

Comments on Lithic Technology & Experimental Archaeology

Since the excavations by Dr. L.S.B. Leakey at Olduvai, we now have evidence of man using stone tools for approximately two million years. This gives one pause when we realize that the Stone Age accounts for at least 99.5 percent of human history. Since artifacts of wood, bone and other perishable materials had little chance of surviving the ravages of the elements and time, we must rely primarily on stone tools to attempt an interpretation of the behavior of prehistoric man. <sup>during the Stone Age</sup> In brief - 99.5 percent of the history of mankind is represented by the stone age and if we correctly approach an analysis of both his stone tools and the manufacturing debitage we can attempt an interpretation of his behavior patterns and attempts at survival. I think Dr. Leakey summed it up very well when he said "For the students of lithic technology, the stone tools of man represent fossilized human behavior patterns."

Today, stone tools are still used in only a few remote places in the world and these societies, too, will probably soon <sup>substitute the more versatile metal</sup> ~~replace their stone tools for the~~ <sup>implements for their stone tools.</sup> ~~more versatile metal counterpart.~~ For this reason, it is imperative that any information regarding the manufacture and use of stone implements - whether past or present - be recorded. It is unfortunate that existing stone age societies generally lack the sophisticated skill of workmanship of some of the prehistoric lithic industry workers. But we seem to note a degeneration of this skill even at the end of the stone age. For this reason, experimental archaeology - and in this case I mean the replication of prehistoric stone implements - can provide information about the manufacturing methods, techniques and maybe even the uses of tools of the stone age. Certainly, experimental replication will help the typeologists and functional experiments can give us clues to how and why the tools were used. By experiment, we will not only be more capable of defining techniques but will also be able to evaluate the many stages necessary to finish the product and <sup>consider</sup> ~~realize~~ <sup>the requisite impact</sup> ~~the importance~~ of appraising broken, malformed and reworked tools. For those who are doing

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computer analysis this is most important for we should allow for inferior workmanship, miscalculation, intentional and unintentional fracture, deficient material, interruption of the worker, the learner, etc. But experimental archaeology must be related and compared to definite aboriginal concepts of a particular technology or clusters of techniques and then used to replicate the stages of manufacture from the <sup>RAW MATERIAL</sup> ~~preforming~~ to completion.

Throughout the stone age, man made his stone artifacts by applying force to various lithic materials to detach flakes from the mass and ultimately shape and form a functional tool. He used various types of force and diverse fabricators. The flake or blade (specialized flake) bears the positive features while the flake scar on the core <sup>retains negative</sup> ~~has the features of the negative characteristics~~. Both the flake and the core may be formed into more complex tools by the removal of additional flakes and when complete these are flake and core tools.

To a casual observer, flakes and their counterparts may look much the same other than <sup>the obvious observation</sup> ~~a noting~~ of their varying dimensions. But, in reality, flakes and their scars are very distinctive and can give clues to the manufacturing tech., direction of force, type of applied force, platform preparation, curvature of the flake, flake termination, stages of manufacture, type of tool used to induce fracture and the type of artifact being manufactured. An analogy might be the comparison of fingers by their shape and tips rather than using the sophisticated science of fingerprinting. However, flakes detached by the same technique may have minor differences but each will only make perfect contact with its original flake scar. But a drastic change of technique will usually show major differences in characteristics of the flake and scar. Unfortunately,

*there is little recovery of pressure flakes other than pressure blades. Most pressure flakes are small & have a tendency to crush during detachment & consequently are lost at the workshop area.*

Rather than burden the flake analyst with lengthy cumbersome ~~xxxx~~ lists of attributes, I would like to call attention to some of the problems of flake analysis and interpretation based on the manufacture of stone implements. The

They are we are forced to make an analysis of them from the scars retained on the artifact

flake or blade character is influenced by many factors. To name a few - the material, the implements used to apply the force, the applied techniques, the thermal alteration of the lithic material or the lack of alteration, and the degree of skill of the artisan.

