The Corbiac Blade Technique and Other Experiments
by Francois Bordes and Don Crabtree

In September, 1967, Dr. Francois Bordes and the writer spent two weeks experimenting with many flintknapping techniques, replicating various artifacts, and analyzing and comparing our work to aboriginal tools. But our prime concern during this work session was the replicating of Corbiac blades and cores, which had been previously defined by Bordes as being a method of detaching blades by indirect percussion with punch and rest. This paper will be primarily concerned with the Corbiac technique of blademaking, but will also include a description of the thinning of bifaces by first direct and then indirect percussion without rest; blademaking by indirect percussion with foot holding; blademaking by indirect percussion without rest; and, finally, a comparison of Clovis blades and cores to the latter technique. Since this has been our first opportunity to work together uninterrupted, we felt we should collaborate and jointly publish our findings and conclusions on the Corbiac technique and other experiments.

Because this paper is primarily concerned with blademaking, it may be well to consider here the technological aspects of a blade. A personal (D.C.) definition is: A specialized, elongated flake with parallel to sub-parallel lateral edges; its length being equal to, or more than, twice its width. Cross or transverse sections may be either plano-convex, triangulate, sub-triangulate, rectangular, trapezoidal, and with one or more longitudinal crests, or ridges. Typical is trapezoidal. <u>On the dorsal side of the blade there should be two or more scars of previously removed blades with force lines and compression rings indicating that force was applied in the same direction as blade detachment</u>. (insert page 2A here)

In the Summer of 1966, the senior author, Dr. Francois Bordes, excavated an Upper Perigordian site at Corbiac in the Dordogne Valley in Southeast France. This proved to be a very important find, for the site yielded a vast quantity of blades, cores (approximately 1,000), burins, and tools in various stages of fabrication; as well as broken, aberrant, and malformed cores. There were an estimated 100,000 precision made blades with very small platforms, denoting a punch technique (later two stone punches were found in this site); and a rest was indicated because the curve of the blade was lessened to such a degree that some could almost be called flat. He carefully examined the vast quantities of both completed tools and those exhausted by use; and analyzed the flake debitage which included the toolmakers' discards - rejected either because of flaws in the stone, miscalculations, or an error in judgement. Always, the worker must either adapt to these conditions and errors and, if they are insurmountable, then the piece must be discarded. Any one, For those who are not familiar with working stone, it seems fitting to mention here a few points regarding blade scars which may help in analysis. To determine the sequence of blade removal from a core, it is well to make note of the striations found on the lateral margins on the ventral sides of the blades and their opposite, or negative, duplications on the lateral margins of the blade scar on the core. The striations, or minute fissuring, is caused by the compression of the blade material as it is removed from the face of the core. Striations are generally more obvious on vitreous materials than they are on stone of a coarser texture. Marginal striations are tangent and oblique to the marginal edge and slant up~~stream~~ toward the proximal end of the blade to the point of applied force. Only a complete blade scar will have the striations on both sides, or the lateral margins. For example, the last blade removed from a core will have striations on the lateral margins of both the core and blade. On the other hand, a core scar with striations on one lateral margin will indicate that a second blade was removed which eliminated the striations from one edge of the previous blade scar on the core.

or all three, of these factors may be involved with any single piece, for there is no exact repetition of factors when one is reducing an irregular mass of flint to blades or tools. This is one of the reasons why debitage is always important for it provides the many stages of development of toolmaking and, in this case, the making of both blades and cores.

After a careful analysis of tools, cores and debitage, Bordes eliminated both pressure and indirect percussion as the blademaking technique and defined the manufacturing method as indirect percussion with rest. He then spent his evenings experimenting with and eliminating various manufacturing methods in an effort to ultimately resolve the exact Corbiac blade and core technique. This took much time and hard work, for each experiment had to include the many individual stages of manufacture. But, ultimately, he was successful in consistently reproducing the cores and blades of this culture.

Unlike other artifact types which have definite form, outline, and functional purpose, cores are variable. Their form, style, and types are many and the technological patterns vary, each retaining multiple diagnostic traits. Because the core demands very definite techniques for blade detachment, it is consistently reduced in size and changed in form and character during the intervals of first to last blade removal. Then the exhausted or malformed core is either abandoned, or further modified into another artifact; or simply reduced to useable flakes with sharp cutting edges. End products such as these would hardly be recognizable as former cores. A large population of either malformed or otherwise abandoned cores usually indicates an abundance of raw material and a blade or blade-tool industry. This paper emphasizes replicating the Corbiac cores and then later compares, by rational theory, the Clovis core style pertinent to the blades found at Blackwater Draw.

(Details and description of the Corbiac cores to be inserted here by Bordes)

Our duplications of the Corbiac cores were generally unifacial but a few were bi-directional. They were almost entirely made from either cobbles or ovoid lumps of obsidian with outside measurements of from seven to fourteen inches before preforming. After the top of the cobble was removed to provide a platform area, the overall length averaged between six and ten inches.

Following is a description of the Bordes experiments of replicating Corbiac blades and cores by indirect percussion with rest.

Preforming the Core:

Invariably the preforming of the core is the most difficult and important step of blademaking, and the Corbiac technique is no exception. If the core is not made right, then the blades will either fail to detach; they will step or hinge fracture; platforms will crush; the end of the core will be detached, * or the results will not be replicas. I cannot emphasize too strongly the importance of core preparation. (Figs 1-12) It is impossible to remove true blades from an improperly prepared core and no amount of skill can overcome poor preparation or conquer certain strains and flaws in the material.

A suitable piece of material, relatively free of flaws, of adequate size and proper texture is selected for the experiment. (Fig 1.) (Photo 3) The size of the rough material selected will depend on just how large a blade is desired and, to some degree, on what is available. Since our experiments were done at my home in Idaho, we used obsidian for it is plentiful here and we had very little flint. We would have preferred to use the flint of the Corbiac culture as obsidian is considerably more brittle than flint and, therefore, more subject to breakage from end shock. However, this substitution of material did not cause us to vary the Corbiac technique,

*blades will vary in thickness; will terminate before reaching the end of the core; bulb of force will be accentuated; shatter lines and fissures will be present; presence of eraillure scars, compression rings and undulations.

but only to modify it to conform to the material. In this case we considered this good flintknapping practice and probably an aid to refining the technique when applied to flint. Always, techniques must be adapted, or slightly modified, to suit the nature of the working material; for different textures and hardnesses require a variation of techniques. For example, because we were working with obsidian, we had to strengthen the platform area by grinding, decrease the velocity of the blow, detach thicker blades, and use a lighter percussor. This is not always necessary when flint is used.

After the cobble, or mass, of material has been selected for blade-making, the experimenter must mentally orient the proposed core within the cobble. That is, he must calculate to economically remove material from the mass in order to retain as nearly as possible the ultimate size of the nodule and yet properly prepare the core to the desired size and shape. One can never immediately start removing blades from a rounded mass and, therefore, the first step of core preparation is to eliminate the rounded surface and establish a working platform for preparation of a ridge to guide the first blade.

If the cobble is spheroid, an antler billet is used to percuss the natural facet on the cobble to remove a flake and establish a working platform. However, if the cobble is rounded and consequently has no natural facet, then the worker must establish one. This facet is needed to serve as the striking area, otherwise the blow will ricochet from the rounded edge when an attempt is made to remove the first flake. Material that is rectangular, blocky and without rounded surfaces is much preferred and more suitable for core and blademaking than round or spheroid cobbles. Angular material often has natural longitudinal ridges which may, after slight modification or unifacial trimming, suffice as a ridge to guide the first blade. If the longitudinal ridge is at the corner of a rectangular block of flint-like material, it is relatively simple to prepare the proper platform to facilitate the removal of the first blade. The rectangular shape eliminates elaborate preforming and just a slight grinding and polishing of the corner will ready the piece for blade detachment.

To remove the first flake from a rounded cobble, the worker uses a medium-sized hammerstone of semi-hard texture. A hammerstone is necessary for shaping a rounded cobble, for the antler billet would not deliver sufficient force to detach a flake from the curved surface. The worker holds the hammerstone almost vertical to the rounded edge of the cobble and strikes an intense blow to remove a flake and thereby establish working angles for further shaping the core. Usually, only one break is necessary to eliminate this rounded surface and establish the working surface for further preparation of the core. After this has been done (either with an antler billet on a natural facet; or with a hammerstone on a rounded cobble to prepare a facet) then the worker is ready to establish a ridge.

