PLATEFORM VARIABILITY AND Flake MORPHOLOGY:  
A COMPARISON OF EXPERIMENTAL AND  
ARCHAEOLOGICAL DATA AND  
IMPLICATIONS FOR INTERPRETING  
PREHISTORIC LITHIC TECHNOLOGICAL STRATEGIES

Harold L. Dibble

INTRODUCTION

At the heart of research on prehistoric lithic assemblages are two fundamental questions. First, what were the processes by which prehistoric flintknappers produced their implements? And second, why did they produce the forms they did? In the current literature a great deal of attention is paid to the factors that govern the design of various retouched types (e.g., Binford 1980; Torrence 1983, 1989; Bamforth 1986; Bleed 1986; Bousman 1993; Andrefsky 1994; Kuhn 1994), their production (e.g., Sollberger 1977; Flenniken 1978; Bradley and Sampson 1986; Whittaker 1994; Shott 1996), and their maintenance (e.g., Gallagher 1977; Hayden 1977, 1979; Dibble 1984, 1987, 1995b; Barton 1988, 1990, 1991; Neeley and Barton 1994). Increasingly, however, attention is being paid to the technology of blank production: in fact, many believe that this is the most potentially informative avenue of research (e.g., Tixier et al. 1980; Inizan et al. 1992; Sellet 1993).

Most technological studies, whether based on archaeological materials (e.g., Collins 1975; Marks and Volkman 1983; Volkman 1983: Sullivan and Rozen 1985; Baumler 1988; Cziesla et al. 1990) or replicative (flintknapping) experiments (e.g., Crabtree 1966; Bordes and Crabtree 1969; Newcomer 1971; Mauldin and Amick 1989; Ohnuma 1995), have focused on core reduction sequences. While these frequently tend to be heavily descriptive, i.e., simply documenting variability in reduction patterns (e.g., Bœda 1994; Delagnes 1995), there is also a concern for explaining technological variability in terms of its adaptive significance, whether relating it to raw material variability (Bietti and Grimaldi 1995; Dibble et al. 1995), overall intensity of utilization (Baumler 1988; Dibble 1995b), or other factors (e.g., Munday 1979; Marks 1983; Henry 1989, 1995; Shea 1995). The focus of this article is on the relationship between certain platform variables and flake morphology, drawing on data from actual prehistoric flake assemblages and controlled experimental studies.

While it is undeniable that core reduction sequences represent a significant aspect of lithic technological variability, the attention paid them has resulted in a shift away from even more fundamental processes of flaking. Some of the earliest works on physical properties of flaked stone were those of Goodman (1944) and Bourdier (1963), while Kerkhof and Müller-Beck (1969) were the first to discuss concepts of Hertzian fracture and its application to stone tools. Soon after there was a virtual explosion of interest in fracture mechanics, with the works of Speth (1972, 1974), Faulkner (1972), Bonnichsen (1977), Cotterell and Kamminga (1979, 1986, 1990), Cotterell et al. (1985), Tsirk (1974, 1979), and Bertouille (1989). However, the direct application of these results to archaeological materials has not yet enjoyed a great deal of success. There have also been controlled experiments designed not to focus on fracture mechanics, but to document relationships between particular independent variables controlled by the flintknapper and other, dependent variables that are observable on flakes. While many relationships have been found (Speth 1986).
One of the major problems in such experiments is that the experimental designs have not allowed for the production of very realistic-looking flakes. For example, in a series of experiments performed by the present author (Dibble and Whittaker 1981; Dibble and Pelcin 1995), flakes were removed along the sides of plate-glass cores. The flakes themselves more closely resembled burin spalls than normal archaeological flakes or blades, and platform width and flake width were always constant, equaling the thickness of the plate glass. The design of the cores and the nature of the flakes produced from them, plus the fact that so many variables were held constant, resulted in very artificial products that bore little resemblance to most archaeological lithic materials. Moreover, it is a fact that many variables -- platform morphology, core morphology, various aspects of the delivery of force when striking the core, and the flaking qualities of the raw material itself -- interact during the production of a flake. Many of these are "invisible" when analyzing real lithic artifacts. Legitimate questions can therefore be raised regarding the applicability of these results to archaeological materials. What is clearly needed -- and this is the purpose of the present paper -- is to demonstrate that the relationships which became apparent in these controlled experiments hold true for archaeological materials and, moreover, that they represent a significant aspect of prehistoric technological variability.

