volume XIII

number 3 1970

a quarterly publication of

CURATOR

the american museum of natural history

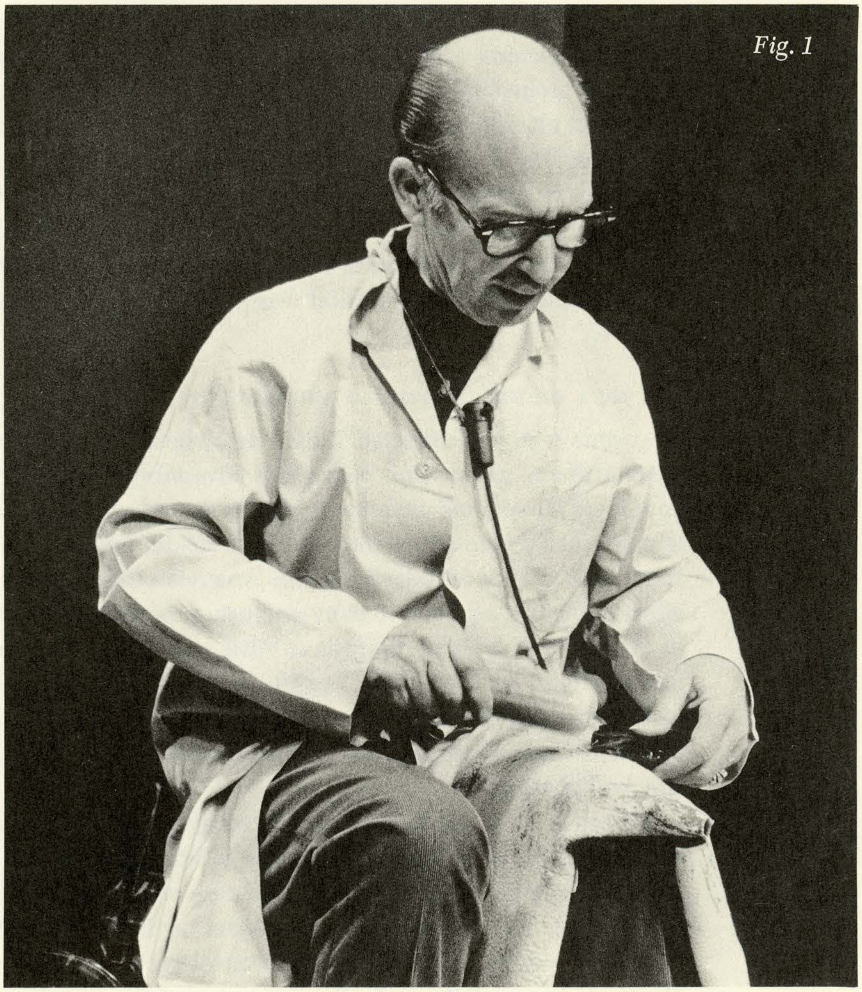


Fig. 1

Man's Oldest Craft Re-created

DON E. CRABTREE
RESEARCH ASSOCIATE IN PREHISTORIC TECHNOLOGY
IDAHO STATE UNIVERSITY MUSEUM
AND RICHARD A. GOULD
ASSOCIATE CURATOR OF NORTH AMERICAN ARCHEOLOGY
THE AMERICAN MUSEUM OF NATURAL HISTORY

From February to September, 1970, The American Museum of Natural History presented a stone toolmaking exhibit that was based on an idea known to archeologists and anthropologists as "experimental archeology."[1] This is not altogether a new idea, but the authors of this article, along with Dr. Junius Bird, Curator of South American Archeology, were privileged to be able to crystalize this concept and present it, for the first time, to large public audiences. The response from those who saw the exhibit and from the institutions involved with it was so enthusiastic that it seems worthwhile to describe how the exhibit was planned and what it was intended to achieve.

THE IDEA OF EXPERIMENTAL ARCHEOLOGY

Anyone who has collected Indian arrowheads or seen ancient, chipped stone artifacts in museum collections invariably finds himself wondering how these stone tools were made, and how and why they were used. This is particularly true when they are well made. Stone tools are so remote from the existence of today's average American that it takes an imaginative effort to picture a person making and using these implements. Most efforts of this sort fail because there is so little recorded about their fabrication and function. In truth, they boggle the mind, and it is no wonder that many educated Europeans living as late as the eighteenth century still regarded chipped stone tools as "thunderstones," created in some magical way by lightning.[2]

For some, the stone tools of ancient man are merely curios. But to archeologists, anthropologists, and students of lithic technology they represent fossilized human behavior (a happy phrase coined by anthropologist S. L. Washburn). As most people know, stone artifacts generally survive the ravages of weathering and decay in archeological sites better than artifacts of wood, bone, cloth, and other organic substances. Archeologists have come to depend heavily upon these surviving stone tools for their interpretations of ancient cultures.

When considered in terms of the whole span of human culture-history, the discovery and use of metals is a relatively recent and rapid development, having occurred within the last 10,000 years along with such other

[1] As far as we know this term was first coined by John E. Pfeiffer ("The Emergence of Man," New York, Harper and Row, 1969, p. 353).
[2] de Jussieu, Antoine, "De l'origine et des usages de la pierre de foudre," *Mémoires de l'Académie Royale,* Paris, 1723, pp. 6–9.

Fig. 1. Author Don E. Crabtree chips a stone tool at The American Museum of Natural History's exhibit.

major developments as agriculture and urban life. Since present evidence indicates that tool-using man has existed for approximately two million years, this means that tools of stone, wood, and bone have predominated for at least 99.5 percent of human history—and, of course, of these artifacts it is mainly those of stone that have survived to be studied and examined 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. Thus, stone tools provide archeologists with one of the most important bodies of evidence of human behavior over most of the span of human culture-history. Small wonder, then, that archeologists are keenly interested in knowing all they can about stone tools.

