SOME ASPECTS OF PRESSURE FLAKING

by Don E. Crabtree

Anyone who has collected Indian arrowheads or studied museum collections of ancient chipped stone artifacts invariably meditates upon the method of manufacture and the functional purpose and application of such implements. This is particularly true when the artifacts reveal a high degree of knapping skill and inventive design by the worker. Stone tools are so remotely related to their modern counterparts that it requires a vivid imagination to simulate the act of prehistoric man making and using these implements. Most efforts of modern man to replicate these stone tools fail because there is so little recorded about their fabrication and function. In truth, the manufacturing techniques and function of such tools boggles the mind.

For some hunters and collectors the stone tools of ancient man are merely curios. But to archaeologists, anthropologists, and students of lithic technology they represent fossilized human behavior. Archaeologists have come to depend heavily upon these surviving stone tools for their interpretations of ancient cultures.

Stone tools provide archaeologists with one of the most important bodies of evidence of human behavior over most of the span of human culture-history. Metal, glass, and other products in civilization are no more than a few thousand years old. Since present evidence indicates that tool-using man has existed for approximately two million years, this means that stone, wood, and bone tools have predominated for approximately 99.5 percent of human history. It is mainly those of stone that have survived to be studied by scholars. Even after the invention and spread of metals, there remained some isolated societies that continued to make and use stone tools. A few of these, like the Australian Desert Aborigines and certain groups of New Guinea natives, still use stone tools today.

Scholars today have three main avenues open to them for finding out how ancient stone tools were manufactured and used: (1) stratigraphic excavations in which context supplies information about the manufacture and use of stone tools: (2) living archaeology in which ethnographic and historic data are examined; (3) experimental work in which efforts are made to replicate the processes and products of pre-historic stone tool making. Strategraphy is important to students of flintworking because it defines associations such as those of Folsom points with extinct bison, reducing the number of possible explanations about such an implement. Strategraphy also permits the experimental flintworker to examine the history of lithic technology and tool function to which he is a contributor.

Living archaeology is sometimes called ethno-archaeology. This approach involves the study of contemporary societies where stone tools are still manufactured and used. It also includes research into historic sources which give early accounts of people who made and used stone artifacts. Unfortunately, references in historic documents about this sort of behavior are limited and, therefore, demand a careful and cautious interpretation. Early accounts of heat treatment of glassy rock were misinterpreted and applied to the process of flaking stone by dropping cold water on heated rocks. Experiments have proven this to be an impossible means of controlling the detachment of flaking and forming artifacts. In truth, the thermal treatment was a process of altering the stone prior to flaking which made the rock more receptive to flake detachment. Even more important, the impact of Western technology throughout the world has been so great during the nineteenth and twentieth centuries that there are few traditional societies anywhere that still do this, most of them having long since abandoned stone tools for metal ones. This line of research has the quality of a race against time, as scholars try to find and study these groups before they completely abandon the art of stone chipping.

Recent work has shown that controlled experimentation can often provide information about the use and manufacture of stone tools which is simply not available by any other means. By attempting to make exact counterparts of known types of ancient stone artifacts, the experimenter through both his successes and failures in the laboratory reconstructs the possible ways in which such artifacts were made. By using these artifacts in a variety of ways and with a variety of materials (again, always under controlled conditions) and by examining the results, usually under a microscope, he can infer some of the possible ways in which the ancient tools were used.

Experimental stone-working archaeology has proved useful, for it allows the experimenter to view the results of applying force to flint-like materials. He can then analyze and evaluate the character of both the flake and the flake scar whether made by intent or miscalculation.

Experimental flintknapping archaeology also demonstrates the importance of recovering the flaking debris which results from the manufacturing stages. These debris flakes may be related to the stages of fabrication from inception to completion, or from the rough stone to the completed product. Comparison of the flintworker's debris with that from archaeological sites increases the probability that an experiment is correct when there is evidence of agreement between the recent and the aboriginal debris.

