20. Hammerstone with punch (free hand)

This technique has been described under No. 17 except that in this case and as Redding described it (1880), a hammerstone was used instead of the billet. I found that the billet was considerably more useful than the hammerstone, but with practice one may become proficient in using the hammerstone. The disadvantage in using the hammerstone is that it is difficult to project the hammerstone with sufficient velocity and proper follow-through without causing aberrant fractures. Also, the left hand is directly in line with the blow causing the knapper to flinch. The shape of the hammerstone is usually oval and not flat and causes the force to be deflected unless the blow is very accurate. The objective piece is usually too light to have sufficient inertia to prevent its moving with the force imparted. The flakes have salient bulbs of percussion and exaggerated compression rings and often terminate as step or hinge fractures. Should there be a choice, the billet is preferred over the hammerstone.

21. Hammerstone with punch and rest

This is much the same as described under No. 18 except that a hammerstone is used instead of the billet. The hammerstone causes the punch to become softened from it's mushrooming from repeated blows. The hammerstone imparts more shock than does the billet causing the flake or blade to have more pronounced compression rings than when using a billet. In order to perform this technique a second person is needed. A

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A toolmaker can do without a second person by holding the objective piece between the knees or by resting it on the ground or a suitable support. A well-padded knee or the foot may be used to hold the core for blade making. A second person is needed for holding when this technique is used to make bifacial tools. The flakes or blades will be quite flat because of the support; the moreresistant the rest or anvil the flatter the flake. The velocity and weight of the hammerstone must conform to the work being accomplished.

22. Hammerstone with punch, rest, and clamp

The clamp or holding device permits the objective piece to remain stationary while giving the knapper more maneuverability. The clamp is generally used for blade making and is too cumbersom to use for removing flakes from bifacial artifacts. The blade type will be similar to those using method 21, but having more uniformity.

23. Indirect, hammer freehand

This technique requires the use of an anvil of either stone, antler or bone. The objective piece is placed on the anvil held in the hand and then the artifact is struck by a percussor. Such a technique makes it difficult to determine the exact plane of fracture and usually causes the working edge of the artifact to be crushed or bruised. It is not a good sharpening technique but is useful to turn the edge or to cause a bevel to be formed to be used for a platform. In this fashion blades may be backed for knives or severed for micro blades and the making of geometrics.

Burin core preforms can be made by first snapping a thick flake or blade. Then one turns the flake vertically and rests the 90 degree break on a flat part of the anvil. Then one strikes it with a percussor removing a long narrow flake on the upper margin. The flake or blade can then be inverted and the process repeated to remove the snapped part.

The correct angle of the core faces is determined by the knapper. The angles depend on the angle in which the flake or blade is held on the anvil. Burin blades may then be removed by pressure and the core left with a sharp edge. The first burin blade removed by indirect percussion is usually triangular in section while the following blades will be either rectangular or rhombohedral in section and will have the same width as the burin core. The bulb of force will be diffuse becuase of the wide contact between the edge of the core and the anvil. Concentric rings of force will be more pronounced when percussion rather than pressure is used.

The intensity of the blow determines the termination of the burin blade. If the force of the blow is dissipated before the blade reaches the distal end of the core, a step fracture will form at the distal end of the burin blade. If additional blades are removed, each will be slightly shorter than the one that caused the first step fracture. If the force is not dissipated, the blade will be removed the full length of the core and remove it's distal portion.

The term indirect at present blankets two sets of techniques. The first is the various uses of an intermediate tool to transmit force from the percussor to the objective piece. The other encompasses the group of techniques in which the force is delivered directly to the objective piece, being reflected by an anvil causing a flake to be dislodged by the inertia of the anvil.

24. Indirect with hammer and rest

This method of flake removal is much the same as described under No. 23, except that an anvil or suitable rest is used in a fixed position and not hand held. The anvil can be keeled, pointed, flat edged or simply oval depending on what function or technique is to be performed. This technique permits the knapper considerably more latitude in the work to be performed because the larger the anvil the greater the inertia and therefore the greater the range of size of flakes that may be removed. The flakes may be removed more uniformally from the objective piece. The hammerstone or percussor must be of a softer nature than a polished hard stone hammer or the objective piece will be either bruised or shattered. Discoidal anvils may be used for notching large bifaces to facilitate hafting. The bulbs of force are absent when the cone of force has been split, yet the flake and flake scar has close, well-defined compression rings radiating from the point of contact.

There are several ways of using indirect percussion and the flakes and flake scars will have similar characteristics pertinent to each method used. For an example, the backing of a knife by the burin technique cannot be compared to removing the cortex from a nodule. There is a need for additional experiments in using the indirect percussion technique because the objective piece may be place with greater accuracy than by using direct free hand percussion, Also the technique of splitting the cone should be further investigated.

25. Indirect with a fixed punch

This method of flaking is done by securing a punch-like object made of antler, bone, horn or stone in a log or some other object with enough weight to increase inertia. The objective piece is then positioned on the pointed end of the punch at a pre-selected spot or platform and the core or artifact struck with a percussor that will not cause fracture or bruising. Such a technique permits accurate placement of the object being worked. Change of form of the core due to position, changes the area that is to receive the force of the percussor. My experiments have not permitted me to remove blades from a core with the accuracy of hand holding the punch and then directing the blow at the correct angles. The fixed punch technique can be used to notch large thick bifaces if much care is exercised. The intensity of the blow must be directed with considerable control or the artifact will be broken.

It is possible to make one style of a burin or burin core by placing one angle of a truncated flake or blade on a fixed projection and then striking the flake or blade.

Such a method requires considerable practice in calculating both the angle of the blow and the angle at which the objective piece should be held. Experiments using the fixed punch technique in making either unifacial or bifzcial artifacts have resulted in only thick, steep angled implements because the artifact must be held at such an angle that a blow may be delivered to it's face that only short flakes may be removed. With this technique a long narrow artifact is easily broken because there is no way to dampen the shock of the blow. The flakes that are removed by the fixed punch have salient bulbs are rapidly expanding usually feathered at the distal end and short because the force cannot be directed across the face of the artifact.

26. Pressure, Freehand, unhafted pressure tool

Free-hand pressure flaking is accomplished by placing the objective piece in the unsupported left hand protected by some yielding material such as leather, grass or cordage and then pressing off flakes from the margins of the preformed artifact or by the use of a pressure tool held in the right hand. The pressure tool is without a handle and is commonly of antler or bone, used as is or may be served to protect the hand.

The objective piece is held in the left hand with the side to be flaked towards the palm. The flakes will be removed from the underside and their detaching cannot be observed by theknapper as only the leading edge is exposed. The objective piece is held by the fingers with the thumb extended. The fingers are pressed on the top of the objective piece with just sufficient pressure to immobilize the artifact to be. Any excessive pressure will cause the objective piece to be fractured when the pressure is applied to it's edge. The objective piece is held in the palm in such a manner that the proposed flake will be directly over the concavity formed between the heel of the thumb and the palm approximately in line with the center of the wrist and between the second and third fingers when they are securing the lithic material. The angle in which the objective piece is held depends on the preference of the knapper and what problem of flaking is to be accomplished.

The methods of holding the objective piece and the pressure tool are many and varied as was the skill in applying the pressure. The pressure tool is held in such a manner that it will rest just slightly forward of the first knuckle and as close to the tip of the pressure tool to afford greater leverage. The wrist is held rigid with the pressure being applied from the right shoulder through the arm. The muscles of the back are used in conjunction with the shoulder as the knapper leans into the work being performed as each flake is being detached from the objective piece. Such movement makes it necessary for the knapper to be seated rather than standing.

The previously described method of pressure flaking is used in stages to remove irregularities and to develop a more regular form in order to remove flakes with regularity. The knapper cannot duplicate a series of flake scars or remove flakes that are uniform from a surface that is irregular.

This method of stone working by the simple application of pressure has been wildly observed and reported by explorers and historians and a few archaeologists. Multimillions of tools have been made by using freehand pressure flaking in most parts of the world occupied by man. The freehand pressure technique is used on blades or flakes and preforms made by the percussion technique. This method was probably first used to resharpen a dulled edge and to modify a flake or blade to suit some functional objective piece that would facilitate holding or halfing.

A blade, flake, uniface or biface may be sharpened to the same degree of sharpness as originally removed from a core by removing a series of pressure flakes from its margin. The technique of sharpening involves more than just pressing a series of flakes from the edge of the objective piece. The tip of the pressure tool is placed on the prepared edge at either one end or the other, and the first flake removed by pressing inward and downward. The bulb of pressure will be removed with the flake leaving the edge that is uncrushed, then the tip of the pressure tool is placed directly over the ridge caused by the removal of the first flake and pressure applied in the same fashion as the first. The spacing is such that the bulbar part of the flake removed will intersect the bulbar scar left from the previously removed flake. This process is continued until the desired part has been sharpened. The edge will be as sharp as a newly removed flake if the worker had sufficient skill to avoid crushing the edge. The edges sharpened in this manner will naturally be slightly more irregular than the edge of a freshly removed flake or blade. The irregularities do not lessen the cutting qualities.

If the artifact is flaked unifacially, the flaked surface will have a series of small channels, and their spacing will correspond with the interval in which the pressure tool was placed on the edge of the objective piece. Both flake and flake scar will bear compression rings radiating from the point in which the pressure was applied. The flake scars are usually slightly oblique being directed from right to left by a right handed person holding the objective piece in the palm of the left hand. Should the person be left handed then the flake scars will be directed in the opposite direction. The flake scars can also be collatoral and at right angles to the leading edge. The way the objective piece is held, the way the edge is prepared and the skill in which the pressure is applied will be revealed in numerous technological traits. It is unfortunate that flakes removed by this method are usually broken because of the close contact with the protective pad held in the left hand.

The flakes are removed from the under surface of the artifact pressing towards the palm of the left hand and in so doing are usually crushed or broken with only the proximal end of the flake remaining intact. These flake parts with platforms may be examined and the edge of the artifact reconstituted to show the edge preparation, the angle of the edge and the angle at which the pressure was applied. Complete unbroken flakes will show the curvature of the artifact by examination of the arc of the ventral surface.

The distal ends of the flakes are also diagnostic and can reveal how the pressure was applied. Should the flake feather at its distal end and at its termination become increasingly thinner and be sharp with no truncation then it will show that the flake was removed by more downward than inward pressure. It was snapped quickly and without follow through of the pressure. Such a flake is never produced when one is making a wide thin artifact . Should the flake terminate in a hinge or step fracture, it could be a mistake on the knapper's part. It may have been done on purpose to stop the flake midway on the face of the artifact. Then the toolmaker meets the flakes termination by removing another flake from the opposite side to intersect the hinge or step, thinning the artifact. Single flakes may be aberrations of the normal, so flake populations and assemblages of workshop debris are necessary before worthwhile appraisals can be made. Each artifact with multiple flake scars must be appraised individually to show the sequence in which the flakes were removed and the character of the flake scars.

Having both artifact and accompanying flakes allows the appraiser to then associate and evaluate the various stages of manufacturing. Observations of aboriginal work, particularly projectile point industries, show that certain cultural groups are distinctive because of the random nature of their flaking being concerned mainly with function and little thought of regularity or artistry.

27. Pressure, free hand hafted

The application of pressure free hand with a hafted pressure tool is much the same as described under No. 26, except that the pressure tool is more sophisticated and somewhat refined. There are many ways and remifications of making a composite pressure tool (Tebiwa 10:1) A pressure bit is inserted into a handle whose length will conform with the technique for which it will be used. The hafted pressure tools may be separated into two classes: the short and the long. The short fabricators are made to fit the hand and permit new bits to be inserted into the handle as they become worn. Instead of continual resharpening, new bits may be inserted.

The long tool is used in a slightly different manner than the short one. The method of holding differs and greater pressure may be exerted because of the increased leverage. The long-handled pressure tool is grasped near the bit in the right hand with the handle parallel with the inside of the forearm. The elbow holds the long handle of the pressure tool against the body. The tool held in this manner permits the worker to exert considerably more pressure on the objective piece by using the arm without tireing the wrist.

Flakes of greater dimention may be removed by the long-handled tool than by the short one. It is somewhat easier to keep the tip of the pressure tool in line with the ridge on the artifact, making the flaking more uniform. The tip of the pressure tools on both short and long styles will affect the character of the proximal end of the flake as well as the flake scar. The tip with a flat surface will contact a larger portion of the edge of the objective piece than will one with a sharper point. The former causes the bulb of pressure to be more diffused while the latter causes it to be more alient.

The width of the flake or flake scar doesn't depend entirely on the width of the tip of the pressure tool but on the interval in which the tool was placed on the margin of the objective piece. Closely spaced flakes may be detached with a fairly blunt pressure tool. The amount of pressure required to remove a flake is directly proportional to the width and not the length. The exterior surface or the dorsal side of the flake to be will control its relative length. The thickness of the flake is regulated by the distance in from the leading edge at which the tip of the pressure tool is placed. This distance from the edge is also a factor in controlling the width of the flake. The nearer the edge of the objective piece that the tip of the pressure is placed without the edge crushing the less pressure is required.

Additional purchase may also be gained by the use of the thighs. The back of the left hand is placed on the inside of the left thigh while the back of the right hand is placed on the inside of the right thigh, then by simultaneously pressing the thighs together and coordinated with pressure from the forearm and shoulder. As this pressure is applied the left hand is moved in such a way that as the inward pressure is applied by the pressure tool, the left hand is moved to control the downward pressure.

This permits a flake to be detached first at the platform and then guided across the face of the artifact by the motion of the hand holding the objective piece.

The long handle pressure tool is commonly used for medium to large projectile points and bifacially flaked knives. (These will be described in detail under point types). The character of the flakes using the short or long handled tools will depend upon the nature of the work being done. Their form and characteristics should be quite uniform and show consistent patterns, if the implements beinf manufactured are the same. However, because the objective piece is held in the hand and the hand is rotated as the flakes are removed the flakes will be curved on the ventral side and the artifact will be convex on its flaked surface.

The platforms of the flakes removed by the use of the pressure technique will denote the manner in which the artifact was held. By replacing the flakes in the left hand with each flake between the artifact and the palm, it can be seen that the platform will correspond with the former lateral margin of the artifact. Should the transverse angle be at right angles to the longitudinal axis of the flake, then the flake would be a collateral flake if the sides of the artifact edges were parallel. Should the angle of the platform be either to the right or left, then the flaking would have been diagonal.

The size of the pressure flake (width and thickness) will have certain limits depending on whether a short or long pressure hand tool was used. The strength of the knapper is also important. There is naturally a limit to the size of the flakes which may be removed by the hand held pressure technique. The nature of the material will also play a part.

28. Pressure, hand held with rest

The hand held pressure with rest is much the same as in No's 26 and 27 except that the objective piece is supported on something besides the hand. A rest or semi-rigid support is used. Such a support will cause a difference in both flake and flake scars. The flakes will be flatter on the ventral side than those that have allowed the objective piece to move when the pressure is applied. The flakes will feather at the distal end of the flake. Bifacial tools made by the use of this technique will have a spine or ridge running longitudinally down the median line of both faces of the artifact. The cross section will be rhomboid or diamond shaped.