This article deals primarily with the relationship between certain platform variables -- platform thickness, platform width, and exterior platform angle -- and flake morphology. A number of interesting findings come from the studies presented below. First, it is shown that these platform variables have a tremendous effect on flake size and morphology, in spite of the fact that so many other potential factors are uncontrollable in dealing with archaeological samples. Thus, platform variation and its effects on flake morphology are fully applicable to archaeological investigation. Second, these platform variables are under the direct control of the flintknapper and presumably are intentionally varied to achieve particular results. By focusing on these variables when analyzing prehistoric assemblages, we can add a new dimension to reconstructions of lithic technology that goes beyond core reduction patterns based on the sequencing and direction of flake removals. Third, it is likely that some of the alternative ways of preparing platform morphology have effects that are both interpretable and explainable in terms of current models of technological efficiency, resource economy, and mobility. Thus, attention to platform variation may contribute to an overall understanding of technological variability in terms of prehistoric adaptations.

MATERIALS AND METHODS

Two primary sources of data, derived from both experiments and archaeological samples, are presented here. Data from controlled experiments are drawn from a previously published study (Dibble and Pelcin 1995) designed to assess the significance of hammer mass and velocity on flake mass. This sample contains a total of 177 complete flakes, produced from half-inch plate glass cores; the flakes were removed along one edge by dropping steel ball bearings on an adjacent edge. The two adjacent edges (one representing the platform surface and the other the exterior surface of the core) were cut so as to produce exterior platform angles of 55, 65, and 75 degrees. Angle of blow was held constant, but different sized ball bearings were dropped from varying heights.

The archaeological data used in this paper represent many different industries and technologies. Chronologically they include the Lower, Middle, and Upper Paleolithic: geographically they represent Africa, the Near East, and Europe; and technologically they express varying emphases on Levallois, flake, biface, and blade production (see Table 1). Only complete, unretouched flakes are used in this analysis and in all cases the total flake population above 3 cm in maximum dimension from a given assemblage was studied. While the total sample size is high (over 12,000 complete flakes), the data sets are not completely comparable: they were collected over a period of more than fifteen years in several different studies, and for some of them not all of the variables of interest were recorded. Thus sample sizes for any particular analysis vary considerably. In addition, sample sizes for extreme values, when broken down by other variables, tend to get small quickly. In the analyses presented here, sample sizes of less than 5 cases were eliminated.
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**Table 1.** Industrial context and sample sizes (by different variables) for the archaeological assemblages used in this study. A value of zero indicates that a particular observation(s) was not made on that assemblage.
For all of this material, including the experimental flakes, measurements were taken in a consistent manner even though the actual recording was done by several different individuals. Length is the distance from the point of percussion to the most distal point on the flake. Width is taken perpendicular to and at the midpoint of the length axis: thickness, at the point where the length and width axes cross. Platform width is the measurement along the platform from one lateral edge to the other. Platform thickness is measured from the interior to the exterior surface of the platform at the point of percussion. It represents neither maximum platform thickness nor the shortest distance from the point of percussion to the exterior surface. Bulb length was taken on the interior surface from the point of percussion to the base of the bulb. All measurements are expressed in mm.

Exterior platform angle, or the angle between the platform surface and exterior surface, is measured with a goniometer directly behind the platform, and expressed in degrees. On flakes with curved exterior surfaces, the measurement of this angle can vary depending on the point on the exterior surface at which the measure was taken. For the sake of consistency, the angle used was that formed by two lines -- one represented by the platform thickness, the other extending down the exterior face directly in line with the axis of percussion to a distance equal to the platform thickness. Weight was variously taken to the nearest 1 or 2 grams, depending on the precision of the scales being used. For the experimental flakes, platform width and flake width are constant (one-half inch) and only three values of exterior platform angles are represented.