Preparing the ridge:

To create the first ridge longitudinally from the top to the bottom of the core, the worker uses an antler billet and strikes with sufficient force on the natural or prepared facet (platform) to remove a single flake from the rounded side of the cobble. (Fig 3) The antler billet and direct percussion is used for this flaking process to prevent the strains and shattering which would result from a harder percussor. This is the first step in a series of flakes to be removed in this same manner along one margin of the cobble to establish a ridge. (Fig 4) After the first flake is detached, the cobble is reversed and struck in this same way from the other side, using the scar of the first flake as a platform surface for removal of the next flake. The worker continues to strike flakes alternately on the edge of the cobble from top to bottom until a ridge is established. (Figs 4-9-10) An edge, or ridge, made in this manner will be sinuous, or wavey, from the alternate flake scars. If the waves are too accentuated, then the ridge will not be straight enough for blade removal. Therefore, the crests of the waves are removed by striking with the antler billet directly on the crests to detach them and, thereby, straighten the ridge. (Fig 5) This ridge will serve as a guide for removal of the first blade. Removal of the initial blade (ridge) will create two longitudinal ridges for removal of additional blades and so on around half the ~~circumfrence~~ circumference of the core. This preparation and follow-through is of the utmost importance because the form and shape of the core controls the type of blade detachment.

Severing the Top of the Core:

After the ridge is formed, then the top of the core is removed by any one of the following described methods:

1. Striking the core on an anvil stone (Fig 11)
2. By direct percussion with a hammerstone
3. Preparing a platform on the longitudinal ridge and then severing the top by indirect percussion with punch technique. (Fig 12)

Bordes preferred method 2, but I found that Method 3 was easier and more accurate for me.

When a core top is severed, Photo 22 the angle of the blow must be calculated and delivered to create a platform area with an angle corresponding with the core type to be replicated. The top (or platform) surface of the Corbiac core is severed to result in less than a right angle to the long axis of the core. (Fig 13-14) Photo 22 This platform angle is the result of the angle at which the force to remove the core top is directed and this blow must be in line with the pre-established ridge. Since the Corbiac core is prepared with a single ridge and the platform angle is less than forty-five degrees, it will be unifacial and not entirely

Polyhedral or cylindrical. The back, or the side opposite the working face of the core, usually retained the natural cortex surface. As blades were removed from the working face, they created new ridges, causing the working face to assume a rounded, polyhedral appearance with longitudinal facets. The working edge of the core top then had the appearance of a semi-circle. Sometimes, we were successful in detaching as many as thirty us~~e~~able blades from a core, depending on its size and proper application of manufacturing techniques. Later, when Bordes was giving a demonstration at the Washington State University in Pullman, he successfully detached fifty-three blades from a single core. Our cores were abandoned when the platform surface was exhausted and they were left with very little, or no, platform surface and the core was by this time elongated and half-cylindrical, showing blade scars on the rounded side and cortex on the other.

Angle of Core Top:

The top of the core is designed to slant at less than a 45 degree angle away from the apex (working edge). (fig 13) photo 22 This provides a bearing surface for seating the punch and prevents the tip of the punch from slipping and ricocheting from the platform part of the working face when the blow is delivered. Because of the acute angle at which the punch is held, it would be impossible to remove a flake or blade if the platform surface slanted toward the working edge.

Other core types, which generally do not have the top at this angle, overcome the slippage of the punch either by grinding; removing small flakes to leave small depressions (bulbar scars) in which to seat the punch; or by using rough natural eroded surface. However, the Corbiac core shows none of these characteristics.

Platform Preparation:

A small hammerstone is substituted for the antler billet to isolate the platform area. Isolation is accomplished by holding the hammerstone in the right hand; the core in the left hand; and pressing and thrusting the hammerstone downward against the top and toward the outer edge of the core above the pre-established ridge. Photo 15 This action will remove small flakes from the leading edge without causing hinge or step fractures. This operation is continued until the center of the platform is oriented above the ridge and in line with the center of the proposed blade. This preparation strengthens the platform part as well as removes any overhang. If isolation is not complete, then small flakes are removed from the top of the core on each side of the platform area until it is properly oriented and isolated. Note: these flakes are removed from the top of the core rather than the leading edge. For additional strength, the platform is then abraided on its top by rubbing with a granular stone other than a flint-like material. This dragging motion of the abrasive stone across the platform part will round the edges and give it a polished appearance.

If the core is prepared on both ends in the above described manner and blades are removed from both ends and terminated by feathering at the middle part of the core, a bi-directional core will result which is sometimes called bi-polar but which, in reality, is not. Bi-polarism is the result of force being ~~subjected~~ delivered simultaneously to the core from both ends.

(Cultural sequence of bi-directional and unifacial cores to be inserted here by Bordes)

<u>Seating the Core on Rest</u>:

When the core has been completely preformed and the platform prepared for the first blade(ridge) removal, it is then placed between the feet on a resiliant support to eliminate shock at the distal end. For our experiments, we used a pine board approximately 2 X 2 X 14. (Fig 16 21,22) Photos 13-17-35

The straightness of the Corbiac blades is the result of using a rest for it prevents movement of the core as the blades are detached and simultaneously causes force to be exerted at the base of the core when the blow is delivered to the prepared platform at the upper end of the core. Cores not supported on a rest will produce strongly curved blades. Corbiac blades are further characterized by the absence of undulations and waves of compression, features which are characteristic to those detached from the core by direct percussion with a hard hammerstone. Another distinct feature of the Corbiac blades is their distal end termination. The ends feather out without removing any part of the distal end of the core. This is due, in part, to the rest or anvil and can be controlled to a degree by the angle at which the punch is held.

The blademaker assumes a seated position slightly elevated above the core; places the core on the rest and holds it tightly between both feet. (photo 13/17) Core is positioned on the rest with the side to be worked pointed away from the worker with its distal end supported by, but overhanging, the edge of the wooden rest. This allows the blades to clear the plank and thereby eliminates breakage. The core is held by the feet in almost a vertical position (or to suit the convenience of the worker) with the longitudinal ridge placed away from the worker. This vertical position may vary slightly with the worker's preference.

Detaching Blades:

The indirect tool is a cut section of reindeer antler about six inches long with one end shaped to a blunt point. (fig 21; photo 13/17/35) It is possible to use a stone punch when working flint, but this would not be satisfactory to use on ~~the~~ more ~~friable~~ brittle materials such as obsidian. This punch is held in the left hand and its tip placed and held on the platform at a low angle. (exact angle to be calculated)

Using a heavy section of antler about fourteen inches long for the percussor, (photo 13, 17) the right hand delivers a blow of sufficient force to the proximal end of the punch to detach the blade. When working flint, a soft hammerstone may be used in lieu of the antler percussor because some siliceous rocks are not as brittle as vitreous stone. The antler punch as well as the antler percussor acts as a shock absorber and causes the force to be delivered more slowly to the platform of the proposed blade. At present, there is no means of measuring the amount of force necessary to remove a blade from a core, for much depends on the type and size of the material and the blade length desired. Since the blade is first detached at the proximal end of the core and then literally peeled down its face, the amount of force is reduced if the platform is isolated from the core prior to blade detachment. A quick rule of the thumb method to determine the necessary amount of force is to calculate the area on the ventral side of the proposed blade in relation to the material and then formulate the ~~amlunt~~ amount of force necessary for detachment. When making blades, the same material should consistently be used, for one becomes accustomed to controlling the blow on a given material and it may take several days to correlate the amount and kind of force necessary when material is used which is different in texture and elasticity. Some materials are worked best with a short high velocity blow with no follow through; while others are best worked by using a slow blow with a heavy percussor and a follow through. Blades leave the core at considerable velocity and must be recovered on some type of soft, yielding material to prevent fracture.

Then the blades are studied and their character compared to aboriginal blades being replicated and each detail noted and evaluated. Corbiac blades have very small platforms with the angle corresponding to that of the core before blade detachment. There is a general absence of eraillure flakes on the bulb of force and no fissures radiate from the point of force in the bulbar part. The blades have one or two longitudinal ridges (percentage unknown) and the curve is so slight as to be almost flat; and they are free of undulations on the ventral side. (Further description and drawings of blades and dimensions to be inserted here by Bordes). One cache ~~contains specimens~~ ~~of blades found~~ at Corbiac contained blades which were as much as forty centimeters long. For our experiments, we had no rough material large enough to attempt replications of this dimension. Corbiac blades are usually feathered and terminated without removing the distal end of the core. (photo 44, 12) At the proximal end, the blade is the width of the platform area which is minute in relation to the size of the blade. (photo 12) At each lateral platform margin, the blade rapidly expands in a curve until it reaches its width limitation and then runs longitudinally parallel to the opposite edge to its termination and can vary from parallel to sub-parallel. (Photo 12,44)

In our experiments, the widths of the blades were variable and were controlled by the form of the working face of the core. The more attenuated the ridge and the narrower the core, the narrower the blade. The thickness of the blade is also controlled by the position of the punch and the design of the platform in relation to the core. The nearer the punch is placed to the leading edge of the core, the thinner will be the transverse section of the blade. A blade that is triangulate will have the platform oriented in line with the single ridge on the core and the blade that is trapezoidal in transverse section is one that has had the platform oriented between two longitudinal ridges. The proximal ends of the blades are characterized by very small platforms (relative to the blade size) of a uniform consistency which cannot be replicated by using direct percussion and a hammerstone or billet. The size of the platforms are the contact area of the punch's semi-pointed tip. The bulbs of force are not prominent and are generally in line with the ventral surface of the blade. Also, the bulbs are smooth, usually without eraillure flake scars and have no signs of shatter scars radiating from the point of force. These features indicate that the interval of contact was more prolonged than when a hard blow is delivered by direct percussion with a hard hammer.