Experiment and actual practice in the rudiments of stone flaking will soon make one aware of the physical properties of the material when subjected to force, the human factor involved in developing the obvious muscular motor habits, coordination of hands and mind, conscious control and planning, and the feel and perception of the causes and effects. Experiment also permits one, as it did the aboriginal, to devise and design ways and means of overcoming the everchanging conditions encountered when reducing rough material to a finished artifact.

The writer would like to carry this interest in technology a step farther and made the inquirer aware that the completed artifact represents only the final stages of manufacture and that it is equally important to reconcile the beginning and intermediate stages of fabrication. These, too, are very important because there are multiple technological traits represented in these initial steps which furnish information for defining the manufacturing techniques. For this reason, the importance of a careful study and analysis of flake debitage should be continually stressed.

It is not my intention to make a flintknapper of every student and anthropologist, but I hope that these manufacturing steps will be read and studied in detail and even tried to some extent by those interested in lithic technology. Just observing the final series of flake scars and the form of the artifact or reading the description of manufacturing techniques is not enough. There is no substitute for actual experiment. Contrary to popular belief, the act of removing a flake by percussion or pressure is not too difficult and the amount of force exerted is only relative to the width of the flake and the isolation of the platform area. The difficulty of both pressure and percussion flaking is learning to control the width, length, thickness, form, and termination of the flake. Dexterity and experience sometimes permit the flintworker to overcome the difficulties of flaking stone into tools.

Experimental flaking progresses partly by insight gained from experience and partly from the mastery of several techniques so that alternate means of production can be systematically explored. Flakes which are the by-product of other work may sometimes be chipped into diverse tools but the best results are obtained either by the planned reduction of a core or the selection of a predetermined flake. The process of experiment can perhaps be best explained by analyzing the Hohokam points, which comprize techniques ranging from the simple to the highly sophisticated and complex methods of manufacture. Hohokam points encompassed such a wide range of techniques that one or more explanations for prehistoric points can be obtained and some possibilities can be eliminated.

Some Hohokam points are common, utilitarian, everyday hunting points derived from assorted flakes and materials. These points appear to have been made from a flake by pressure alone. The manufacturing sequence is as follows: First, the flake is straightened, then retouched and notched, completing each point individually. The flake is hand-held and straightened by pressure flaking. (1) The bulbar part at the proximal end is removed from the ventral side of the flake. This is done by applying inward pressure from the outer margin of the flake diagonally toward the center of the flake. As the flake being detached nears its termination point, outward pressure is applied to dissipate the inward force and to step or hinge fracture the flake at the median line. (2) Then a flake is detached from the opposite margin to meet this step or hinge fracture, thereby thinning and straightening the proposed artifact. If the flakes are not terminated in this step or hinge fracture, then the bulbar part will not be thinned. (3) Finally, the dorsal side is made regular by pressure retouch and then the base is notched, completing each point individually.

Having only a small representative collection of these points and no flaking debris as a guide to replication, the primary stages of the manufacturing techniques must, of necessity, be inferred - for the actual technological traits remain with the manufacturing debitage flakes. The collection I have replicated serves only as a guide for the final stages of pressure flaking and notching techniques. However, my replications are based on actual experiments--rejecting and accepting various stages of manufacture until simulation of the aboriginal artifact is acquired. The stages of developing the rough material from the first to the final phases of pressure flaking and notching will be described according to my experiments, but the primary stages are not necessarily aboriginal. However, if the finished product is a true replica, then it is safe to assume that the primary and intermediate stages are parallel to those of the aboriginal.

To make the core preform, an obsidian cobble slightly larger than the proposed artifact was selected. Before any work was begun the raw material was carefully examined to determine if it contained any imperfections or deeply bruised parts. If it appeared to be relatively free of flaws or imperfections, then it was tapped with a hard hammerstone to calculate its resonance. A dull thud, or hollow sound, indicates previously undetected planes of weakness, cracks, fissures, and general imperfections. When this happened, the stone was abandoned and a new piece was selected and tested. Good lithic material should respond to the hammerstone's tap with a ringing sound, indicating that the vibrations of the hammerstone's contact are evenly transmitted throughout the raw material.