A very conservative approach was taken with regard to all of these measurements: if landmarks were unclear, or if it looked as though a portion were missing, then the measurement was recorded as missing. Such problems were most apparent for the platform measurements, exterior platform angle, and bulb length. The measurement of exterior platform angle is especially difficult if the platform surface was markedly curved in the interior-exterior plane just behind the point of percussion or if the exterior surface of the flake was too irregular. Again, such cases were omitted from consideration. On two separate occasions the level of inter-observer reliability on this measure was checked and the results found to be satisfactory. Both the definitions of these observations and the general conservatism in their recording should be kept in mind when verifying these results with independent data.

Throughout this paper two words -- effect and association -- are used seemingly interchangeably to describe relationships among variables, but it is important to recognize the difference in their meanings. When the word "effect" is used, as in the effect of platform thickness on flake weight, it is because it is believed that there is a true independent-dependent, i.e., causal, relationship between the two variables. Association, on the other hand, means that two variables co-vary, but not necessarily because changes in one directly cause changes in the other. Many of the analyses that follow are based on showing relationships between variables. By themselves, these relationships do not demonstrate causal relationships, but only associations. In flintknapping, however, many clear independent-dependent relationships do exist, given that the knapper can change such factors as how the blow is delivered or the morphology of the core surface before the flake is struck. If other relevant variables are held constant, and increases in platform thickness are correlated with increases in flake weight, for example, then it is clear that the relation is causal: platform thickness was determined prior to the formation of the flake and, because other potential variables were not factors in producing variability in weight, platform thickness is left as the sole independent variable. Admittedly, when dealing with archaeological assemblages there are a great number of potentially relevant variables that cannot be controlled, so it is difficult to assume a causal relationship between any two variables. This is why controlled experiments, in which many variables are held constant, are necessary, and it is one more reason why a comparison between experimentally-derived results and those based on archaeological materials is crucial. Nonetheless, there are still many instances in which a demonstrated relationship cannot be assumed to be causal.

Although there is a great deal of variation in the kinds of assemblages represented here, the flakes, both experimental and archaeological, represent primarily hard-hammer direct percussion techniques in which the hammer struck a platform surface. No claim is made that the relationships found here are directly applicable to other tech-
niques, such as bifacial thinning, bipolar, pressure flaking, etc.

One final clarification is needed to facilitate interpretation of the analyses that follow. In virtually every example except Figure 1, the individual data points shown on the graphs do not represent individual cases, but rather average values of the Y-axis variable for all of the cases within a given interval of the X-axis variable. Thus the probability statistics given in the figure legends are based on Analysis of Variance of the differences among the means and not correlations based on individual flakes. This approach was taken because individual variability, especially in the archaeological data, is quite high; in fact, there is often so much individual variability that it tends to obscure real relationships. This variability is a result of two things. First, it is a fact that many variables contribute to flake morphology. If we are interested in examining just the relationship between platform thickness and flake weight, for example, it is impossible to choose flakes that are constant in every other measure. Thus individual flake variability is high because of the varying effects of those other variables, but the use of averages can help to isolate significant trends. The second source of variability is measurement error, a result of either the difficulty of taking certain measurements or of problems in operationalizing certain attributes. An example of the second problem is platform area, which is the product of platform thickness and platform width. This is a fine measure if the platform surface is rectangular in shape, but it will vary from the true area if the platform surface is round, triangular, or virtually any other shape. To the extent that these are random and not systematic errors, individual variability may be high, but the average values will accurately represent the central tendency.

RESULTS

Various controlled experiments have demonstrated that two aspects of flake platforms -- platform thickness and exterior platform angle -- have significant effects on flake size (Speth 1972, 1974, 1981; Dibble and Whittaker 1981; Dibble and Pelcin 1995). This has been shown (Dibble and Pelcin 1995) by plotting flake weight against platform thickness for three different exterior platform angles (see Figure 1). For each value of exterior platform angle, increasing the platform thickness resulted in heavier flakes. Likewise, the slope of the relationship between platform thickness and weight differed among the three values of exterior platform angle, such that higher exterior platform angles resulted in increasingly heavy flakes for the same value of platform thickness.