Marginal striations on the ventral sides were not noted on flint blades but were quite obvious on blades of obsidian. An deviations of straightness of the ridge, or ridges, caused the blades to follow the irregularities and a malformed blade resulted. (fig 20) If differential resistance within the material caused the previous blade scars on the core to be deviant then subsequent blades would also be deviant. In some cases, the ridge could be straightened by placing the platform farther back from the leading edge of the core and then increasing the normal amount of force. This detached a thicker blade and thereby straightened the ridge. If an imperfection was encountered on the ridge, it could be removed by detaching a series of flakes at this irregular part to straighten the ridge. Some imperfections could not be overcome and then the core had to be abandoned.

Should a blade terminate in a step or hinge fracture prior to complete detachment, then the core must be either abandoned or recovered by removing the balance of the blade up to this truncation. This is done by preparing a platform on the distal end of the core and directing the force, at a reduced velocity, to intersect, terminate, and detach the blade at the step or hinge fracture. Each error, miscalculation, or imperfection in the material must be considered individually because each presents a different set of problems to the worker. No amount of skill can overcome some of the problems encountered and then the core must be discarded.

When appraising both aboriginal and experimental artifacts to resolve the approximate technique, we would agree on manufacturing methods but our individual experiments were somewhat different, yet replications were almost duplicate. As previously mentioned, Bordes had resolved the manufacturing technique of the Corbiac blades; which involved a seated position with the core held between the feet on a rest, placing the punch on the platform above the prepared ridge at a low angle, and striking away from the body. After Bordes had demonstrated this technique and I experimented several times, I found I could replicate Corbiac blades with this technique. However, it was more comfortable for me to reverse both the working face of the core and the striking pattern.

I assumed the sitting position andplaced the core on the rest between the feet with its edge clearing the support but with the working face of the prepared ridge facing me. Then I seated the punch on the platform above the ridge at the same angle previously described in the Bordes' method but with the tip of the punch pointed toward me.

The velocity of striking was not changed, but the blow was delivered to the punch toward me rather than striking away from the body as practiced in the Bordes method. This was easier and more accurate for me because it does not require leaning so far forward and also because I had been doing a similar but varied blademaking technique for the last six months and had become accustomed to this pattern. This position is more dangerous than the Bordes technique as the blades detach toward the worker but it has the advantage of being able to see what is actually happening. This slight variation permitted me to align the punch on the guiding ridge with much greater accuracy and actually view the blade detachment. Since the angle of seating the core, striking pattern, punch and rest were the same in both experiments, the termination and flatness of the blades was much the same.

Indirect Percussion Without Rest:

When the above described position became unduly tiring, I experimented with a more comfortable body position. I sat on a little taller stool, placed the core on a pad of folded layers of buffalo hide and held it between my knees for both the preforming of the core and detaching blades. This position was more comfortable and I was able to make blades with less effort than in the seated position with the core held between the feet. Photo 38 However, the blades made by knee-holding had an entirely different character than those made by the Bordes' technique for this method lacked the solid support of the core.

Even though the angle of applied force, the type of blow, and the platform preparation were the same, the lack of support on the base of the core allowed it to be partially projected from the force of the percussor and, therefore, the curve of the blades was more accentuated. Also, the blades did not feather out and they often terminated with a part of the distal end of the core adhering. This knee-holding experiment did show, however, that fewer blades were broken because the leather pad acted as a cushion for the dorsal side of the blades, dampened the shock and, therefore, allowed the recovery of more intacted blades. more blades were recovered intact. We concluded that this method would not produce the Corbiac type of blade.

Bordes observation of this technique did, however, result in additional experiments and slight modification of the Corbiac technique.

He tried wrapping the core in a cloth, Photo 17 or any soft material, to lessen the shock and prevent ~~projection~~ propulsion of the blades. This did reduce blade breakage. The ideal way, of course, to reduce breakage and remove blades intact, is to regulate the amount of force of the blow to a ratio which will detach but not project the blades. This skill can only be attained by practice and repeated experiments.

Our experiments in blademaking revealed technological differences which were significant when related to those of the aboriginal. For instance, we noted that blades made by this technique were similar to the Clovis blades illustrated and described by F.E. Green (The Clovis Blades, American Antiquity, Vol.29, No.2, pages 145-165, Oct, 1963)

The major difference between the Corbiac blades and those produced by this technique is in the degree of curvature of the blade and, interestingly enough, ~~enigmatically,~~ ~~this same~~ is the difference ~~is~~ noted between the Blackwater Draw ~~blades~~ blades and the Corbiac blades. The Blackwater Draw blades had most of the characteristics of the Upper Paleolithic Corbiac blades, except they were strongly curved and they did have a marked resemblance to those made by our indirect percussion-without-rest technique described above. It is not the intention of the writer to imply that there is a merging of Old and New World technique but only parallels in methods of blade detachment. The fact that a rest <u>is</u> or <u>is not</u> used may appear to be a minor technological trait but. in reality, this pronounced curve in the blade indicates a major difference in fabrication. Our experiments indicated that strongly curved blades are the result of the core moving when the blow is imparted to the punch; and that flat, or gently curved blades, resulted when the core was securely immobilized and a support used at its distal end. It is interesting to note that a minor change in technology can cause a major technological trait which can serve as an archaeological index to determine invention or tradition and cultural differences in time and space.

In terms of reconstructing the sequence of events in blade production, it is evident that the cache of blades from Blackwater Draw represents the first stage of blade manufacture. These blades are characterized by the cortical surface of the parental material on the dorsal side and have a triangulate, transverse cross section. This condition indicates the aboriginal flintknapper took full advantage of the additional strength provided by the single ridge on the dorsal surface. This technique is to be distinguished from blades with a trapezoidal cross section with two ridges occurring on the dorsal face. Blades with triangular cross sections are stronger since there is a greater mass of material than occurs on blades with a trapezoidal cross section.

If we mentally reconstruct the core from which the curved Clovis blades were detached, it would be quite conical with pronounced curved blade scars on the sides. Also, the angle of striking platforms, in relation to the longitudinal axis, would be the same on the core as is exemplified on the blades. It is a common practice to form a regular surface on the working face of a core by first removing cortex flakes and blades. Blades made during preforming to make the surface of the core regular, have a functional edge and with the cortex used as backing, they serve as excellent knives and cutting implements. Therefore, it is not surprising that a cache of such blades was found; but it is impractical to assume that the Clovis people defined the sophisticated technique of blademaking and then ceased detachment after the first series of blade removal. It is highly possible that after removing a series of these curved blades, the Clovis people went on to a rest method and ultimately produced straighter blades. This thought is, of course, hypothetical but is certainly substantiated by the Clovis scrapers which give evidence of flatter blades, trapezoidal in cross section.

Strongly curved blades are generally unsuitable blanks for projectile point manufacture for it would be impossible to flake both surfaces without further accentuating this curve. Clovis projectile points vary in size and form and only the smallest could be derived from blades of the dimension of those from Blackwater Draw. (James M. Warnica, New

Discoveries at the Clovis site, American Antiquity, Vol.31,No.3, Part 1, Jan. 1966) The majority of Clovis projectile points indicate that they were derived from preforms considerably larger than the finished artifact. (Distribution of Fluted Points in Arizona, Larry C.Agenbroad, Kiva,Vol.32,No.4,April 1964; An Early Man Site at Big Camas Prarie, South Central Idaho, B.Robert Butler,Vol6, No.. Tebiwa,1963; Elephant Hunting in North America, C. Vance Haynes,Jr., Scientific American, June, 1966, and Ancient Man in North America, H.M. Wormington) Most of these Clovis projectile points indicate that they were not derived from blades but rather from large primary and secondary flakes or ~~by the~~ core technique. None bear the characteristic ventral surface of a blade and there are occasional scar remnants of the initial preforming which indicates that the actual points were made from material larger than the Clovis blades represented at Blackwater Draw. Therefore, at present, one can assume that blademaking encompassed a seperate group of technological traits not related to projectile point manufacture. However, the Clovis blades represented in the Blackwater Draw cache ~~is~~ incomplete ~~and~~ until future blades and, hopefully, cores are unearthed, many technological details will remain uncertain.

Of further note in Greens report is an illustration showing one face of a core from a surface collection in Comanche County, Texas. (American Antiquity, Vol. 29, No. 2, Page 161, 1963). This core is almost a duplicate ~~to~~ of cores we produced with the Corbiac technique. The blade scars indicate that the same platform and core preparation ~~was~~ were used and, therefore, the blades removed from the core should have been comparatively flat and feathering at their termination. The Texas core still bears the lateral flake scars which are the result of preparing the ridge to guide the first blade. This core ~~is typical of a~~ ~~replicates~~ REPRESENTATIVE OF the Corbiac type core and, therefore, should have produced blades that have only a slight curve, small striking platforms and unaccentuated bulbs of force.