A preform cannot be thinned by using this technique. Examples of flaking of this character are to be found on some varieites of Eden points, usually those that are flaked collaterally. Some drills show the use of the rest. The flake scars usually terminate before or at the point midway across the face of the implement.

One of the methods used in flaking experiments is to use very thick stiff leather as a pad for the left hand with another piece folded and placed on top of the other and placed in such a manner that it will parallel the proposed flake. The folded strip of leather provides clearance for the flake to be removed from the artifact. I also use for experimental purposes a rubber heel with a groove cut into it for clearance. The rubber heel is preferred because the folded leather has to be adjusted after each flake is removed.

Pressure is applied differently than when more downward and inward and gradually increased until the flake is removed. The flake comes off with a sharp snap and a different sound than without the support. The gradual application of pressure is important because as the pressure builds up to the point of fracture the flake will part from the parent mass in a straight line without curving and will terminate with a sharp edge at the tip. A flake removed in this manner literally exolodes because of the elastic qualities of the material.

Care must be used in seating the tip of the pressuretool to prevent the edge from being crushed. The seating of the tip may be done by removing minute flakes from the edge margin as each flake is removed or the entire perimeter or lateral edges may be slightly beveled by a wipeing action to turn the edge. The edge can also be slightly polished by the use of an abrasive stone to be made stronger.

The hand is stabilized by resting the back of the left hand on the thigh and not permitted to move or the flake will not terminate with a feathered tip. The flake will curve and cause the artifact to be biconvex in cross section. The way the hand is supported and the artifact is held will influence the flake character. In order to further immobilize the artifact it may be rested directly on a grooved stone, log or any similar medium.

Experiments have shown that the fingers or the thumb must be given exercise and time to develop as each new position requires a new set of muscles to hold the objective piece while being worked on by the right hand holding the pressure tool. A novice knapper will find discomfort in a short time of working at any position and will find it most difficult to change techniques and develop new muscles and callouses. Experiments in replicating techniques will soon convince one that after one has become proficient using one method there is no reason to make the change if the artifact serves a functional purpose.

29. <u>Pressure, reverse, finger held</u>

A method of flaking that is reversed from the normal of pressing towards the body, using this technique the pressure is away from the body. Such a way of applying pressure causes the flake scars to resemble those made by a left-handed person. The reverse flaking technique has been noted in numerous artifact assemblages occurring in both the New and Old World. (Observed and discussed at Lithic Technology Conference, Les Eyzies, France November 23 to 28, 1964). At this time it is difficult to be sure if the maker was using the reverse technique or was simply left handed. When the majority of the artifacts has flake scars directed away from the worker, one could then conclude that the reverse tedhnique was used, as it would be unlikely that left handness would be so prevalent.

It was noted by H. Holmes Ellis (personal communication, 1940) that the occurence of the beveling of bifacial artifacts (knives) corresponded with the present percentage of left handed people. This study revealed that both the beveling and the direction of flaking indicated left handness rather than a change of technique. However, in the Valley of Mexico and the State of Colima a high percentage of the pressure work does indicate that the reverse technique was used. The use of this technique was first resolved and developed and brought to my attention by Gene Titmus, an accomplished flint-knapper, who developed this technique independently and without my assistance. The Titmus technique has also brought to my attention the importance of the individual development of ethnic groups methods of flaking stone; each identifiable through characteristic flakes and flake scars.

By comparing the results of our experiments with each attempting to use each others methods, we have found that it is difficult to change the technique. We have found each others technique to be awkward because of different muscles that needed developing in order to hold the objective piece. In both cases the platforms had to be prepared in reverse. Both Titmus and I have now been able after many hours of practice to replicate one another's technique but not with the accuracy of our original method. These experiments have shown that once you are accustomed to a particular method it is unlikely you will change techniques if the end result is the same. It would seem plausible that aboriginal workmen once developing a technique would be unlikely to change.

The reverse technique is done with the worker in a sitting position with the thighs spread so that the back of the left hand is placed on the inside of the left thigh and towards the body and away from the knee. The left hand supports the objective piece by resting it on the third joint of the forefinger and the palm of the hand. The first and second fingers are spread in such a manner that the flake to be detached will have space between the fingers. The thumb holds the objective piece in place. The hand is protected by a folded cloth or soft leather pad and is sometimes wrapped around the first finger with the balance of the protective material on the palm covering the other three fingers. This technique is commonly used for retouching projectile points, and sharpening bifacial artifacts.

First the base of the artifact is placed in the palm of the left hand with first finger extended and pointing towards the right thigh. The other three fingers are slightly curved under the pad to assist in the support of the preform. The distal end of the artifact is pointed towards the body with the lateral margin to be flaked towards the first finger. A small platform must then be prepared on the lateral margin or the leading edge to seat the tip of the pressure tool. The platform is prepared the same distance from the base as will be the width of the first flake. The platform preparation is done by removing minute flakes pressing from the under side of the artifact towards the thumb in a direction opposite that of the proposed flake. Removing these tiny flakes makes a small notch. The edge of the notch towards the base will have an abrupt angle for seating the tip of the pressure tool. The first flake will have to be removed with care or the base of the artifact will be partially removed with the flake.

The pressure tool is held in the right hand with the pressure tip as close to the first knuckle to increase the leverage. A short hafted pressure tool is used because the pressure is directed outward and away from the body. A long pressure tool is cumbersome and gives the knapper no advantage of leverage. Experimenting and practice will determine the distance from the edge to place the tip of the pressure tool. The farther the tip is placed into the body of the objective piece the thicker the flake will be. The pressure tool is held at an angle to the lateral margin and in line with the proposed flake to be removed. The angle at which the pressure tool is held will determine the obliqueness of the flake scar on the artifact. The pressure tool is pressed directly in line with the proposed flake, then downward pressure is exerted towards the first knuckle of the left hand. The inward pressure must be adequate before the downward pressure is applied slowly and gradually increased until the flake parts from the artifact.

After the first flake is removed from the base of the objective piece, the scar is examined to see if a suitable ridge is left to guide the next flake. If the angle in which the downward pressure is applied is not perpendicular to the long axis or the lateral margin, the ridge will be eliminated and will permit the second flake to spread. If the first flake is successful and a ridge or crest is left, then by the use of the pressure tool the edge is trimmed by pressing downward on the margin until the scar left by the bulb of pressure is straightened and is in line with the ridge.

Another notch is then made in the same manner as the preparation for the first platform in removing the first flake. The inward pressure must now be in line with the ridge and be applied first before the downward pressure is applied. Each successive flake is then removed in the same way until one reaches the tip of the artifact. Both the downward and outward pressures must be adjusted as the flakes diminish in size.

The slightest miscalculation in applying both pressures, platform preparation and the position of the tool on the platform will cause a step fracture. Should a step fracture occur then the next flake will also step fracture at the same point as the previous one. This is due to the increased mass left by the step fracture and the next flake cannot be given enough strength to bypass the increased resistance. Any interruption of the flaking pattern such as step fractures or imperfections in the material will prevent parallel flaking. All conditions must be ideal. Occasionally one can recover from a step fracture by removing a flake from the opposite margin and on the same side to intersect the flake scar with the hinge fracture.

Should the first series of flakes be successful then the objective piece is turned over and the next series started at the base on the opposite side. After this side is flaked the lateral margins must then be reworked to make their edges regular again before the next two series of flakes can be removed. The knapper now startes at the tip or the distal end of the artifact and removes the flakes toward the base. The first flakes must be removed from the fragile tip with great care and direct the pressures downward more than outward or the tip of the artifact will be severed. After enough flakes have been removed from the distal end of the artifact to a position on the edge, then one will direct the flakes in line with those previously removed from the opposite margin.

The flakes removed from an objective piece to parallel flake the surface of an artifact are in reality dimunitive blades. Blades larger than those made by parallel flaking an artifact involve the same principles and a similarity of technique. An association of blade making and parallel flaking is not unreasonable and any evidence of aboriginal similarities remains to be seen. There is some evidence of a relationship in the Denbigh complex, Lena River in Siberia, polyhedral cores and parallel flaking in meso America and possibly some Early man sites in North America.

30. Pressure with Rest and Clamp

Pressure with the aid of rest and clamp is a method used in experiments replicating various burin types and micro cores associated with several of the Artic cultures. The pressure tool is long enough to be grasped by both hands, at least eight inches long. The clamp is made from two pieces of wood or bone loosely tied to allow the objective piece to be inserted between them and the lashings serve as a fulcrum when the opposite ends of the wooden or bone staves are spread.

After the objective piece is made secure in the scissor-like clamp, the objective piece is rested on a stone or bone anvil with the objective piece extending beyond the anvil to permit the blade to clear the anvil. The knees are then placed on the holding device to secure both clamp and the objective piece, which in this case is either a core or a flake intended to be a burin core. A platform is prepared on either the core or the flake to prevent the pressure tool from slipping as the outward pressure is applied. The tip of the pressure tool is then placed directly over a ridge previously prepared to guide the blade, and in from the leading edge far enough to avoid it's crushing and at such a distance that will control the thickness of the blade. The right arm and shoulder then applies the downward pressure and the left hand pulls slowly outward until the blade is removed from the core. Should the knapper desire a burin blade with a hinge fracture at it's distal end then the downward pressure is decreased to a degree that will not permit the blade to travel to the distal end of the burin core and the outward pressure is applied.

It appears that two types of burin blades were useful, one with a sharp termination or at least modified by flaking it's distal end until it was sharp. The other sty;e has a hinge fracture at it's termination and is a most useful tool for bone working. Repeated hinge fractures require considerable control on the part of the knapper to regulate the proper downward and outward pressures. There are many burin cores that bear evidence the technique was repeated many times on the same core.

Another type of burin blade is made on the margin of a blade using the sharp edge of the blade to make this scalpal like tool. The back of this type of a burin blade is lunate with the curved surface at right angle to the sides. The cutting edge is flat and opposite the curved back. The burin blade made on a blade is a supurb cutting implement. The burin blade using the margin of the blade is in reality a very specialized flake and has little resemblance to the normal concept of a blade. The manufacturing technique is similar to that used in blademaking.

The core tool has little resemblance to the common concept of a core. It has had only one flake removed from one to four margins, but usually only one margin was used. In section it is a very steep triangle, and it's apex being the cutting edge. The technique is the same as in a normal burin except that the downward and outward pressures are exerted simultaneously with the downward pressure controlling the length.

The blade is first truncated to make a platform surface to apply the pressure tool.

I have found that if the burin blade is to terminate in a hinge fracture, it helps to have the rest directly under the downward force. The burin blades are usually rectangular in section with the exception of the first which will generally be triangular. Blades removed from the polyhedral core will be either trapezoidal or triangular. At their proximal ends some technological traits show that the overhang or lip left by previously removed flakes was left intact. Other prehistoric workers removed the overhang left by the bulb of pressure. This appears to be a cultural difference or preference. Those that removed the overhang to help isolate the platform area made cores of slightly better quality. (Charles Borden and J.L. Giddings)

Further comments on the technique of manufacturing are to be considered. Some may be apprehensive regarding the pressure method used as a means of removing burin blades and blades from micro cores. The area to be fractured is most certainly not beyond the limits of pressure flaking, yet most still cling to the phrase that they were struck or calling the burin blade a spall which indicates that it was removed by a spalling hammer (stone mason's hammer for rough dressing stone). Direct percussion is used to preform the core, but the platform preparation on both burin cores and micro cores show that pressure was used. The actual detachment of the blades require more accuracy than can be had by direct percussion. From my experiments I believe that the majority of microblades and burin blades were pressed off.

When the burin core is used to preform a function, it is necessary to have a sharp cutting edge at the intersection of the platform surface and the lateral margin of the core. When striking on an anvil (Technique No. 9) or using the hammerstone free hand (No. 10) or indirect percussion with rest (No. 24) the cutting edge is bruised and rendered unfit for cutting. However, these techniques are useful for the burin core preparation.

31. Pressure with Short Crutch

The use of pressure with a short crutch permits the user to put forth more pressure than any hand holding technique. The objective piece may be held in either the hand or a holding device. The short crutch is made by afixing a cross piece to a short staff about sixteen inches long or to the comfort of the worker. The crutch can be used either on the chest or rested against the shoulder. The artifact held in the hand can be bifacially flaked by the use of shoulder crutch. The left hand holds the objective piece in the palm with the thumb extended and the fingers stabilize the piece without the application of great pressure. The edge opposite that being worked rests edgewise at the base of the fingers. This position permits the strength of the left hand and arm to oppose the pressure of the right shoulder without unduly tiring the fingers of the left hand. The left hand is also assisted by the support of the thigh of the left leg.

The necessary platforms are prepared either individually or the entire margin of the leading edge is prepared by grinding or micro flaking. The pressure tool is positioned in line with the ridge of the proposed flake if it is to be parallel flaking, or else a flat surface is chosen if the flakes are to be expanding. The style of flaking being determined by habit or the proposed function the artifact is to perform. This technique is useful for making large bifacial artifacts such as knives, lance points or spears, but slightly cumberson for small projectile points.

The technique is to firmly seat the tip of the pressure tool on the prepared platform near the proximal end. One pulls with the left hand and pushes with the right shoulder with force adequate to remove the flake. However the flake will not part from the artifact until the right hand presses towards the wrist of the left hand and the left hand will turn the artifact by slightly straightening the left wrist. These motions are done slowly until the flake parts from the artifact. Increased padding is needed to protect the left hand. Generally the pressure is applied at right angles to the long axis which causes the flakes to be removed collaterally rather diagonally. The angle of the flaking is dependent on the habits and rhythm of the worker and the manner in which he is accustomed to hold the objective piece.

The short crutch is also an ideal pressure tool for making micro blades and burin blades. In order to use the short crutch, the objective piece must be secured by a holding device and the worker positioned kneeling over the core. The shoulder is used to bestow the downward pressure first while the hands press outward until the blade is removed. As the blade is being removed, it's path must be unobstructed to prevent breakage. The platforms on the core must be prepared in order to provide the proper seating of the pressure tool to prevent the pressure tool from slipping and crushing the leading edge. The character and the angle of the proximal end of the blade will indicate the type of platform preparation and the type of core that was used if the core is missing. The crushing of the leading edges of the core is the usual cause for abandonment rather than core exhaustion. If the blade is broken before it is entirely removed from the face of the core, it will force abandonment of the core before it can be entirely used.

I can cite no reference in literature of any observers noting that the short crutch was used aboriginally. The shape of some of the composite pressure tools used in the Artic does, however, suggest the use of this implement. Because of the nature of the material used to make a crutch (probably wood) the ravages of time limits the possibilities of finding such an instrument intact. The same situation also probably eliminates the finding of clamps and holding devices. I have found this implement most useful for conducting experiments that appear to replicate certain aboriginal techniques.