Another way of presenting these relationships, in the format that will be used throughout the remainder of this paper, is shown in Figures 2 and 3. In Figure 2, for example, the average weights of the experimental flakes with various platform thicknesses are plotted and it is clear that increased platform thickness results in larger flakes. In Figure 3, the relationship between exterior platform angle and weight is shown broken down by different values of platform thickness. Within each interval, increasing the exterior platform angle results in larger flakes. Note that the largest average flake weights result from high values of both platform thickness and exterior platform angle. In the archaeological sample, increases in platform thickness have a similar effect on flake weight, as shown in Figure 4.

Although the effect of platform width on flake weight was not addressed in the experiment because of the design of the cores, it is possible to examine this relationship with the archaeological sample. As can be seen in Figure 5, platform width expresses a similar association with flake weight. However, the relationship shown here is possibly misleading: since platform thickness tends to be highly correlated with platform width, it could be that the platform width-to-weight relationship is really only a reflection of the relationship between platform thickness and weight. In order to determine the effect of platform width alone, Figure 6 displays the average weights of flakes by intervals of platform width within particular intervals of platform thickness. In this way it can be seen that, for a particular interval of platform thickness, increases in platform width result in larger flakes. Given, then, that both platform thickness and platform width directly affect flake size, it should be no surprise that platform area (the product of platform thickness and platform width) also shows a clear relationship with weight (Figure 7). Since platform area reflects the combined influence of both platform thickness and platform width, all of the remaining analyses of archaeological data will be based on it.

To demonstrate the effects of exterior platform
angle on weight, it is necessary to control for the competing effects of platform area. Again, the clearest way to do this is to plot exterior platform angle against weight by particular intervals of platform area, which allows us to hold platform area relatively constant and thereby isolate the effects of exterior platform angle alone. When this is done (Figure 8) the effects of exterior platform angle on weight, for particular platform areas, are clear and follow patterns similar to those seen in the experimental data (refer to Figure 3).

Since exterior platform angle and platform area each have a direct relationship with overall weight, it would be expected that increasing either or both of these platform variables would also increase flake dimensions, i.e., length, width and thickness. This is generally the case in both the experimental (Figure 9) and archaeological (Figure 10) data. In comparing these two figures, bear in mind that the experimental cores had a constant platform width, so that on these cores platform area is directly and linearly related to platform thickness (in other words, doubling the platform thickness doubles the platform area). Thus the platform thickness of the experimental flakes is directly comparable to the platform areas used with the archaeological data. Likewise, the widths of the experimental flakes was also constant, so their surface areas are directly reflected by length alone.

Platform morphology alone is thus a significant factor affecting flake size, whether size is expressed in terms of weight or dimensions. Obviously, flake weight is a direct function of the three dimensions, but the importance of separating these two aspects of size (weight versus dimensions) will be addressed in more depth later in the paper. For now, it is clear that a flintknapper has two options for increasing overall flake size: prepare either higher exterior platform angles or bigger platform areas. While these are not mutually exclusive options over a range of different flake sizes, to produce a flake of a given size there is the possibility of having a high platform area and low exterior platform angle, or conversely, a low platform area and high exterior platform angle. Thus, using weight as a reflection of size, when we look at the data for any single weight, these two variables should be inversely related to each other. As shown in Figure 11, this is the case for both the experimental (upper graph) and archaeological (lower graph) data. Thus, adjusting platform area or exterior platform angle represents two alternatives open to the flintknapper.

It should be clear that, in every case in which direct comparisons can be made, the archaeological data show the same relationships between platform morphology and flake size that are seen with flakes produced under controlled experiments. This is important for a couple of reasons. First, it helps to validate the results obtained from such experiments. In spite of their artificial conditions, they are useful for isolating and objectifying relationships that are relevant to archaeological materials. Some of these relationships are difficult to observe in normal flintknapping simply because so many variables are operating simultaneously. Second, looking at it from the opposite point of view, the successful extension of the experimental results strongly suggests that a large number of potentially significant independent variables (hammer type, angle of blow, etc.), which were controlled in the experimental situation, exert only minor, if any, effects on these relationships (see also Pelcin 1996).

Other factors can be examined in the archaeological data to see what effects they may have, if any. Three types of comparisons that reflect aspects of overall core reduction technologies are presented here: scar morphology, technological category, and industry. In Paleolithic research (e.g., Dibble and Bar-Yosef 1995) attention is currently focused on these kinds of variables as representing a major source of inter-assemblage variability. Thus it is important to see whether or not different core reduction technologies affect the relationships under investigation here.