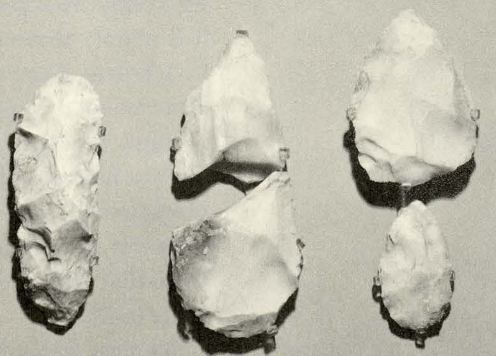
Scholars today have three main avenues open to them for finding out how ancient stone tools were manufactured and used:

1) *Stratigraphic excavation.* This remains the most orthodox archeological approach, and it is still one of the best. Through careful, systematic excavations, archeologists often find stone tools and waste materials in association with dwellings, campsites, butchered animal bones, or other features that give clues to their manufacture and function. For example, there was the 1926 discovery at Folsom, New Mexico, of the now-famous Folsom fluted point. This is a distinctive type of stone projectile point (a variety with a channel flake removed longitudinally from each face), which was found embedded among the fossilized bones of extinct bison, *Bison antiquus.* This find demonstrated at once both the great antiquity of this projectile point type and its use as an instrument for killing big game. The main point to consider here, however, is that archeological excavations necessarily destroy the site where they are carried out. It is always incumbent upon the archeologist to keep detailed records in the form of notes, photographs, and drawings of each layer he uncovers, since he will destroy the site as he proceeds to dig to deeper layers. Once an excavation has been made, there is no way it can be done over again. When most people think of archeology, it is usually excavation they are thinking of. This aspect of archeology cannot be called an experimental science, because experiments, if they are scientific, must be repeatable, and archeological excavations clearly are not repeatable.

2) *Living archeology.* Sometimes called ethno-archeology, this approach involves the study of contemporary societies where stone tools are still manufactured and used. It also includes research into historic sources that give early accounts of people who made and used stone artifacts. Unfortunately, references in historic documents about this sort of behavior are limited. Even more important, the impact of Western technology throughout the world has been so great during the nineteenth and twenti-

2 Quarrying

Archaeologists use the term "quarry" for those places where materials for stone artifacts were repeatedly collected. Materials may occur on the surface as fragments, pebbles, cobbles, or nodules, or they may have to be mined or broken from rock outcrops. At quarries, one finds quantities of waste flakes and scrap, often from the initial rough shaping of pieces for transport. Finished artifacts are rare. Mistakes – the blanks or preforms which broke or were not satisfactory – are common.



Ancient "Mistakes"

Battle Mtn. Quarry Site, Nevada.

Materials for quarries were carried and traded for long distances. When a material has properties which differ from one quarry to another, then the artifacts made from it, like bits of paper in a paper chase, reveal ancient routes for trade and travel.

An Australian Aborigine at the Mt. Weld Quarry in Western Australia collects flakes to be trimmed into tools at a later time. The flakes, made by striking a chert nodule with another rock, are broken at random and vary in size and form. This "block-on-block" technique is extremely wasteful. Hundreds of debris flakes may be left for each one selected as a tool.

Debris

Hammerstones

eth 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 forever. Perhaps the most dramatic recent example of this type of study has been among certain isolated groups of Aborigines in the Western Desert of Australia, but other interesting cases are known in New Guinea, the Amazon Basin of South America, and Turkey. This approach, while yielding much valuable information, is observational rather than experimental.

3) *Experimental archeology.* While most people do not think of archeology as an experimental science, recent work has shown that controlled experimentation can often provide information about the use and manufacture of stone tools that is simply not available in any other way. 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 the possible ways in which the ancient tools were used. Most modern textbooks in archeology include at least a perfunctory discussion of how stone tools are made and used, but it has only been in recent years that the experimental approach to this question has received the careful and systematic treatment by scholars that it has deserved. The exhibit described in this article served both to show some of the earlier attempts in this direction and to present the results of more recent experiments, which had hitherto been described only in specialized scientific publications or not at all.

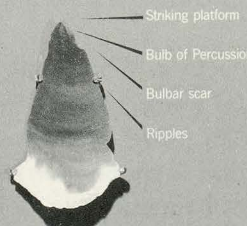
Experimental stone-working archeology has proved useful, for it allows the experimenter to view the results of applying force to flintlike materials. He can then analyze and evaluate the character of both the flake and flake scar whether made by intent or miscalculation. It is not necessary to become proficient in the art of flint knapping to be able to identify flakes that result from certain conditions of the experiment and to note the wide range of flake styles. Even a try at working stone will help to identify a shell-like conchoidal flake, which is characteristically different from a long parallel-sided blade. Experimental flint knapping readily demonstrates that the approach must be preconceived, and particular techniques executed, before the flake or blade is removed.

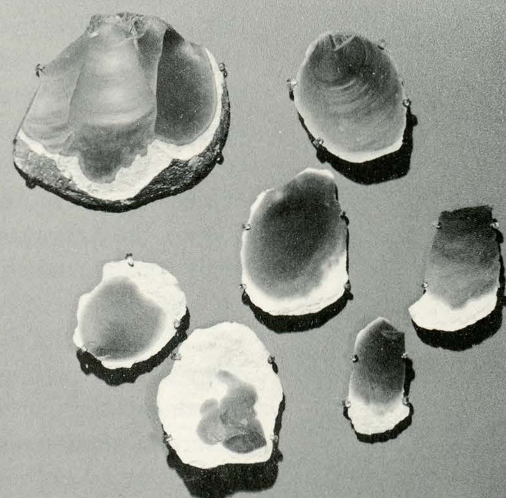
Experimental flint knapping archeology also demonstrates the importance of recovering the flaking debris that results from the manufacturing stages. Then the flakes may be related to the stages of fabrication from its inception to completion; or from the rough stone to the completed product.

continued on page 188

4 Cores and Core Tools:

Flakes struck off by man usually show a pronounced bulb of percussion along with other features such as a striking platform, ripples and fissures radiating out from the point of impact, and a bulbar scar. Nodules or pebbles of silicious rock which serve as the source for flakes are called "cores" by archaeologists.





