph by the author). Gridlines on this image are 10mm apart.

4.2.4. Flake v1

Flake v1 was probably the second removal from this group and had snapped off at the distal end (Figure 14). Refitting and the underlying scar pattern indicated it may have originally been twice as long. The extant piece measured 12x9x1 mm and had been struck from the centre of the proximal ventral surface. The EPA was high (~90°) and the flake relatively symmetrical with no apparent twist. The dorsal surface was difficult to read but the right-hand side had the scar from an overlying invasive transverse removal travelling in from right to left. This scar was presumably made by a flake similar in form to v2 and from the same sequence.

Figure 14. Blade-point 5.19, flake v1 with the black arrow indicating direction of removal blow and the red arrow dorsal scarring direction (photograph by the author). Gridlines on this image are 10mm apart.

4.2.5. Long flake v3

Long flake v3 was made up of two parts and measured 28x13x2 mm (Figure 15). Struck from the proximal ventral surface the platform extended slightly beyond the finished point indicating that it was removed before final shaping occurred. The EPA was low (~45°) and the long flake asymmetrical veering to the right in plan-view. This piece had a twist and refitting showed how the side of the long flake closest to the mother blade's bulb was higher than the side that was further away. Both the asymmetry and twist were caused by the long flake circumventing the central bulbar prominence of the mother blade. The right-hand dorsal face of this flake bore scars from invasive removals coming in from right to left. This reflected the overlying sequence of invasive thinning from the right-hand edge. The next blade-point to be discussed here is number 4.3.

Figure 15. Blade-point 5.19, long flake v3 with the black arrow indicating direction of removal blow (photograph by the author). Gridlines on this image are 10mm apart.

4.3. Blade-point 4.3

Of the fourteen pieces known to come from this blade-point only two definite refits were found. Both of these were from the distal end, one from the dorsal and one from the ventral surfaces.

4.3.1. Flake d5

Flake d5 was a complete removal measuring 8x9x2 mm from the left-hand distal dorsal section (Figure 16). The low EPA (45°) is consistent with it having been removed from a blade edge. It was asymmetrical with the right-hand dorsal surface running off to the right. This was one of the pieces that showed a pronounced transverse twist in relation to the platform with the left-hand side higher and the right-hand side lower. This piece was useful in that the twist could be understood only in relation to the dorsal scar pattern. In this instance, a dorsal arête split the face in two travelling at 90° away from the platform. Refitting showed the surface on the right-hand side of the arête to be the mother blade's original dorsal face. On the left of the ridge was an invasive scar travelling in the same direction as the flake's ventral rippling. This flake was one removal in a left to right series travelling away from the tip along the left-hand dorsal distal edge. Importantly, the right-hand dorsal surface was flat, whilst the left-hand surface was chiselled out and therefore concave. The platform was not horizontal but angled between the flat right-hand surface and the concave left. Discussing the twist in relation to the platform was useful to ascertain its degree, but not for explaining the phenomenon. Examining the twist in relation to the dorsal scar pattern was certainly a much more useful approach. The twist on this piece illustrated the transition between the lower concave face and the upper original flatter surface. Longitudinally there was a slight curve at the proximal end.