The nature and quality of the raw material will not only determine to a degree the techniques required, but also the type of percussion tools needed to reduce the material to a usable form. If the raw material occurs in large blocks, boulders, or other massive forms, it can be made portable by trimming pieces into blanks, preforming, or making cores for detaching flakes.

Large hammerstones are used for the initial fractures and to remove non-homogenous parts and cortex. Hammerstones become progressively smaller as the objective piece is reduced in size and nears the preform stage. The size, weight, and texture of the hammerstone (or billet) must conform to the size, weight, and texture of the material being flaked. That is, highly vitreous materials require a relatively soft hammerstone, while less vitreous materials will respond well to the harder hammerstone.

Obsidian, because of its vitreous and brittle nature, is vulnerable to the induction of undue fatigue, platform collapse, and shattering by the percussor and, therefore, the hammerstone must be of a relatively soft yielding material such as sandstone, limestone, vesicular basalt, reconstituted tuff, or materials of similar texture. But materials like flint and chert are more resistant and, therefore, the hammerstone can be of granite, quartzite, or other hard stone.

The form of the hammerstone can be ovoid or discoidal for, t when one part becomes flattened by use, it can be rotated and a new striking area exposed. This is one reason why a well-used hammerstone is often spherical. It is well to mention here that hammerstones have a diagnostic value and are highly variable in form and weight depending on the technique used by the worker.

Initial blanking and preforming is by direct percussion with a hammerstone but it is better to change to an antler billet for the thinning of the preform. The antler billet permits the worker to increase the velocity of the blow with greater control; it imparts less shock to the material and lessens the risk of stone tool breakage. The billet can be a section of elk, caribou, reindeer, moose, or deer antler, or even a piece of very hard wood.

Flakes struck or pressed from the margins of an artifact are positive cone parts and their scars are the negative cone parts. When a vertical blow is delivered to a flat surface well in from the margin, a complete cone is formed. When a rectangular piece is struck vertically at right angles on the margin, a half-cone is formed. If the vertical blow is delivered to the corner of a rectangular piece, a quarter cone is formed. The angle at which the force is directed will be manifest on both the negative and positive fracture plane of the cone when the force is percussion. Since the fracture plane of the cone is fairly constant, it is relatively simple to interpret the direction in which the blow was delivered.

Using flakes as blanks is an economical method of utilizing material. A single core may furnish as many as a hundred blanks for small points whereas the core tool method uses a mass of material to produce a single point. Flake blanks are selected for their straightness and form, and the proposed artifact is generally oriented longitudinally. Generally, thin flakes can be used for making smaller points by pressure alone, but they must be slightly thicker, longer, and wider than the proposed point. It should be remembered that blanks do not disclose the intended desigh of the tool but preforms do show the form of the final product.

To remove the curve from the distal end of a flake, blows are struck on the end from the dorsal toward the ventral side of the flake and the force is directed toward the proximal end (bulbar part). Flakes are removed from the blank in this manner until the ventral surface is flat from the distal end to midway of the flake.

The flake is then turned end-for-end and the bulbar part on the ventral side is removed. To do this, a platform must be established at the proximal end of the flake blank. This is done by striking on the ventral surface toward the dorsal to remove one corner at the base of the flake blank. This leaves a beveled edge on the corner of the flake blank which is used as the platform to strike off the bulbar swelling on the ventral side at the proximal end. Generally, after one or two flakes have been removed in this manner from the ventral side at the base, and the distal end has been worked as previously described, the flake blank will be sufficiently straight.

If the flake is of vitreous material and has the proper dimensions, it can serve as a blank, or preform without modification. If the ultimate result is a small point, then it is entirely possible to eliminate the preforming stage, use the flake as is, and make the entire artifact by pressure alone. However, reducing the rough piece to the finished artifact by pressure alone requires a greater output of energy than when the worker uses percussion to reduce the surplus material.