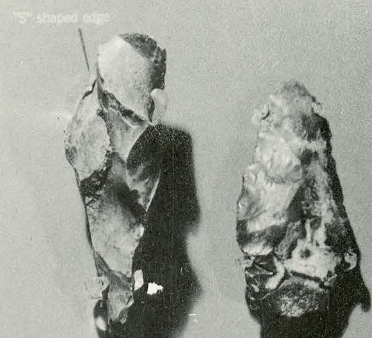
Flakes Removed by Direct Percussion.

Danish core, approx. 2000 B.C.

This display shows cores made by Mr. Crabtree along with others from Europe, Australia, and South America. All of these cores were fashioned by means of "direct percussion" from a hammerstone. In some cases, ancient men used the cores as choppers or scraper-planes after they had finished removing the flakes they wanted. Others, like two shown from the site of Huaca Prieta, Peru, appear to have served only as a source of flakes and were not used for any secondary tasks.

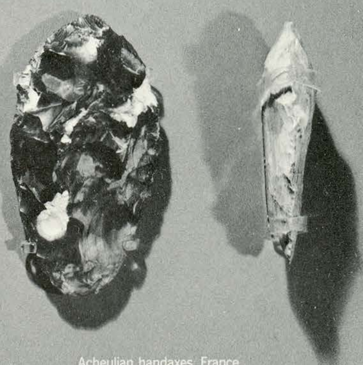
Cores from Huaca Prieta, Peru, approx. 2000 B.C.

5 Cores and Core Tools: Handaxes

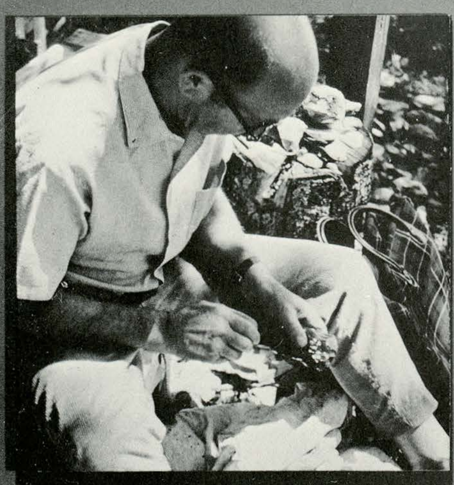


Chellean handaxes, France, approx. 400,000-300,000 yrs. old.

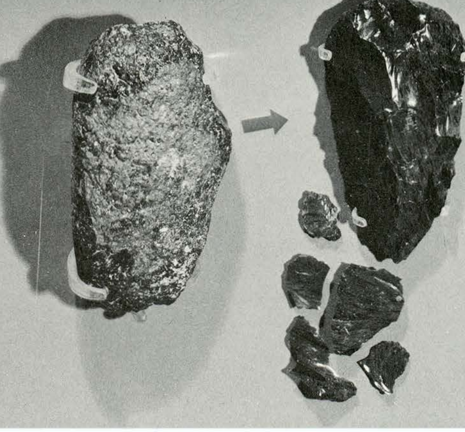
Recent archaeological evidence suggests that handaxes originated more than two million years ago as simple chopping tools made from pebbles in East Africa. In Africa, Europe, and the middle East more regular, standardized forms developed. These were "bifacially flaked," that is, flaked on two sides to produce a sharp edge. The earliest examples, known as "Chellean" handaxes, occur in Africa and Europe. They are characterized by irregular trimming, the retention of part of the original pebble surface, and a rather sinuous or S-shaped edge.


Acheulian handaxes, France, approx. 300,000-80,000 yrs. old.

Gradual improvements of these tools over many thousands of years finally resulted in the classic "Acheulian" type of handaxe, with its more regular trim, thinner cross-section and straight working edge. These handaxes are thought to have been used for butchering and skinning game and perhaps for digging and woodchopping.



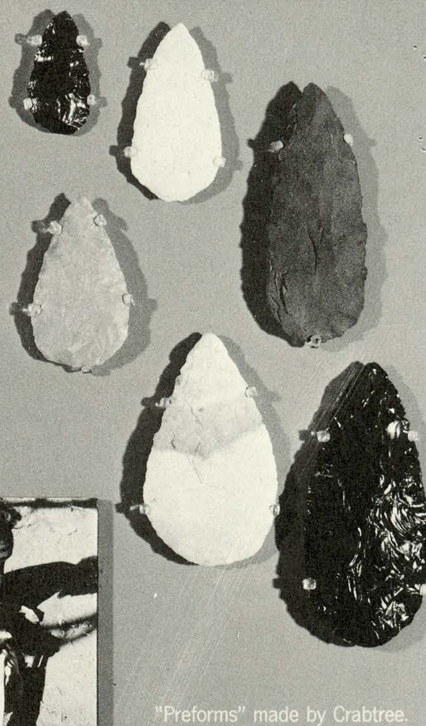
Mr. Crabtree has made several such tools to show how a handaxe is shaped from a nodule of raw rock. Note particularly the rows of flat flakes removed by percussion. Removal of these "thinning flakes," as they are called, gives the tool its distinctive shape. Before they can be struck off, the edge of the tool must be prepared by partial or rough grinding with another stone; this provides a striking platform and a more suitable ground surface to hit. Through his experiments, Mr. Crabtree has shown that Chellean and Acheulian men must have developed a similar grinding technique in order to trim their handaxes.



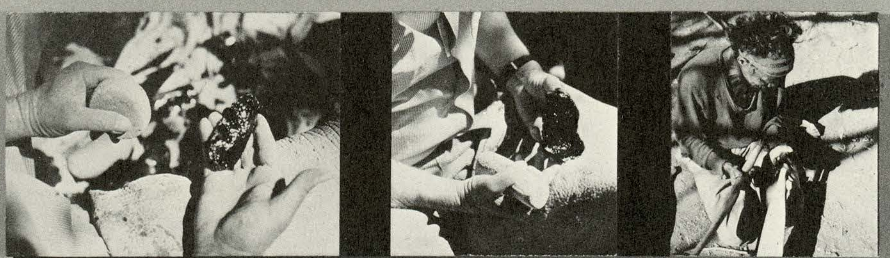
6 Cores and Core Tools: Fine Percussion-Flaking

As the art of percussion-flaking developed, a variety of approaches to it was discovered. Direct percussion with a hammerstone was used nearly everywhere, but ancient flint-knappers realized that the flaking qualities of different hammerstones varied. Mr. Crabtree's experiments show that a hard hammerstone effectively strikes long flakes from a core, while a hammerstone of softer material serves better for removing thinning flakes from a biface. Ancient man also used strikers made of antler or wood for direct percussion, and wood strikers continue in use among present-day Australian desert Aborigines.