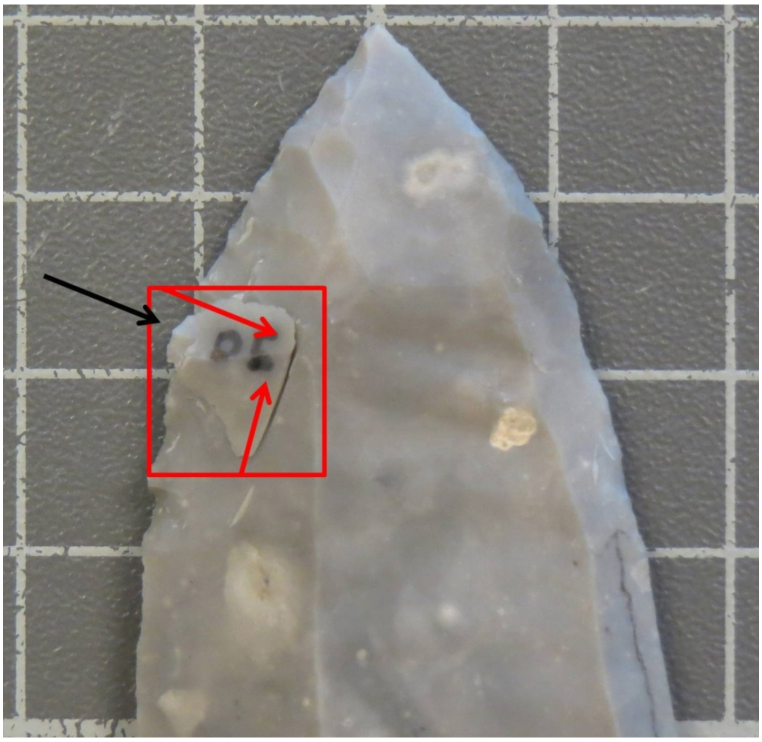

Figure 16. Blade-point 4.3, flake d5 with the black arrow indicating direction of removal blow and the red arrows indicating dorsal scar pattern (photograph by the author). Gridlines on this image are 10 mm apart.

4.3.2. Flake v7

Flake v7 was a complete flake measuring 10x13x1 mm (Figure 17). Struck from the distal ventral left-hand tip of the blade it had a low EPA (45˚). The flake’s dorsal surface veered to the right when viewed in plan. There was no apparent twist. The dorsal surface was hard to read but refitting showed part of the mother blade’s original ventral surface extant at the distal end of the flake. The proximal end showed a scar from a previous and partly overlying removal that trended in the same direction as the flake’s ventral rippling. This showed it to be one in a series of removals travelling from right to left along the blade-point’s ventral left-hand edge towards the tip.

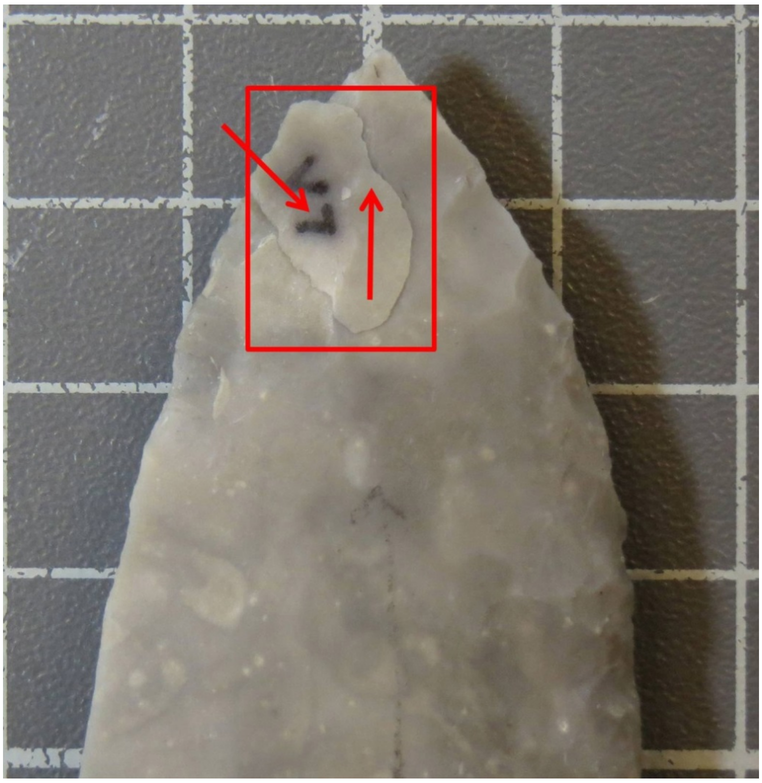

Figure 17. Blade-point 4.3, flake v7 with the red arrows indicating the dorsal scar pattern (photograph by the author). Gridlines on this image are 10mm apart.

5. Identifying characteristic blade-point *debitage*

Analysis of the above refitting process illustrated four key features or tendencies associated with blade-point form and the resultant *debitage*. The features discussed here are not really differing types, as some pieces display more than one tendency at the same time and thus could be included in more than one list. Examples of each of the tendencies are discussed in turn.

5.1. Linear sequential reduction flakes

Three refitting pieces have been categorised as linear sequential reduction flakes. This term reflects their sequential removal from along a margin. They are defined by their perpendicular dorsal (d) scar pattern (Figure 18), and refitting indicated they were associated with blade edges as opposed to ends. Three of the four came from the ventral (v) face and three of the four had a low EPA. Refitting showed these flakes to be removed sequentially. It can be summarised that these pieces occur in sequences, are associated with blade edges and are distinguished primarily by perpendicular scar patterning.