In order to save space, the comparisons presented here are based on only two of the relationships shown above: platform area-to-flake weight, and exterior platform angle to the ratio of surface area to platform area. The first (Figure 12) is the effect that scar morphology has on these relationships, which appears to be minimal. The second (Figure 13) examines the role that basic technology plays, as recorded on flakes that are clearly diagnostic of one or another of three major technological categories -- Levallois, blade, and “normal” (or non-diagnostic). Admittedly, these technological classes are very superficial and probably encompass a tremendous amount of variability. Nonetheless, they all show the same general relationships.
The third comparison (Figure 14) is broken down by industry. Here the number of potential factors that may affect the relationships in question is quite high. Raw material is one of the more important of these. While most of these industries are made on local flint, the Nubian Khormusan people utilized ferracrete sandstone, while the flints used at the other sites also differed in terms of size and abundance. However, good data on the raw materials used in these assemblages are not available in a way that could be systematically incorporated into the present analysis. There are also clear technological differences among these industries, which result in different core morphologies. The Khormusan, Levantine Mousterian, and Biache are all considered Levvallois industries, though the specific reduction sequences vary considerably (cf. Boëda 1988; Meignen and Bar-Yosef 1988, 1991, 1992; Dibble 1995a; Sellet 1995). The Levantine Upper Paleolithic sample is composed of both Ahmarian and Levantine Aurignacian, which have varying emphases on blade production. Level F4 from Pech de l’Azé is Mousterian of Acheulian tradition and includes some biface manufacture, while Combe-Capelle has relatively little Levallois production and no bifaces. Although the various industries are somewhat separate from each other, which presumably reflects the effects of these uncontrolled variables, the basic relationships are still apparent within any one of the assemblages.

What these figures suggest is that, while core reduction technologies differ among Paleolithic assemblages, they do so independently of the kinds of relationships examined here. Thus platform morphology and its effects on flake morphology represent a completely separate dimension of lithic technology and flake assemblage variability.

DISCUSSION AND CONCLUSIONS

Platform area alone has been utilized for some time as a means to control for original flake size in assessing the degree of reduction that took place on a flake tool from retouching (Dibble 1987, 1995b). The results presented here support such an approach, though they also suggest that exterior platform angle should be taken into account as well, in assessing flake size. The implications of these results go beyond attempts to reconstruct or control for original flake dimensions. They suggest that platform characteristics are of major technological importance for the production of flakes. The aspects of the platform that were addressed here (platform thickness, platform width, and exterior platform angle) are all under the direct control of the flintknapper, and they are true independent variables in that they directly affect flake morphology. This is not to say that they represent the only factors affecting flake morphology, and they are certainly not the only important factors giving rise to lithic assemblage variability. But they do have major effects and undoubtedly reflect strategies employed by the flintknapper to produce different results. They represent aspects of lithic technology that are relevant to behavior and should not be ignored in reconstructing prehistoric technologies.

It should be emphasized again that these results have relevance only for flakes produced by direct percussion on a platform surface. The extent to which they are applicable to flakes produced by pressure is not known, though it is likely that the relationships would remain essentially the same. The results obtained from other techniques, such as bifacial flaking (in which the exterior edge of the platform is struck) or bipolar flaking, are probably not directly comparable. It also bears repeating that, as clear as these relationships are, there is a great deal of variability among individual flakes. It is quite easy to find large flakes with small platforms and small flakes with large platforms. Many factors interact in complex ways to give rise to flake morphology and results are not always completely predictable. On the other hand, even with only a moderate amount of experience, a flintknapper can achieve a significant degree of control over flake variability. By isolating the contribution that platform morphology makes on flake variability, our understanding of different flaking strategies is enhanced, even if that contribution is less than 100 percent.