Conclusions:

The technique without rest resulted in typical Blackwater Draw Clovis style blades and the Corbiac technique produced cores much the same as the core found in Comanche County, Texas. The presence of Clovis blades in the New World does not necessarily indicate a blade culture, but only an industry and the knowledge of blademaking. Blades are supberb cutting implements, particularly for dismembering large game. Upon becoming dulled, they may be modified into other assorted tools with a minimum of effort. The limited finds of whole blades and cores would seem to indicate a shortage of suitable raw material for making blades. Blademaking ~~blademaking~~ is a conservation measure as well as a means of avoiding transpor~~ting~~tation of surplus material ~~a~~ long distances from ~~the~~ a quarry.

Blade industries are represented in many parts of the New World from the Arctic to South America. Technologically, blademaking encompasses a wide range of variations and modes of detachment, various flintknapping tools, methods of applying force such as direct percussion, indirect percussion, pressure, and any combination of the three. Numerous techniques and technological traits are represented in both forming and preparation of the surface prior to removing blades. Last, but not least, the relationship of technique to the raw material is involved.

Insert Page 27

Since the discovery of the large, thin, precision flaked bifacial implements at the Simons Site in Idaho, the junior author has spent much time experimenting with various techniques to resolve this method of thinning. Replicating these implements presented a real challenge for they were thinned by the removal of incredibly large, rapidly expanding flakes from both faces and all margins. Their manufacturing technique was unique because:

1. The area of fracture of the flake scars on the artifacts is many times the area of the transverse section of the artifact.

2. The amount of force necessary to remove a flake of this dimension in relation to the thinness of the implement would almost necessarily be too great to detach the flake without breaking the artifact.

3. The angles of imparted force must be calculated with incredible accuracy.

4. The intensity of the percussor must be calculated to correspond to the area to be fractured.

5. The contact point of the percussor and the impact area of the artifact must be diminutive, yet strong enough to withstand the force necessary to remove such a large flake.

All these problems caused me to experiment with various thinning techniques. Although the following described method produces replicas of the Simons material, I cannot resolve this as the actual technique until further experiments are conducted. At the Lithic Technology Conference in Les Eyzies (Nov. 1964), Bordes and I had tentatively eliminated a direct percussion technique and also dismissed the possibility of a rest. Now, finally, we had a chance to experiment further with this type of biface thinning.

Following is a description of the thinning technique with punch minus rest.

(introduction to be inserted here)

Thinning of Bifaces; first by Direct and then by Indirect Percussion:

Indirect percussion with punch technique was further tried for thinning large bifacial implements such as knives, lance and spear points, large thin discs, and flaked scrapers. This technique includes two phases, or steps, of fabrication - first direct and then indirect percussion. The artifact is first preformed from a large thick flake, or by removing most of the surplus material from a large nodule or rough mass of quarry material, by direct percussion with an antler billet or hammerstone; and then later refined with the indirect percussion technique. (Fig 23)

Preforming by Direct Percussion:

(1) The rough material is placed on the thigh of the left leg which is covered with a pad of several layers of buffalo hide. This padding supports the objective piece and, at the same time, dampens the shock induced by the percussor. During the preforming stage of manufacture, the objective piece is held, not on top, but rather on the outside of the left thigh. (Photo 50) The support provided by the padded thigh relieves the left hand of the entire support of the objective piece and frees the hand to manipulate the piece into position to receive the blows of the percussor. The pad also protects the left hand from bruises and cuts from the flakes as they are detached from the objective piece.

When maximum thinning and forming has been accomplished by direct percussion, then the marginal edges are turned, or beveled. This is done by pressing the edges of the artifact on a basalt cobble until the correct angle is attained. The angle is variable, depending on the form of the piece being worked. Then the longitudinal edge is rubbed on the basalt cobble until the leading edge is slightly rounded. (Photo 15) This beveling and grinding strengthens the edges so that any part of the edge can be used as a striking platform and, therefore, individual platform preparation is eliminated during the next step of further thinning the artifact by indirect percussion.

Thinning by Indirect Percussion with Punch:

(2) Now that the worker has reached the limitation of thinning and forming the artifact by the direct percussion technique (1), he further refines the piece by indirect percussion with punch (2). (Photo 37)

The objective piece is placed on the pad on the inside of the left thigh with its flat side resting on the pad and the leading edge upright for striking to detach flakes on the side resting on the left thigh. The knees are pressed together to hold the artifact in position. Only the edge of the objective piece is exposed to permit the tip of the punch to be placed on the prepared platform part. I find that the artifact being supported lengthwise on the leather pad and held firmly by the pressure of the thighs has a dampening effect which reduces the amount of breakage when detaching large thin, wide flakes. The angle of the punch is approximately the same as that used in detaching blades from the core. However, unlike the detaching of blades from a core, we are not using a ridge to guide the flake removal. Consequently, the lateral edges of the flakes expand. The tip of the punch is oriented in alignment with the horizontal axis of the preform at less than a 45 degree angle while thinning the sides adjacent to the lateral edges. Thinning of the proximal and distal ends is accomplished by placing the tip of the punch at the same angle as above, but pointed toward the gravitational center of the artifact. Gradually, the angle of the punch is increased as flake removal nears the middle of the artifact. Flakes will have to terminate in the midsection of the artifact, otherwise they will remove the opposite edge.

The punch is struck a sharp, quick blow with no follow through. If a heavy blow is struck with a heavy percussor and a follow through used, the opposite edge of the artifact will be removed. For extreme thinning, a caribou antler percussor is used because caribou has a flared, flat surface and the blow can be delivered on the flat part. This gives a greater contact surface, thereby increasing the accuracy of the blow. Because the weight of the artifact is less than a core, the blow is modified. The worker strikes the punch a short quick blow with greater velocity which prevents undo movement of the artifact. This allows extreme thinning because it removes a thin, rapidly expanding flake which will terminate in a hinge fracture at the median line of the artifact. The curvature of the flake determines the convexity of the transverse section of the implement. Usually, one entire margin is worked in this manner and then the artifact is reversed and the same technique applied, but having the flakes intersect the previously struck flake scars.

Thinning a biface with this technique is difficult and requires much experimenting to judge the proper intensity of the blow and to dissipate the force before the flake travels across the entire surface of the artifact and removes the opposite edge. This technique produces flake scars which are very similar to those found on the Simon Site material (Tebiwa, Vol.   ) and Debert bifaces (D.S. Byers and G.F. MacDonald)

Indirect Percussion with Foot-Holding:

This experiment involves the further thinning of a biface which has been previously preformed with an antler billet and simple direct percussion. After this initial step, the preform is placed on the ground, or a layer of damp sand, held in place by the foot and further thinned by indirect percussion with an antler billet and an antler punch. In this instance, the percussor was a splayed section of reindeer antler.

The platform surfaces of the preform ~~is~~ were prepared by beveling and grinding the edge to strengthen it to withstand the force to be applied during flaking. Then the artifact is placed in a horizontal position with the long edge of the beveled side flat on the ground, carefully nested until it is evenly supported by the earth or sand. Then the worker kneels on the right knee with the body bent forward. To stabilize the body, the left knee is positioned at the left side of the upper chest and the left foot is placed on top of the artifact but with the beveled edge exposed. Only slight pressure is exerted on the artifact by the left foot, as too much pressure, or an irregularity of the support, will cause the artifact to be broken when force is imparted to the punch.

The punch is grasped in the left hand by the thumb and fingers and held vertical to the long axis of the artifact, but slanted away from the operator at an obtuse angle. The exact angle is determined by the cross section of the artifact and by experiment. To insure firm seating, the tip of the punch is placed as near as possible to the leading edge and yet not into the body of the artifact. If the punch is placed too far in from the edge, either an excessively thick flake will be removed or the objective piece will break. Also, if the tip of the punch is placed too far inward from the leading edge, the platform part of the flake will expand and a large lunate section will be removed from the lateral margin of the artifact, causing malformation.

Generally, for the first flake removal, the punch is placed on the lateral margin at the base of the artifact. This is the strongest part of the artifact and, therefore, permits the experimenter to be fairly bold with the first blow without danger of causing an unpredictable fracture of the object~~ive piece.~~ This blow will be the criteria for further blows and, therefore, one should examine the results to determine if the flake and scar have the anticipated character. If the flake is too short, then the angle of the punch may be re-positioned to direct the force more inward into the body of the implement being fabricated. If the flake is too long, then the angle of the punch is held closer to the body of the worker. The amount of force is delivered in accordance with the size of flake desired. Only experiment can determine the amount of force needed.

Flakes are removed bilaterally from both margins in this same manner and the force is gradually dissipated as the flakes ~~conformingly~~ are proportionately ~~are~~ reduced in size as the thinning process nears the tip of the artifact. When one margin and one face has been flaked, then the edge is re-prepared for removal of the next series of flakes from this same edge but detached from the opposite side.

Our experiments with this technique were successful and we concluded that it had possibilities of having been used aboriginally. However, we felt that additional experiments were necessary before any definite conclusions could be reached.