32. Pressure with long Crutch

The use of this technique has been previously described in a separate paper, Crabtree, 1968. However, other experiments have been made to employ the use of this flaking device to make large bifacial artifacts. The results have not been too impressive because of the method of holding. The biface cannot be secured in a holding device in the same manner as the polyhedral core and because of the length of the pressure tool, the flakes cannot be curved over the face of the artifact. The method is not to be abandonded and needs additional experimentation. An answer may be the use of wooden pegs driven into a log to support the artifact and the preformed artifact be flat and thin rather than biconvex.

Several experiments have to be conducted with the long crutch and a combination of pressure and percussion. To perform this technique a second person is needed to apply the percussion while the one induces both downward and outward pressure. The crutch can be used with a cross piece for resting against the chest and with a crotch or projection fairly close to the tip of the pressure tool to receive the blow delivered in conjunction with the pressure.

The pressure tool can be used without the projection in a similar manner if the staff of the crutch is lengthened and held so that it protrudes back of the right shoulder so that the second person can deliver the blow directly in line with the shaft.

It is most important that the forces be coordinated perfectly to remove a blade. Blades considerably larger than those using pressure alone may be removed. The blow must be delivered by a person familiar with the amount of energy required to detach a blade of given dimention in combination with the applied pressure.

Only a few experiments have been done using this technique because of the shortage of massive material of good quality and an assistant with a knowledge of stone flaking. The first experiment was done in 1940 with the aid of H. Holmes Ellis at Columbus, Ohio using Harrison Co. Indiana flint. We used a percussion prepared core which was placed in a hole in the ground with about a half inch of the top exposed, so that a foot could be placed on it's top to hold it firmly. The hole in the ground was then elongated to provide clearance for the blades to prevent their breakage. The pressure tool used was one with a straight shaft and the blow delivered at the end opposite the pressure tip. The results were encouraging, but the blade lacked the uniformity desired. This was due, I find now, to improper core preparation and coordination of the forces.

Since the initial experiment and by study of the behavior of flint-like materials recent experiments with my colleague Gene Titmus we have been able to remove blades twelve inches in length and two inches in width, using obsidian for the material by the use of this technique. There is still need for additional experiments because of some paradoxical results caused by improper support and the use of silicious materials instead of obsidian.

33, Pressure (Notched Tool)

The use of the notched tool as a pressure implement is only useful for removing short flakes because the fulcrum is only the distance the notch is deep and the length of the flake cannot exceed this distance. The notched tool is much the same as the set of indentations on a glazier's glass cutter. It is useful for material with parallel sides; and since most artifacts are convex on at least one surface, the tool will slip before a flake may be detached. Plate glass or sawn slabs may be roughly shaped by a notching tool. Metal or antler is better than bone because of it's additional strength.

34. Pressure with Lever and Fulcrum

This device was made from a seven-foot bar of hickory wood with a heavy duty strap hinge affixed to one end and a slot made in the center of the shaft to insert a copper bar and then drilled and a bolt inserted so that the capper bar could be moved with the long axis of the shaft. The hinge was then made secure against a six by six upright timber also well secured. Sash cord and pulleys were then used to manipulate the wooden bar vertically. A loop was made for the foot to invoke the pressure. A clamp held the objective piece allowing the use of both hands to move the copper bar towards the operator to provide the outward pressure. The slot in the wooden bar was six inches from the hinge making it simple to calculate the ratio of force necessary to remove a blade of a given dimention.

With this device the experimenter by the use of weights and scales can formulate the amount of downward force, the amount of outward force and measure the plane of fracture. It can also be used to show the differences in the amount of applied force necessary to cause fracture in materials of different textures and to show differences in platform preparation. Some testing has been done, but final conclusions are still to be evaluated. It is doubtful if such a device was used aboriginally. The device is only to determine the consistency of flake character under controlled conditions and then relate them to problems that confronted the experimenter and the aboriginal.

35. Pressure with Fixed Pressure Tool

This is a method of removing flakes from the objective piece by holding the piece between the thumbs and both fore fingers and pressing the lateral edge on an antler tine set at an angle in a wooden socket. The socket may be drilled into a log with the tine firmly affixed and slanting towards the worker sitting astride the log. The pressure is applied on a prepared platform on the edge of the proposed artifact. Both hands holding the objective piece press first forward and then downward to detach the flake. The flake is removed from the top of the artifact rather than downward and is removed between the thumbs, they being separated to allow clearance for the flake as it is removed.

The use of this technique has a serious drawback and that is the flakes fly directly towards the knapper's face and could easily cause blindness if the worker is not properly protected. Another disadvantage is that the work is being done on the lateral margin opposite that of the worker, making it difficult to place the platform on the antler tip with accuracy. The experiments in using this technique have been limited because of thumb exhaustion. The technique does, however, have merit because the flakes can be removed without any obstruction and the ridges may be aligned with accuracy.

The fixed pressure tool inhibits the movement of the pressure tool and therefore it is difficult to cause a flake to curve over the median line of the long axis of the artifact. The flakes are flatter than when the pressure tool is held in the right hand. The tip of a projectile point is difficult to make using the fixed pressure tool. To my knowledge there is little reference for this technique being used aboriginally, so intensive experimentation was limited to testing this method of flaking. It was tried briefly for unifacial notching and serrating being a quick means of making d enticulate edges when the edge of the pressure tool has been shaped so that it has a sharp leading edge. When the artifact is turned over to deepen the notches, wedging occurs and the debtates are broken often. Perhaps continued practice would overcome this drawback.

36. Pressure on Anvil

This technique is probably the simplest of all techniques of pressure flaking. It can be used with some diversity from the making of a very simple projectile point, scraper graver, perforator or simply turning the edge for platform preparation. The anvil can have a wide range of sizes depending on what is to be accomplished. A small water worn pebble of medium hardness is held in the right hand and on the second joint of the first finger with the hand partly clenched. The thumb holds the flake or blade against the pebble while the left hand holds the balance of the blade between the first finger and the thumb. The right thumb then presses the flake against the pebble while the right hand turns the objective piece.

The flaking is started at one end of the flake to be modified and then as each flake is removed there is left a slight projection to be used as a platform for each successive flake to be removed. A flake that is flat and of the correct thickness may be transformed into a rough projectile point in a few minutes. There is no need for a pad or pointed pressure tool. A thin pebble or flake may also be used for notching the base and is done by using the same technique. The lateral margins as well as the flaking is alternated to make the artifact regular in form. The flaking surface of the projectile point in this manner will not have sharp edges and the flakes will be short and irregular.

This technique may be used while standing or walking; and if the tip of a projectile is broken, it may be reported by the hunter as he still pursues the quarry. Flakes and blades used as cutting implements indicate that this method of backing was used to prevent injury to the hand while using the sharp flake. Many aboriginal flakes have the one edge modified by the use of this technique that can be easily mistaken for use flakes while in reality the opposite side of the flake was the one that wasused and the flake or blade was nearly dulled to prevent injury to the user.

It is a technique that can be done hurriedly with little effort and a minimum amount of equipment. The anvil-like pressure tool may be picked up most anywhere. I find that the pebble is a most useful pressure tool for turning the edges before more refined retouch with a pointed pressure tool. The edges are apt to be dulled as it is most difficult to keep the pebble from contacting the sharp edge as the flake parts from the artifact.

The pressure tool or anvil does not necessarily need to be a pebble. It may be of any material hard enough to remove a flake, even hard wood. The wood will not crush the edges as readily as stone, and antler horn and bone are quite satisfactory. The same technique may be employed to turn edges, but the anvil is placed on the thigh or on the ground and the artifact is held in the two hands while applying pressure. One cannot expect the control using the large anvil as when the objective piece and the anvil are held in the hands.

37. Implement Used to Detach the Flake

The device is used to cause a plane of fracture in materials with isotrophic qualities. The tools used to produce fracture by impact (force, mass, motion and inertia) are called percussion tools or percussors. Some implements are used by gradually increasing force with the minimum amount of motion to a mass of isotrophic material that is caused to become stationary. The material is compressed to the point of fracture. The implement is a pressure tool or a compressor. There are two different means of applying force indirectly. One is the technique previously described (the use of the long crutch) which is a combination of both pressure and percussion when a blow is delivered to the crutch. The staff of the crutch is used to transmit the percussive force to the objective piece being already assisted by the application of pressure. The tool could be called a compressor percussor. The other is the indirect tool used to transmit only percussive force to the objective piece.

To fabricate artifacts from the most minute to the massive requires tools for removing micro flakes to giant spalls and quarrying operations. The size of the percussors will have great range. Tool size may be reduced by increasing the velocity of the percussor. Force is simply an effort exerted by or upon bodies at any instant. When he induces fracture the wielder of the hammerstone may not be conscious of the physical happenings but only of the desired results.

A common problem in physics will help to illustrate the variables that confront the stone knapper. If a block of flint is struck by a hammer weighing 20 pounds with a velocity of 30 feet per second, what is the force of the blow? What happens when the velocity is increased or decreased? What happens if the objective piece moves with the blow and what happens when the hammerstone is smaller than 20 pounds? A simple formula is: The mass is M pounds weight divided by 32, then the momentum would be 21/32 X 30, or 18 and 3/4 units. If this is to be destroyed (the hammerstone stopped) in 1/100 of a second, the average force against the flint would be 18 and 3/4 divided by 1/100 or 1,875 pounds. If the hammerstone had struck the flint placed in sand and was stopped in 1/5 of a second since the force was in effect twenty times as long, it was only one twentieth as great, or less than 100 pounds. By the same token a two and a half pound hammerstone traveling at 30 f.p.s. and stopped in 1/100 of a second would only have 84 pounds of force, and a one-pound hammer around thirty-three pounds. One can readily see that any changes in the velocity, the weight of the hammerstone or the type of support can greatly alter the effect of the percussor on the objective piece.

A hammerstone larger than the objective piece will cause the piece to be projected with and in the same direction as the trajectory of the percussor. One must consider the center of gravity of the percussor as a glancing blow will not deliver the entire force potential. Experiments in using the hammerstone will soon cause one to realize how many variables confront the knapper. An indirect percussion tool is usually thought of as a cylinder or a punch-like object used to transmit force from the percussor to the objective piece.

Implements used for pressure flaking are generally hand held and used to apply force directly to the objective piece by the gradual application of pressure in two directions, generally inward and outward (Tebiwa 10:1:60-73.

<u>Tools Used in Removing Flakes</u> ???

The use of certain stone working tools may be identified by examining flake assemblages and repetitious flake scars. The percussion technique rather than pressure indicates that percussors with certain qualities will cause flakes that may be related to specific implements. The more resilent the percussor the longer the interval of contact between the percussor and the objective piece.

Such an interval permits a more gradual application of force and reduced the amount of compression on the objective piece. Similar flakes and flake scars can result from the use of both a polished agate pebble and the ball part of a ball peen hammer if they are used with equal velocity and all other conditions were the same. The other conditions are the same trajectory or path of flight of the percussor, the same platform angle and preparation, the same distance from the leading edge and the surface of the objective piece must be the same. The flakes will then be the same, with the platform showing a part of the cone truncation that corresponds with the area contacted by the hammer or hard stone percussor. There will be accentuated compression rings, their prominence increasing as the flare becomes thinner, An implement of wood will not cause the cone to be truncated and in some cases crushed because of the nature of the wood.

The type of work that is being done is to be considered, whether it be blade making or making a biface. The proximal end of the flake will penetrate a soft percussor and will be pulled from the artifact causing the bulbar part to have a distinctive lip and a diffused bulb of applied force. The part of the proximal end of the flake contacting the soft tool will be greater than with the hard hammerstone.

The degree of resiliency is variable in the percussors: minerals for hammerstones, antler, bone, shell, horn and woods of different hardness, Each will produce characteristics that will blend from one to the other depending on its structure. Predominance of characteristics in flake assemblages will indicate that certain tool types were used to perform certain techniques of flake and blade removal. The exact material used for the percussor may be questioned but it's relative hardness or softness will be indicated by an examination of the debitage. H. Mewhinney (_______ date).of publication)
H. Mewhinney (date) failed to replicate each flake by the use of different percussors. Before one makes final conclusions the conditions in which the flakes were removed, the dorsal surfaces, the area of the ventral surface, the platform part, and the termination

of the flake must be the same. The flakes must be designed for the same purpose, such as flakes to be made into projectile points, flakes made by thinning a biface or specialized flakes such as blades.

Flake types fall into certain categories depending on what stage or phase of stone tool production they were made. There are flakes that are typical to certain techniques and there are those that are aberrant forms and one must judge accordingly. Flakes removed when a platform surface is being prepared or the form of the artifact is altered to make it more symmetrical have little diagnostic value because of the random nature in which the flakes are removed.

The flakes segregated from flake assemblages must have attribute characteristics that will separate them from others with different characteristics before they may be related to tools and technological traits. Upon separation from the chipping debitage the groups of flakes selected must have certain similarities, even though slight variations. The platform angle should be consistent in it's relation to the longitudinal axis. The preparation of the platform such as grinding, polishing, relieving and isolation of the platform should be examined. The width of the platform or the distance from the leading edge to the point of impact govern the thickness, the curvature of the flake, the undulations or the compression rings, the flakes dimentions such as length, width, and thickness, the termination of both margins and distal end.

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These are but a few of the aspects to be considered that are common to most flake assemblages.

The flakes removed by indirect percussion are difficult to relate to the tool material because the force is transmitted to the objective piece by the use of an intermediate tool. Sharp lines of demarkation make it difficult to separate a well controlled percussion technique and the use of the indirect tool. The use of the punch indirectly does, however, permit the knapper to achieve superior control in placing the punch with great accuracy. It is an aid in calculating the angle at which the punch is struck. Flakes that haveplatforms that are consistently smaller than one eighth of an inch in area will indicate that an intermediate tool was used.

At the present time the writer feels that no amount of human skill could be developed to remove flakes consistently by the use of simple direct percussion. The flakes removed by the use of indirect percussion are generally with well prepared platforms, sometimes being isolated and not uncommonly ground. The flakes are considerable flatter with edges that have no margin or in other words feathered. The flakes ventral surface is parallel to the working face of the core or the objective artifact. The bulbs of applied force are generally diffused and the ventral side of the flake has little or no compression rings because the shock is eliminated by the use of the intermediate tool and the blow delivered with a reduced velocity.

The implements used to remove flakes by pressure are difficult to identify from either the flakes or the flake scars. There are, however, a few characteristics that should be noted. The amount of pressurethat may be used to detach flakes is limited unless a lever used with a fulcrum or the chest crutch is employed. Flakes in excess of a half inch in width, not length, will be a rarety in most aboriginal sites as such a technique is commonly used to refine and sharpen artifacts made by employing the percussion method. Blades and micro blades as well as pressure made burins and other exotics are an exception rather than the rule.