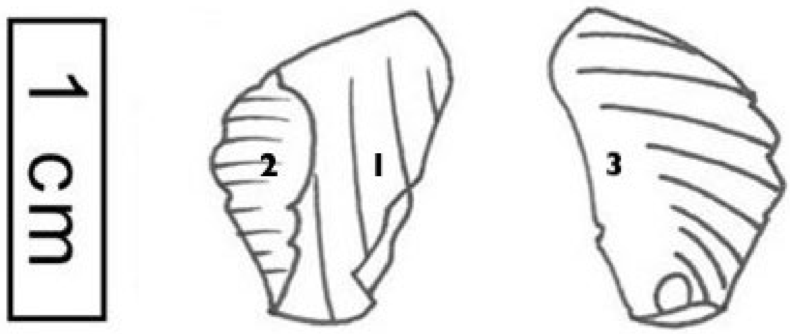

Figure 18. Flake 4.2 v1, a good example of a linear sequential reduction flake (drawing by the author). Scar no. 1: remnant of ventral surface of mother blade indicating orientation; no. 2: scar from flake removed while this flake was still part of the mother blade; no. 3: ventral surface of flake; it indicates that it was one in a sequence of removals from left to right along the edge of the mother blade.

5.2. Vertical sequential reduction flakes

On blade point 4.2 three flakes were classed as vertical sequential reduction flakes (v2dm d1+d3c and v2c), a removal type distinguished by a dorsal scar pattern trending in the same direction as its own ventral rippling (Figure 19). This is indicative of sequential reduction at the same point. 4.2 v2d is useful to discuss as it bears the scar of an earlier refitting removal 4.2 v2a. Whilst this overlying flake was obviously also of similar type, it does not bear the same scar pattern as it was used to initiate the process. Of the three pieces listed as vertical sequential removals all bear scarring along the longitudinal axis of the dorsal surface and all come from proximal ends. These flakes are distinguished by their longitudinal scar pattern on both faces and were associated here with the proximal section of blades.

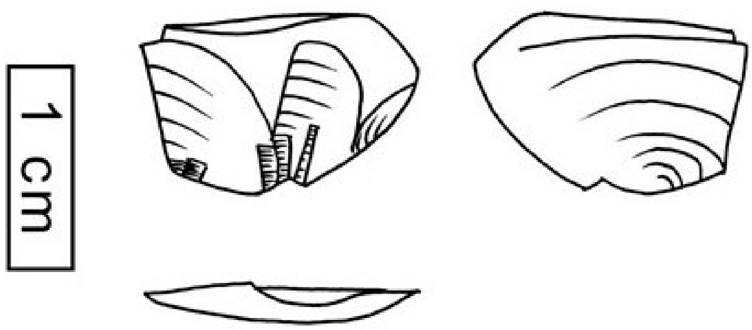

Figure 19. Flake d1+ illustrating the characteristics of a vertical sequential reduction flake (drawing by the author). The flakes removed in this reduction sequence are all in the same direction.

5.3. Ventral bulb reduction flakes

Inevitably, bulb reduction flakes derive from the proximal end and the ventral face. 5.19 v3 is a good example of how these pieces circumvent the bulb (Figure 20). Of the four flakes of this type (4.2 v2a, v2d, v3 and 5.19 v3) all are asymmetrical in plan and twisted in transverse profile, two dramatically so. These factors are the primary characteristics of this type.

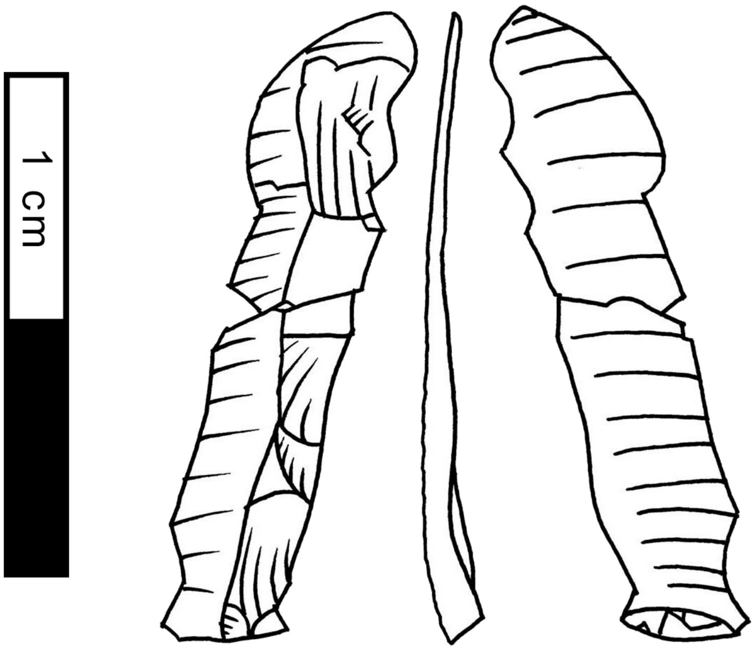

Figure 20. 'Long flake' 5.19 v3 illustrating the asymmetry associated with bulb reduction flakes (drawing by the author).