The techniques of foot-holding and knee-holding (previously described) are the same, except for the manner in which the artifact is held. The one major disadvantage of foot-holding is that the flake is removed from the blind side of the artifact, whereas the knee-holding technique permits instant examination of both flake and flake scars.

The Corbiac Blade Technique and Other Experiments
by Francois Bordes and Don Crabtree

In September, 1967, Dr. Francois Bordes and the writer spent two weeks experimenting with many flintknapping techniques, replicating various artifacts, and analyzing and comparing our work to aboriginal tools. But our prime concern during this work session was the replicating of Corbiac blades and cores, which had been previously defined by Bordes as being a method of detaching blades by indirect percussion with punch and rest. This paper will be primarily concerned with the Corbiac technique of blademaking, but will also include a description of the thinning of bifaces by first direct and then indirect percussion without rest; blademaking by indirect percussion with foot holding; blademaking by indirect percussion without rest; and, finally, a comparison of Clovis blades and cores to the latter technique. Since this has been our first opportunity to work together uninterrupted, we felt we should collaborate and jointly publish our findings and conclusions on the Corbiac technique and other experiments.

Because this paper is primarily concerned with blademaking, it may be well to consider here the technological aspects of a blade. A personal (D.C.) definition is: A specialized, elongated flake with parallel to sub-parallel lateral edges; its length being equal to, or more than, twice its width. Cross or transverse sections may be either plano-convex, triangulate, sub-triangulate, rectangular, trapezoidal, and with one or more longitudinal crests, or ridges. Typical is is trapezoidal. On the dorsal side of the blade there should be two or more scars of previously removed blades with force lines and compression ringsindicating that force was applied in the same direction as blade detachment.

For those who are not familiar with working stone, it seems fitting to mention here a few points regarding blade scars which may help in analysis. to determine the sequence of blade removal from a core, it is well to make note of the striations found on the lateral margins on the ventral sides of the blades and their opposite, or negative, duplicationson the lateral margins of the blade scar on the core. The striations, or minute fissuring, is caused by the compression of the blade material as it is removed from the face of the core. Striations are generally more obvious on vitreous materials than they are on stone of a coarser texture. Marginal striations are tangent and oblique to the marginal edge and slant upstream toward the proximal end of the blade to the point of applied force. Only a complete blade scar will have the striations on both sides, or the lateral margins. For example: the last blade removed from a core will have striationson the lateral margins of both the core and blade. On the other hand, a core scar with striations on one lateral margin will indicate that a second blade was removed which eliminated the striations from one edge of the previous blade scar on the core.

In the Summer of 1966, the senior author, Dr. Francois Bordes, excavated an Upper Perigordian site at Corbiac in the Dordogne Valley in Southeast France. Thisproved to be a very important find, for the site yielded a vast quantity of blades, cores (approximately 1,000), burins, and tools in various stages of fabrication; as well as broken, aberrant, and malformed cores. There were an estimated 100,000 precision made blades with very small platforms, denoting a punch technique (later two stone punches were found in this site); and a rest was indicated because the curve of the blade was lessened to such a degree that some could almost be called flat. He carefully examined the vast quantities of both completed tools and those exhausted by use; and analyzed the flake debitagewhich included the toolmakers' discards - rejected either because of flaws in the stone, miscalculations, or an error in judgement. Always, the worker must either adapt to these conditions and errors and, if they are insurmountable, then the piece must be discarded. Any one, or all three, of these factors may be involved with any single piece, for there is no exact repitition of factors when one is reducing an irregular mass of flint to blades or tools. This is one of the reasons why debitage is always important for it provides the many stages of development of toolmaking, and in this case, the making of both blades and cores.

After a careful analysis of tools, cores and debitage, Bordes eliminated both pressure and indirect percussion as the blademaking technique and defined the manufacturing method as indirect percussion with rest. He then spent his evenings experimenting with and eliminating various manufacturing methods in an effort to ultimately resolve the exact Corbiac blade and core technique. This took much time and hard work, for each experiment had to include the many individual stages of manufacture. But, ultimately, he was successful in consistently reproducing the cores and blades of this culture.

Unlike other artifact types which have definite form, outline and functional purpose, cores are variable. Their form, style and types are many and the technological patterns vary, each retaining multiple diagnostic traits. Because the core demands very definite techniques for blade detachment, it is consistently reduced in size and changed in form and character during the intervals of first to last blade removal. Then the exhausted or malformed core is either abandoned, or further modified into another artifact; or simply reduced to usable flakes with sharp cutting edges. End products such as these would hardly be recognizable as former cores. A large population of either malformed or otherwise abandoned cores usually indicates an abundance of raw material and a blade or blade-tool industry. This paper emphasizes replicating the Corbiac cores and then later compares, by rational theory, the Clovis core style pertinent to the blades found at Blackwater Draw.

Details and description of the Corbiac cores to be inserted here by Bordes

Our duplications of the Corbiac cores were generally unifacial but a few were bi-directional. They were almost entirely made from either cobbles or ovoid lumps of obsidian with outside measurements of from seven to fourteen inches before preforming. After the top of the cobble was removed to provide a platform area, the overall length averaged between six and ten inches.

Following is a description of the Bordes experiments of replicating Corbiac blades and cores by indirect percussion with rest.

Preforming the Core:

Invariably the preforming of the core is the most difficult and important step of blademaking, and the Corbiac technique is no exception. If the core is not made right, then the blades will either fail to detach; they will step or hinge fracture; platforms will crush; the end of the core will be detached; blades will vary in thickness; will terminate before reaching the end of the core; bulb of force will be accentuated; shatter lines and fissures will be present; presence of eraillure scars; compression rings and undulations; or the results will not be replicas. (see fig. 1, 12) I cannot emphasize too strongly the importance of core preparation./ It is impossible to remove true blades from an improperly prepared core and no amount of skill can overcome poor preparation or conquer certain strains and flaws in the material.

A suitable piece of material, relatively free of flaws, of adequate size and proper texture is selected for the experiment. (Fig. 1,Photo 3) The size of the rough material selected will depend on just how large a blade is desired and, to some degree, on what is available. Since our experiments were done at my home in Idaho, we used obsidian for it is plentiful here and we had very little flint. We would have preferred to use the flint of the Corbiac culture as obsidian is considerably more brittle than flint and, therefore, more subject to breakage from end shock. However, this substitution of material did not cause us to vary the

Corbiac technique, but only to modify it to conform to the material. In this case, we considered this good flintknapping practice and probably an aid to refining the technique when applied to flint. Always, techniques must be adapted, or slightly modified, to suit the nature of the working material; for different textures and hardnesses require a variation of techniques. For example: because we were working with obsidian, we had to strengthen theplatform area by grinding, (Photo 15) decrease the velocity of the blow, detach thicker blades, (Photos 12, 44) and use a lighter percussor. (Photos 13,17) This is not always necessary when flint is used.

After the cobble, or mass of material has been selected for blade-making, the experimenter must mentally orient the proposed core within the cobble. That is - he must calculate to economically remove material from the mass in order to retain as nearly as possible the ultimate size of the nodule and yet properly prepare the core to the desired size and shape. One can never immediately start removing blades from a rounded mass and, therefore, the first step of core preparation is to eliminate the rounded surface and establish a working platform for preparation of a ridge to guide the first blade. (Photo 3)

If the cobble is spheroid,an antler billet is used to percuss the natural facet on the cobble to remove a flake and establish a working platform. Material that is rectangular, blocky and without rounded surfaces is much preferred and more suitable for core and blademaking than round or spheroid cobbles. Angular material often has natural longitudinal ridges which may, after slight modification or unifacial trimming, suffice as a ridge to guide the first blade. If the longitudinal ridge is at the corner of a rectangular block of flint-like material, it is relatively simple to prepare the proper platform to facilitate the removal of the first blade. The rectangular shape eliminates elaborate preforming and just a slight grinding and polishing of the corner will ready the piece for blade detachment.

However, if the cobble is rounded and consequently has no natural facet, then the worker must establish one. This facet is needed to serve as the striking area, otherwise the blow will ricochet from the rounded edge when an attempt is made to remove the first flake. To remove the first flake from a rounded cobble, the worker uses a medium-sized hammer-stone of semi-hard texture. (Photos 3, 35) A hammerstone is necessary for shaping a rounded cobble, for the antler billet would not deliver sufficient force to detach a flake from the curved surface. The worker holds the hammerstone almost vertical to the rounded edge of the cobble and strikes an intense blow (Fig.1, Photo 3) to remove a flake and thereby establish working angles for further shaping the core. Usually, only one break is necessary to eliminate this rounded surface and establish the working surface for further preparation of the core. (fig. 2, photo 2) After this has been done (either with an antler billet on a natural facet; or with a hammerstone on a rounded cobble to prepare a facet) then the worker is ready to establish a ridge.