The use of pressurepermits the worker to accurately remove flakes with percision and at the same time leave razor sharp edges to serve as supurb cutting, scraping, and perforating implements. The artifact can be made more regular and symmetrical as well as being better serrated and notched for hafting purposes than by the use of percussion.

Repetitious flakes removed along a margin can have much diagnostic value because a population of like flakes may then be studied to interpret the tool used to remove them and the technique. Flake series such as these may then be related to the type or character of the artifact and then in turn be related to a functional analysis of the flaked stone tool. (Frison, 1967) Frison has reassembled flakes of similar characteristics andmaterials and reconstructed the margins of artifact edges even though the artifact was not found. The flake study revealed techniques that were unique and undiscovered until this study was done with aboriginal material. The modification of artifacts and concentration of certain industries were noted, The flakes showed a rhythm that was almost mechanical being spaced with exactness and precision. Their platforms indicated that a pressure tool with a broad flat tip was used to remove them. The contact surface of the platform was as wide as the tip of the pressure tool, causing the resultant flakes to have bulbar parts almost completely diffused. I observed that the pressure was disseminated the width of the tool.

The techniques of applying pressure are both traditional and individual there being numerous methods of holding both pressure tool and artifact as well as techniques of applying pressure. The different amounts of both inward and downward pressures, the spacing of the flakes and the nature of the tool tips, all result in flakes that have distinctive qualities that may be identified as diagnostic traits. Both artifacts and flakes must be appraised individually, then grouped into categories that indicate technological traits. The same patterns may show a continimum in time and space. Individual and traditional traits characterized by single sets of components may also be observed. They may not be sufficient to create a complex until additional information is made available on other components exhibiting similar diagnostic technological traits.

The material is which the pressure tools are made will always be a matter of conjecture, unless there is a direct association of the tool kit and the artifacts. However, it is entirely possible by a study of pressure flakes to form conclusions with some degree of accuracy about the type of tip on the part of the pressure tool contacting the artifact as the flake is being removed. A very pointed tip of the pressure tool will cause the pressure to be confined to a limited area, it being the apex of the cone or the beginning of the bulb of pressure and will cause the bulb to be salient.

A broad pressure tip will distribute the pressure and will cause the apex of the cone to be elongated and cause the beginning of the bulb of pressure to be diffused. Should the point of contact with the margin of the objective piece be broad then there is little or no definition of the bulb. The width of the pressure tool contact may be determined by measuring the truncated part of the cone. This is also true when determining the contact zone or platforms of flakes removed by either direct or indirect percussion. The nature of the hammerstone or percussor may also be deduced. Certain percussion techniques cause the platform surface to collapse. Platform collapse renders the flakes and blades useless for identification of the tool used to detach them. The absence of the platform isusually the result of a glancing blow delivered near the margin at a steep angle.

The examination of flake assemblages will disclose enigmatic groups of flakes that will be difficult to relate to any certain tool types. They will indicate that techniques were used that caused the platform part to be shattered as each flake was removed.

Size and weight of Flake

The size and weight of the flake or blade is useful in determining the developmental stage or phase the artifact has reached from raw material to the completed implement. The size and weight is also indicative of what tools were used to produce flakes of varible sizes. The size of the flake would ordinarily suggest that the weight would be comparable, but thin flakes would have greater area than those that are thick and massive in relation to their plane of fracture. Massive flakes may be associated with the natural occurence of the material to be used as artifacts such as in quarries and alluvial deposits. Large flakes suggest the use of direct percussion with the aid of a hammerstone, hafted or unhafted. The flakes will have well defined bulbs of percussion with the point of impact inward from the leading edge in various degrees.

Flakes that result from reducing the raw material into workable forms will be quite random because of the way it has to be done. Platforms and angles must be created to receive the blow of the hammerstone at the correct angle. The flakes that result from platform preparation are usually short and thick. Because the surfaces are irregular the flakes will lack uniformity. The manner in which the blow is struck may cause the platform area to be similar. The debris that results from this operation will include rejected flakes that lack homogenity and are abberant in form. There will be exhausted cores. There will also be cores that have been distorted and bruised from miscalculations of the knapper and are beyond recovery. A source industry yields an assortment of sizes and weights of flakes with similar platform surfaces. There is a general lack of refined flaking and pressure flakes are usually absent.

The size of the artifact to be produced will govern the size of the flakes and the stage of making. As the artifact nears completion the flakes will normally be reduced in size and weight. The thinning flakes that result from a large biface will be much lighter in relation to their plane of fracture because of their thinness and expansion from the point of applied force.

The size and weight of pressure flakes will be limited because of the amount of force a person can exert. The exact limitations of strength of the human animal is unknown, but he is restricted without the aid of levers or mechnaical devices to aid him. The quality and kind of materials also will limit the size and weight of flakes that may be detached by the use of simple hand held pressure. Unfortunately flakes removed by hand-held pressure techniques are usually broken during removal because of the supporting pad held in the left hand. Pressure flakes can be removed in their entirety if clearance is provided between the artifact and the protective pad.

Quantities of pressure flakes found unbroken will indicate that a special technique was used to preserve the flakes for further utilization as small cutting implements. Because of the curvature of the pressure flakes made by retouching an artifact, they are easily broken if they are stepped on. The proximal ends of the pressure flakes will usually suffice in denoting a technique and their mode of detachment. Generally the width of hand-held pressure flakes is less than one-half inch and the retouch flakes on a projectile point much less. Their small size limits their recovery with the common screening methods and their full recovery would probably require special recovery techniques. Exceptions are pressure flakes removed by methods other than hand holding are those of making blades by pressure to be used as cutting tools. Examples of pressure blades are those from the Artic Valley of Mexico, (Lorenzo date) and the Hopewell, (Baby date). There are many other examples, though not quite so well known. Some of these are without the refinement of the examples mentioned. One of the most diminutive is the burin blade, also difficult to recover. (Borden date, Giddings, date, Irving, date).

Blades removed by percussion and indirect percussion will ordinarily be greater in size and weight than those removed by pressure. Obsidian blades from Colima, Mexico and those from Guatemala are noteable for their large size and weight and are larger than many removed by the percussion technique. The size and weight of flakes and blades are to be considered to denote techniques and the implements used to remove them from a core.

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Primary and Secondary Flakes

The primary flakes can be considered as those detached initially from quarry operations or from large cobbles and nodules and commonly retain some of the original surface on the exterior of the flake, such as natural planes of fracture, cortex, or the bruised exterior common with cobble and boulder forms. The cortex is common with the flint and chert nodular forms being the partly silicified or heavily weathered surfaces. The primary flakes are usually removed by the use of heavy direct percussion tools. The points of impact are set in from the leading edge approximately the thickness of the flake. The bulbs of percussion usually show good definition, and are salient. Flakes removed by the bipolar technique, however, have little or no bulbs.

The first primary flake will be entirely covered with the natural surface on the dorsal side. The second primary flake will have a portion of the first flake scar usually being divided along a median line from the proximal to the distal end on the dorsal side of the flake. Should the first primary flake be removed to prepare a platform for a core and cause a flat surface that will serve as a platform for the removal of additional flakes or blades, then the second flake will be the one covered with the natural surface. The flakes are then removed from the entire perimeter if the objective piece is to be used as a core for making blades or flakes.

The first series of primary flakes is recovered by certain aboriginal peoples to be used as knives and saws depending on the texture of the material. The natural cortex is used as a backing because it's smoothness is comfortable for the user. The backed knives and saws appear to be designed for this particular purpose. Should the raw material be used for a biface and the core method be used instead of using a primary or secondary flake, then the entire natural surface of the objective piece is removed, and all of the exterior surface will be reduced to primary flakes. The primary flakes are often abandoned unless they contain useable material for diverse artifacts. They are commonly being scrapers rather than projectile points. The exterior surface is commonly flawed or covered with a rind that will not flake because of its softness or bruises. The primary flakes are useful in determining the sources of the material. Cobbles indicate a secondary source from aluvium. Primary deposits of the silicious material may still retain some of the matrix in which the material was formed. The cortex on flint and chert may contain some identifiable limestone or diatomite.

The term spall is used for any large flake and was derived from modern quarrying operations for securing building stone. The blocks from the quarry were trimmed by the use of a spalling hammer. The resultant flakes were called spalls. Both large primary and secondary flakes could fall in this class, but a separation by using the terms primary and secondary flakes would be useful if one has an interest in technology.

Secondary flakes are those removed after the exterior of the objective piece is removed. Should the secondary flake be specialized to form a blade, then the dorsal side of the blade will bear two or more longitudinal scars originating at the proximal end of the blade to form one or more parallel ridges. A secondary flake may have flake scars on the dorsal side that are transverse, oblique, collateral, longitudinal, or random, depending on the exterior surface prior to striking off the flake, whether removed by percussion or pressure.

Debitage or debris that results from the flaked stone industries that accumulates at some distance from the source of raw material will have a predominance of secondary flakes in the remains. The trimming, thinning, and sharpening flakes removed by percussion are quite common. The pressure retouch flakes because of their size are easily lost unless means of special recovery are used. The pressure retouch flakes do not account formass or weight, but are numerous.

From the results of experiments pressure flakes can be separated for technological studies. It is a common practice to first remove any irregularities from a preform by the use of pressure, then one or two and sometimes three series of flakes are removed from the entire surface of the artifact. The purpose is to make a very regular surface in order to remove all flakes from one margin, or to accomplish the various styles of precission flaking. The dorsal surface of flakes removed after the first series of pressure work will naturally bear the scars of the previous pressure flaking. (See examples of the primary and secondary flakes (reference to figures??) detached by both pressure and percussion).

Flakes with Pronounced Undulations and Waves

Flakes that bear accentuated undulation waves and concentric rings of force show that materials with isotrophic qualities received force in the form of a blow induced in such a manner that shock was caused and the material compressed along it's plane of fracture. The waves, when extended, will form concentric rings around the point of applied force causing an effect much the same as dropping a pebble into still water. The greater the velocity or hardness of the percussor, the greater will be the magnification and accentuation of the waves.

There are several factors that are involved besides the velocity and hardness of the percussor. Other factors are the texture of the material and the r elative thickness of the flake to be produced. It might be of interest to note that at the obsidian quarry in Glass Buttes, Oregon the surface is littered with rejected obsidian in the form of broken artifacts, flakes, partly exhausted cores, and material tested and found to be inferior. The site was occupied aboriginally and is now almost continually occupied by the rock hounds and mineral collectors. The obsidian broken aboriginally and that fractured in recent times is very simple to identify because of the fractures made by rock hammers and mauls used by the recent collectors. The metallic hammers have caused shattering and a predominance of flakes bearing the accentuated concentric rings while those aboriginally are relatively smooth showing that the flakes were pulled from a core with limited velocity and the use of a soft hammerstone.

Flakes that have been removed from a core with pre-established ridges will not have the undulations of a thin flat flake. The spine on the dorsal side of the flake stiffens the flake and eliminates a great deal of the bending. The same is true when a thick flake is removed from a core. Excessive compression is prevented. The waves provide a clue to the technique, the type of percussor, and the velocity of the blow. Waves are sometimes found in some materials that have planes of weakness that will cause the flake to undulate. Materials include silicified sediments with varves, those with crystal differences, with flow structure in some volcanic glasses, and planes of weakness due to the crystal structure as in quartz crystal.

The material used for the artifact is to be considered when making an appraisal of the undulations of flakes. The coarse, granular textured material appears to dampen the formation of the waves as the force is not transmitted from one granule to the next. This reduced the shock-producing waves of force. The waves become larger and further apart as the distance from the point of applied force is increased and the energy is dissapated.

The Angle of the Platform in Relation to the Longitudinal Median Axis

The study of platform angles is most useful in determining the type of a core that was used to make the flake or blade. It is necessary to project an imaginary line from the dorsal edge of the platform to the ventral edge in order to visualize the whole platform surface of the core. The flake or blade can then be held with the platform angle corresponding to an imaginary 180 degree line. For example, a flake removed from the corner of a rectangular core would have a platform angle that would be 180 degrees in relation to the longitudinal axis which is 90 degrees. Another aboriginal example is the polyhedral cores from Meso-America that result from making the pressure blades.

The principal of the cone is involved in the design of the core prior to the removal of flakes and blades. Experiments in cone behavior indicate that the angles of the cone remain fairly constant. The core must then be designed in such a way that the plane of fracture of the cone will correspond with the flake or blade. When direct percussion or indirect percussion is used, the force must be directed at an angle corresponding to the angle of the cone. The core must be prepared with a platform corresponding to the style and form of the flake or blade desired.

In the rectangular core the blade is removed by the application of both downward and outwart pressure. On the other hand if the applied force was accomplished, vertical or at 90 degrees to the 180 degree platform, the resultant flake will be one quarter of a cone. From the truncated part of the cone the flake would expand as the forces radiate and cause the flake to be thick and expanding at it's distal end. It will be of no functional value. If all corners were then removed from the four sides, the core would then start to resemble a conical core. Then if the force were applied in the same manner as flakes or blades were removed, the angles of the flakes on the platform area would remain the same and the core would be conical. This illustrates only one technique which could be a technological trait. There are numerous other core types and methods of flake and blade removal. After the core is prepared in a certain fashion and the flakes removed using the same tools and the same technique, the angles of the platforms will correspond to the long axis.

The variants in the platform angles have a direct bearing on the technique used. A conical core will have a platform angle that will be approximately 70 degrees when the flake or blade is removed by direct percussion. This happens when the percussionary force is applied at a 90 degree angle to the face of the core. The anterior surface of the core can be designed in a multitude of forms to receive the force necessary to remove a blade or flake. The style and forms of cores range from the most rudimentary to very complex. The more refined cores will have a greater uniformity of flakes and blades bearing platform angles that will also be uniform.

Some residual cores show thatthe lithic material received percussionary force that was random in nature and the flakes were removed on any surface that presented an angle that could be used as a platform. Flake debris made by the use of indiscriminate blows of the hammerstone on the objective piece are distinctive only because of their random nature. Each flake would be variable in both platform angle and form. Such informal flaking results in a core residue that is globular and usually reduced in size until no additional functional flakes may be removed. The surface has often been crushed from repeated blows until no further flakes may be removed.

Recent examination of flake debitage at field schools conducted at the Grasshopper ruin and at Vernon, Arizona allowed the direct application of selecting of flakes with like platform angles and then examining the groups of flakes having similar platform angles. The flakes showed a similarity of form and also a similarity of techniques used to remove the flakes. Some flakes showed little or no platform or measurable platform angle and were without the usual bulbs of force. This showed that a special technique was used to remove such flakes. These unusual flakes were without exception covered with the exterior surface characteristic of pebbles and cobbles.

From my own experiments they were probably removed by severing one end of the pebble by the use of the anvil technique. This causes the cone of applied force to be severed, eliminating the bulb of force. The technique is to place the pebble on an anvil stone and then strike the pebble in such a fashion that the anvil will cause the objective piece to become inert while the force imparted by the hammerstone will cause the cone and the end of the pebble to become severed. Such a fracture is easily recognized after the examination of a few of the flakes removed by the use of the described technique. Such flakes were found only at Vernon and none were observed at Grasshopper.