Another technique, was indirect percussion with a bone or antler punch used to transmit and direct the force of the blow. These refinements in technique enabled ancient stone-workers to make thin and symmetrical bifaces that frequently served as "preforms" - that is, as basic forms, or blanks, which could later be trimmed into projectile points, knives, and other tools.



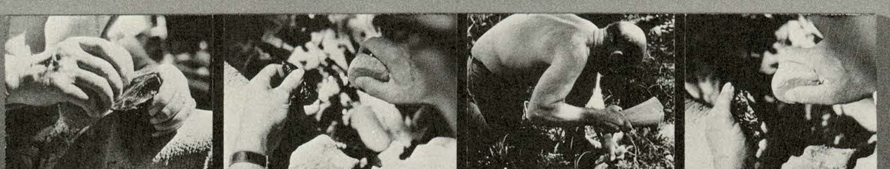
"Preforms" made by Crabtree.



3 kinds of percussion-flaking:
Direct percussion with a hammerstone.

Indirect percussion with a piece of antler.

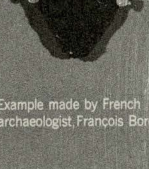
Australian Aborigine using direct percussion with a wooden striker.



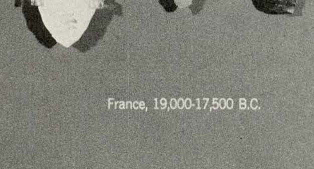
Finished biface (the actual one shown in the photograph).

Solutrean Points

Perhaps the finest example of percussion-flaking in the world is represented by the bifaces of the early "Solutrean" culture of France, dating to about 20,000 years ago. The French archaeologist, Dr. François Bordes, a flint-knapper like Mr. Crabtree, has developed the art of percussion-flaking to the point where he can manufacture examples of Solutrean bifaces like the one shown to the right.



Example made by French archaeologist, François Bordes.

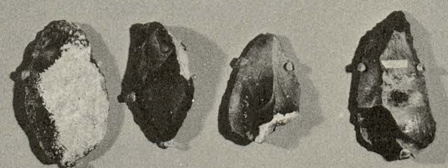


France, 19,000-17,500 B.C.

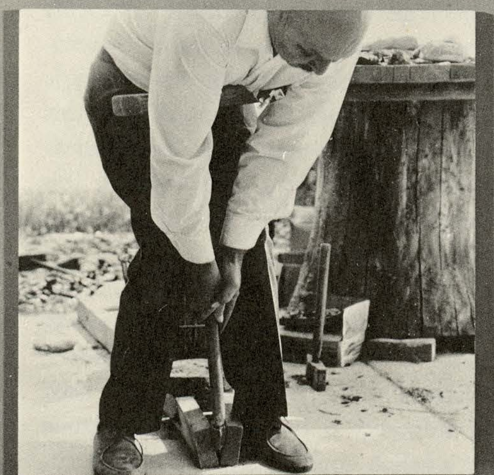
7 Flakes and Blades

One mark of ancient man's increasing mastery of stoneworking was his development of a core from which he could strike or press off elongated flakes of more or less uniform size and shape. These flakes, often with razor-sharp edges, served mainly as cutting tools; archaeologists call them "blades." The photograph sequence above shows Mr. Crabtree removing blades from a core by means of direct percussion. To do so, he uses a hard, almost pointed hammerstone and strikes a light, glancing blow, as if brushing the core, directing the force in line with the ridge scar of the previously removed blades.

Modern flake knives,
Australian Desert Aborigines.

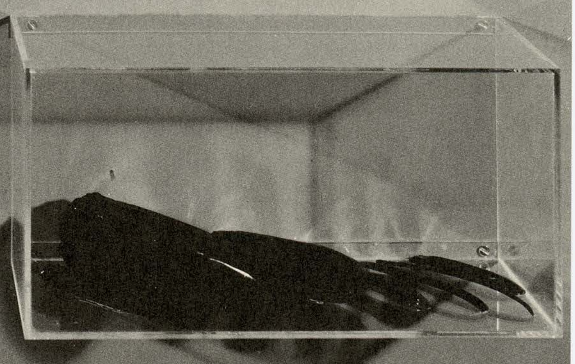


Mousterian flake tools, France,
approx. 80,000-30,000 B.C.



Blade cores made indirect
percussion by Mr. Crabtree.

Even more efficient blade removal is achieved by pressing blades away with a chest crutch. With the core firmly anchored in a clamp, Mr. Crabtree brings his weight to bear on the crosspiece of the chest crutch, its tip resting on the edge of the core platform in line with the ridge scar of the previous blades. He exerts increasing pressure simultaneously downward and outward without striking the platform until the blade pops off. Mr. Crabtree's method recreates that used by Indians of Mexico and elsewhere to make blades. It also reveals the importance of abrading or smoothing the core platform edge prior to blade removal. Through these experiments, we can now better comprehend how the Mexicans were able to make the outstandingly fine blades and cores shown at right.



Each stage may show one or more diagnostic traits, while the finished product will show only the final stage of flake scars on the finished artifact, and one has to postulate the first and intermediate stages.

PREPARATIONS FOR THE EXHIBIT

As with all exhibits at The American Museum, preparations involved careful searching through the literature for useful information and checking of details for label copy. This task was performed by an undergraduate museum volunteer. However, the curators responsible for the exhibit also felt that a firsthand acquaintance with the methods and problems of this approach was needed. So in May, 1969, the authors, along with Dr. Bird, spent two weeks in Mr. Crabtree's lithic workshop in Kimberly, Idaho, discussing, observing, and trying out personal experiments.