Blademaking is the most efficient way of utilizing the raw material for blanks. When good quality material is scarce, blades represent an economical means of conserving stone. A blade is a specialized flake with parallel or sub-parallel lateral edges, whose length is equal to or more than twice its width. Blades can serve a dual purpose. They may be used freshly struck from the core as good cutting implements and, when dulled, they may be modified into projectile points. A blade large enough to serve as a blank for a projectile point can be removed from a core by either simple direct percussion, indirect percussion, or a combination of pressure and percussion. If properly designed, it has the outline of the proposed point, thereby requiring a minimum of flaking for its completion.

For almost all flintknapping, a low seat is desirable for it has the advantage of raising the posterior above the level of the feet and enables the worker to use the thighs and knees for support. When doing percussion work, and for increased leverage during pressure work, the left knee or the top of the thigh is used as a support for the wrist of the left hand holding the objective piece. The seated position also permits the worker to use the right thigh as a fulcrum and hinge for the right elbow, thereby increasing the accuracy of the blow. Also, as the blow is struck, the knees may be gradually brought together to increase the accuracy of the percussor's contact and deliver the blow at the correct angle to a predetermined point on the platform of the objective piece.

If I use the position and striking method described above, I can detach an initial flake from one end of the cobble by striking with a hard hammerstone at a low angle. Then the cobble is turned and the second blow delivered on the plane surface left by the detached flake, and so on around the perimeter of the cobble. As the blow is struck on the margin of the objective piece, the left hand involuntarily responds to the subjected force of the percussor, causing the left hand to roll the objective piece upward, synchronizing the blow with the point of contact. By turning the cobble and alternating the flake removal, the plane surface left by the previously detached flake serves as the platform for the next flake removal.

The billet, or hammerstone, used for preforming is designed with a rounded working end to permit greater striking tolerance of the edge. Also, the rounded end gives the percussor a greater area of contact surface and, therefore, a glancing blow can be delivered to the edge without striking too far into the body of the preform. The tolerance of the blow is the distance of the tangent of the arc of the rounded edge of the percussor. For precision flaking, the rounded-end billet, or hammerstone, has a distinct advantage over the discoidal hammerstone--for the flatter discoidal surface limits its width of the contact area between the percussor and the objective stone. All irregularities must be removed, the blank s straightened, thinned, narrowed, and roughly shaped into the form of the proposed artifact.

To reduce breakage caused by shock, thinning is started on the platforms at the distal end of the blank. The percussor is directed in a straight line to the platform, but at slightly less than a right angle to the long axis and angling toward the gravitational center of the objective piece. The striking angle will vary according to the desired thinness of the preforming. The thinner the preform, the flatter the striking angle; the thicker the preform, the steeper the striking angle.

After the first large irregularities are removed, the edge is prepared for the next series of flake removal. Edge beveling can be done by an alternate technique of turning the margin. The edge of the preform is pressed inward against the edge of a smooth anvil stone at right angles to the face of the proposed artifact. When the bevel is approximately at a 45° angle, then the edge is rubbed forward and backward against the anvil stone in a cutting motion to remove any sharp, weak edges. After each margin has been flaked, the edge must be re-prepared for platform purposes in order to flake the opposite side from the opposite margin. The blank is percussion-flaked bifacially and bilaterally in this manner until it is preformed into the proposed shape of the finished point.

The percussion tool used in these experiments was a section of antler with the end rounded to transmit sufficient force to the marginal platform to detach a flake of the desired dimension without prematurely breaking the preform. Antler is semi-yielding and, therefore, prevents platform crushing of the brittle obsidian being worked.

When a more refined pressure technique is used to remove individual flakes, the tool is a piece of antler, bone, horn, shell, wood, or metal which is shaped to a blunt point at the working end. Pressure tool tips are rounded because a sharp, pointed tool would not have sufficient strength to remove a flake without breaking the pointed tip. The diameter and size of the tool will depend on the size of the flake to be removed. As the detached flakes become progressively smaller, a tool with a smaller tip is substituted.