There are, however, many other features to be considered besides just the platform angle. The angle of the platform is often impossible to measure because of the technique used and the flake being incomplete. An example of a complete flake with a platform that is unmeasureable is one that has been isolated and ground such as a channel flake or the flakes removed from the edge of a biface for thinning purposes.

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Width of Platform Surface

The width of the platform surface depends on two factors. One is the amount of platform surface contacted by the percussor and the other is the distance from the leading edge that the force was imparted. The first is useful in determining the type of instrument used to apply the force. If direct percussion was used to remove the flake or blade, the contact surface of the percussor will be the truncated cone part or the area that contacted the hammerstone. Hard round hammerstones will limit the area of contact. A soft hammerstone will contact a greater area and cause the truncated cone part to be of greater size. By the same token a wood billet will show little or no definition of the cone or it's truncation. The wood upon impact will allow the leading edge to penetrate and cause the bulb or cone part to be diffused. The amount of diffusion or definition will depend on the nature of the material used as a percussor. The more the percussor conforms to bhe objective material and the flatter the area between the contact of the percussor and the objective piece, the broaderthe platform. The softer percussor material will conform more readily than one of greater hardness.

The use of the punch as indirect percussion permits the worker to limit the contact area by isolating the platform as well as affording accurate placement of the indirect percussion tool. Pressure techniques show the same principals are involved.

A pressure tool with a wide tip will contact a greater portion of the material being worked and cause a broader bulb of pressure to be formed. The use of a pressure tool with a narrow tip causes a limited bulb of pressure to be formed. The hardness or softness of the pressuretool does not cause any apparent change in the character of the flake or bladelette. The width of the flake and the platform area may be controlled to a degree by placing the tip of the pressure tool in from the leading edge. As the flake is removed a greater platform area is also removed. The wider the flake the greater is the pressure necessary to remove the flake, causing the width of the flake to be limited to the amount of pressure the worker is able to exert.

The second part of controlling the width of the platform is the distance from the leading edge that the force is applied. For direct percussion or indirect percussion, the point of contact between the objective piece and the percussor is set inward from the leading edge. The platform area will spread towards the leading edge causing a platform area to be formed that would be larger than if the force had been applied on or near the leading edge. An example of the use of the technique of striking away from and back from the leading edge is found in Levalloisean flake with expansion of the platform area from the point of impact to the dorsal side of the flake. Flakes of this nature are designed on purpose to serve a certain function and are usually removed by the use of a hard hammer stone to concentrate the point of impact.

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<u>Thickness of the Platform Surface or the Distance from the Dorsal Edge to the Ventral Edge of the Platform Surface</u>

The thickness of the flake or blade is partly discussed in the previous section and those factors must be considered. The distance in from the leading edge does, however, cause the flake to be at least as thick as that distance. The width of the platform area can be controlled by the design of the core or the isolation of the platform area. For example, a core that is very narrow will allow a very narrow thick blade to be removed. The burin blade is a good example of the thickness being equal to the width of the blade. The thickness may exceed the width of the flake or blade many times if the flake is severed by the use of the burin technique.

The point of applied force by percussion or pressure is applied at a point back or away from the leading edge the same distance as the desired flake or blade thickness. Should the core be flat on the face the flake will expand and the lateral margins will gradually thin until their termination. The flake will be plano convex and thick in it's midsection. A longitudinal ridge or a narrow core will confine the applied force and cause the flake or blade to be of approximately the same thickness of it's entire width and length.

The complete control depends on the worker's ability to prepare conditions on the objective piece and to impart the applied force with the proper intensity to produce a fracture of a predetermined dimention. There are, however, methods of making flakes that will be thicker at the distal end than at the proximal end. Usually such a techn ique is accomplished by a specially prepared platform, often by grinding to prevent the platform from collapsing, and then a blow with increased velocity is imparted upon the platform. This causes a flake or blade to be removed that will be thicker at it's distal end than at the proximal end. As the flake is removed from the core the base of the core is removed with the flake. These flakes appear throughout the various time horizons and wildly separated geographical regions and have been used for a variety of tool types.' Those made by accident commonly occur when the worker is thinning a biface by using a percussion technique rather than a pressure method. The flake removes the opposite lateral margin and the distal end of the flake has bifacial flake scars that cause the flake to resemble a tool of undetermined function while in reality it is a flake that results from the over-exuberance of the worker. A similar occurence is caused when removing blades by both pressure and percussion. These flakes and blades have the distal end of the core at the end opposite to that which received the force. Such flakes and blades have a name in French terminology and are called, "Eclat otrepasse" and "Lamelles otrepasses (Tixier: 1963:44.)

In order to replicate flakes and blades that go over and beyond the base of the core, one permits the core to rotate with the force whether it be pressure or percussion. As the core turns the flake will have an accentuated curve and will be concave on it's ventral side. Such flakes are well designed to be modified into scrapers with a minimum of retouch. Others removed in the same fashion but from a core that has a flat surface can also be modified into projectile points without major preforming as the transverse and distal ends of the flakes are used. These specialized flakes at their terminal parts are flat which is an advantage over using a normal blade which is generally slightly curved. The distal ends are bipointed and subtriangular and could be used as they are when the platform part has been removed.

Types of Platform Preparation

The platform part of a flake or blade is the key to understanding the flaked stone industries. It is this portion of a flake that determines the behavior of the isotrophic material when subjected to force, whether it be pressure or one of the forms of percussion. The techniques used in fracturing the stone will make themselves apparent when flakes are sorted by separating them according to the likeness of platforms. The platform parts will bear a remnant of the core from which they were removed. From this core remnant, one will be able to reconstruct the type of a core that the flake was removed from. The angle of the platform in relation to the longitudinal axis will show the top face of the core. It will also show what pains if any were used to prepare the area that received the force to detach the flake.

The platforms will range from the most embryonic to the most meticulous preparation. Examples are the use of the natural surface and the isolation and polishing of the platform. The platforms are selected or made by the worker to receive the type and kind of force necessary to remove the flake or blade. Each fabricating tool and technique require surfaces to be used as platforms. The platforms are designed in a variety of ways in order that flakes and blades may be removed that have certain form and dimention, whether an artifact is being formed or specialized flakes are being removed. Should a specific artifact flake or blade be desired in quantity and each be uniform in size, shape and of the same character, then the platform and other conditions must also be the same. Because the platform is the first consideration in making flakes that will be uniform, they are most useful in proposing technological traits.

The kinds of platform surfaces are: the use of the natural surface that presents a facet to receive the force; the platform with facets prepared by flaking; the isolation of platforms; platforms made by artificial grinding; platforms made by polishing; the absence of platforms on completed flakes; the platform crushed and shattered; the orientation of the platform with the longitudinal axis; and the angle of the platform. The following will detail the various aspects of the platform part of the flake.

46 The Use of Natural Surface for the Platform

Lithic material found in its natural state must be reduced into forms that will lend themselves to stone implement making. In order to reduce the raw material into core tools or simply to make useable flakes and blades, the material must be fractured with techniques that will conserve the material and still retain qualities that will make useful artifacts. Our experiments have shown that there are definite advantages in using material that still retains it's natural cortex. When working flint to make a series of uniform blades, the cortex acts as a cushion to dampen the blow (when using direct percussion). The blow delivered with a hammerstone on the cortex surface reduces the platform shattering. The cortex will yield with the blow because it is the partly silicified rind on the exterior of the nodular forms of this material. The hammerstone is projected at an angle to the surface of the flint, and the cortex, because of it's nature, will not permit the hammerstone to glance or ricochet and will transmit the force into the objective piece. The cushioning of the cortex reduces the end shock and by the same token reduces the breakage of the blades or large flakes.

Upon using the flint nodule for a core tool, the cortex is removed and serves no purpose for that particular type of tool making. The naturally rough and eroded surface of material other than flint reduces the glancing of the percussor. The use of the natural surface on obsidian was designed to prevent the pressure crutch from slipping as is in evidence on the platform surfaces of many of the polyhedral cores frlm Meso-America. Cortex is also found to furnish a distinct advantage when experimenting with similar techniques because it eliminates individual platform preparation and/or artifical grinding.

47 Platforms with Prepared Facets

A platform that bears one or more negative flake scars, (often called a facet) is flaked for the purpose of either seating the pressure tool or to form an area to receive the force from a percussor to remove a flake or blade. Each shows the need of uniform preparation to remove a preconceived flake or blade. The preparation of platforms becomes a second nature to one familiar to working flint-like materials. The platforms may be prepared individually or a whole margin may be prepared at one time. Individual preparation of each platform is usually necessary when making a core tool from a cobble or nodule as each flake is removed from a surface that is deviant from the previous condition. Because of the lack of uniformity of the raw material, the flakes and platforms will be necessity be variable and each platform will have to conform to the condition. Upon trimming the surplus material from a core tool, the worker will usually remove as large a flake as possible without endangering the proposed artifact. When using the core technique, the platforms will be variant because the flakes will be directed into the objective piece from around the perimeter of the objective piece. Since the flakes will vary in thickness the point of impact by the percussor will be struck at variable distances from the leading edge, causing the platform surface to vary in breadth and thickness.

The initial reduction of the nodule to a biface is generally done by the use of a hard hammerstone and will cause the bulb of percussion to be salient or well defined. Such flakes will usually have but one facet or plane of fracture to be used as a platform. When the preforming is completed and the objective piece is ready for thinning, the edge can be beveled on the margine (one of many techniques) and the bevel will be used for the platform surface or the platforms made for each individual flake to be removed for thinning. The thinning flakes will have platforms that will be considerably more uniform than those made when roughing out the preform. Should the material be of a tabular nature such as silicified clays and sediments, the natural margins are usually with right angle edges. These must be removed in order to be able to flake the proposed artifact bifacially. Rhe flaking is usually done by the use of direct percussion and a hard hammerstone. After the first flake is removed, the flake scar will be used for a platform for the next flake and these flakes will have platforms with a single facet. The objective piece will be turned and the flakes will be removed alternately. In this case a series of flakes will be quite uniform.

Upon using pressure flaking techniques the same methods are used only the flakes are pressed off rather than being struck off. Pressure usually requires more meticulous platform preparation and the preparation must be done with great care because a platform properly prepared doesn't require nearly the amount of pressure as unprepared or improperly prepared platforms. In contrast by using percussion the worker can usually remove the flake by increasing the velocity of the blow hile when using pressure there is a limitation of the worker's strength. Pressure flakes removed by preparing each individual platform are usually multifaceted because the worker will remove one or two micro flakes on the margin to remove ridge left by the bulb of pressure and then remove other micro flakes horizontally for the platform surface and then remove one or two other micro flakes to free the platform. The platform surface or facet is positioned directly over the ridge left by the previously made flake scar. The amount and number and size of the micro flakes that were removed from the lateral edge to free the platform will depend on the spacing of the flakes. Should a wide collateral flake be desired, then the ridge is not used and the flake will be allowed to expand. The faceting of the platform will depend on what flaking technique is used and the angle of the retouch flakes in relation to the long axis of the artifact. The angle that the retouch flakes are removed from the margins will depend on the thickness of the artifact desired. Some types are quite thick and are diamond shaped in their transverse section such as the Eden point. Others are thin in section with flat flaking on the surfaces of the blade part. Each technique requires variations of the platform preparation; and if not polished or abraided, will have characteristic faceting. Projectile points, for example, that are thick will have the platforms faceted in such a manner that they will be isolated and away from the leading edge so that when the flake is removed the bulb of pressure will not remove the lateral edge with the flake and cause the edge to be quite irregular.

A feature commonly noted is the technique of making small facets on the dorsal side of the flakes near the proximal ends to remove the overhang left from prior flake removal such as preforming and the first pressure forming of the artifact. The removal of the overhang changes the surface from being concave to one that has a slight convexity causing a little more material to support the platform and prevent the flake from collapsing and causing a step fracture. This technique is used for both pressure and percussion. The word facet is not uncommon in archaeological literature and is but a term to denote a fracture plane made by intention or naturally and signified no direction of the flake scar. It is relatively unimportant in denoting any technological differences in the scars and how they were made. It is a term that has meager significance and should be used in the most general way when one is ignoring the features shown in a flake scar. Facet is a good word but it doesn't mean much.

Isolation of the Platform

The isolation of a platform is to either put by it's self, place apart or to segregate. The isolation of the platform is used for several reasons. 1. to provide a protuberance that may be contacted with greater accuracy when using percussion; 21 the flake can be removed with less force when using either percussion or pressure; 3. the platform may be prepared by the removal of flakes to make the desired angle, ground or polished; 4. the platforms may be spaced at the desired intervals; 5. the platforms may be isolated and extended away from the proposed edge to eliminate deep bulbs of force, and at the same time reducing the shock to the artifact. The five reasons are further explained as follows:

1. The accuracy is increased because it is much easier to strike a projection extended in such a way that part will be contacted by the percussor before it can contact any other part of the objective piece. By the use of this technique one may be

able to govern and select the point of impact at the discretion of the knapper. This form of platform isolation may be used for removing flakes, blades and in forming the artifact. A simple example of the use of platform isolation is the preparing of a ridge at the top of a Levalloisian core in order to remove a flake of predetermined size and form.

2. It requires less force (pressure or percussion) to remove a flake or blade because the initial shearing of the flake begins at the proximal end or at the bulbar area. Since this part has been reduced in area, the amount of lithic material is not so great. Once started the balance of the blade or flake requires less force. The differences in the amount of force are quite obvious when the knapper is performing pressure work. One can immediately note that much less pressure is needed if the platform has been freed from the objective piece by platform isolation. Noticeable is that one must cause fracture to either side of the bulbar area beforethe flake will part from the objective piece if the platform has not been isolated. Both the flake and the bulbar scar show a hackled or fissuring from the increased force necessary to cause a detachment at the proximal end of the flake. Platform isolation is not necessary, but is usually associated with the more refined techniques of flaking. The isolation of the platform makes use of principal of the cone. The truncated part of the cone is extended because of it's isolation from the objective piece. Such an extension permits the

knapper to apply force more directly in line with the proposed flake without using the normal plane of fracture of the cone. One needs only to apply sufficient outward pressure to cause the proximal end of the flake to part and then the entire cone will be removed with the flake. An example of the use of this technique is the platform isolation of the channel flake preparation of the Folsom projectile points.

3. The angle of the platform may be prepared more easily when the platform part has been relieved and the angle can then be adjusted to the technique being used to remove the flake. One technique is to alternately remove a flake from the lateral margin and each flake scar provides a platform for the next flake. This is a preliminary procedure for the final flaking. After the lateral margins have been flaked in this manner, the edges will appear saw edged with projections like the set in a rip saw. These projections or the individual saw teeth can then be used as platforms to completethe flaking of the bifacial artifact and the edges will be slightly sinuous or undulating. Because the tips of the saw teeth to be used as platforms are sharp and pointed, they must have the points removed by minute flaking or be abraided by grinding or polishing to prevent the flake from collapsing. The polished platform will withstand more force than the flaked or the ground surface.