As a result of this period "on the rockpile," as we called it, Dr. Gould and Dr. Bird realized fully for the first time several important facts about the art of stone chipping. To begin with, it is an *art*. Although there are many aspects to stone chipping that look mechanical and repetitive, there is scope for craftsmanship, too. There is a need for physical strength, coordination, and intelligent planning, just as there is in becoming a skilled carpenter. And some people are better at it than others, or better at certain techniques than others. For example, there is a tacit understanding between Mr. Crabtree and French archeologist and stone chipper François Bordes that while one of them is slightly more accomplished at percussion-flaking, the other is somewhat better at pressure-flaking. Any analysis of ancient stone tools, particularly those of complex design, must take this into account. Ancient stone tools are not always as uniform in character as some archeological typologists would have us believe, and some of this variability may be attributable to individual differences in craftsmanship even when the same methods of manufacture were used.

Another basic fact to emerge from this two-week session was an appreciation of the importance of the various kinds of raw material used in stone tool manufacture, as well as the kinds of tools (i.e., billets, hammers, punches, and pressure-flakers made of bone, antler, wood, and stone) used to shape these raw materials. A slight difference in the texture of the stone material, or in the weight or shape of a billet, could make a dramatic difference in shaping a tool. These variables had to be considered before we embarked upon any toolmaking experiments and, indeed, they were the subjects themselves of a number of important experiments that we found essential to describe in the exhibit.

Here, truly, was an activity in which one learns by doing. Films and demonstrations are always helpful, as are written descriptions, but in planning an exhibit of this kind we found that we had to work with the materials ourselves before we clearly understood the problems involved. At the same time, these two weeks afforded us an opportunity to get specialized photographs of certain stone-working experiments for use in the exhibit, and it enabled us to make and organize various types of stone tools, flakes, cores, and blades specifically for the exhibit. In most museum exhibits one presents the specimens one already has, but we stood this approach on its head by making the specimens for the exhibit. To supplement the exhibit, we also arranged a loan of examples of work from earlier experiments from the Museum of Anthropology at Idaho State University in Pocatello.

It was also during this session that the basic plan of the exhibit took shape, and with it there developed an unusual division of labor regarding the actual preparations. While Mr. Crabtree prepared most of the materials used in the exhibit and the expertise concerning them, Dr. Gould assumed the task of selecting archeological and ethnographic stone tools from different periods and localities from The American Museum collections, organizing them into display cases, and writing label copy for the exhibit. Since Dr. Gould had to leave New York in August, 1969, for a year of field work in Australia, Dr. Bird supervised the actual construction of the exhibit, seeing that artifacts, photographs, and labels were arranged correctly and making last-minute changes when necessary. He also saw to the arrangements concerned with Mr. Crabtree's demonstrations for the public of stone chipping for eight days at the start of the exhibit.

Following the series of live stone-chipping demonstrations in the exhibition, it had been hoped to use an edited version of the film *The Shadow of Man,* which shows Mr. Crabtree at work. However, funds were not available for this, so a self-operating slide show of stone chipping by Mr. Crabtree and by Australian Aborigines was used instead. In retrospect, it still seems that some kind of motion picture would have been preferable to the slides (although the slides were well received and fitted in better than originally expected). Our reason for saying this stems from the difficulties we experienced in describing the motor patterns connected with stone working. These simply have to be seen to be understood, and no amount of verbal description or sequences of still photographs can communicate the true nature of these complex motions.

Organizing and installing the exhibit was made easier by the use of 23 display panels of uniform size and shape. These were flat backed and simple in design, with easily detachable glass fronts (a tremendous advantage later on, as the Exhibition Department found when they wanted to photograph the displays in place). The panels were arranged in a wide circle, facing inward, and were numbered sequentially, from left to right, from the point where the visitors entered. Mr. Crabtree presented his stone-chipping demonstrations within the area enclosed by the exhibit. Since an auditorium-style seating arrangement does not work well with this type of demonstration, it was found that the best arrangement was to allow the public (including press and television) to array themselves around the mat on which Mr. Crabtree worked. This limited the number of visitors who could watch at one time, but, because most stone-chipping work is done close to the body and cannot be seen except up close, it did not really matter. Unless one uses closed-circuit television, only about thirty people can comfortably watch a stone chipper at work at one time. Nevertheless, these demonstrations were all packed with visitors, many of whom no doubt had difficulty in seeing what was happening. The exhibit was designed by George Gardner of Yang-Gardner Associates, New York, and was built by Lynch Exhibits of Pennsauken, New Jersey. The total cost of the exhibit was approximately $28,000. Installation in the museum took only four days, and dismantling at the end was accomplished in one day.

Only one major problem was encountered during the exhibit. The individual display cases were not sealed, and there was enough of an opening on the sides to allow someone to slide his hand inside each case from behind. As a result, several specimens were stolen (one of these was recovered after a spectacular chase by a guard through the halls of the museum) before this defect was remedied. These openings on the sides and top of each case also meant that dust gradually settled over the materials inside. By the end of the exhibit this was quite noticeable. Any future attempts to present this type of exhibit must be checked for security, since objects like stone arrowheads and spearpoints are both tempting to the potential thief and relatively easy to conceal.

THE DISPLAYS

It was in the display cases themselves that the essential nature of experimental archeology became apparent. In this article we would like to review a few of the more dramatic examples, treating them as case studies of both this scientific approach and the ways it was presented:

Artifacts of man and "artifacts" of nature—Scarcely a week goes by in a large museum when someone does not bring in a bag, valise, or cigar box full of stones to be examined by one of the curators. These people bring their stones to an archeologist rather than to a mineralogist because they have reason to believe that the rocks were shaped by ancient man. Upon examination, however, most prove to have been shaped by nature rather than man. Inevitably one is asked the question: "How can you tell a naturally shaped stone from one that was shaped or used by human beings?" This is a fair question, and it has concerned scholars as much as it has the small boy who shows up in a curator's office clutching a bag of stone arrowheads. There are many cases of archeologists who have mistakenly identified natural rocks as human artifacts in their excavations and surveys; and the reverse situation, where archeologists sometimes fail to recognize stone tools among the materials they are dealing with, is not unknown either.