5.4. Dorsal ridge-following flakes

Three pieces fell into this category (4.2, d1+d3, and 5.19, d2 and d6+d4) and 5.19 d2 illustrated the phenomena well (Figure 21). A blade's dorsal ridge can present an obstacle to a thinning flake's progress. Consequently, a removal will tend to divert and follow the ridge. Examples show how this could occur when a flake was struck from the left, right or centre of the proximal end. Obviously, this was a solely a dorsal phenomenon. Elongated asymmetry seems to be the characteristic that defines this type of removal. However, heavily worked proximal ends also seem to be indicative.

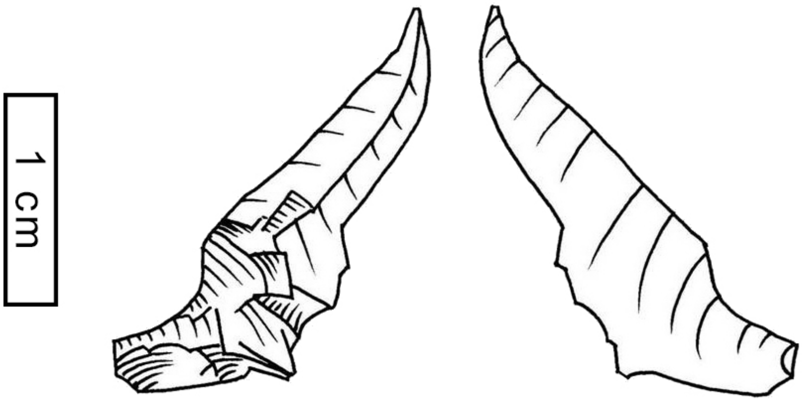

Figure 21. Flake 5.19 d2 illustrating direction of removal blow in relation to axis of the dorsal ridge of the blade (drawing by the author).

Having established some general *debitage* tendencies associated with the production of blade-points what follows is a comparison of these experimentally generated characteristic models and archaeologically recovered micro-*debitage* from two Lincombian sites: Beedings in Sussex and Glaston in the Midlands.

6. Comparing experimental and archaeological materials

Beedings is quantitatively the largest Lincombian site in Britain, with some of the metrically largest blade-points recorded. A Middle Palaeolithic blade technology was also recovered, which introduces the possibility of equifinality. At Glaston only Lincombian material was retrieved including the metrically smallest blade-point within the British corpus.

6.1. Vertical sequential reduction flakes

As discussed, vertical sequential reduction flakes are distinguished by a dorsal scar pattern trending in the same direction as its own ventral rippling. The form of these two refitting fragments from Beedings (Figure 22) is consistent with a process of intensive reduction at one point. As well as evidence of previous and attempted removals on their dorsal surfaces, each of these fragments has the remnants of what appears to an original ventral surface on the left and right dorsal margins respectively. Jacobi's (2007) technological discussion of the Beedings blade-points emphasised bulbar reduction. Similarly, refitting on the three experimental blade-points suggested that most material was removed from the proximal end and the ventral face. These two pieces are interpreted here as evidence of the intensive reduction of a bulbar section.