4. The individual isolation of platforms permits the knapper to place accurately on the core or artifact a platform in exactly the desired selected point and at the correct interval for uniform flaking procedure. Techniques of platform isolation may

be prepared by using a variety of techniques and not only the example cited.

5. The isolation of the platform further aids in eliminating part of the shock to the artifact and helps reduce accidental fracture, particularly when making thin bifacial implements. The shear of the flake from the objective piece can be caused by reducing the force necessary to remove a flake of equal size with an unisolated platform.

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Ground Platforms

The use of grinding in preparing platform surfaces is not uncommon aboriginally, and I find that it is an aid for certain techniques. The grinding can be used to cause the proximal end of the flake or blade to part more readily from a core. It can be used to give more strength to the platform part and also act as a medium to prevent the pressure implement from slipping when using outward force or percussion. A common practice in using the grinding technique appears in the obsidian blade making industries in Meso-America. The preformed core was either ground or the natural roughened surface was used for the platform area. Upon examination of the ground cores the platform part was ground not by theuse of a grinding stone but by rubbing the top of the core on a flat surface that was covered with coarse particles or grains of abrasive material. The grains of abrasive rolled and bruised the surface rather than causing striations if the grains were fixed as in sandstone. In order to get a similar texture on the platform part of the core, I have used silicon carbide on a piece of plate glass or a flat cast iron surface. The grit size is No. 60. A surface that has been treated by this sort of an abraiding process is weakened in much the same manner as a repeated scribbing and scoring with the modern glass cutter. It is common knowledge that vitrious material roughened by sand blasting or other means is considerably more friable than a polished surface. The grinding of the top of the core allows the blade to be parted from it's proximal end with a lessened amount of force than one with a plane of fracture made by removing a flake and then using the scar as a platform surface. The grinding also prevents the tip of the pressure tool from slipping as outward force is used in conjunction with the downward force. The grinding is used not only for weakening but also for strengthening the platform part, but by a slightly different application of the grinding principal.

In order to strengthen the platform it is slightly rounded to remove any sharp projections and edges that are too thin to withstand the force necessary to remove the flake or blade. This principal is best understood and used in modern industry in grinding and beveling glass plate and mirrors to prevent their having an edge that is fragile. Glass tubeing and drinking glasses are fire polished to cause the edges to be strengthened. The ground edge of an artifact permits a flake to be removed without the platform collapsing and prevents it's breakdown which would cause step fractures. Platform grinding is useful for the preparation of platforms either individually or on the entire margin to be subsequently flaked by the use of pressure or percussion. Flakes and blades that have had the platforms slightly rounded by grinding will permit the knapper to remove and cause to fracture an area larger in size than one unground with the same restricted platform size. Flakes and blades with the platforms prepared by grinding generally have a platform area that only makes up the apex of the cone part and expands in various degrees as it reaches it's termination. The rate of expansion depends on the exterior surface of the flake or blade. The bulb of force is lacking in prominence.

The grinding of platforms is not to be associated with the shaping and forming of stone implements as in the Neolithic period. It appeared rather early in time as a means of special platform preparation and has continued into modern times. It was observed in 1961 by Norman Tindale when he was filming pressure flaking of artifact by the Australian aboriginals. They were observed and recorded by motion photography of first rubbing the lateral margins of the preform prior to pressure flaking. After the first series of flakes were removed from both margine, the artifact would then be rubbed against an abrasive stone to remove irregularities and edges that were sharp and too fragile to withstand the pressure without crushing. After the last series of pressure flakes was removed from the lateral margins, the artifact was serrated by the use of a pointed bone causing the projectile point to be a very shart artifact.

My own experiments in the use of grinding in preparing edges, platforms, and the entire platform surfaces of the tops of polyhedral cores has been a great step forward in replicating certain techniques. I had been using the grinding technique for several years before I found the technique of grinding used aboriginally. While visiting witt Joseph Barberri, an experimenter in stone working, and collaborating with Dr. J. A. Harrington, Southwest Museum, Pasadena, California, I found they had independently discovered the use of platform grinding. I have found more recently that platform grinding is not uncommon in North America and was particularly prevalent among the Paleo-Indians.

The previously described technique of grinding the polyhedral core is an exception to normal platform grinding. The difference is that the top of the core is ground to weaken the platform surface while the other uses are to strengthen the platform. When in the laboratory I use a coarse scythe stone made of silicon carbide because it is harder than sandstone , it abraides more rapidly and is not so time-consuming to use. When thinning a large bifacial artifact by percussion, the lateral margins are abraided only on selected portions opposite that of a proposed flake to be removed, usually where there is a protuberance or irregularity that needs to be removed. When the surfaces of the artifact have been made regular, then the entire margins with the exception of the tip are abraided if the artifact needs additional thinning. When the margin is rubbed with the abraiding stone from the base towards the tip, the platforms are automatically exposed because the ridges left by the previous flake scars make an edge that is thicker at the origin of the ridges. These thickened parts on the lateral margins are the most suitable platforms.

The pressure techniques are accomplished in a similar manner. The margins after being ground permit the knapper to place the tip of the pressure tool on the edge at regular intervals and by experience will know at what interval to place the pressure tool in order that the ground edge will be removed with the flake and a sharp edge left on the lateral edge. Wide collateral retouch demands that much pressure must be exerted; and in order to prevent the platform part from crushing or collapsing, it is necessary to grind the margins. Scrappers and cutting implements that have been dulled by use have the edges abraided by function and no plane grinding is necessary to pressure retouch them.

Polished Platforms

Polished platforms serve the same purpose as platform grinding except that the higher the polish the greater the strength. The polishing is usually used on individual platforms when specialized flaking occurs. The Folsom channel flakes are characterized by this feature. They require a special preparation in order to give strength to such a small platform part to remove a relatively large flake from the base to the tip without causing the platform collapse.

When certain specialized flakes are needed functionally or to manufacture a special artifact demanding that the flake or blade be of a size relatively large in relation to the platform, then the platform requires the special treatment of polishing. Lou Napton

Stanislaus State College, Turlock, California exhibited long thin flakes made of jaspers and other silicious materials found on the Madison river. They had platforms that had been polished. Because of the arrangement of flake scars on the dorsal sides of the flakes, they appeared to have been abandoned during the thinning process of making large bifacial artifacts. Examples shown me by Richard Daugherty, Washington State University, had similar characteristics. The dorsal sides of each flake have a plane surface with use flakes on it's margins. This appears to be a cutting implement of a highly specialized nature.

There are no doubt many occurences of the polishing technique which will become known when other collections of flake assemblages are studied for this feature. Grinding is preferred to polishing the margins when the preparation is to be used for hand held pressure flaking. The polished surface allows the pressure tool to slip before a flake may be removed when the entire margin is polished rather than being polished individually.

51 <u>Absence of Platforms on Complete Flakes</u>

Engimatic flakes and blades occur aboriginally that do not bear platforms. Their method of removal is not fully understood. The problem is in need of further exploration by a series of experiments. Whatever the technique employed, it is worth mentioning since flakes of this nature occur in some sites. The Poverty Point site is one that has quantities of blades made from pebble cores and quite a number of them have the characteristic absence of platforms. Robson Bonnichsen exhibited micro blades collected that had the same features of probable independent development. The only similarity is in the character of the platform part. There are several large flakes from the terraces of the Fraser River, British Columbia (Borden 1968) which I examined lack platforms. These specimen's are the result of either striking directly on an anvil stone or placing the objective piece on the anvil stone and then by direct percussion removing a flake. Such a method causes the cone of percussion to be severed with neither a bulb of percussion nor a platform. This is a technique described under bi-polarism.

I have found that flakes and blades may be removed from a core with little or no platforms when the core is placed on soft earth or sand. The percussor (antler or soft sandstone) is directed at a low angle across the top of the core. As the percussor contacts the leading edge the hammerstone is pressed downward causing the force to be mainly outward rather than downward. The results are not uniform and the flakes and blades often step fracture, but some of the blades are without platforms. Additional experiments will be necessary before such a technique is entirely understood. Blades from the Poverty Point site would have to be carefully appraised and compared to the results of experiments before any final conclusions may be drawn relative to the actual technique used.

There are also flakes that have no bulbs of force and no platforms caused by rapid thermal changes, freezing of absorbed water, mineral growth within the lithic material and exfoliation from internal pressure will cause the exteriors to be spalled off. Flakes such as these will have no rings of force originating on a margin and caused by impact. These flakes do not necessarily indicate that man was involved in their making. The flakes do in some cases resemble pot lids and are plano convex in selection. If any compression rings are present, they are incomplete circles around a point in the center of the ventral or convex side of the flake.

Platforms Crushed Upon Removal From The Core

Flakes and blades will be noted that have the platform part of the proximal end absent. Such occurrences are due to the technique, errors in judgment, and the nature of the material being used. When the platform is not prepared to suit the conditions of the technique being used and the velocity of the blow is too great for the size of the platform surface, then the platform will probably be shattered and crushed. Because of the increased velocity the flake or blade will still be removed from the core. The action of removal is so fast that the force is transmitted through the crushed part and into the flake causing it to be fractured from the core.

Flakes or blades that have the proximal ends missing create a problem when an attempt is made to reconstruct the entire flake to determine it's probable mode of manufacture. One must then look for other diagnostic features shown in the balance of the flake or blade, such as a consistency of form, straightness or curvature, termination and undulations as well as the character of the dorsal side. Should a predominance of flakes or blades occur with this feature, then a distinctive technique will be indicated. The crushing of the platform usually causes the flake to be truncated and is not to be confused with flakes or blades that have had the proximal end removed intentionally. Lithic material that is not vitreous and is of a granular nature or has been poorly silicified will allow the platforms to collapse more readily than material of better quality and homogeneity.

53 Platforms Orientated with the Longitudinal Axis

The form of the flake or blade will depend on the selction of the platform on the objective piece. The exterior surface is the first consideration in deciding the form. The platform must then be orientated to the surface conformation of the core or artifact. The selection of the platform in relation to the proposed flake or blade is the number one consideration between failure and success in removing a flake or blade from the core.

The position of the platform on the objective piece must be placed at a distance from the leading edge to insure sufficient strength of material to remove the proposed flake and yet make a flake of the desired thickness because the farther into the objective piece the platform is positioned the thicker theflake will be. There cannot be a concavity under the platform and the vertical axis must be in line with the center of the predominant mass that will make up the flake. The platform must be positioned both vertically and laterally with the axis of the proposed flake. The angle of the platform cannot slant towards the dorsal side of the proposed flake and must be either at right angles or less to prevent the percussor or pressure implement from ricocheting or slipping on the surface.

The platform must be positioned in such a manner that there will be no bostruction to hinder the path of the percussor when it is projected to the platform surface. When using pressure or indirect percussion, the top or face of the platform which receives the impact must be in line with the trajectory of the percussor or the axis of applied force. The axis of applied force may be directed from the right or left or oblique from vertical. The axis of applied force is not perpendicular to the proposed plane of fracture which would be 90 degrees but less than a right angle, generally about 70 degrees depending on the angle of the platform. The relationship of the platform angle will indicate the manner and the angle in which the force was applied.

A singular example of platform orientation is blade making on a polyhedral core. The platform is selected on the margin of the core to make a blade of a predetermined form and thickness. Should the blade desired be triangular in cross section, then the platform is positioned directly above a marginal ridge left from the removal of a former blade. If the blade is to be trapezoidal in cross section, the platform is placed directly above the channel with the marginal ridges on either side. In both cases whether the single ridge was used or the two ridges, the platform's position from the leading edge will control the thickness of the blades.

There are limitations of thickness. If the platform is too far in from the leading edge, the entire face of the core will be removed as well as the distal end of the core. Considerable thought and planning is necessary to position the platform in relation to the axis of the proposed flake. At the stage when the knapper is making an irregular surface regular, the platform must be selected with the thought that it will serve to remove as much unwanted material from the artifact without the possibility of fracturing the objective piece in the wrong place. Should there be a protuberance or an unwanted lump on the face of the artifact, then one must study the nature of the obstruction. An attempt must be made to select and design a platform in such a position that a flake can be removed that will elminiate the irregularity with the flake.

The longitudinal axis of the proposed flake must be considered before the platform is selected. The platform, in relation to the axis of the flake, is positioned in such a manner that sufficient material will be encountered. The platform must be placed as near the intended area as possible. Another example of positioning the platform in relation to the proposed flake axis is that a flake has collapsed slightly in from one lateral margin and at it's termination is a step fracture that must be eliminated. A platform area is selected on the opposite margin so that the second flake will on the same plane of fracture intersect the step fracture left by the first.

The treatment of the platform in regard to the axis of the flake is necessary when one is to accomplish precision retouch on an artifact such as a projectile point.

An example is the type of retouch that each flake is parallel with the next and the flakes have been removed diagonally from both lateral margins. The platforms must be very carefully positioned sothat the longitudinal axis of the pressure flakes will intersect those removed from the opposite margin. When one examines pressure flakes that have been removed from the surface of a projectile point at it's last stage of retouch and the flakes were removed parallel to one another, their direction of flaking will be evident by relating the platform to the longitudinal axis of the flake. The styles and methods of the flake removal may be important in recognizing traits characteristic of certain cultural groups of people.

54 Depth of Bulb of Force

The depth of the bulb of force is related to the technique used in detaching a flake or blade, and can be an important diagnostic feature. The bulbs of force are remnants of the cone part. They are caused by the application of force by a variety of techniques and tools. These are: direct percussion, indirect percussion, pressure and combinations of pressure, and of pressure and percussion. The variety of materials is important.

The application of force by these methods, tools, and materials cause differences in the character of the bulb of force. The deepest bulb of force rarely is greater than one half of the cone. An example of more than one half of a cone causing an accentuation of the depth of the bulb of force is the technique of notching and serrating by the use of a pressure tool. When the notch in a projectile point is within the margin and the notching flake is removed in one flake rather than several flakes, the single flake will be lunate with the tips of the moonlike flake extending around the point of pressure.

Another example is found in the use of percussion. A hard hammerstone is used to strike in from the margin of a thick tabular flake to cause a fracture on the margin that will be U shaped. The blow is struck on the ventral side causing a notch to be formed that is unifacial and with a bevel from the ventral side to the dorsal side. Removing such a flake causes a deep bulb of force to be formed on the objective piece as a negative bulb of percussion. This specialized fracture on the margin of the objective piece makes an implement that would be most useful for shaping the wooden shaft of a spear or an arrow because the concavity is designed to fit the curvature of the shaft.