In cases like these the experimental approach has proved of benefit. It seemed to us that this basic question should be dealt with in one of the first displays in the series. It is not enough to say that the stones in a given assortment were formed by natural processes. One must be able, eventually, to show how certain stones do indeed resemble some man-made stone tools, and one must be able to understand clearly how they were formed without man's aid.

In one series of experiments, Mr. Crabtree placed some pieces of suitable stone (flint, chert, etc.) in fires and kilns to heat them rapidly, causing a phenomenon known as "potlidding." Rapid heating and cooling of these kinds of stone can cause round, lenticular pieces to become detached from the main body of stone. These pieces, he found, can vary greatly in dimension, often occurring in sizes that we might regard as convenient for stone tools. Potlidded flakes (due mainly to temperature changes) occur commonly in nature and make up one of the most common classes of material claimed as human artifacts.

Stones that have been rolled downhill (for example, those from rockslides and avalanches) or tumbled in water on a rocky beach or in a creek are also likely to show signs of breakage and chipping that are easily mistaken for human workmanship. Mr. Crabtree and others have found that in any collection of this sort a few stone flakes are always indistinguishable from man-made flakes. At his laboratory he has re-created this situation by dumping loads of obsidian and other suitable lithic materials from the bed of a truck. In picking through this material afterward he has found a few flakes that, if they occurred in an excavated human habitation or quarry, would instantly be accepted as man-made. In such a case the extremely low percentage of these flakes compared to the amount of other material present shows that they were not worked by man. Also, these "dumped" lots contain relatively large numbers of particular kinds of stone flakes that appear only rarely in human sites (where, as experiments have shown, they occurred as mistakes by the stone chippers). Quantitative experiments of this kind can show archeologists what to expect from sites in which only natural processes account for the materials present as compared with the situation in genuine human sites.

Perhaps one day we will be told that there were once men living on the moon. Now that lunar exploration is under way, this possibility may not be as farfetched as it sounds. Many of the natural processes studied by Mr. Crabtree in his experiments occur on the moon just as they do on earth. As lunar exploration becomes more intensive in the future we may hear of the discovery there of "human" artifacts of stone, and no doubt such a discovery can be counted on to generate much frothy debate in the news

continued on page 194

16 Pecking, Grinding and Polishing in the Old World

Shaped by flaking

Finished
Flaked and ground

Axeheads, Denmark age unknown)

Axeheads pecked and ground

In one experiment Dr. N.C. Nelson used this Danish stone axe to cut down the small maple tree shown here. The entire task took six minutes.

Danish adze blades, 2000-1350 B.C.

Hole begun in beach pebble as an experiment by Robert Bird, age 10.

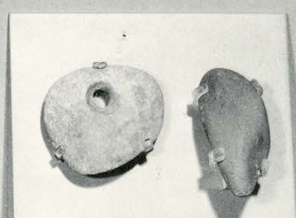
Danish "boat-shaped" or battle axes, approx. 1600-1350 B.C.

17 Pecking, Grinding and Polishing in the New World

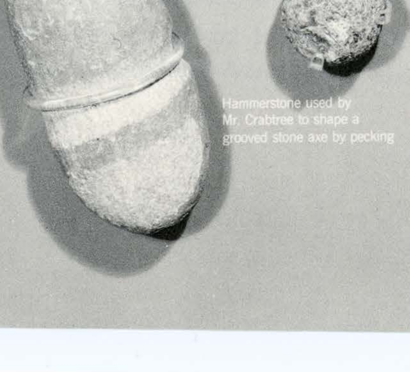
Grooved Axes Eastern United States
(Age uncertain)

American Indians made extensive use of ground, pecked, and polished stone artifacts. These ranged in quality of workmanship from simple notched pebbles used as net-sinkers to elegant polished axe- and adze-heads known as "celts", such as those shown from Costa Rica. Mr. Crabtree's experiments have shown that certain artifacts - some stone axes, for example - can be shaped rather rapidly by pecking. With this technique, the area to be reduced or shaped is struck with a hammerstone, pulverizing a small section at the point of contact. Final finishing may be done by the slower procedure of grinding. These techniques offer the possibility of very precise shaping, and an opportunity of making a wider variety of tools than would be possible by chipping alone.

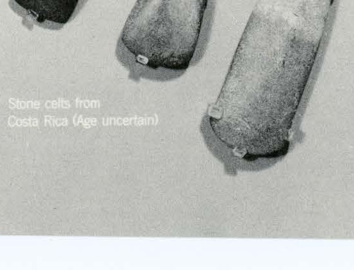
Notched net-sinker, Eastern United States (Age uncertain).



Fishnet sinker and hammer for pecking holes, Peru, ca. 2000 B.C.



Hammerstone used by Mr. Crabtree to shape a grooved stone axe by pecking



Stone celts from Costa Rica (Age uncertain) media. But experimental archeology by then ought to have amassed a body of data sufficient to settle such debates, whether they occur on the moon or back on earth.

In the displays discussing this question, examples of "natural artifacts" produced in experiments were shown side-by-side with similar objects found in nature. This presentation set the stage for the further discussion of how to recognize man-made flakes and artifacts, even when the workmanship on them is minimal. Man-made stone flakes and cores were presented in such a way as to indicate their identifying characteristics and with explanations of how these characteristics resulted from the processes of manufacture.

Processes of manufacture—The backbone of the exhibit consisted of a series of displays devoted to showing how experiments have led to the discovery of ways in which different kinds of stone artifacts, known from different localities and time periods, could have been made. Stone artifacts from The American Museum's collections were placed alongside examples of Mr. Crabtree's work. In some cases the various stages in the manufacture of a particular object were represented. The live demonstrations were mainly concerned with techniques of manufacture, as were many of the slides shown after the live performance.