Force is applied to the stone to induce fracture to detach the flake and leave its corresponding scar on the mass. Both flakes and flake scars retain features which give clues to interpret the aboriginal manufacturing processes. The flake retains more diagnostic features than the flake scar because the platform adheres to the flake and it bears other characteristics and traits which can indicate the mode of detachment and stage of manufacture. It permits the analyst to consider the platform character of the proximal end and evaluate the termination of the distal end. It retains the positive character of the bulb of force; designates the area contacted by the fabricator; sometimes has lips and overhangs, curvature, undulations; allows inspection of both the dorsal and ventral surface; denotes form and dimensions and we can often differentiate between the workers intent and the error. But the flake scar is not without diagnostic features. It can indicate the direction of applied force, depth of the negative bulbar scars, flaking rhythm, manner of holding, spacing, use of ridges to guide direction of flake removal, manner of termination, thinning, notching, serrating, etc. For this reason experimental replication of prehistoric stone artifacts has been useful to ~~better understand~~ <sup>replicate, interpret & record</sup> the subtle variations of flakes and scars resulting from different techniques. <sup>(over)</sup> Because stone tools have an almost universal distribution covering a vast time span and represent independent developments of multitudes of techniques, it is doubtful if all of these ~~techniques~~ <sup>FULLY</sup> will ever be understood or defined. However, as the science of lithic technology progresses, experimental archaeology will make possible the associations of the same or parallel techniques which have features and characteristics in common. Duplicate or parallel techniques will not indicate or prove a direct connection between extinct societies for, no

Certainly experimental archaeology helps to perceive from some artifacts may look morphologically the same, but be made by entirely different techniques. So if we have some knowledge of stoneworking we can more readily define these differences.

doubt, innumerable independent techniques were developed and some can be outright inventions which have no parallel. <sup>Identical</sup> Specific flake styles are possible by using diverse approaches to obtain results <sup>Specific</sup> which are similar. <sup>finished products</sup> ~~which are similar but not identical to another implement.~~ ~~over~~

Many factors must be considered in determining the technique. ~~One~~ <sup>Uc</sup> ~~important factor is to~~ <sup>must first</sup> evaluate the vast differences in lithic materials. I can not stress this too much and have yet to visit a quarry without evidence of previous aboriginal use and giving mute testimony to the workers discriminating choice of superior material. Examples of tested and discarded materials are <sup>& generally concur with their discard reasoningly imperfections in the</sup> abundant in quarry sites. Regarding material, let's discuss obsidian. Obsidian <sup>material, having cleavage planes, lack of elasticity, varying size, granular texture,</sup> is described geologically as a volcanic glass with a vitreous <sup>mass,</sup> black in <sup>now homogeneous, etc.</sup> color and having the ability to fracture chonchoidally. It was universally preferred by toolmakers for certain tools because under controlled conditions it responded to the workers intent and gave flakes, blades and tools with a <sup>more resistant material such as</sup> keen edge. For agricultural tools he generally preferred, basalt, flint, chert, etc. Yet obsidian varies in workability. These <sup>variations</sup> differences in workability are: its elastic qualities, keenness of edge, mineral constituents, differences in geological age and formation, and all of these qualities can and do influence the workability of the material. Obsidian also comes in a variety of colors and sheens. The worker must also appraise obsidian containing impurities, inherent stresses and strains, temperatures of solidification, flow structures, gas bubbles and size. All of these good or bad qualities can and do influence control or restrict the outcome of the end product whether the desired implement be a flake, blade or a multiple flaked implement. Predominantly siliceous rocks like quartzites, flint, chert and endless varieties of chalcedonies are even more variable. The worker must either modify or develop techniques which conform <sup>+ respond to</sup> with the material being worked. For example - a whole different cluster of methods and forces would have to be applied to quartzites and basalts when the worker is accustomed to working with more vitreous rock such as opal, obsidian or heated siliceous material.