The tip of the stone working implement or the contact surface permits the force (either pressure or percussion) to be concentrated and causes the cone of force to have a small truncation which is removed with the flake. It in turn is the positive bulb of force and the flake scar is the negative bulb of force. The accentuation and depth of the bulbar scars are useful in denoting technique variations. Pressure or percussion applied at right angles to the lateral margin of an artifact also causes the bulb to be accentuated. If the angle is less than a right angle, a smaller part of the cone will be removed and lessen the depth of the bulb of force. The bulbs of force that have good definition are commonly found on flakes and flake scars (negative bulbs) that have had the point of force selected in from the leading edge or lateral margin.

55

Flake with Diffused Bulb of Force

Both flakes (positive scars) and the flake scars that bear the negative scar that have flatter bulb areas are caused by the type of a percussor used, the manner in which the objective piece is held and the type of platform surface. One cannot help but notice the outstanding differences between bifacially worked artifacts with regular smooth lateral margins and compare them to those with irregular scalloped edges caused by this deep bulbs of force. In part this sharp definition and lack of definition of the bulbar area of both flake and flake scars is caused from the angle of striking. The higher angle or the nearer to perpendicular to the long axis of the objective piece the deeper will be the cone part if the point of the percussor is small. This causes a cone to be formed with a small apex. On the other hand if the angle is lower and the percussor will make a wide contact on the objective piece, the truncation of the cone part will be wide. The cone will not have the definition that is shown when using a percussor that contacts a small platform area.

A fair example of causing the bulbs to be diffused is the use of the wooden baton as with the billet technique. The margin of the objective piece penetrates into the wood and shows no definition of the cone part on the bulbar area. Because of the yielding nature of the soft billet, the time of contact is increased which reduces the shock to the objective piece and eliminates shattering of the platform part. As the time of contact between the soft percussor is increased, it allows the flake to be pulled away from the artifact. The soft percussor removes a part of the leading edge with the flake and just under the point of force. On the flake there will be a semi-circular ridge running transversly from one lateral margin to the other. The ridge is lunate and one edge or the top which makes up the ventral side of the platform and the other edge of the rim is concave which is the reverse of the flake normally removed by direct percussion. The flake scar in the platform area is convex and usually without the typical eraillure scar. I have noticed that during the course of experiments, flakes with attributed similar to billet struck flakes will occur when using direct percussion with a platform prepared by grinding. The point of contact between the percussor and the leading edge is in too far from the margin.

Because the strength of the platform has been increased by grinding, the force is allowed to spread and eliminate the formation of a cone and also causes the bulb of force to be diffused. Flakes and flake scars that have a diffusion of the bulbar part can be made by the use of the pressure technique. Th e lateral margins are first rounded by the removal of small flakes either individually or by the shearing process or by abraiding the edges. The pressure tool tip is broad and blunted and the tip of the pressure tool is placed in from the leading edge far enough to permit the flake to spread. In doing so, part of the edge of the artifact on either side of the pressure tool is removed. Typical of the diffused bulbs of pressure is the Eden projectile point time of contact between the soft percussor is increased, it allows the flake to be pulled away from the artifact. The soft percussor removes a part of the leading edge with the flake and just under the point of force. On the flake there will be a semi-circular ridge running transversly from one lateral margin to the other. The ridge is lunate and one edge or the top which makes up the ventral side of the platform and the other edge of the rim is concave which is the reverse of the flake normally removed by direct percussion. The flake scar in the platform area is convex and usually without the typical eraillure scar. I have noticed that during the course of experiments, flakes with attributed similar to billet struck flakes will occur when using direct percussion with a platform prepared by grinding. The point of contact between the percussor and the leading edge is in too far from the margin.

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56 Absence of Lip on Ventral Side of Platform

Flakes without the lip on the underside of the platform on the ventral side are far more predominant than those with the diagnostic lips. This is due to several steps and stages of making implements from the rough material to the final stage that will make use of the diffused bulb. The technique of making flakes with lips is not practiced by all aboriginal stone flakers and therefore has limited distribution. The range of curve of the bulbar part can be concave as with the flakes with a lip. Some are without a lip or curve as in those which are a produce of cone splitting so that the ventral side is flat and parallel with the long axis of the flake or blade. There are those that have a ball-like appearance at the proximal ends of the flakes which makes up the bulbar part. Those that have strong fat convex bulbs of force are usually caused when the force was directed well into the objective piece and then the force dissapated before the flake could complete it's path across the face of the artifact or core. Such flakes do not terminate with a step or hinge fracture but are very short with thick proximal ends. The bulbar part on the ventral side of a flake or blade can range from a high convexity through flat to being concave. The varying degrees depending on what technique was used to remove the flake. See Figure ________.

Presence of the Overhang Left by the Bulbar Scar of the Previous Flake

The overhang occurs at the top of the core and is the negative of the bulb of force left when a type of flake is removed and found on the dorsal side near the proximal end of the flake. In certain flake assemblages one will note that the overhand was not removed. Some toolmakers made more formal preparations of the core before the flake was removed. If the overhang was removed from the core prior to the removal of the flake, then the flake will bear evidence that the core was prepared before the flake was removed. Certain Artic cultures when making micro blades did not bother to remove the overhang from the cores. This is evident on the blades, a minor cultural difference yet a diagnostic trait. (David Sanger, conversation, Society for American Archaeology Meeting, 1967, Ann Arbor). The removal of the overhang permits the worker to place the tip of the pressure tool, punch, or apply the percussor to the leading edge without danger of the overhang collapsing. This assists in positioning the platform with the longitudinal axis. If the overhang is removed, fewer cores will be abandoned or have their platform parts rejuvinated.

Some techniques do not require the overhang to be removed. For an example when I am making blanks to be modified into preforms and then pressure flaked into arrow points, I select a suitable piece of material that will serve as a core and then by simple direct percussion and the use of a hammerstone remove a series of flakes from around the perimeter of the core. The technique does not require that the overhang be removed, and the point of impact is placed far enough from the leading edge that there is no danger of the platform collapsing. Since thicker flakes are desired for the blanks, one has plenty of tolerance without the danger of crushing the platform. Any protuberance left on the flake from not removing the overhang will be removed when the blank is made into a preform. Typical of the flake with the overhang present is the chapeau de gendarme found in both the Old and New Worlds. For those not familiar with this flake type is that when the platform part if facing the viewer the proximal end resembles a policeman's hat. This feature is caused by the stoneworker's removal of one flake directly behind the first. The flake then has on it's dorsal side and near the platform part, a negative bulbar scar and on the opposite or ventral side the positive bulb of force. The Clactonian flake (Burkett______) also has the feature of commonly having the overhang on the flake and seems to be characteristic of early morphology. At least it is a technique that involves simplicity and littor or no preparation.

Flaking debitage that results from the preforming of artifacts, generally bifaces made singularly by the use of the core technique and direct percussion, make it unnecessary to remove the overhang before striking off individual flakes. The platform is selected by making use of fracture planes made by previous flake removal. The angles of the percussor are changed to conform with the existing angles of the previously made flake scars. Any special platform preparation is unnecessary until the preform is to be thinned. The flakes removed in this stage of implement making will generally have the overhang present on the dorsal side of the flake at the proximal end if they are not primary flakes still bearing the natural or cortex surface. (See Figure__________).

58 Absence of the Bulbar Overhang Showing Special Platform Preparation

The absence of the overhang on the dorsal side of the flake or blade indicates several technological traits for planned removal of this part of the flake prior to the removal of the flake from the core. The reason for removing the overhang is to permit the worker to align the longitudinal axis so that the platform will be in line with the proposed flake. The surplus material was left by the bulb of applied force when the previously removed flake was detached from the core. As each flake is removed from a core to form an artifact or to remove flakes and blades to be used as blanks or left unmodified to be used as cutting implements, it causes a depression to be formed from the bulb, leaving a depression that must be eliminated before the next flake may be removed.

The method of removing the overhang can be removed in a variety of ways and each may be a technological trait. Upon using percussion the overhang is removed by using the same technique. I have found that during the course of experiments that flakes and blades have distinctive flake scars on the dorsal sides and at the proximal ends of the flakes and blades that result from the removal of the overhang. The ideal method is to drag the percussor along the platform face of the core at right angles to it's long axis, and at the same time press into the cores leading edge which causes the percussion tool to pull the flakes away from the core without causing the leading edge to be crushed and cause step fractures. The dragging motion of the percussor pulls the flakes away and causes the flakes to feather out at their distal ends. It would appear that the removal of the overhang is a minor step in platform preparation, but mechanically it is difficult if the platform part of the core is at right angles to the long axis of the core. The angle of the core top in relation to the angle of the overhang is so great that the percussor is caused to glance or ricochet from the surface unless pressure is applied to the percussor simultaneously as it contacts the leading edge of the core. It is not uncommon to find that the dorsal sides of the flakes were crushed at the olat-form part to remove the overhang. In order to obtain a thin blade or flake the platform must also be thinned by removing the overhang. By examining the flake scars on the dorsal side of the flake at it's proximal end, one will note a variety of flake scars which indicate the use of certain techniques. It has been noted that certain cultural groups had had individual rhythms of removing the overhang when and if it was removed.

On the other hand the removal of an overhang left by the previous flake scar is a simple matter if the platform face of the core is not at right angles to it's long axis, and is beveled or less than a right angle. The percussor or pressure tool can then be applied directly to the leading edge without crushing or causing step fracturing. The flakes o n the dorsal side and at the butt of the flake will terminate by feathering. The depth of the bulb of applied force will be indicated by the amount of material that is removed in order to align the platform with the long axis of the flake or blade. The alignment of the flake in relation to the core is that the vertical axis of the proposed flake or blade must be in the center of the transverse section as well as longitudinally. When the platform is isolated and the force directed so that the cone of force will follow the long axis of the blade or flake, the depth of the bulb of force is reduced and the overhang is almost eliminated and then requires little or no need to prepare the leading edge for removing the next flake. Flakes that have been made in this fashion will not bear signs of overhang removal. See Figure__________).

59 (Should precede # 56)

Presence of the Lip on Ventral Side of Platform

The occurrence of a lip on the ventral side of the flake or blade is an enigma in part. The lip, when an occurrence is noted, is an important diagnostic trait and is the result of a special technique or techniques. The occurrence of the lip on the proximal end of the flake or blade is different in that it leaves no overhang on the core as the overhang is removed with the blade. The presence of the lip is characteristic to the use of a soft hammerstone or billets of soft material and the preparation of the platform. Blades recently examined from the Middle and Upper Paleolithic cave of Jerf Ajla which is located near Palmyra in the middle of the northern Syrian desert of the Near East collected by Bruce Schroeder of Toronto University (personal communication) had such a lip. The angle of the platform was less than a right angle to the longitudinal axis of the blade. There was also a noteable absence of eraillure flakes on the bulbar part. The size of the platform was very small (about two milimeters). The uniformity of these flakes indicates that they were removed by a punch. It is unlikely that these blades were repeatedly struck off by simple direct percussion. The blades are too large to have been removed by the application of pressure directly to the objective piece.

The occurrence of the lip seems to be characteristic to a soft percussor or at least the interval of contact between the percussor and the objective piece has been increased and causes the platform to be uncrushed and the compression rings reduced or eliminated as the ventral sides of the flakes are noteable because of their smoothness.

The lip occurs when a yielding percussor is used. Francois Bordes, Jacques Tixier, Gene Titmus and I have observed this.

Experiment with soft hammer techniques is important. Another phase of the use of soft percussors is the forming and thinning of bifacial artifacts. A lip is formed on the flake because the lateral margin of the artifact is removed with the flake because the leading edge penetrates the soft percussor and is pulled from the artifact. The character of the flakes removed from the margins is that at the proximal ends of the flakes or the platform part will bear the flake scars that will be bifacial rather than unifacial. The removal of the flakes with the lip will not make an overhang on the artifact. The flake with the lip will be without an eraillure flake and the cone will have no definition and be diffused. Flakes removed in this manner will resemble artifacts themselves as the flake will appear to be intentionally bifacially flaked at its proximal end and terminate with a feather edge. The platform part will extend laterally and have onits ventral side a lunate overhand rather than the normal bulb of force. The lunate overhang is the lip and is found on the flake rather than being found commonly on the core. The high part of the platform part may also show signs of abrasion that could be misinterpreted as use or function rather than grinding to strengthen the platform in order to prevent its crushing or collapsing.

Pressure flakes derived from retouching an edge that has been dulled through use or by intentional grinding and or abraiding will have lips on the ventral side and at the proximal ends if the technique used to remove them from the objective piece is done by removing the entire margin of the artifact with the flake. Flakes removed with the lip will cause the lateral margins to be left very sharp with little or no crushing of the retouched edges. Flakes of this style with the lip will occasionally remove the opposite lateral margin of the biface and can be considered accidental. Single flakes and blades are not sufficient to establish a technological trait, but a series is necessary to show that a rhythm and a pattern was incorporated in their making. The exact mechanical and physical problems that cause the lips to occur is not fully understood. It appears that because the flake is pulled away from the parent piece without excessive shock the truncated cone part (when blade making) is compressed without shattering. The material around the cone is not damaged. In forming and thinning bifacial implements, the margins are pulled away with the flake as it is removed.

The edges of the artifact and the proximal end of a core have different problems of angles. The obtuse angle of the artifact permits the flake to be released and also furnishes an adequate footing or platform for the soft percussor. The blade core has an angle of 90 degrees or less from the long axis which does not permit one to use a billet and confine the force to the small platform common to such cores.

60

Flake Bearing Sharp Definition of Truncated Cone Part

The apex or truncated cone will be indicative of the area contacted by the percussor. A percussor with a wide face will cause the truncation to also be wide and a percussor that is strongly convex at its striking part will cause the truncation to be limited to the surface contacted. The size of the truncation will suggest the style of percussor that was used to remove the flake. One must bear in mind that there is a relationship to the size of fracture plane to the size of the cone truncation because the truncated part must have sufficient strength of material to withstand the force necessary to remove the flake or blade. Should the hammerstone be either too hard or the velocity of the blow too great, the apex of the cone will collapse or shatter.

The majority of the flakes and blades that at the proximal end or butt end will be thick from the dorsal side to the ventral side. The platform face will commonly bear one or more scars of impact. If more than one, they show the inaccuracy of the knapper and demonstrate that they (the blows) lacked velocity or were too far in from the leading edge. They are common when the hard hammerstone was used when making simple flakes and blades. The truncated part will be slightly less than a half circle and will be lumate in appearance. Eraillure flakes are common and a flake removed by simple direct percussion without an eraillure flake will be an exception.

Unsuccessful attempts to remove flakes will cause cones to be formed that will be complete and will still be contained within the objective piece. The cones that are complete and still within the objective piece are the result of the percussor being too light or the velocity of the blow not sufficiently great to remove the flake or blade. Repeated abortive attempts to remove a flake or blade will cause the cone angles to intersect one another and ultimately render the part of the objective piece useless because of the indiscriminate planes of fractures caused by the intersecting cones. The overlapping of cones also occurs in nature from repeated pounding of one stone against the other. The repeated pecking of a hammerstone on an objective piece results in incipient cones and an ultimate collapse of the surface of the material being worked on. This feature is common to the Neolithic period.

