THE POTENTIAL OF LITHIC TECHNOLOGY

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Since the 1962 Conference of Western Archeology on Problems of Point Typology, organized and chaired by Dr. Earl Swanson and held at Idaho State University, there has been an accelerated interest in lithic technology. Following this meeting, Dr. Marie Wormington instigated a Lithic Technology Conference which was sponsored by the National Science Foundation and held at Les Eyzies, France in November 1964. Fourteen anthropologists from both the Old and New World attended the session and, among other things, they ultimately agreed that technological approaches were vital to the assessment and evaluation of international stone-working industries. It was here that Dr. Wormington coined the term "lithic technology" which now covers research and experimental approaches to all fields of stone implements.

Prior to this time there were many who struggled unsuccessfully to promote interest in this science but their success was minimal. We are now reevaluating the published works of such technologists as Boucher de Perthes, Louis Figuier, Sir John Evans, Leon Coutier, Halvor Skavelem, Andres Kreigh, Henry Osborn, H. Holmes Ellis, W. H. Holmes, A.L. Kroeber, Louis Leakey and the fine but little known work of the lithic analyst, Dr. Ludvig Peiffer. Their research and experiments, now acknowledged and appreciated, are a major contribution to our knowledge of the unlimited and independent development of the techniques of the stone tool industries. The potential of experiment as an approach to a more thorough understanding of the processes and stages of forming stone implements is now well recognized.

Many times I have asked myself, "What is the purpose of lithic technology and experimental archaeology and what impact will it have on our knowledge of the Stone Age?" One answer always persists: "it is a useful aid in the interpretation and understanding of the fossilized remains of human behavior patterns of prehistoric societies". Dr. Lewis Leakey's excavations at Olduvai date man the toolmaker at two million years; and the excavations of his son, Richard Leakey, in Ethiopia may even extend the time beyond this date. This means that at least 99.5% of all human history is covered by the Stone Age and places the burden of interpretation of stone implements squarely on the lithic technologist. Until the innovation of fired clay in the form of ceramics and the rare exceptions of bone and antler, only unusual quirks of nature allowed the preservation of wood and fiber implements. Therefore, in order to extend the history of man, the student of human occupation and its time span must rely to a great extent on stone implements, broken tools and the lithic debris of the workshop.

The novice lithic technologist may sometimes be confused between man-made tools and nature-facts. The elements can sometimes modify stone to the point where one wonders if it is a product of man or nature. This is why actual experience in forming stone artifacts will provide additional information about both the finished artifact and the waste products involved in their manufacture and will enable him to distinguish between man-made artifacts and those formed by nature. Experiment enables one to study the unlimited subtle varieties of techniques used through time and to note their geographical distribution in order to resolve the consistencies and diversities of technological patterns. Some tools exhibit simple and diversities of technological patterns. Some tools exhibit simple techniques, some incorporate combinations of techniques, while still others are formed by rare and exotic flintknapping methods.

Learning even simple techniques is time-consuming and there are no short cuts. The worker must pre-conceive each fracture and then formulate ratios of velocities, inertia, yield, volume of percussor, area of fracture and relate these to the resistance of the material to be fractured. There are no words to explain the necessary amounts of force, the angles involved and the everchanging conditions encountered during the reduction of the raw material to the finished product. Flintworking can in some ways be compared to the game of golf - there are no words to tell the golfer how hard to strike the ball, at what angle, which club to use, etc., which will assure him of winning the gold cup. Only practice will make him a winner and the same is true of learning the art of flintknapping.

Another wide-open field for the lithic technologist is the study of the raw lithic materials used by prehistoric man which can also tell us something of his life style and behavior patterns. It is not enough to secure suitable material through a dealer and limit one's time to learning flintknapping. Prehistoric man's first concern was securing suitable material for his stone tools; the lithic student must, therefore, first know his material and it is well, if possible, to know its source. What may appear to be ideal material may, upon testing, be found lacking in the qualities necessary for controlled flaking. If possible, it is well to visit quarries, for here we can observe prehistoric man's quarrying methods and learn how to select suitable stone by evaluating his rejection of certain materials. Gould has told me of observing the aborigines of Australia spending hours selecting and analyzing their materials before they begin chipping.