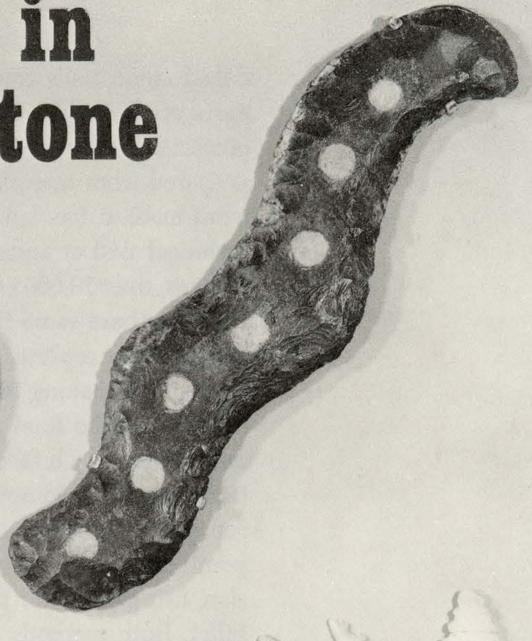
Broadly speaking, these techniques comprise two main types: percussion-flaking and pressure-flaking. It is in the latter category that the experimental approach has offered some unique contributions. For example, there is the case of heat treatment of lithic materials. In an important series of experiments, various kinds of lithic materials were placed in a kiln and subjected to controlled heating at different rates and temperatures. It was found that heating could alter the structure of certain stone materials, making them easier to pressure-flake, and producing more controlled and even results than was possible on unaltered material. Examples of chert and flint modified in this way were presented in a "before-and-after" sequence in one of the cases.

Heating the stone material prior to flaking relieves internal stresses and strains and makes the material more vitreous, or glassy, than in its raw state. Glassy treated material is more elastic and produces sharper edges. Each material has a different response to the application of heat. Alterations of temperatures and time periods of heating and cooling vary according to the kind and size of the lithic material. The thermal treatment process is considerably more complex and sophisticated than simply dumping the stone into a fire. But thermal alteration is not desirable for drills, scrapers, adzes, etc., when a tougher, stronger tool is needed and extreme sharpness of the edge is not important.

This discovery, the result of laboratory experiments by Mr. Crabtree, became a hypothesis that accounted for the unique attributes of pressure-

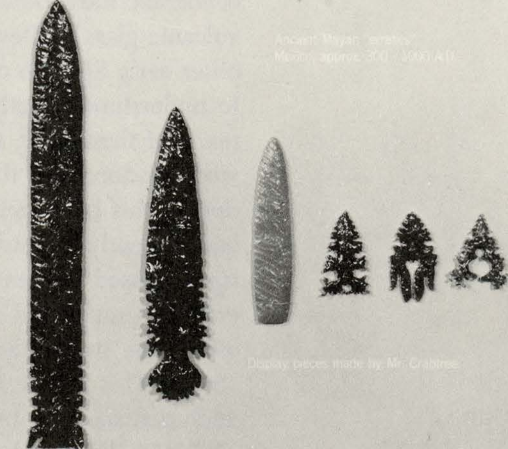
19 Virtuosity in Chipped Stone

Historic Yurok Indian,
display blades
Northern California



Ancient Mayan eccentrics
Mexico, approx. 300 - 900 A.D.

Occasionally archaeologists uncover examples of chipped stone craftsmanship so elaborate or large that they can be explained only as objects intended for display, burial, ritual, or as works of art. This case contains some outstanding examples of this rare class of objects. Except for the historic Yurok Indian blades, which were publicly displayed as symbols of wealth, little is known about the intended uses of these splendid artifacts. Shown at the right are some artifacts made by Mr. Crabtree (including one of bright red builders' glass) which mark his craftsmanship as at least as outstanding as that of the prehistoric flint-knappers represented here.

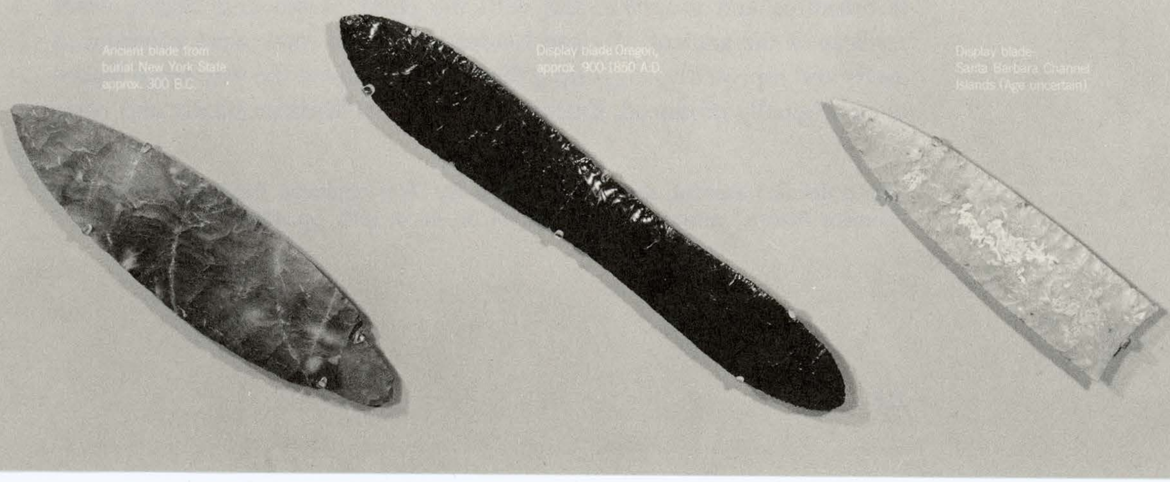


Display pieces made by Mr. Crabtree

Ancient blade from
burial New York State
approx. 300 B.C.

Display blade Oregon,
approx. 900-1850 A.D.

Display blade
Santa Barbara Channel
Islands (Age uncertain)



flaked stone tools found archeologically at different periods in different parts of the world. For example, many of the fine, pressure-flaked stone projectile points made by the Paleo-Indians of North America were clearly prepared from materials treated in this way. Awareness of the heat-treatment method has led to a new appreciation by archeologists of the high technical skill of ancient flint knappers, even, as in the case of the Paleo-Indians, over 10,000 years ago.