Before the worker can start pressure flaking, the hand holding the objective piece (material being worked) should be protected with a pad of leather or other suitable material to prevent detached flakes from being driven into the flesh. If necessary, the objective piece may be rested on the padded thigh, or on rests of wood, stone, or any medium which will support the piece as it is held in place by the fingers or heel of the left hand. If wood or stone is used for the rest, it should be covered with a thin layer of yielding material so the objective piece will be evenly supported, otherwise accidental fracture could occur. Should the irregularity be a step or hinge fracture, a short pressure tool with a flat thin tip is used to remove the balance of this flake.

A step fracture occurs when a flake terminates prematurely in a right angle break. The tip of the pressure tool is placed on the right angle of the step fracture and pressed downward as almost simultaneously outward force is applied to detach the mass from the face of the artifact. If the right angle break of the step fracture has enough bearing surface to withstand these two forces, then the balance of the broken flake will detach. If it does not detach, then the worker must establish a larger platform. To do this, the pressure tool is seated on the margin of the artifact directly above the right angle break and the worker deliberately terminates a second flake in a step fracture in the same place as the original break. This establishes a larger platform. The pressure tool is then seated on this platform and downward and outward force is applied to detach the unwanted mass. A step fracture can sometimes be removed by flaking from the opposite margin to intersect the step fracture and detach the unwanted mass. A hinge fracture terminates in a concave break rather than the right angle break of the step fracture. Removal of the hinge fracture can be accomplished in the same manner as the step fracture.

After the surface of the preform has been made uniform by removing the irregularities (such as step and hinge fractures) then the edges are made even and straight. The artifact is held on the pad in the palm of the left hand. A rod-like pressure tool (bone or antler tine) is placed parallel with the edge at a right angle to the longitudinal axis of the artifact. As the right hand presses the tool downward, it also applies inward pressure to the leading edge. A shearing motion results and the projections are removed in a straight line. This action is repeated bifacially and bilaterally until the preform has straight edges.

To detach flakes which curve beyond the median line or to the opposite margin, the left hand holding the objective piece is relaxed with the fingers exerting just enough pressure to support the artifact. This permits the artifact to roll slightly when pressure is applied, thereby detaching a curved flake. Excessive pressure of the left fingers will frequently cause the artifact to break when pressure is exerted by the right hand. The left hand must be protected by padding to fit the palm of the hand such as leather, cloth, fiber, shredded inner bark (sagebrush, cedar, etc.), a grooved piece of wood, or a padded stone. But the palm of the hand must be cupped to prevent the padding from touching the part of the surface of the artifact being flaked. This manner of padding and cupping the palm will allow clearance for the flake detachment and thereby avoid premature fracture. Different paddings offer different resistance to the objective piece and, therefore, will vary the flake character. By holding the left hand rigid and using a resistant pad, the applied pressure will detach flakes which terminate with a feathered edge. If the pad is soft, then the artifact will move and curved flakes will result.

The order of flaking is a matter of preference. One soon becomes accustomed to removing the flakes in a series along one edge from left to right (from the base to the tip) or vice versa, or by removing them alternately from the same margin but from opposite faces.

To provide strength, the long, narrow, barbed Hohokam point must be left thick at the median line. The edges must be made thin so they can ultimately be deeply notched and some of the notches altered into barbs. This is achieved by detaching flakes which leave large bulbs on the margin and which are quite wide in relation to their length and terminated by feathering at the median line. This leaves the median line fairly thick and the edges slightly concave. The interval of placing the tool on the margin, the width of the tip of the pressure tool, and the amount of platform detached determines the width of the flake. If the tip of the tool is set near the edge of the platform, a thin flake will be detached with less platform adhering. If the tip of the tool is set far back on the platform, the detached flake will be wide and thick at that part for the platform adheres to the detached flake.

The distal ends of projectile points must be made sharp to allow penetration of both the artifact and the shaft. The distal end of the projectile point is placed flat on a solid surface which has been previously covered with a single piece of leather or hide. This padding conforms with any slight irregularities in the artifact and supports and provides uniform resistance during the application of pressure. The compressor is a slightly rounded but semi-pointed piece of bone.