Preparing the Ridge:

To create the first ridge longitudinally from the top to the bottom of the core, the worker uses an antler billet and strikes with sufficient force on the natural or prepared facet (platform) to remove a single flake from the rounded side of the cobble. (Fig. 3) The antler billet and direct percussion is used for this flaking process to prevent the strains and shattering which would result from a harder percussor. This is the first step in a series of flakes to be removed in this same manner along one margin of the cobble to establish a ridge. (Fig. 4) After the first flake is detached, the cobble is reversed and struck in this same way from the other side, using the scar of the first flake as a platform surface for removal of the next flake. The worker continues to strike flakes alternately on the edge of the cobble from top to bottom until a ridge is established. (Fig. 4,9,10) An edge, or ridge, made in this manner will be sinuous, or wavey, from the alternate flake scars. If the waves are too accentuated, then the ridge will not be straight enough for blade removal. Therefore, the crests of the waves are removed by striking with the antler billet directly on the crests to detach them and, thereby straighten the ridge. (Fig. 5) This ridge will serve as a guide for removal of the first blade. Removal of the initial blade (ridge) will create two longitudinal ridges for removal of additional blades and so on aroundhalf the circumfrence of the core. This preparation and follow-through is of the utmost importance because the form and shape of the core controls the type of blade detachment.

<u>Severing the Top of the Core:</u>

After the ridge is formed, then the top of the core is removed by any one of the following described methods:

1. Striking the core on an anvil stone. (Fig. 11)
2. By direct percussion with a hammeerstone. (Photo 22)
3. Preparing a platform on the longitudinal ridge and then severing the top by indirect percussion with punch technique. (Fig. 12)

Bordes preferred Method 2, but I found that Method 3 was easier and more accurate for me.

When a core top is severed, the angle of the blow must be calculated and delivered to create a platform area with an angle corresponding with the core type to be replicated. The top (or platform) surface of the Corbiac core is severed to result in less than a right angle to the long axis of the core. (Fig. 13-14, Photo 22) This platform angle is the result of the angle at which the force to remove the core top is directed and this blow must be in line with the pre-established ridge. Since the Corbiac core is prepared with a single ridge and the platform angle is less than forty-five degrees, it will be unifacial and not entirely polyhedral or cylindrical. The back, or the side opposite the working face of the core, usually retained the natural cortex surface. As blades were removed from the working face, they created new ridges, causing the working face to assume a rounded, polyhedral appearance with longitudinal facets. The working edge of the core top then had the appearance of a semi-circle. Sometimes, we were successful in detaching as many as thirty usable blades from a core, depending on its size and proper application of manufacturing techniques. Photo 44 Later, when Bordes was giving a demonstration at the Washington State University in Pullman, he successfully detached fifty-three blades from a single core. Our cores were abandoned when the platform surface was exhausted and they were left with very little, or no, platform surface ; the core was by this time elongated and half-cylindrical, showing blade scars on the rounded side and cortex on the other.

Angle of Core Top:

The top of the core is designed to slant at less than a 45 degree angle away from the apex (working edge). (Fig. 13) Photo 13 This provides a bearing surface for seating the punch and prevents the tip of the punch from slipping and ricocheting from the platform part of the working face when the blow is delivered. Because of the acute angle at which the punch is held, Photo 13 it would be impossible to remove a flake or blade if the platform surface slanted toward the working edge.

Other core types, which generally do not have the top at this angle, overcome the slippage of the punch either by grinding; removing small flakes to leave small depressions (bulbar scars) in which to seat the punch; or by using rough natural erroded surface. However, the Corbiac core shows none of these characteristics.

Platform Preparation:

A small hammerstone is substituted for the antler billet to isolate the platform area. Photo 15 Isolation is accomplished by holding the hammerstone in the right hand; the core in the left hand; and pressing and thrusting the hammerstone downward against the top and toward the outer edge of the core above the pre-established ridge. This action will remove small flakes from the leading edge without causing hinge or step fractures. This operation is continued until the center of the platform is oriented above the ridge and in line with the center of the proposed blade. This preparation strengthens the platform part as well as removes any overhang. If isolation is not complete, then small flakes are removed from the top of the core on each side of the platform area until it is properly oriented and isolated. Note: these flakes are removed from the top of the core rather than the leading edge. For additional strength, the platform is then abraided on its top by rubbing with a granular stone other than a flint-like material. Photo 15 This dragging motion of the abrasive stone across the platform part will round the edges and give it a polished appearance.

If the core is prepared on both ends in the above described manner and ~~bla~~ blades are removed from both ends and terminated by feathering at the middle part of the core, a bi-directional core will result which is sometimes called bi-polar but which, in reality, is not. Bi-polarism is the result of force being delivered simultaneously to the core from both ends.

(Cultural sequence of bi-directional and unifacial cores to be inserted here by Bordes)

Seating the Core on Rest:

When the core has been completely preformed and the platform prepared for the first blade (ridge) removal, it is then placed between the feet on a resiliant support (Photos 17,35) to eliminate shock at the distal end. For our experiments, we used a pine board approximately 2X2X14. (Fig. 16,21,22 Photos 17,35)

The straightness of the Corbiac blades is the result of using a rest for it prevents movement of the core as the blades are detached and simultaneously causes force to be exerted at the base of the core when the blow is delivered to the prepared platform at the upper end of the core./ (Photo 13) Cores not supported on a rest will produce strongly curved blades. Corbiac ~~blac~~ blades are further characterized by the absence of undulations and waves of compression - features which are characteristic to those detached from the core by direct percussion with a hard hammerstone. Another distinct feature of the Corbiac blades is their distal end termination. (Photo 12) The ends feather out without removing any part of the distal end of the core. This is due, in part, to the rest or anvil and can be controlled to a degree by the angle at which the punch is held.

The blademaker assuses a seated position slightly elevated above the core; places the core on the rest and holds it tightly between both feet. (Photos 13 & 17). Core is positioned on the rest with the side to be worked pointed away from the worker with its distal end supported by, but overhanging, the edge of the wooden rest. This allows the blades to clear the plank and thereby eliminates breakage. The core is held by the feet in almost a vertical position (or to suit the convenience of the worker) with the longitudinal ridge placed away from the worker. This vertical position may vary slightly with the worker's preference.

Detaching Blades:

The indirect tool is a cut section of reindeer antler about six inches long with one end shaped to a blunt point.(Fig.21,Photos13,17,35). It is possible to use a stone punch when working flint, but this would not be satisfactory to use on more brittle materials such as obsidian. Thispunch is held in the left hand and its tip placed and held on the platform at a low angle. (exact angle to be calculated)

Using a heavy section of antler about fourteen inches long for the percussor, (See photo) 13, 17, 35 the right hand delivers a blow of sufficient force to the proximal end of the punch to detach the blade. When working flint, a soft hammerstone may be used in lieu of the antler percussor because some silicous rocks are not as brittle as vitreous stone. The antler punch as well as the antler percussor acts as a shock absorber and causes the force to be delivered more slowly to the platform of the proposed blade. At present, there is no means of measuring the amount of force necessary to remove a blade from a core, for much depends on the type and size of the material and the blade length desired. Since the blade is first detached at the proximal end of the core and then literally peeled down its face, the amount of force is reduced if the platform is isolated from the core prior to blade detachment. A quick rule of the thumb method to determine the necessary amount of force is to calculate the area on the ventral side of the proposed blade in relation to the material and then formulate the ~~amiunt~~ amount of force necessary for detachment. When making blades, the same material should consistently be used, for one becomes accustomed to controlling the blow on a given material and it may take several days to correlate the amount and kind of force necessary when material is used which is different in texture and elasticity. Some materials are worked best with a short high velocity blow with no follow through; while others are best worked by using a slow blow with a heavy percussor and a follow through. Blades leave the core at considerable velocity and must be recovered on some type of soft, yielding material to prevent fracture.

Then the blades are studied and their character compared to aboriginal blades being replicated and each detail noted and evaluated. Corbiac blades have very small platforms with the angle corresponding to that of the core before blade detachment. There is a general absence of eraillure flakes on the bulb of force and no fissures radiate from the point of force in the bulbar part. The blades have one or two longitudinal ridges (percentage unknown) and the curve is so slight as to be almost flat; and they are free of undulations on the ventral side. (Further description and drawings of blades & dimensions to be inserted here by Bordes) One cache found at Corbiac contained blades which were as much as forty centimeters long. For our experiments, we had no rough material large enough to attempt replications of this dimension. Corbiac blades are usually feathered and terminated with - out removing the distal end of the core. At the proximal end, the blade is the width of the platform area which is minute in relation to the size of the blade. At each lateral platform margin, the blade rapidaly expands in a curve until it reaches its width limitation and then runs longitudinally parallel to the opposite edge of its termination and can vary from parallel to sub-parallel.