Along these same lines, there is a series of experiments aimed at reproducing exact replicas of the Folsom fluted point. The technical difficulties involved in making this particular type of stone point are formidable, particularly in the final stages when the longitudinal channel flakes are removed from each face. These experiments show that the removal of these flakes can be accomplished in at least two completely different ways. One can press the flakes off by using a shoulder-crutch with a hard, bluntly pointed tip. Or, one can strike the flakes off by means of indirect percussion, using an antler punch to direct the blow struck by a hammerstone or billet. Both methods give satisfactory results and provide alternative explanations for how this technical feat could have been accomplished by the ancient Indian stone chippers. Demonstrations and descriptions of both of these methods, with examples of the finished and semifinished products, were presented in the exhibit.

Perhaps the most elegant series of experiments presented in this exhibit concerned the production of ancient Mexican blades of obsidian (a natural volcanic glass).[3] Despite fairly detailed descriptions by Torquemada and other early Spanish observers, archeologists have always found it difficult to understand exactly how these fine and extremely sharp-edged blades, many of them long, thin, and of exceptional regularity of size and shape, were produced. In these experiments it was clear from the start that producing this blade must have required a mechanical clamp of some kind, and the early Spanish accounts indicated that a chest crutch with a hard tip was used to press the flakes off their stone core. After much trial and error, a simple and successful clamp was constructed of three pieces of wood, the two longer loosely joined with rope, thongs, or a metal substitute. This device held the stone core firmly in place, and it could be anchored securely by the operator standing on it as he worked. A clamp of this kind would have been easy for the ancient Mexican stone chippers to assemble and use. Working with the chest crutch and clamp, exact replicas of the ancient Mexican blades and blade-cores were reproduced easily and repeatedly, suggesting that this was indeed the way these blades were originally produced. Examples of identical Mexican blades and cores

[3] For a detailed account, see Crabtree, Don E., "Mesoamerican Polyhedral Cores and Prismatic Blades," *American Antiquity*, vol. 33, no. 4, 1968, pp. 446–478.

from The American Museum's collections were exhibited alongside the results of Mr. Crabtree's experiments and photographs and drawings illustrating the clamp and crutch method. This method was among those demonstrated at the beginning of the exhibit, and then, as throughout these demonstrations, examples of the finished products (blades, cores, flakes, handaxes, arrowheads, etc.) were passed among the visitors.

Other experiments—Topics also presented in the display included: "Hafting," "Stone Tools to Make Other Tools," "Raw Materials and Quarrying," "Ground and Polished Stone," and "Virtuosity in Chipped Stone."

The exhibit also gave an opportunity to show some of the earlier and less well-known experiments in this direction. In particular, it was found that Dr. N. C. Nelson, who for many years was Curator of Archeology at The American Museum, had conceived and carried out several useful experiments. We were fortunate to possess the notes on these, as well as the materials produced during them, so they, too, became a part of the exhibit.

From a historical point of view, the most interesting of Nelson's experiments took place in connection with his studies of Ishi, the last wild Indian of North America, in 1912. Ishi, the survivor of a small band of Yahi Indians, emerged from his hiding place in northern California in 1911. Until he died in 1916, Ishi lived at the museum at the University of California in San Francisco, supplying information about traditional Indian life to scholars and giving public demonstrations of his stone chipping.[4] During the time he spent with Ishi in California, Nelson photographed him at work and learned directly from him how to make stone arrowheads and spearpoints. These photographs, along with examples of both Ishi's and Nelson's work, were displayed in the exhibit.

Later on, Nelson carried out a series of experiments with some ancient Danish groundstone axheads. He attached these to wooden handles and used them to chop down trees of various sizes, timing the results and observing the wear occurring along the working edge of the tool after use. One of these hafted stone axes and the section of a tree he cut down with it in six minutes were displayed together in a case relating to ground and polished stone tools. Nelson, as a scholar, was often ahead of his time in the ideas he developed and tested, although his research results were not always widely known. Thus, we were pleased to be able to present these aspects of his research before the public for the first time.

CONCLUSION

Above all, this was a teaching exhibit. Few of the artifacts displayed could be rated as art objects, so it would not be possible to justify the ex-

[4] For a readable and accurate account of this Indian's life, see Theodora Kroeber's "Ishi in Two Worlds," Berkeley and Los Angeles, University of California Press, 1961.

hibit on artistic grounds alone. The exhibit was intended, instead, to demonstrate to the public the validity of an idea we here call experimental archeology. The enthusiasm and interest shown by the visitors justified our efforts and may even have generated some interest among professional archeologists and students of archeology to pursue this approach in their own research. At this time the entire exhibit is being readied for shipment to the Museum of Anthropology at Idaho State University, where it will soon reappear.

BIBLIOGRAPHY

Crabtree, Don E.: *A stoneworker's approach to analyzing and replicating the Lindenmeier Folsom.* Tebiwa, vol. 9, no. 1, pp. 3–39. 1966.

———, *Mesoamerican polyhedral cores and prismatic blades.* American Antiquity, vol. 33, no. 4, pp. 446–478. 1968.

———, *Flaking stone with wooden implements.* Science, vol. 169, pp. 146–153. 1970.

———, and Davis, E. L.: *Experimental manufacture of wooden implements with tools of flaked stone.* Science, vol. 159, pp. 426–428. 1968.

Custance, A. C.: *Stone tools and woodworking.* Science, vol. 160, pp. 100–101. 1968.

de Jussieu, Antoine: *De l'origine et des usages de la pierre de foudre.* Mémoires de l'Académie Royale, Paris, pp. 6–9. 1723.

Gould, Richard A.: *Chipping stones in the Outback.* Natural History, vol. 77, no. 2, pp. 42–49. 1968.

Kroeber, Theodora: *Ishi in two worlds.* University of California Press, Berkeley and Los Angeles. 1961.

Nelson, Nels C.: *Flint working by Ishi.* In William Henry Holmes Anniversary Volume (ed. by F. W. Hodge), Washington, D.C., pp. 397–402. 1916.

Oakley, Kenneth P.: *Man the tool-maker.* British Museum of Natural History, London. 1967.

Pfeiffer, John E.: *The emergence of man.* Harper and Row, New York. 1969.

Swanson, Earl H. Jr.: *An introduction to Crabtree's experiments in flintknapping.* Tebiwa, vol. 9, no. 1, pp. 1–2. 1966.