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detach specific flake styles

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Often lithic material was available in limited quantity, quality, size and variety which had a direct bearing on the endeavors of the stoneworker. Over large geographical areas, ideal lithic material was scarce and often it was obtained from considerable distance. Discriminating stone workers who had access to a variety of materials selected their materials according to the intended design and functional ~~intention~~ purpose. When they intended their tools to be subjected to repeated impact and hard rigorous treatment they selected material resistant to shock to insure a longer lifespan for the implement. When they wanted tools with a keen cutting edge, they selected highly vitreous material. For example: certain obsidians with superior elastic qualities were selected for manufacturing pressure blades and other obsidians not as elastic were more desirable for artifacts which required ~~an~~ multiple flaking. Silica is compounded and blended by nature with other elements giving varieties with diverse qualities - some desirable and some undesirable. The toolmaker was a good geologist and knew how to choose superior materials for specific needs.

Since we are discussing materials, let's consider those who had access to only inferior material and yet made adequate tools. When you are analyzing such tools don't <sup>indiscriminately</sup> write off the workmanship as inferior <sup>tools having random flaked step or hinge - fractures flakes as being</sup> - <sup>rather</sup> But, consider the material and you may discover that you have a superior workman who was forced to use inferior material. Don't put these tools aside and label them as "crude", but combine your evaluation of the material and workmanship and this may change your opinion of the group of people forced to survive under these conditions.

As some metals are annealed and tempered, so also may siliceous rocks be altered by controlled application of heat. At some early period of time, man found that internal stresses and strains inherent in the rock could be relieved by subjecting them to controlled heat. This made the material more homogeneous thereby changing its texture from coarse to vitreous and thus improved the flaking quality and enabled the worker to <sup>control flake detachment</sup> produce a tool with a sharper edge.

Often, lithic material containing impurities will undergo a color change during alteration. When this happens, the color change will be more pronounced near the exterior of the altered material. But controlled heating does not change the texture of the exterior or exposed surface. Only when a flake has been removed to expose the interior surface can the texture change be noted. We do not, as yet, know when prehistoric man discovered this annealing process, but Dr. Francois Bordes has noted the alteration as far back as Solutrean.

Often in a collection or at an excavation we will find an aboriginal <sup>blade, core or artifact which will retain a portion</sup> flake, <sup>on the dorsal side</sup> and note <sup>on the dorsal side</sup> on the dorsal side a portion of the natural surface <sup>of the stone</sup> of the stone, <sup>which will not respond to the alteration.</sup> <sup>on the dorsal side</sup> But if the ventral side of <sup>or if the surface does not respond to heat treatment</sup> the flake is lustrous in contrast to the dorsal side then we can safely assume that the material was subjected to thermal alteration. When we do not have the debris and must rely on only the flaked surface of artifacts such as projectile points, <sup>cores etc</sup> we can look for a facet of the natural material which might be still adhering to the face of the artifact. Then we can compare this facet with the flaked surface to determine if the material was altered. If the facet is dull and the flaked surface is lustrous and of a different texture than the natural facet then we can be pretty sure the material was altered. <sup>With care we can attack a flake to note any</sup> If such evidence is not obvious then we must resort to an experimental approach and conduct a controlled heating process on the same material to ascertain if the material has been altered by heating. <sup>appearance under natural light</sup>



Thermal alteration of lithic materials is a sophisticated process involving critical temperatures, correct duration of gradually raised and maintained heat exposure, controlled cooling process, and calculation of time and temperature according to the size, type and quality of the material being altered. Until one is familiar with the stone, each material must be tested individually. When the correct formula has been determined for a given material then any deviation in control of raising and lowering of temperatures will result in the material being unchanged or worthless. The temperature range for altering siliceous minerals will vary from 450F to 1000F and only the trial and error method will determine the ideal temperature index. Basalts and obsidians respond to a much higher temperature without danger of crazing and they will withstand more rapid temperature changes than siliceous rocks. One archaeological example of the use of heat treatment are the Hopewell cores and blades from Flintridge, Ohio material. Analysis reveals that most of these were made of treated flint.