The point of the pressure tool is placed on the margin of the tip and downward pressure is applied vertically to the lateral edges. No inward pressure is applied. This single direction of vertical pressure to the edge causes the flakes to terminate at the median line of the tip, thereby forming a ridge down the center. The most common method of tipping is to fingerhold the tip of the point and press the flake off diagonally from the tip toward the base, leaving a chevron or herringbone pattern on both faces of the tip.

The manufacture of Hohokam and other North American points may have involved the use of an antler pressure flaker and some notching of points could have been done with bone fabricators. In some parts of the world antler was simply not available. This includes Australia and much of South America. In such places pressure flaking had to be done with bone or wood and the latter material is often more suitable than archaeologists might think. There is much in common in the use of antler and wooden pressure flakers but there are also some important differences. We may consider these differences and similarities by examining a manufacturing sequence with a wooden pressure tool.

When properly used, wooden pressure tools make fine compressors. Selected hardwoods have sufficient strength to transmit the force necessary to exceed the elastic limit of the lithic material and to induce fracture. When the stone reaches its elastic limit, shear stresses are induced, fracture occurs, and a flake is detached. After much trial and error, it was determined that a wooden flaker with a sharp, pointed working end would not tolerate the pressing strain and would either split or break. But a shaft of selected hardwood (20 to 60 centimeters long and 2 centimeters in diameter) with a blunt working end was strong enough to withstand and transmit sufficient force to fracture the material. But wood must be carefully selected for flakers. It must be sufficiently hard to prevent too deep a penetration of the lithic material into the tip of the wooden flaker, and it must be tough or fibrous enough to prevent splitting. Very hard, highly resinous woods (such as ironwood) were found to be too brittle and would break. Ironwood is good for wood billets but not for compressors. Coarse-grained wood will split before a flake can be removed. The worker should experiment with various types of wood until he finds a satisfactory billet or pressure flaker. At this time, I cannot express a preference because I have not used a sufficient variety of woods. However, experiments reveal that the Calafate wood, a species of barberry that grows in the grasslands near Fells Cave, is a satisfactory tool for pressure work. Junius Bird generously provided four pieces of Calafate, and I gathered some Manzanita from Arizona; both were satisfactory for pressure flakers. Other woods were also tried, but none was equal to the Calafate and Manzanita. I hope to obtain some Australian hardwoods for future experiments.

I was accustomed to flakers of bone, antler, and metal, but I found it necessary to modify the holding method and to vary the application of pressure with the wooden implement. The tips of bone, antler, and metal flakers will withstand more downward pressure than the wooden tool. They also allow greater control and "feel" of flake detachment and the worker can remove long, narrow, curved parallel flakes from one lateral margin to the other. Although this accomplishment was not realized in this experiment with the wooden flaker, it cannot be rejected, because the experiment may have been too brief to allow it. The coordination and rhythms of muscular motor habits become ingrained in the worker who has used bone, ivory, and metal flakers for years; the new technique and the different "feel" of wooden tools make response difficult. It was necessary to attempt a variety of diverse approaches to overcome some of the difficulties encountered. The wooden pressure tool would slip, the tip would break, the wood was insecure and would yield when pressed against the margin of the artifact, and "feel" was limited. "Feel" has little meaning to the novice, but, when one has pressure-flaked with bone, antler, or metal, which adheres to the platform of the artifact, one is accustomed to feeling the flake part from the piece being worked. Pressure tools must be kept in alignment, and the flake must be pressed off across the face of the artifact to delete small step fractures or irregular areas. The wooden pressure-flaker experiment was limited to a few weeks, whereas years of working with bone and antler compressors have disciplined my muscle response to adjust to harder flakers. If more time were allowed to become familiar with the wooden flaker, I believe it could be as efficient as the harder tool and its use expanded to include diverse techniques.