Beyond the demonstration of the relationships between platform morphology and flake morphology, what is interesting is that prehistoric knappers adopted different strategies with respect to how they set up platform morphology. For example, among the assemblages included here, there is a high degree of variability in terms of platform area and exterior platform angle (Figure 15). Some assemblages -- for example, the Levantine Mousterian from the site of D40 -- seem to maximize both exterior platform angle and platform area. Others appear to minimize platform area but
exhibit relatively high exterior platform angles, or vice versa. Although the choice of adopting one strategy over another may simply reflect different technological traditions, it may also be related to a number of other factors.

As shown above, increasing either platform area or exterior platform angle increases overall flake size. Industries that have, on average, high values for both probably reflect an attempt to maximize the size of the resulting blanks. This may reflect conditions in which raw material was large and plentiful. But differences also result from increasing platform area, on the one hand, and exterior platform angle, on the other. These may reflect different flintknapping strategies that may also be related to either raw material or other considerations.

The choice of one or the other of these approaches is related to differences in flake morphology, especially with respect to flake dimensions relative to platform size. If flakes are made bigger by increasing the size of their platforms, then there is a general decrease in flake dimensions relative to platform size (Figures 16 and 17). Adjusting the exterior platform angle shows the opposite association: flake dimensions in relation to platform size increase with higher exterior platform angles. For the archaeological sample only the ratio representing flake area to platform area is shown, but there is a similar effect for both length and width individually. Thus, increasing the exterior platform angle results in larger flakes relative to their platform areas.

This difference, which is illustrated schematically in Figure 18, has a couple of important implications. First, there is a consideration of core maintenance. By producing larger flakes with larger platforms, more of the edge is removed as the striking platform for a given flake area. If the exterior platform angles are increased instead, then the striking platform of a core is conserved longer, thereby extending the usefulness of the core in relation to the size of the flakes taken from it.

Second, platform area represents, for most purposes, wasted material on a flake blank: it provides no cutting edge, and is rarely retouched, and its overall size may constrain hafting. Furthermore, it can be shown in the archaeological data that bulb length is also associated with platform area (Figure 19), though it is likely that platform width contributes more than platform thickness to bulb length. Given that the bulb is itself a function of platform size and it, too, represents a less desirable portion of the total flake weight, it would not always be advantageous for a flintknapper to follow a strategy of increasing flake size by increasing platform size. By producing flakes with higher exterior platform angles, however, s/he can increase flake dimensions while simultaneously holding down the size of both the platform and bulb. This would help maintain core striking platforms and, at the same time, produce more efficient flake blanks.

On the other hand, employing higher exterior platform angles has disadvantages. As shown by Speth (1981) and Dibble and Pelcin (1995), the range of both force and angle of blow that will produce a flake is considerably less with higher exterior platform angles than with lower ones. Therefore, it is generally easier to produce flakes with lower exterior platform angles. If raw material is abundant, then core maintenance may not be a significant consideration and smaller exterior platform angles may be employed. If it is scarce, then increasing flake exterior platform angles would help both to economize cores and to produce more efficient flake blanks, though the degree of control necessary in flaking is increased. With these considerations in mind, it is interesting to note that both D40 and Combe-Capelle are primary exploitation sites in the immediate vicinity of raw material (Munday 1976; Marks, personal communication; Dibble and Lenoir 1995), and both are among those sites with the highest platform areas. There may also be considerations involved with the maintenance of high platform angles through faceting or other methods of core platform rejuvenation.

Certain aspects of platform variability described here also have implications for recent discussions of flake size and group mobility, in which it has been argued (Kuhn 1994, 1996; cf. Morrow 1996), based fundamentally on surface area to weight ratios, that smaller flakes are more efficient in terms of transport costs. It is true that allometry alone would predict that smaller flakes have greater surface area to weight, since surface area increases as the square, while weight increases as the cube. If all dimensions increase equally, then larger flakes, even though they could sustain more resharpening because of their abso-
lute size and thus have higher potential use-lives, would necessarily have smaller surface area to weight ratios and thus would represent less efficient objects for transport. It has been repeatedly demonstrated, however, that larger blanks were consistently selected for tools and transported during the Paleolithic, at least (Geneste 1985; Dibble 1988, 1995a, Dibble and Holdaway 1993; Meignen 1993; Dibble et al. 1995). If larger flakes are less efficient, then why are they consistently the ones being selected and transported?