The percussors and compressors used to form the stone tool <sup>definitely</sup> ~~also~~ influence the character of the detached flakes and scars and the toolmaker <sup>the worker</sup> selects his <sup>hammer</sup> ~~percussor~~ <sup>to size & type of material, the desired fracture dimension of one</sup> ~~to perform a specific technique or a group of related~~ techniques. Hammerstones, billets, punches, compressors and all fabricating tools should be recovered from sites and their wear patterns studied to <sup>help</sup> determine the technique and type of applied force. For example, the edge ground cobble technique leaves a consistent wear pattern on the side of the hammerstone rather than on the end and these can often be mistaken for a rubbing stone. But when the wear patterns on these cobble are properly interpreted they can indicate a distinctive type of blade detachment.

There are ~~many~~ <sup>three major</sup> and very general classes of flake detachment: Direct percussion, indirect percussion and pressure. A minor technique is the combined use of pressure and percussion. Flake detachment techniques involve a knowledge of elastic limits of the materials, Newton's law of motion, force,

gravity, weight, mass, density, friction, levers, moment of force, center of gravity, stability of bodies, projectile motion and kinetic energy. This is, indeed, a comprehensive list of factors which must be mentally evaluated and rationed to ~~xxxx~~ accomplish the controlled fracture of lithic materials. It is highly unlikely that prehistoric man was aware of these scientific laws but as his techniques became more sophisticated ~~it is safe to assume that he~~ <sup>did take</sup> ~~took~~ advantage of these principles.

The earliest stone tools were probably natural erosional products selected by man for their <sup>sharp</sup> ~~shap~~ cutting edges and he probably used spheroids as hammers or missiles. Direct percussion was probably man's first approach to intentional fracture to form tools and expose useful cutting edges. <sup>This early technique</sup> ~~Direct percussion~~ was used to form a wide variety of percussion tools and involved many and varied <sup>(personal common)</sup> percussion techniques. One of the simplest is described by Richard Gould when he observed the Australian aborigines in the process of toolmaking. They threw the lithic material against boulders and then selected flakes with sharp cutting edges to be used "as is" and others were selected to be modified into functional implements. This technique of using a fixed anvil stone is often called "block on block". When further refined, it will lead to other related techniques. But considerable more fracture control is possible when the material is not thrown against the anvil but, rather, is held in the hand and then struck on the anvil stone. This allows the worker to predetermine the point of contact and accurately detach his flake and expose an edge. It affords the worker more accuracy and the degree of velocity can be adjusted and proportioned according to the weight of the material being flaked and the desired dimension of the intended fracture. ~~But~~ <sup>§</sup> But even better control of the flake or blade detachment may be gained by the worker specially designing the part of the material to be contacted by the fixed percussor. This point of contact is known as the platform. There are many methods of platform preparation which have diagnostic value and influence the character of the flake or blade. A few examples of platform preparations are: Making the proper angle on a plane surface, isolating the

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preparation are: Making the proper angle on a plane surface, fracturing the

platform area surface, removing the overhang from previous flake scars, grinding the surface, polishing the margin, faceting by the removal of one or more flakes, and the orientation of the platform with guiding ridge or ridges.

\* Time does not permit discussing the various types of percussion and pressure techniques, but all involve proper preparation of the striking or pressing area, correct angle of applied force, control of applied force, predetermined flake termination and other factors too numerous to mention. It is enough to say that both the flakes and their scars must be studied very carefully to arrive at any decision pertaining to the technique. Some of the problems which can often be answered by an evaluation of the lithic debris ~~are:~~ <sup>broken or malformed artifacts:</sup>

1. How was an artifact made and ~~with~~ what tools were used to form it.
2. Why was the implement made in this particular form.
3. Why were certain lithic materials selected for specific artifacts.
4. ~~How~~ <sup>How</sup> was the tool intended to be used.
5. What task was it to perform.
6. Was the tool a multi-purpose tool.
7. How was the tool held in order to perform a specific function.
8. Was the tool hafted.
9. How was the tool hafted.
10. What was the action of the tool on the objective material.
11. Was the tool pulled or pushed.
12. Does the tool strike or press the objective material.
13. Was the tool used for scraping or cutting.
14. How can the angle of the tool edge be compared to the resistance of the material being formed.
25. What is the difference between attrition and corn polish.
16. What causes the striations on the working edge of the tool.
17. What are the directions of the striations on the working edge of the tool.
18. Was the tool used as a burnisher.
19. Do some softer materials being formed have an abrasive action on the tool.