If the tip of the wooden pressure flaker is rounded to resemble the end of a broom or mop handle, considerable pressure can be applied without the flaker breaking. As work proceeds, the tip of the compressor is rotated to expose new surfaces, to retain the rounded shape, and to regularize the wear pattern. If the tip becomes fibrous, it can be rubbed on an abrasive stone to expose a new hard surface.

New pressing techniques had to be devised to use the bluntly rounded wooden tip. The blunt end contacts a wider part of the artifact edge and detaches flakes with wider proximal ends than when a harder pressure tool is used. With the wooden flaker, the worker uses a thrusting motion in a straight line toward the edge and then presses away from the artifact to detach a flake. The wooden flaker is firmly seated on a slightly beveled platform and then thrust downward and away in a simultaneous motion, snapping rather than pressing off a flake. If basalt or other coarse-textured materials are being worked, much more force is necessary to detach flakes. If the downward and outward forces are not coordinated, the snapping method may break the flakes off short and terminate the end in a step fracture rather than in the desired feathered edge.

The method of holding the wooden pressure tool is quite different from the method used with antler or other hard flakers, because the harder tool will tolerate more downward pressure at its tip. When wood is used, the artifact being pressure-flaked must be firmly supported. The support may be a padded anvil stone, or, if hand-held, the artifact may be held in the left hand with its lateral margins horizontal and the back of the hand solidly supported against the inside of the left thigh. The worker sits on a low seat and holds the wooden flaker as close as possible to the tip to increase the leverage. If the pressure tool is longer (about 60 centimeters), one end can be rested against the right ribs and kept in alignment with the forearm of the right hand. This position enables the worker to use the forearm and shoulders to increase the vertical pressing force. The low seat raises the left thigh above the posterior, thus permitting more pressure to be exerted by the arm and applied through the pressure tool to the vertical edge of the artifact which is held perpendicular to its longitudinal axis. The position of the Australian aborigine worker differs somewhat since he is accustomed to sitting on the ground.

The wooden flaker is placed on the margin of the artifact, and controlled pressure is applied inward in alignment with the proposed flake. As the pressing force increases, an outward force is imparted which causes the flake to detach from the artifact. Examination of aboriginal flake scars and scars made experimentally reveals that pressure was applied in the same direction. The technique differs from the one used with antler or bone flakers, which are held at an angle to the margin with force directed at right angles to the long axis of the pressure tool.

The wooden flaker technique and the change of applied pressure require the worker to use a different set of muscular motor habits and, in the beginning, will form either blisters or calluses on the right hand. After a few attempts, a blister formed at the base between the first and second fingers until I became accustomed to the change in technique. It requires about 3 weeks of intermittent practice before the right hand is really comfortable and tolerates the tool without the bruising. Perhaps the shaft of the pressure tool could be served with fiber or sinew to make it more comfortable and to prevent slippage.

Preforming by direct percussion leaves fairly large, randomly spaced flake scars and creates crests and hollows that must be removed by pressure to make the artifact symmetrical and regular. A platform is established by making a bevel on the edge in alignment with the ridge to be removed. The bevel is made by pressing the wooden flaker at right angles to the margin to detach small flakes and to slant the edge toward the face being flaked. The tip of the pressure tool is then seated firmly on the platform, and the worker, by pressing first inward and then outward, detaches a flake which in turn removes the ridge. When the major ridges are removed, the piece is ready for the next stage of final pressure flaking. When the artifact is to be pressure-flaked bifacially, the worker has a choice of techniques, but the following are suggested: (1) Pressure-flake one-half of the face from one margin and then one-half of the opposite face from the same margin. After one margin is worked, we have an artifact flaked from one margin and on one-half of both faces. The technique must be repeated from the opposite margin to complete the artifact, but now the detached flakes must meet and terminate at the median line to intersect flakes removed from the opposite margin. (2) One-half of one face can be pressure-flaked from one margin, then the piece turned and the same face flaked from the opposite margin, with the flakes meeting and terminating at the median line. We now have a unifacially flaked artifact, and the technique must be repeated on the opposite face to complete the artifact.