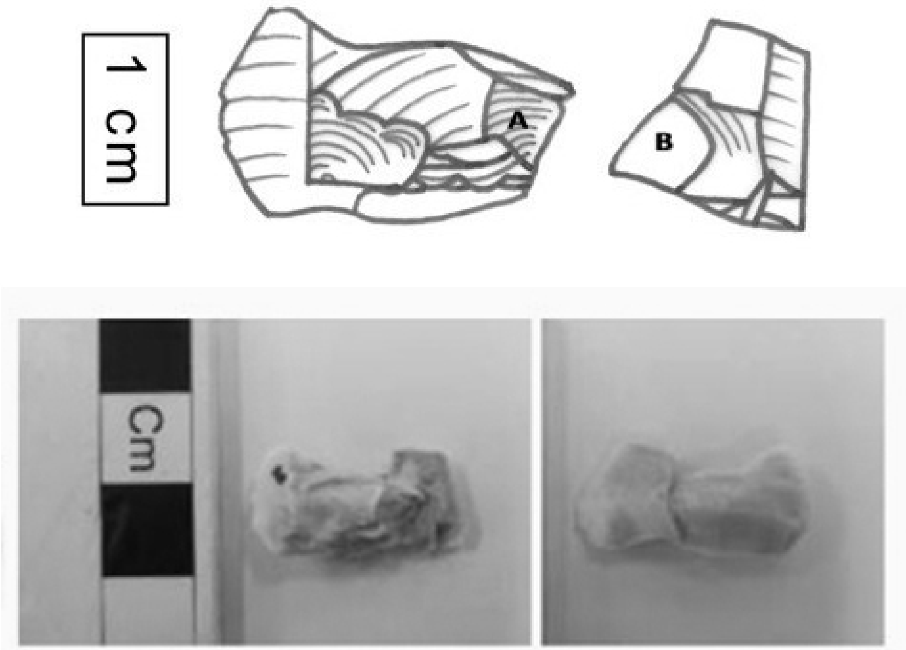

Figure 22. MP19a (12x19x4 mm) and MP22a (12x11x3 mm) conjoining pieces (A sits on B) indicative of vertical sequential reduction (drawing by the author).

6.2. Ventral bulb reduction flake

Experimentally, bulb reduction flakes were asymmetrical in plan and twisted in transverse profile. This flake (Figure 23) is from Beedings and has a plain and lipped platform remnant. It has longitudinal asymmetry and transverse twist. Consequently, it is interpreted here as having been removed from a bulbar section.

Figure 23. MP38 a bulb reduction flake (13x9x3 mm) (drawing by the author).

6.3. Dorsal ridge-following flakes

Elongated asymmetry was the characteristic that defined this type of removal within the experimental corpus. However, heavily worked proximal ends were also indicative. This archaeological example (Figure 24) is from the site of Glaston. It is a large transversely twisted flake with the platform remnant broken off at some point in time, but with the bulbar section still present. On the dorsal proximal right-hand side of this piece a series of 'steps' show it to have been heavily worked. The steep drop-off on the dorsal left is the result of a scar from an earlier successful invasive removal suggesting a left to right reduction sequence. The flake's longitudinal profile supports the notion that its primary function seems to be mass reduction as the proximal section is thick whilst the distal section is thin and feathered. The pronounced twist is perhaps partly due to the dorsal left-hand invasive removal cutting into the transverse cross-section. Its elongated asymmetry and heavily worked proximal section correspond with the experimental ridge following pieces.

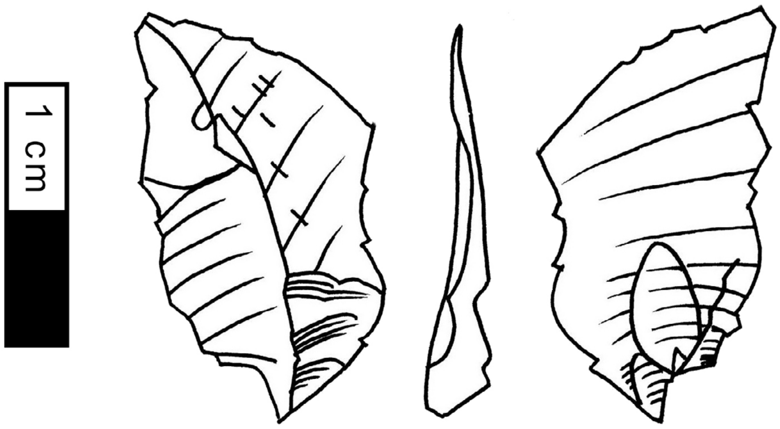

Figure 24. Dorsal ridge following flake Gl11 (22x13x4 mm) (drawing by the author).

6.4. Linear sequential reduction flakes

These two refitting archaeological flakes (Figure 25) come from the 2008 excavation at Beedings.

The experimentally generated linear sequential reduction flakes were defined by their perpendicular dorsal scar pattern, and refitting of the experimental examples indicated they were associated with blade edges as opposed to ends. It was not possible to 'read' the ripples on the main part of the ventral surface of these archaeological flakes, however, refitting illustrates a sequence of edge trimming. The experimentally generated flakes generally came from the ventral face and had a low EPA. On the above archaeological examples, the EPA is low and the dorsal surfaces have the remnants of previous removal attempts from what would have been the mother blade's ventral surface. Platform remnants on both these flakes are large and plain and the bulbs diffuse. Finally, these examples are significantly larger than the experimentally generated edge trimming flakes indicating that the artefact reduced in antiquity was large, perhaps of similar scale to some of the refitting blades within the original Beedings collection discussed at the beginning of the paper.