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As prehistoric man improved his stone toolmaking he progressed to flaking more of the surface. The evolution of tools progressed <sup>from simply affixing an edge</sup> ~~from~~ from the first embryonic attempt to handaxes with a natural surface ~~knelt~~ <sup>to</sup> entirely flaked handaxes ~~to~~ <sup>to bone projectors, spears, blades, burrs</sup> ~~to bone projectors~~ <sup>substantia cutter, bone & hard woods for the flaking</sup> implements which enabled him to ~~make a~~ <sup>better control his flake</sup> attachment, & ~~make thinner~~ <sup>make a</sup> ~~beaver edged tool~~. Progression continued to the Solutrean when we first note the use of pressure flaking. And so on to the New World where we find fluting & a predominance of pressure work.

20. How can use flakes be identified as opposed to intentional retouch.
21. What are the characteristics of use flakes.
22. What is indicated by a series of use flakes of certain character, termination, change of angle, increased resistance, improper use, beginners or apprentices, mishandling.
23. Was the tool abandoned upon completion of task.
24. Was the tool broken from accident, manufacture, or due to imperfections in the material.
25. Was the tool exhausted from resharpening.

These are only a few of the problems encountered when evaluating lithic material. Each flake or artifact must be considered independently. Then clusters of like attributes will have diagnostic significance.

This is all well and good you say, but I am not a flintknapper and have no one to teach me and no debris to analyze. It is certainly not my intent to make a flintknapper out of every student, but for those seriously interested in lithic technology I do recommend that they try fracturing stone.

You need not become proficient at the art but even a try will <sup>give you a</sup> ~~help you understand~~ ~~some of the many problems involved.~~ ~~Also you are lucky to be studying~~ ~~during an period where information on this art is readily available, to you.~~ *feel for fracture the help you to better understand the mechanical problems involved. If you don't have material available - then use building glass, old T.V. tubes or any suitable glass.*

I.S.U. has films for rent or sale showing the various types of pressure and percussion work. Tom Hester has written a fine bibliography containing almost everything written on lithic technology. And we now have lithic tech. courses available in almost every ~~other~~ major university with many students teaching actual flintknapping. *Many students have attended our summer field school in knapping & have become quite proficient at toolmaking. Most of these graduates are available to give demonstrations & show actual mfg & explain the implications of debitage.*

Barring these approaches you can practice experimental archaeology on your own as prehistoric man did ~~was~~ *Francis Bordes, Bruce Bradley & I learned this way & it*

was only by trial & error that we eventually achieved  
replication.

It is certainly not my intent to infer that only  
Toolmakers are qualified to interpret technologies. <sup>become typological</sup> A  
case in point is Ruthann Knudson. She was  
intensely interested in Pales man's tools ~~and that the~~  
curate her thesis on this subject. She worked ~~with~~  
Marie Wormingtons excavation at Hersey <sup>was fortunate to have</sup>  
on several occasions <sup>the was present</sup>  
when I did demonstrate Toolmaking at the site. <sup>more intelligent than</sup>

Being a keen observer she noted each step of my  
& later studied the debitage. Then after looking at  
Pales man Collections throughout the country she applied what  
she had observed & came up with an accurate tech.  
description of many tools. When she attended our  
field school she brought her <sup>index cards</sup>  
analysis of these tools along & in every instance  
her technological analysis was correct. In her  
case the school served to verify her conclusions.

In conclusion, experimental archaeology has  
many approaches & we heartily recommend all of  
them to those concentrating on lithic tech.

I was fortunate enough to have the benefit of Marie's  
vast knowledge of lithic tech.