Assuming that flakes will be reduced until they reach some minimum size (Dibble 1995b, Kuhn 1994), larger flakes do have an advantage in that a smaller proportion of their overall size is simply waste. As pointed out by Kuhn (1996), however, the real issue is not overall size, but shape: for flakes with the same weight, thinner flakes with larger surface areas are more efficient (in terms of resharpening potential) than thicker flakes that have less surface area. Such a change overcomes the predicted allometric relationship, and thus represents a possible technological strategy that could be advantageous under certain circumstances. In fact, it has been shown at Combe-Capelle (Roth et al. n.d.) that transported flakes (those imported into the site) do exhibit higher surface area to weight ratios than those that were manufactured from immediately available material and left behind. So it seems likely that at least some Paleolithic peoples recognized the advantage of such flakes when they selected them for transport.

The archaeological data presented here also suggest that knappers influence such differences in flake shape by changing their platform morphology. In these data, varying ratios of platform width to platform thickness are associated with different ratios of flake surface area to thickness. When both exterior platform angle and platform area are controlled, the ratio of platform width to platform thickness does not have a significant association with overall flake weight (Figure 20, upper graph). However, producing larger platform widths relative to platform thicknesses clearly changes the distribution of weight, expressed by flakes with increasingly higher ratios of surface area to thickness (Figure 20, lower graph). Thus, one way to increase a flake’s surface area to thickness, and therefore make it more efficient, would be to increase platform width relative to platform thickness. Moreover, even when we look at assemblage averages (Figure 21), the relationship between platform width to thickness and flake surface area to thickness is clear. The distribution shown here may indicate that some of these industries were intentionally providing more efficient flakes for transport.

These are just two examples to show that understanding platform morphology and its effects on flake morphology may relate to an overall understanding of the adaptive significance of lithic technological variability. Further research is needed in this area, and it would be premature to claim that flake platform variability is more important than other aspects of lithic technology. On the other hand, it cannot be denied that it represents a significant factor, and one with potential for interpreting assemblages in terms of past behavior and adaptation. What must be kept in mind is that platform variability reflects actions that a flint knapper takes prior to the removal of a single flake, presumably to achieve certain desired effects. Understanding what those effects are should help in recognizing particular strategies employed by prehistoric flintknappers.

Knowing the effects of various platform characteristics on flake morphology, however, is only one aspect of the problem. There is also a need to understand and recognize different options for controlling them. There are probably many different ways to change platform angles, for example; and likewise, platform shape can vary as a result of many different actions. Moreover, there is an obvious need to understand more of the effects of core surface morphology on flake variation, especially lateral and longitudinal convexity. This is more than just a question of scar patterns, since similar core morphologies can be produced in different ways..

As stated at the beginning of this paper, patterns of core reduction sequences represent an important aspect of lithic technology, and the identification of particular reduction patterns is a justifiable goal in lithic research. It is hoped, however, that a case has been made here that understanding even more fundamental aspects of flintknapping also can provide insights into how and Why lithic assemblages vary. By adding this dimension to our analytical arsenal, our understanding of prehistoric lithic technologies will improve.
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**Figure 1.** Graph of flake weight against platform thickness for experimentally produced flakes, including all combinations of indenter mass and velocity. Symbols represent different exterior platform angles (circles: 75°, squares: 65°, triangles: 55°) (from Dibble and Pelcin 1995).

**Figure 2.** Relationship between platform thickness and flake weight, combining all values of exterior platform angle, in experimental data ($F=7.6$, $df=9$, $P < .001$). In this and all subsequent figures, each data point represents the mean 'Y' value of all the cases within each interval of the 'X' values.

**Figure 3.** Relationship between exterior platform angle and weight, broken down by intervals of platform thickness, in experimental data. Within each interval of platform thickness, flakes with higher exterior platform angles have higher average weights (all significant at $P < .01$).

**Figure 4.** Relationship between platform thickness and flake weight for combined sample of archaeological data ($F=114.58$, $df=9$, $P < .001$).
Figure 5. Relationship between platform width and flake weight for combined sample of archaeological data (F=390.7, df=5, 9050, P < .001).