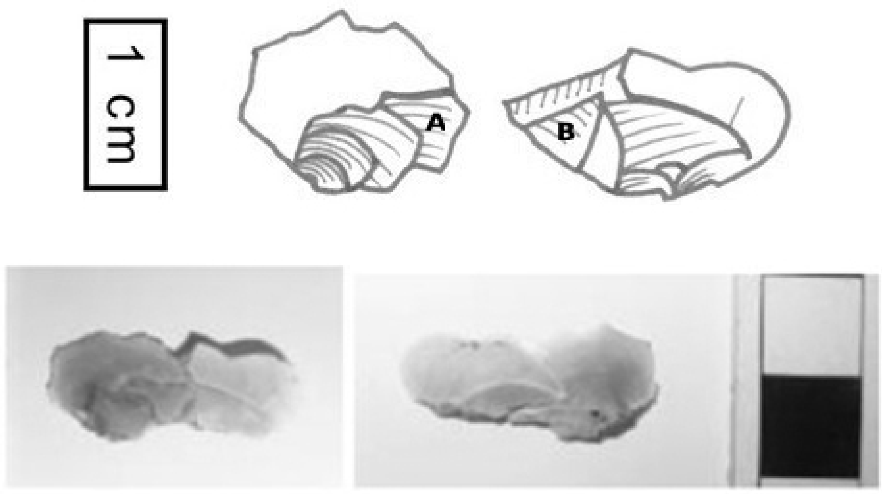

Figure 25. MP31 (11x16x3 mm) and MP37 (9x17x4 mm) conjoining pieces (A sits over B) indicative of the linear sequential reduction along an edge (drawing drawing and photograph by the author).

Micro-*debitage* patterns recognised within the experimental corpus do seem to provide useful tools for relating elements of Lincombian micro-*debitage* collections to particular aspects of blade-point production. This leads on to the next section of this paper which will present a review of the points drawn out within earlier sections, along with a reconsideration of the issue of performance.

7. Performance and developing engagement

My initial research question was designed to comprehend how blade-points were made in the Palaeolithic past, and why they were made in the way they were. I was able to achieve a good grasp of how an experimental flint-knapper in the present manufactured blade-points, and why he produced them in the way he did. Subsequent laboratory-based analysis allowed me to comprehend the ways in which these experimentally produced artefacts differed from the archaeological examples. From this I was able to develop some hypotheses as to why this may be the case. From this process, I have drawn out two main points. Firstly, when marshalling experimental production, the present-day context of an experimental flint-knapper needs to be considered. This example has been used to illustrate how factors such as material availability and the performative aspects of the present-day craft, can influence how past technological processes are interpreted and reproduced. It is argued therefore that certainly the early phases of this experimental production process need to be primarily recognised as interpretation, rather than replication. However, as discussed within the main body of this paper, the final stage of transforming blades into blade-points allowed four significant micro-*debitage* characteristics to be recognised. Because these characteristics are tightly tied to blade-point form, in theory, they should find correlates with *debitage* produced during EUP blade-point production. The comparisons of experimentally derived characteristic pieces with archaeological micro-*debitage* from Beedings and Glaston have been presented to argue that this is largely correct. This leads me to a reconsideration of the role of performance.

It would seem that experimental production is valuable in (at least) two ways: firstly it can be a useful tool for filling in the archaeological gaps when the experimentally generated material is tightly constrained to the archaeological record. The critical application of experimental production can, therefore, be useful for developing our understanding of past technological process. However, once we have established our new and developed understanding, experimental production can be utilised again. The performance of experimental production can be used to provide a narrative structure that can engage both academic and non-academic audiences with the more coherent and correct technological model.

8. Conclusion

In relation to the overall research question presented at the beginning of this paper, the issues that have emerged through this research mean that my process experiment can perhaps be better understood as a feasibility study or pre-experiment. However, recognising the value of the later phase micro-*debitage* component it is argued that this experimental production process is a tool that can be used twice: firstly, to critically develop a better understanding of particular aspects of a past technological process; secondly to then allow specialist and non-specialist audiences to engage with, and comprehend the complexity of this same past technological process.

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