In our experiments, the widths of the blades were variable and were controlled by the form of the working face of the core. The more attenuated the ridge and the narrower the core, the narrower the blade. The thickness of the blade is also controlled by the position of the punch and the design of the platform in relation to the core. the nearer the punch is placed to the leading edge of the core, the thinner will be the transverse section of the blade. A blade that is triangulate will have the platform oriented in line with the single ridge on the core and the blade that is trapezoidal in transverse section is one that has had the platform oriented between two longitudinal ridges. The proximal ends of the blades are characterized by very small platforms (relative to the blade size) of a uniform consistency which cannot be replicated by using direct percussion and a hammerstone or billet. The size of the platforms are the contact area of the punch's semi-pointed tip. The bulbs of force are not priminent and are generally in line with the ventral surface of the blade. Also, the bulbs are smooth, usually without eraillure flake scars and have no signs of shatter scars radiating from the point of force These features indicate that the interval of contact was more prolonged than when a hard blow is delivered by direct percussion with a hard hammer.

Marginal striations on the ventral sides were not noted on flint blades but were quite obvious on blades of obsidian. An deviations of straightness of the ridge, or ridges, caused the blades to follow the irregularities and a malformed blade resulted. (Fig. 20) If differential resistance within the material caused the previous blade scars on the core to be deviant then subsequent blades would also be deviant. In some cases, the ridge could be straightened by placing the platform farther back from the leading edge of the core and then increasing the normal amount of force. This detached a thicker blade and thereby straightened the ridge. If an imperfection was encountered on the ridge, it could be removed by detaching a series of flakes at this irregular part to straighten the ridge. Some imperfections could not be overcome and then the core had to be abandoned.

Should a blade terminate in a step or hinge fracture prior to complete detachment, then the core must be either abandoned or recovered by removing the balance of the blade up to this truncation. This is done by preparing a platform on the distal end of the core and directing the force, at a reduced velocity, to intersect, terminate, and detach the blade at the step or hinge fracture. Each error, miscalculation, or imperfection in the material must be considered individually because each presents a different set of problems to the worker. No amount of skill can overcome some of the problems encountered and then the core must be discarded.

When appraising both aboriginal and experimental artifacts to resolve the approximate technique, we would agree on manufacturing methods but our individual experiments were somewhat different, yet replications were almost duplicate. As previously mentioned, Bordes had resolved the manufacturing technique of the Corbiac blades; which involved a seated position with the core held between the feet on a rest, placing the punch on the platform above the prepared ridge at a low angle, and striking away from the body. After Bordes had demonstrated this technique and I experimented several times, I found I could replicate Corbiac blades with this technique. However, it was more comfortable for me to reverse both the working face of the core and the striking pattern.

I assumed the sitting position andplaced the core on the rest between the feet with its edge clearing the support but with the working face of the prepared ridge facing me. Then I seated the punch on the platform above the ridge at the same angle previously described in the Bordes' method but with the tip of the punch pointed toward me.

The velocity of striking was not changed, but the blow was delivered to the punch toward me rather than striking away from the body as practiced in the Bordes method. This was easier and more accurate for me because it does not require leaning so far forward and also because I had been doing a similar but varied blademaking technique for the last six months and had become accustomed to this pattern. This position is more dangerous than the Bordes technique as the blades detach toward the worker but it has the advantage of being able to see what is actually happening. This slight variation permitted me to align the punch on the guiding ridge with much greater accuracy and actually view the blade detachment. Since the angle of seating the core, striking pattern, punch and rest were the same in both experiments, the termination and flatness of the blades was much the same.

Indirect Percussion Without Rest:

When the above described position became unduly tiring, I experimented with a more comfortable body position. I sat on a little taller stool, placed the core on a pad of folded layers of buffalo hide and held it between my knees for both the preforming of the core and detaching blades. (Photo 38) This position was more comfortable and I was able to make blades with less effort than in the seated position with the core held between the feet. However, the blades made by knee-holding had an entirely different character than those made by the Bordes' technique, for this method lacked the solid support of the core.

Even though the angle of applied force, the type of blow, and the platform preparation were the same, the lack of support on the base of the core allowed it to be partially projected from the force of the percussor and, therefore, the curve of the blades was more accentuated. Also, the blades did not feather out and they often terminated with a part of the distal end of the core adhering. This knee-holding experiment did show, however, that fewer blades were broken because the leather pad acted as a cushion for the dorsal side of the blades, dampened the shock and, therefore, allowed the recovery of more intact blades. We concluded that this method would not produce Corbiac type of blades.

Bordes observation of this technique did, however, result in additional experiments and slight modification of the Corbiac technique.

He tried wrapping the core in a cloth, or any soft material, to lessen the shock and prevent propulsion of the blades. (Photo 17) This did reduce blade breakage. The ideal way, of course, to reduce breakage and remove blades intact, is to regulate the amount of force of the blow to a ratio which will detach but not project the blades. This skill can only be attained by practice and repeated experiments.

Our experiments in blademaking revealed technological differences which were significant when related to those of the aboriginal. For instance, we noted that blades made by this technique were similar to the Clovis blades illustrated and described by F.E. Green (The Clovis Blade, American Antiquity, Vol.29, No.2, pages 145-165, Oct.,1963)

The major difference between the Corbiac blades and those produced by this technique is in the degree of curvature of the blade and, interestingly enough, isthe same difference noted between the Blackwater Draw blades and the Corbiac blades. The blackwater Draw blades had most of the characteristics of the Upper Paleolithic Corbiac blades, except that they were strongly curved and they did have a marked resemblance to those made by our indirect percussion without rest technique described above. It is not the intention of the writer to imply that there is a merging of Old and New World techniques but only parallels in methods of blade detachment. The fact that a rest is or is not used may appear to be a minor technological trait but, in reality, this pronounced curve in the blade indicates a major difference in fabrication. Our experiments indicated that strongly curved blades are the result of the core moving when the blow is imparted to the punch; and that flat, or gently curved blades, resulted when the core was securely immobalized and a support used at its distal end. It is interesting to note that a minor change in technology can cause a major technological trait which can serve as an archaeological index to determine invention or tradition and cultural differences in time and space.

In terms of reconstructing the sequence of events in blade production, it is evident that the cache of blades from Blackwater draw represent the first stage of blade manufacture. These blades are characterized by the cortical surface of the parental material on the dorsal side and have a triangulate, transverse cross section. This condition indicates the aboriginal flintknapper took full advantage of the additional strength provided by the single ridge on the dorsal surface. This technique is to be distinguished from blades with a trapezoidal cross section with two ridges occuring on the dorsal face. Blades with triangular cross sections are stronger since there is a greater mass of material than occurs on blades with a trapezoidal cross section.

If we mentally reconstruct the core from which the curved Clovis blades were detached, it would be quite conical with pronounced curved blade scars on the sides. Also, the angle of striking platforms, in relation to the longitudinal axis, would be the same on the core as is exemplified on the blades. It is a common practice to form a regular surface on the working face of a core by first removing cortex flakes and blades. Blades made during preforming to make the surface of the core regular, have a functional edge and with the cortex used as backing, they serve as excellant knives and cutting implements. Therefore, it is not surprising that a cache of such blades was found; but it is impractical to assume that the Clovis people defined the sophisticated technique of blademaking and then ceased detachment after the first series of blade removal. It is highly possible that after removing a series of these curved blades, the Clovis people went on to a rest method and ultimately produced straighter blades. This thought is, of course, hypothetical but is certainly substantiated by the Clovis scrapers which give evidence of flatter blades, trapezoidal in cross section.

Strongly curved blades are generally unsuitable blanks for projectile point manufacture for it would be impossible to flake both surfaces without further accentuating this curve. Clovis projectile points vary in size and form and only the smallest could be derived from blades of the dimension of those from Blackwater Draw. (James M. Warnica, New

Discoveries at the Clovis site, American Antiquity, Vol.31,No.3, Part 1, Jan. 1966) The majority of Clovis projectile points indicate that they were derived from preforms considerably larger than the finished artifact. (Distribution of Fluted Points in Arizona, Larry C.Agenbroad,"Kiva",Vol.32, No. 4, April,1964);"An Early Man Site at Big Camas Prarie",South Central Idaho", B.Robert Butler,Tebiwa, Vol 16,No. , 1963; "Elephant Hunting in North America", C. Vance Haynes,Jr. , Scientific American, June,1966; and "Ancient Man in North America", H.M. Wormington,1957) Most of these Clovis projectile pointsindicate that they were not derived from blades but rather from large primary and secondary flakes or by a core tool technique. None bear the characteristic ventral surface of a blade and there are occasional scar remnants of the initial preforming which indicate that the actual points were made from material larger than the Clovis blades represented at Blackwater Draw. Therefore, at present, one can assume that blademaking encompassed a separate group of technological traits not related to projectile point manufacture. However, the Clovis blades represented in the Blackwater Draw cache give an incomplete picture so that until future blade and, hopefully, cores are unearthed, many technological details will remain uncertain.

Of further note in Greens report is an illustration showing one face of a core from a surface collection in Comanche County, Texas. (American Antiquity,Vol.29,No.2, Pages 161-1963) This core is almost a duplicate of cores we produced with the Corbiac technique. The blade scars indicate that the same platform and core preparation was used and, therefore, the blades removed from the core should have been comparatively flat and feathering at their termination. The Texas core still bears the lateral flake scars which are the result of preparing the ridge to guide the first blade. This core is representative of the Corbiac core and, therefore, should have produced blades that have only a slight curve, small striking platforms and unaccentuated bulbs of force.