Figure 6. Relationship between platform width and flake weight, broken down by intervals of platform thickness, for archaeological data. Within each interval of platform thickness, flakes with higher platform widths generally have higher average weights (all significant at P < .01), except for 4-5 mm interval of platform thickness.

Figure 7. Relationship between platform area (the product of platform thickness and platform width) and flake weight for combined sample of archaeological data (F=162.98, df=10.8583, P < .001).

Figure 8. Relationship between exterior platform angle and flake weight, broken down by intervals of platform area, for archaeological data. Within each interval of platform area, flakes with higher exterior platform angles have higher average weights (all significant at P < .05 across full range of exterior platform angles).
Figure 9. Effects of platform thickness and exterior platform angle on flake length and thickness for experimental data (all significant at $P < .001$). Notice that, for a given exterior platform angle, average flake thickness and length increase with increasing platform thickness. Likewise, for a given platform thickness, these averages increase with exterior platform angle.

Figure 10. Effects of platform area and exterior platform angle on flake thickness and surface area for combined sample of archaeological data (all significant at $P < .05$ across full range of exterior platform angles). For a given interval of exterior platform angle, average flake thickness and surface area increase with increasing platform area. Likewise, for a given platform area, these averages increase with exterior platform angle. Note that flake surface areas and platform areas shown here for archaeological flakes are directly comparable to the flake lengths and platform thicknesses, respectively, of the experimental flakes shown in Figure 9 because both platform and flake width were constant in the experimental pieces (see text).
**Figure 11.** The relationship between exterior platform angle and platform size by weight intervals for experimental (upper graph: using platform thickness only, since platform width was constant) and archaeological (lower graph) data (all significant at $P < .001$).

**Figure 12.** Platform morphology and size and shape by different categories of scar morphology. Cortical flakes have surfaces with at least 50 percent cortex; other scar morphological categories have less than that. Upper graph: Relationship between platform area and weight (all significant at $P < .001$). Lower graph: relationship between exterior platform angle and the ratio of surface area to platform area (all significant at $P < .001$).
Figure 13. Platform morphology and size and shape by different technological classes. Upper graph: Relationship between platform area and weight (all significant at $P < .001$). Lower graph: relationship between exterior platform angle and the ratio of surface area to platform area (all significant at $P < .01$).

Figure 14. Platform morphology and size and shape by different industries. Upper graph: Relationship between platform area and weight (all significant at $P < .001$). Lower graph: relationship between exterior platform angle and the ratio of surface area to platform area (all significant at $P < .01$).
Figure 15. Average exterior platform angle plotted against average platform area for several Paleolithic assemblages.

Figure 16. Experimental data. Upper: The ratio of flake length to platform thickness as function of exterior platform angle, by intervals of platform thickness (all significant at P < .01), except platform thickness intervals 12-14 and 18-20). Lower: as function of platform thickness, by intervals of exterior platform angle (all significant to P < .01).
Figure 17. Archaeological sample. Upper: Flake surface area to platform area as function of exterior platform angle, by intervals of platform thickness (all significant at $P < .001$). Lower: Flake surface area to platform area as function of platform thickness, by intervals of exterior platform angle (all significant at $P < .001$).

Figure 18. Schematic cross-section of two flakes produced with different exterior platform angles and platform thicknesses; both are drawn to have the same cross-sectional area. In the upper figure, this area is produced by increasing platform thickness while decreasing the exterior platform angle, with the result that more of the flake volume is taken up by the platform with less distributed on the surface of the core. Although the increased flake surface area is represented in the lower figure in terms of length, it is likely that core surface morphology plays a major role in determining the extent to which length and width are individually affected.

Figure 19. Average bulb lengths by intervals of platform area for combined archaeological sample ($F=97.9$, df=10,1556, $P < .001$).
Figure 20. Upper: Average weight divided by platform area (to control for the effects of the latter) plotted against intervals of the ratio of platform width to platform thickness, by intervals of exterior platform angle. None of these intervals show a directional change significant at P < .05 level. Lower: Ratio of flake surface area to flake thickness as a function of the ratio of platform width to platform thickness (F=6.28, df=7, 443, P < .001).

Figure 21. Average flake surface area to flake thickness ratio plotted against the ratio of platform width to platform thickness for several Paleolithic assemblages.