When techniques other than simple direct percussion are used to remove flakes and blades the truncation of the cone part assumes a quite different character. When the platforms are specially prepared by isolation, grinding, removal of facetting flake or flakes to seat the precussor or pressure tool, the apex of the cone part will be isolated and be an integral part of the proximal end of the flake. The angle of the prepared platform to the long axis of the flake or glade will cause the truncation of the cone part to conform with the truncated part of the cone and will be the platform. There will not be the additional bulk of material adhering around the truncated cone as with the simple direct percussion technique.

b)

Flake Having no Cone Definition

The lack of cone definition is characteristic of flakes that have been removed with a soft percussor such as a billet or at least a hammerstone that makes a large contact area in relation to the size of the flake. Flakes that retain a lip as previously described under (No. 59) will fall into this category. The truncated cone part is spread over a broad area because of the wide contact between the percussion or pressure tool causing the bulb of force to be diffused. Isolated platforms may lose cone definition because the entire cone is forced to shear from the face of a core that has been supported by a rest.

Flakes that have been removed from a core supported by an anvil cause the cone to be split because the opposing forces cause a shear to take place between the anvil and the point of percussion. The flake and the core have no cone definition. The positive and negative scars are much the same and without bulbs of force. This characteristic is caused by splitting the cone by application of force at the same angle as the plane of fracture. A technique common to pebble and cobble industries. (C.F. Borden ________, E.M. Davis _______).

6)

Flakes Bearing Negative Bulb on Dorsal Side and Positive Bulb on Ventral Side

There are flakes that are characterized by one or more flake scars on the dorsal side of the flake at the proximal end. The flakes are usually removed by simple direct percussion if the overhang is present and the platform has not been isolated. Both dorsal and ventral sides generally have deep bulbs of percussion, an eraillure scar on the ventral side and occasionally the eraillure flake still remains in the negative scar on the dorsal side. The situation occurs when a single rapidly terminating flake has been removed from the cone and then another flake struck at the same angle as the first but with greater velocity in order to cause a larger plane of fracture. The second flake must be struck into the leading edge of the core the same distance as the thickness of the maker's design. When the flake is viewed vertically, i.e., from the top, the flake will appear to resemble the wings of a flying bird, and in the Old World is called a _chapeau de gendarme_ or policeman's hat. The _chapeau de gendarme_ flake does not have the overhang removed before it is removed from the core. After removal the ridges on the dorsal side are occasionally taken off. This style of flake is admirably suited for making arrow points and is preformed when it is removed from the core. The flake can be used as it is struck from the core or by a minimum of pressure retouch be made into a projectile point.

When the flakes have more than one flake scar at the proximal end, they are usually on the lateral edges. The compression rings show that prior to their removal from the core, the flakes were taken from the core before the _chapeau de gendarme_ flake was removed causing scars on the lateral margins of the principal flake. The flakes removed on either side of the main flake allow the flake to be expanded at it's base or proximal end. Naturally the best of the flakes made in this fashion were used by the people that made them and only those that were ill formed and aberrant were left for the archaeologist. Bt the same token if the flake was retouched over it's entire surface there would be no clue left as to it's mode of manufacture.

63 Presence of Eraillure Flake

Eraillure flakes and flake scars found on the bulb of applied force and at the proximal end of the flake scar indicate that the flake was removed by being very suddenly compressed and that the cone of force was compressed and the eraillure flake caused to exfoliate from the bulb. There may be several other causes that permit the eraillure flake to be formed such as a plane of shear being formed that has exceeded the elastic limits of the material. Cohesion and planer shear are problems of physics that must be explored further before final conclusions can be arrived at.

The simple field experiments conducted in stone flaking do, however, show that these enigmatic eraillure flake occurs more frequently when the interval of contact between the percussor and the objective piece is lessened. Their presence usually indicates that flakes that bear the eraillure scar denotes that the percussion technique was used to detach the flake. Flakes that have been removed by blows of low velocity and a heavy percussor do cause flakes to be formed that have no eraillure flake. Pressure flakes that have been removed at right angles to the lateral margin and by the use of pressure in one direction, downward without outward or inward will cause the formation of eraillure flakes. The formation of eraillure flakes is characteristic of certain techniques of percussion and pressure and they may be used for diagnostic purposes. Eraillure flakes have no rippling on the side next to the core that indicates any direction of force while on the ventral side of the eraillure flake or that which was attached to the bulbar part of the flake do have compression rings that show that the force originates towards the top but at an oblique angle. This I fail to understant.

Eraillure flakes were made intentionally by Pre-Columbian people in the vicinity of Colima, Mexico and possibly there were other occurences of the eraillure being used for ornaments. The eraillure flakes were perforated by making a hole opposite on another at the margins and then attached to one another to make a necklace; and if there was a variation in size, they were graduated. The size of these eraillure flakes ranged from three quarters of an inch to an inch and a quarter. The dorsal side was convex and without force lines and the underside was concave which caused the flakes to be transparent because of their thinness. The flakes were trimmed to roundness when they were ovate or slightly irregular. The use of the eraillure flakes for decoration demonstrated the Mexican toolmaker's ability to cause these flakes to form at will and e xpress a complete understanding of the behavior of obsidian.

64 Absence of Eraillure Flakes

Bulbs of force that have no eraillure flakes indicate that either percussion or pressure was used to remove the initial flake or blade with a long interval of contact between the point of force and the objective piece. When using percussion the percussor must be of a material that is yielding so as to dampen shock. The velocity of the blow must be reduced in order that the cone of force will not expand and cause the eraillure flake to be released. The use of the billet or soft hammerstone is indicated rather than that of using a hard hammerstone. There are, however, exceptions. One is that when a flake is removed from a core by the use of the hard hammerstone the eraillure flake is absent and is apparently due to the resistance of the material from being compressed sufficiently to cause the eraillure flake to be formed. Because of the additional material at the platform part the cone is not allowed to compress to it's limit of elasticity. The cone, upon exceeding it's elastic limit, will apparently cause an exfoliation which results in the formation of an eraillure flake.

Presence of Radiating Fissures on Bulb and Ventral Side of Flake

Flakes removed by use of hard hammerstones and a blow of considerable velocity cause fissures radiating from the point of force and away from the direction of the blow towards the distal end of the flake or blade. The presence of the radiating fissures is indicative of the type of implement and the intensity of the blow. A slow or low [(Don: doesn't this increase the interval of contact)?] velocity blow reduces the interval of contact between the percussor and the objective piece and eliminates the formation of the radiating fissures. The fissures are apparently caused by the bulb of force being compressed to almost it's elastic limit. This weakens the structure of the cone part of the flake. The cohesion between the flake and the core causes the fissures to be formed as the plane of fracture develops. The fissures

fissures radiate as tangents from the point of applied force.

67 Nature and Occurences of Fissures on the Lateral Margins of a Flake

The lateral margins of some flakes have this peculiar characteristic of fissuring of one or both edges on the ventral side of a flake or blade and on the core. Slight sweeping curved grooves are directed from the margin toward the origin of the applied force, generally the platform part on the ventral side of the flake or blade. The fissuring is more common on a thin lateral margin than on an edge that is thick. The striations are usually quite evenly spaced and graduate from the proximal to the distal end of the flake or blade. Upon becoming familiar with the character of marginal striations, the markings will show the direction of applied force, thereby aiding in the reconstruction and sequence of flake removal. If the flake is fragmentary or incomplete and the platform part missing, the flake may be oriented with the direction of force. The definition of the striations will depend on the texture of the material, the more vitrious material, the more obvious are the fissures. For an example, coarse grained quartzites will not show marginal striations due to it's inelasticity. The striations are not cracks in the material but a series of changing planes much like the risers and treads on a staircase.

68 Terminations of the Lateral Margins of the Flake

The flake termination of the lateral margins of a flake are due to the character of the surface of the core. A perfectly flat face on the surface of of a core will allow the flake to expand and cause a chonchoidal fracture with both margins feathering and cause the flake to be plano convex in transverse section. The outline of theflake is controlled by the surface of the core and any irregularities will cause the flake to be irregular. Duplicate flakes, therefore, have to be removed under duplicate conditions. Since both man and nature have subtle discrepancies of major or minor degrees, one will not e xpect to find duplicate flakes but only flakes that have some common characteristics. Flakes may be compared to fingerprints and only the flake that caused the flake scar to be formed will fit that scar, even though the same material and technique was used to make several flakes. The termination of the edges of the lateral margins indicate overlaps, sequence of the flake removal, technique, stage, and the intention of the worker.

69

Length of Flake

Length of a flake is the longest dimension between the proximal (point of applied force) and the distal end (termination). The length of a proposed flake may be calculated before it is removed from a core by the preparation of the core and the manner in which the applied force is directed relative to the angle of the platform. Specialized elongated flakes are called blades if the length is twice the width and the flake scars on the dorsal side of the flake bear flake scars that show that they were removed in the same direction as the flake was removed from the core. Such is not true of the first blade removed from a core. It may be crested by the removal of transverse flakes to prepare a guiding ridge or it may be a natural ridge selected by the knapper. A flake struck from the right angle leading edge of a tabular piece of material will be several times as wide as it is long, and the sides will be bipointed. Naturally the length of the flake or blade cannot exceed the length of the material being used but only expresses the wide range of flake sizes from the most dimunitive to the very massive. Thinning flakes that result when making a biface can be used to approximate the width of the artifact by placing flakes from opposite margins end to end or doubling the length of the thinning flake. Generally this feature is true, but close examination is nessary, the dorsal side of the thinning flakes may show or bear a remnant of an overlapping flake scar from the opposite side which would indicate that the width of the artifact would be lessend. Another exception is the systematic removal of a series of thinning flakesthat follow the ridge left by the previous flake detachment. Flakes of this style will have a blade like character as the ridge will prevent their expantion causing the flake to run behond the median line of the artifact. An example of this technology is the large Egyptian bifacial knoves, too when the worker followes well definded ridges when removing ribbon like flakes by either percussion or pressure the flake scars may cary from one lateral margin to the other. When the worker ignores the surface character of the object being worked on the flakes will be random in length and width. A plane surface on an artifact #### being flaked will allow the flake ##### detached to spread causing the detached flake to be chonchoidal or shelllike, when ### spaced far enough apart so that one flake scar will not intersect the previous flake scar. The rythmatic spaceing of the flake removal will #### result in flakes that will have simular dimentions. The closer the spaceing the more elongated will be the chonchoidal flake and flake scar. More often than not there is an overlapping of the flake removal and in turn creates a flake scar with less width than the flake removed.

a very small platform. In order to insure against platform collapse the platform is slightly rounded by grinding and smoothing which is a strengthening technique. An extra thick flake poses a problem in terminology, when does a flake cease to be a flake because of thikness ? A large mass of lithic material intentionally quarterd may have little resembelance to flakes, but if the portion bearing the bulb of force would then be a flake while the portion bearing the negative bulbar scar would be the core part. It would then appear that there is no limit to the thickness or size of a flake. Another comment on flake removal , and of particular interest to pressure flakers is that the thikker the platform the greater the amount of force nessary to cause the detachment.

71.

<u>The uniformity of the three dimentions, length, width and thickness.</u>

Experimental archaeology, and more specific Lithic Technology involves all stages of a particular artifacts replication. Unfortunately in most cases we can only examine the last series of flake scars which hopefully will provide clues for the final technque.

69. The width of the flake or blade. The width of a flake or blade will first depend on the size of the material being worked, some flakes will be as wide as the material. It is not an uncommon practice to section a nodule of flintlike material into a series of tablets allowing the flake to intersect the lateral margins. A series of such flakes or tablets are an efficient way of conserving material. The tablet like flakes can then be reduced into an unlimited array of artifacts. The technique is generally by the use of direct percussion and a hammerstone. Making tabular flakes by this technique is a method of utalizing the full width of the material and with much practice and skill the flakes will have parallel dorsal and ventral surfaces. refinements of this technique may have been used in Mesoamerica for making the semi-lunates or the graduated, end-pierced thorasic ornimental pieces, they are not uncommon and were made with exceptional skill. The exact aborigianl series of techniques are still unknown.

The control of the width of flakes and blades is largly due to the natural or intentional dorsal surface of the proposed flake or blade. I find that the more acute or the more convex the dorsal surface the narrower the flake or blade. The actual removal of an intact prism of controlled dimention is manuliplitative process of many complexities and an assortment of many approaches. To be considered is the amount of energy needed to fracture a pre-determined area of lithic material and the materials resistance to fracture, the inertia of the piece being fractured , the platform character, the yeild or resistance of the percussor, the velocity of the percussor or if by pressurethe ratio of downward and outward forces.

70. The thickness of flake or blade. A general rule of the thumb is that The further in from the margin a flake or blade is struck or pressed the thicker will be the material, however the distance between the dorsal and ventral sides at the proximal end of the flake or blade or the platform part can be relitively small and still have considerable thickness. Some techniques of platform preparation was to remove any overhang from a previous scar and then align the area that will recieve the force to corespond with an aria of predetermined thickness. Such a proceedure permits the removal of a thick flake or blade with

81,. The flake truncation by step fracture.

82. ##### The flake truncation by notching or special severing.

83. The intentional modification of flakes.

84. The flakes bearing functional flake scars on lateral edges.

85. The flakes bearing dulled or abraided lateral edges.

86. The flakes that show the rhythms and consistancy of patterns in techniques.

87. Directions of flakes to show technological patterns

88. Typology based on technology

89 - Edge angle of Flake or Blade

90 - LUNATE Flakes

91 Burinated Flakes

92 Flake or Blade sections

93 Flakes with CORTEX

61 ~~60.~~ The flake having no cone definition

62 ~~61.~~ The flake bearing the negative bulb on dorsal side and positive bulb on the ventral side (chapau Gendarme)

63 ~~62.~~ The presence of the eraillure scar on the bulbar part of flake

64 ~~63.~~ The absence of the eraillure flake scar on the bulb

65 ~~64.~~ The presênce of radiating fissures on the bulb of force.

66 ~~65.~~ The absence of fissures on the bulb of force.

67 ~~66.~~ The nature and occurance of fissures on the lateral margins of the flake.

68 ~~67.~~ The terminations of the lateral margins of the flake.

69 ~~68.~~ The length of the flake.

69. The width of the flake.

not written

70. The thickness of the flake.

71. The uniformity of the three dimentions, length, width and thickness

72. The expantion and contraction of the flake from point of applied force to termination.

73. The character and direction of the flake scars on the dorsal side o the flake.

74. The curve or straightness of the flake.

75. The flake termination by feathering.

77, The flake termination removing a greater mass at the distal end of -e flake , rapidly expanding as it leaves the core.

78. The flake truncfation by flexing.

79 The flake truncation by snapping.

80. The flake truncation by hinge fracture.