Conclusions:

The technique without rest resulted in typical Blackwater Draw Clovis style blades and the Corbiac technique produced cores much the same as the core found in Comanche County, Texas. The presence of Clovis blades in the New World does not necessarily indicate a blade culture, but only an industry and the knowledge of blademaking. Blades are supberb cutting implements, particularly for dismembering large game. Upon becoming dulled, they may be modified into other assorted tools with a minimum of effort. The limited finds of whole blades and cores would seem to indicate a shortage of suitable raw material for making blades. Blademaking is a conservation measure as well as a means of avoiding transportation of surplus material long distances from a quarry.

Blade industries are represented in many parts of the New World from the Arctic to South America. Technologically, blademaking encompasses a wide range of variations and modes of detachment various flintknapping tools, methods of applying force - such as direct percussion, indirect percussion, pressure, and any combination of the three. Numerous techniques and technological traits are represented in both forming and preparation of the surface prior to removing blades. Last, but not least, the relationship of technique to the raw material is involved.

Since the discovery of the large, thin, precision flaked bifacial implements at the Simons Site in Idaho, the junior author has spent much time experimenting with various techniques to resolve this method of thinning. Replicating these implements presented a real challenge for they were thinned by the removal of incredibly large, rapidly expanding flakes from both faces and all margins. Their manufacturing technique was uniqe because:

1. The area of fracture of the flake scars on the artifacts is many times the area of the transverse section of the artifact.
2. The amount of force necessary to remove a flake of this dimension in relation to the thinness of the implement would almost necessarily be too great to detach the flake without breaking the artifact.
3. The angles of imparted force must be calculated with incredible accuracy.
4. The intensity of the percussor must be calculated to correspond to the area to be fractured.
5. The contact point of the percussor and the impact area of the artifact must be dimunitive, yet strong enough to withstand the force necessary to remove such a large flake.

All these problems caused me to experiment with various thinning techniques. Although the following described method produces replicas of the Simons material, I cannot resolve this as the actual technique until further experiments are conducted.

Following is a description of the thinning technique with punch minus rest.

Thinning of Bifaces; first by Direct and then by Indirect Percussion:

Indirect percussion with punch technique was further tried for thinning large bifacial implements such as knives, lance and spear points, large thin discs, and flaked scrapers. This technique includes two phases, or steps, of fabrication - first indirect and then indirect percussion. The artifact is first preformed from a large thick flake, or by removing most of the surplus material from a large nodule or rough mass of quarry material, by direct percussion with an antler billet or hammerstone; and then later refined with the indirect percussion technique. (Fig. 23)

Preforming by Direct Percussion:

(1) The rough material is placed on the thigh of the left leg which is covered with a pad of several layers of buffalo hide. This padding supports the objective piece and, at the same time, dampens the shock induced by the percussor. During the preforming stage of manufacture, the objective piece is held, not on top, but rather on the outside of the left thigh. (see photo) #50 The support provided by the padded thigh relieves the left hand of the entire support of the objective piece and frees the hand to manipulate the piece into position to receive the blows of the percussor. The pad also protects the left hand from bruises and cuts from the flakes as they are detached from the objective piece.

When maximum thinning and forming has been accomplished by direct percussion, then the marginal edges are turned, or beveled. This is done by pressing the edges of the artifact on a basalt cobble until the correct angle is attained. The angle is variable, depending on the form of the piece being worked. Then the longitudinal edge is rubbed on the basalt cobble until the leading edge is slightly rounded. (see photo) 29 This beveling and grinding strengthens the edges so that any part of the edge can be used as a striking platform and, therefore, individual platform preparation is eliminated during the next step of further thinning the artifact by indirect percussion.

<u>Thinning by Indirect Percussion with Punch:</u>

(2) Now that the worker has reached the limitation of thinning and forming the artifact by the direct percussion technique (1), he further refines the piece by indirect percussion with punch (2). (no photo)

The objective piece is placed on the pad on the <u>inside</u> of the left thigh with its flat side resting on the pad and the leading edge upright for striking to detach flakes on the side resting on the left thigh. The knees are pressed together to hold the artifact in position. Only the edge of the objective piece is exposed to permit the tip of the punch to be placed on the prepared platform part. I find that the artifact being supported lengthwise on the leather pad and held firmly by the pressure of the thighs has a dampening effect which reduces the amount of breakage when detaching large thin, wide flakes. The angle of the punch is approximately the same as that used in detaching blades from the core. However, unlike the detaching of blades from a core, we are not using a ridge to guide the flake removal. Consequently, the lateral edges of the flakes expand. The tip of the punch is oriented in alignment with the horizontal axis of the preform at less than 45 degree angle while thinning the sides adjacent to the lateral edges. Thinning of the proximal and distal ends is accomplished by placing the tip of the punch at the same angle as above, but pointed toward the gravitational center of the artifact. Gradually, the angle of the punch is increased as flake removal nears the middle of the artifact. Flakes will have to terminate in the midsection of the artifact, otherwise they will remove the opposite edge.

The punch is struck a sharp, quick blow with no follow through. If a heavy blow is struck with a heavy percussor and a follow through used, the opposite edge of the artifact will be removed. For extreme thinning, a caribou antler percussor is used because caribou has a flared, flat surface and the blow can be delivered on the flat part. This gives a greater contact surface, thereby increasing the accuracy of the blow. Because the weight of the artifact is less than a core, the blow is modified. The worker strikes the punch a short quick blow with greater velocity which prevents undo movement of the artifact. This allows extreme thinning because it removes a thin, rapidly expanding flake which will terminate in a hinge fracture at the median line of the artifact. The curvature of the flake determines the convexity of the transverse section of the implement. Usually, one entire margin is worked in this manner and then the artifact is reversed and the same technique applied, but having the flakes intersect the previously struck flake scars.

Thinning a biface with this technique is difficult and requires much experimenting to judge the proper intensity of the blow and to dissipate the force before the flake travels across the entire surface of the artifact and removes the opposite edge. This technique produces flake scars which are very similar to those found on the Simon Site material (Tebiwa, Vol. 6-#1, 1963) and Debert bifaces (D.S. Byers and G.F. MacDonald)

Indirect Percussion with Foot-Holding:

This experiment involves the further thinning of a biface which has been previously preformed with an antler billet and simple direct percussion. After this initial step, the preform is placed on the ground, or a layer of damp sand, held in place by the foot and further thinned by indirect percussion with an antler billet and an antler punch. In this instance, the percussor was a splayed section of reindeer antler.

The platform surfaces of the preform are prepared by beveling and grinding the edge to strengthen it to withstand the force to be applied during flaking. Then the artifact is placed in a horizontal position with the long edge of the beveled side flat on the ground, carefully nested until it is evenly supported by the earth or sand. Then the worker kneels on the right knee with the body bent forward. To stabilize the body, the left knee is positioned at the left side of the supper chest and the left foot is placed on top of the artifact but with the beveled edge exposed. Only slight pressure is exerted on the artifact by the left foot, as too much pressure, or an irregularity of the support, will cause the artifact to be broken when force is imparted to the punch.

The punch is grasped in the left hand by the thumb and fingers and held vertical to thelong axis of the artifact, but slanted away from the operator at an obtuse angle. The exact angle is determined by the cross section of the artifact and by experiment. To insure firm seating, the tip of the punch is placed as near as possible to the leading edge and yet not into the body of the artifact. If the punch is placed too far in from the edge, either an excessively thick flake will be removed or the objective piece will break. Also, if the tip of the punch is placed too far inward from the leading edge, the platform part of the flake will expand and a large lunate section will be removed from the lateral margin of the artifact, causing malformation.

Generally, for the first flake removal, the punch is placed on the lateral margin at the base of the artifact. This is the strongest part of the artifact and, therefore, permits the experimenter to be fairly bold with the first blow without danger of causing an unpredictable fracture of the object~~ive piece~~. This blow will be the criteria for further blows and, therefore, one should examine the results to determine if the flake and scar have the anticipated character. If the flake is too short, then the angle of the punch may be re-positioned to direct the force more inward into the body of the implement being fabricated. If the flake is too long, then the angle of the punch is held closer to the body of the worker. The amount of force is delivered in accordance with the size of flake desired. Only experiment can determine the amount of force needed.

Flakes are removed bilaterally from both margins in this same manner and the force is gradually dissipated as the flakes are proportionately reduced in size as the thinning process nears the tip of the artifact. When one margin and one face has been flaked, then the edge is re-prepared for removal of the next series of flakes from this same edge but detached from the opposite side.

Our experiments with this technique were successful and we concluded that it had possibilities of having been used aboriginally. However, we felt that additional experiments were necessary before any definite conclusions could be reached.

The techniques of foot-holding and knee-holding (previously described) are the same, except for the manner in which the artifact is held. The one major disadvantage of foot-holding is that the flake is removed from the blind side of the artifact, whereas the knee-holding technique permits instant examination of both flake and flake scars.