The edge of one margin is beveled on one face, which removes the overhang left by previous bulbar scars. Then a more pronounced bevel is made on the same margin but on the opposite face, and this bevel is used as a platform area for the pressure retouch. To remove the second series of flakes from the same margin but the opposite face, the edge must again be beveled in the manner previously described. However, now the bevel is on the face to be flaked. After the second bevel is made, the artifact is held in the left hand with the first beveled side resting on the palm and the second beveled side visible to the worker; this bevel serves as a platform to detach flakes on the under side. A series of flakes is removed along the margin beginning at either the base or tip of the artifact, depending on the worker's preference. If work is started at the tip, flakes become increasingly larger as the worker nears the base; if flaking starts at the base, flakes become increasingly smaller as the worker approaches the tip. Flakes progress along the margin toward the base or tip until all of the beveled margin is removed.

When flaking is started on the margin, whether at the base or tip, a short flake with the bevel adhering is removed to establish a ridge. This flake and subsequent flakes become increasingly longer, and all flakes terminate at the median line of the long axis. After each flake is detached, the tip of the pressure tool is again seated on the beveled edge, and flaking is spaced to allow the platform part of the second flake to intersect the sharp edge left by removal of the bevel of the preceding flake.

The wooden flaker does not crush the edge. Consequently, it will detach a flake that has a broad and diffused bulb of force rather than one that is deep. Flaking progresses toward either the base or tip (depending on where the worker starts) along the margin until all beveling is removed. The blunt, thick end of the wooden tool makes the spacing interval between flakes broader than it is when an antler pressure tool is used. The worker intentionally spaces the flakes so that each subsequent flake scar will intersect the last scar and form a straight, sharp edge. When pressure flaking is complete, the wooden flaker leaves edges that are uncrushed and quite sharp. Flaking is continued until both faces and both margins are flaked.

These examples of pressure flaking may serve to show that many pressure flaking techniques can be used to make stone tools and that many more may have been known to prehistoric man. The development of satisfactory replicas permits the elimination of some techniques from further consideration but there is always an area of uncertainty among the remaining alternatives as well as the uncertainty caused by the knowledge that several prehistoric techniques may never be discovered. The flintworker must endeavor to amass a representative collection of archaeological series of cores, flakes, blanks, forms and finished implements. A study of such a library of stone tools may enable him to identify the time inception, geographical distribution and the specific techniques which provide satisfactory replicas of the pressure flaking process itself.

Some final comments on Hohokam points and the use of wooden pressure flakers may be useful. After viewing the results of only one phase of the Hohokam stone tool industry, i.e. the projectile points, there is no doubt that the points were made by master toolmakers. Not all of the stoneworkers were skilled, for the utility points show less ability and certainly not the sophisticated techniques of the elaborate barbed points. It seems clear that the Hohokam had their master toolmakers, and some of the hunters made their own points as best they could. Their flaked stone tools include several distinct types and styles, diverse manufacturing techniques, and a preference for some materials.

Each style appears to have been intentionally designed to serve a definite function. The elaborate barbed forms are difficult to make and it takes several hours to complete just one point. Certainly they must have been designed for a very special purpose more complicated or more important than just for hunting game. The utility points would have been adequate and suitable for killing small game and they can be made from a common flake in just a few minutes. So why go to all this trouble to make such an elaborate point for just hunting? As yet, we do not know the intended function of these elaborate points.

The wooden compressor can be used by a less skilled worker to produce a sharp edge on a stone tool. The wider, blunter tip of the wooden tool narrowed the margin of the worker's visibility for seating the tool on the edge. For me, the wooden flaker required more foot pounds of pressure than is needed with a harder compressor. I did not find the wooden flaker suitable for detaching long, narrow, curved, parallel flakes, but I do not reject the possibility pending further experiment. The wooden flaker will not withstand the amount of downward pressure that a bone, antler, or metal tip will tolerate. It also limits the worker's muscular reaction, "feel," and control of the lithic material response.