At present there is keen interest in the transportation of obsidian from *in situ* occurrences. Due to its workability and sharp cutting edges, obsidian was highly esteemed by prehistoric man

as a stone tool material, but its natural occurrence is often limited and restricted to geologically recent volcanic areas. In non-volcanic areas the aborigines made fine implements of other stones and found highly siliceous materials very responsive to flaking control. For the mineralogist-archaeologist, the horizons are unlimited for study of the evaluation of the mineral constituents of ancient tools: *in situ* occurrences, natural transportation, whether by water or glaciation, in alluvial and colluvial deposits. When we find stone in a region which does not conform with that geological area, we can safely assume it has been transported by man. This can be an important part of our study of the movement of man. The quantity of aboriginally worked material found in a given site will often depend upon the quality of the stone and whether it is native to the region or has been transported. This may afford the archaeologist the opportunity to pinpoint by triangulation the known or unknown sources of material.

Lithic materials used to aid in the manufacture of stone tools also present a wide-open field for study. By this I mean lithics used as abrasives for sawing, grinding and polishing. These are very important to the process of manufacture. Also, lithic materials suitable for pecking were carefully selected by the toolmaker and most of these have yet to be oriented archaeologically.

The student of lithic technology must also become familiar with which stone will respond to thermal alteration, for we now know that past artisans heated and cooled their materials under controlled conditions to achieve better flaking control. According to Denise de Sonnivelle Bordes, thermal treatment of stone has been observed as far back as the Solutrean. Visual examination of the raw material is not enough to determine if it will respond to thermal treatment. One must experiment with each material on an individual basis and note its response to heat temperatures, color changes, heating and cooling times, etc. Some materials will change color and texture while others will only alter in texture and still others will not respond to the heating process. There is a wide range of critical temperatures and each material reacts differently to varying temperatures, duration of heat exposure, color changes, water content and other idiosyncracies. Some material even becomes more crystalline when subjected to heat. The ideal method of alteration is a sophisticated process and the aboriginal technique of exact temperature control is still unresolved by experimenters. The working quality of a quartz crystal, basalt and obsidian is definitely improved by thermal alteration, yet there is little or no visual change. The spring issue of *Tebiwa* (Vol. 17, no. 1, 1974) contains a comprehensive account of thermal treatment by Barbara Purdy and is recommended to all interested in heat treatment of stone.

We now face the definite possibility of dating surface material which has been intentionally altered by man. Dr. John Fremlin, a noted British nuclear physicist, has been achieving excellent results in dating firepit rocks by using new thermoluminescence approaches, but during his research he was unaware that siliceous materials were intentionally altered by man to improve their flaking qualities (personal communication 1972).

Another approach to dating surface artifacts and materials is the knowledge that altered flint-like materials have a tendency to revert to their original texture. If the return to normal is constant, it may be possible to measure and relate lithic materials to the time of the original alteration. Research of altered lithic materials, whether by nature or man, is unlimited and we need more dedicated workers in this field.

Another facet of lithic technology which needs further exploration is the study of fabricators, i.e., percussors, compressors, punches, abrasive stones, anvils, or other supports. Often there are wear patterns on these tools indicating techniques, stages of fabrication and functional scars indicating cultural preference of manipulative use. Often a site yields quantities of lithic debris but a scarcity of the tools used to form the artifact. The stone tools manufactured by man, because of their enduring qualities, will naturally survive the passage of time longer than the tool kits of antler, bone or wood. Little is known of billets and rod-like percussors. Pressure tools or compressors are seldom found in the workshop or site area except for those recovered in the Arctic and in a few dry caves. We have no idea about the tips of the pressure tools used for blade removal nor of the punches used to perforate flakes and blades. Prehistoric man was able to use these punches to achieve a hole of less than one millimeter in diameter on blades, eraillure flakes, flakes, etc.

Our knowledge of lithic technology is still in its infancy when one considers the time span of the stone age and the numerous extinct societies, each contributing a vast array of techniques yet to be resolved by present day researchers. Technicians could spend several lifetimes in attempts to resolve some of the stoneworkings of the Egyptians. One can go on and on about the problems of lithic technology which confront the investigator. We must realize that the techniques were invented by prehistoric artisans and even though the toolmaker left blueprint models and examples of his skills, it is highly unlikely that all of his techniques will be resolved no matter how dedicated the researchers. We will not get the answers from computers. We must look to ourselves for the solutions and thereby experience the joy of rediscovery.

There is a need for continued exploration of the mechanics of flint-like materials when subjected to stress in order to induce fracture. Faulkner, Speth, Tsirk and many others have made major contributions by controlled laboratory experiments. It will be through this approach that we may learn the minimum and

maximum amounts of force necessary to fracture areas of a predetermined size. Different materials require distinct amounts of fource and only experiment can resolve this requirement. The toomaker must also understand the critical interval of contact between the yield of the percussor and the objective piece, the angles of blows, velocities, proper support or inertia of the objective piece, direct or arc-like blows, condition of the surface receiving the impact and other factors too numerous to mention. The amount of force imparted with each blow must correspond with the velocity, collision, impact, dampening - all of which are factors in successful manufacture of stone implements. These are but a few pertinent factors necessary to replicate archaeological specimens. Replication can also contribute relevant information on the behavior of lithic materials when subjected to stress or force.

Another enigmatic part of experimental archaeology is the matter of function. Functional analysis based on experiment will eventually contribute much useful information about the effectiveness, manner of use and the tasks the tools performed. The results of functional experiments will be many and varied and the results will depend largely on the skill, judgment and reason of the person conducting the experiment. Unsuccessful experiment may be just as significant as successful results and the overall appraisal of many individual experimenters doing the same task will yield better understanding of functional endeavors.

Today, our typology uses functional names to identify many stone artifacts: for instance, such terms as scrapers, side scrapers, end scrapers, scrapers on flakes and blades, thumbnail scrapers, one hand scrapers, two hand scrapers, etc. Functional experiment will soon convince one that a thumbnail scraper would be somewhat inadequate to flesh the hide of a bull buffalo. Yet at the Lindenmeier site where the extinct large bison was a staple of the Folsom people, we find an abundance of these objects. This poses an interesting problem of function. Don't forget that a so-called scraper is also a very useful cutting tool. Experiment may show that scraper-like objects could be used to perform a variety of tasks, some for definite purposes and others as multipurpose tools. Richard Gould and Norman Tindale have observed the Australian Aborigine using tools similar to scrapers as hafted objects for hand adzes, and they used these to work very hard wood with much skill and precision. Such observations give us the last of the ethnographic information about the use of stone implements. Unless functional processes are accounted for ethnographically, functional experimental results will be largely personal theories and, therefore, open to debate. The results will be proportional to the skill and ingenuity of the experimenter. When it comes to functional interpretations of the endeavors of prehistoric cultures we are indeed "babes in the woods". For instance, a present day carpenter would be hard put to build a spiral staircase with wooden block planes of his own making. Yet these tools were commonplace a hundred years ago and are bewildering to the present day mechanic. Many manual manipulative skills today require only the movement of a lever or the pressing of a button to accomplish the task. It is, indeed, a challenge to successfully imitate the past work accomplished with stone tools and yet it may be the only way to provide an insight into the workings of the past.

The future of prehistoric technology is, indeed, vast with an unforseeable end. One has only to examine a human skull replica made from rock crystal by prehistoric man and the ancient monolithic construction of the Peruvians to realize our ignorance of the manufacturing skill of the prehistoric lithic technologists.

Lithic research is essential but it should not be totally independent or self-serving. It is well to exchange and compare experiments and results with other research lithic technologists and thereby arrive at an acceptable technique for a given replica. The hundreds of techniques devised by prehistoric man are, to us, a lost art and no one man can ever consider himself an authority or an expert in this field. It will take the combined efforts of all experimenters for many years to ultimately approach the skill of our ancestors. Remember that early cultures were limited to a few techniques while latter day lithic technologists are trying to resolve techniques from the time of Olduvai to the last of the Stone Age. This puts us at a distinct disadvantage and we need to work together to cover this vast time span. It is gratifying to constantly receive letters from attendants of our summer field school giving reports of their successes and failures in experiments. Some have turned their research into specialized lines, such as blademaking, pressure flaking, thermal alteration, etc., but all are willing to exchange ideas and results. This makes for a healthy future for lithic technology and a chance to learn from others failures or successes.