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~~Rough~~ Finished draft of article just sent to *Science*.

See you in March,

Davey

EXPERIMENTS IN MAKING WOODEN IMPLEMENTS BY MEANS OF FLAKED STONE TOOLS

by

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ABSTRACT

A number of contemporary archaeologists are recapturing an almost-lost art, becoming skilled at knapping (shaping) stone artifacts by pressure and percussion. However, little is known of how these could be used. Our study describes three experiments in carving wood implements by use of stone tools alone and outlines some of the problems of making and applying a do-it-yourself, lithic toolkit for the job.

From steel to Paleolithic stone

In this present day of metals and high-speed cutting devices, few people give much thought to the extreme novelty of such materials or to the hundreds of thousands of years during which our clever ancestors coped successefully with a harsh world although equipped only with primary tools of rock. How did they do it?

Today there is an increasing interest in the many technologies for shaping stone and a number of archaeologists are becoming competent knappers who use percussion, pressure and other methods for copying artifacts. But here the inquiry ends. It has occurred to us that the time is ripe for asking further questions: what can you do with such equipment--how would you make a lithic toolkit for a particular job on a do-it-yourself basis?

Five hundred years ago, before Europeans brought small pox and the steel knife to a Paleolithic America, marvelous arts were elaborated with stone tools and a host of household goods was manufactured from wood, shaped by cutting with a tool of some appropriate stone, suitably designed. Even simple Indians of southern and Baja California made a large inventory of gear by this means: bows, arrows, clubs, rabbit sticks, cradle-boards, ceremonial plaques and boats, to mention only a few (1-2).

To gain more insight into how this was done, we have taken a tack opposite to the usual one, considering stone as a means rather than an end and setting up a project of making from various woods a few objects of aboriginal use such as Promontory pegs (probably hide-stretchers) and pottery paddles. Such paddles were used by women of southern California in moulding their large ceramic jars. An anvil of baked clay was held inside the piece, opposed to a wooden paddle(in much the same way we bump out crumpled fenders),the clay being patted and drawn into the desired form.

In our experiments, these paddles were made of a hard-tough wood--southern California black oak--while the Promontory peg was carved from softer willow, gree n and fresh. The paddles were shaped in two ways: with stone tools only and with both stone and fire (Fig. 1).

Fig. 1. (Legend). Oak log (a) dressed on ~~x~~ 1 side, using a large chopper. Pottery paddle #1 (b) shaped and smoothed without fire. Pottery paddle #2 (c) shaped with both stone tools and fire.

Methods of work

Having set ourselves 3 simple goals, we experimented freely, not sticking to any set lithic technology as presently understood (or mythologized) by archaeologists. If a massive, unifacial chopper were needed for squaring hard wood, we made one of stone which proved best adapted (basalt, chalcedony or flint) see Fig 2a; if a squared scraping edge were required, it was made on chalcedony or meta-quartzite using a burin blow (Fig. 2b).

Fig. 2. (Legend). Upper left (a) --heavy, unifacial tool called a chopper, very serviceable as a hatchet. Lower left (c) -- small core-plane of obsidian, with which paddle #2 was finished and burnished. Upper right (b) -- [redacted] burin blow scraper with square edge, ideal for smoothing.

Lower right (d)-- rounded end-scraper of flint.

(methods of work cont'd)

For peeling and trimming soft wood, a freshly struck obsidian blade was found to be superior to the sharpest steel knife. Both of us made tools as needed.

New motor habits had to be worked out in connection with our new tool-kit. Stone instruments differ from steel ones not so much in sharpness as in brittleness. Steel is tougher. We found that a distinct problem in the experiments was to retrain ourselves not to twist a stone implement or attempt to pry with it as one can with a metal blade. Unless it is used straight in the plane of cut, a stone tool (whether axe, scraper or knife) snaps if it is thin, or little damage flakes pop off the flat, riding surface of a thick one.

Different rake angles of working edges were tried as well as unifacial and bifacial designs. It was found that for either hard or soft wood, a chopper which was unifacial with a bevel of about 30-45 degrees was better than a double bevel on a biface. Bifaces might be better for skinning and fleshing hides or boning meat. However, this proposition remains to be tested.

It must be clearly understood that our experiments do not recapitulate any single, aboriginal technology, but constitue a free-wheeling pilot project. The objectives were to increase understanding, from an archaeologist's point of view, of the serviceability of various members of a diversified lithic toolkit as well as use of supplements such as fire and abrasives. We were also interested in particular skills for getting the best results out of stone tools. Obviously, one should be trained in these from childh childhood, since body postures and flexibility as well as relative strength of muscle groups would be critical for being an efficient, stone age wood worker (3). As an example, we are culturally unaccustomed, as adults, to sitting cross-legged and holding work with our heels as Australians do.

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PROGRAM OF EXPERIMENTS

1) Soft wood

Problem: To make a Promontory peg (Fig. 3a)

Wood: Freshly cut willow (Salix sp.)

Procedure: a) Slice off branch from tree with large obsidian flake. b) Outline top and shoulder cuts of peg with a small obsidian saw, "backed" or blunted on 1 edge (Fig. 3b). c) Peel bark with backed obsidian flake (Fig. 3c). d) Whittle peg to shape with same flake knife. e)Detach with obsidian saw having teeth "set" or flaked to alternate bevels. f) Fire-harden point.

Time: ½ hour

2) Hard wood

In order to work hard, or tough and resistant woods with flaked stone, a number of additional aids had to be used:

a) Antler wedge for splitting

b) A series of massive (0.5-1.0 kilograms) choppers for roughing out shape (Fig. 2a)

c) Squared burin edges which make good scrapers when either pushed or pulled (Fig. 2b)

d) Rounded end-scrapers, pulled toward the operator with a draw-knife motion (Fig. 2d)

e) The powerful agancy of fire (used on 1 specimen)

f) A pump-drill

Experiment A

Problem: To make pottery paddle #1 without using fire

Wood: Southern California mountain oak (Quercus kelloggii)

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Fig. 3. Promontory peg (a) of willow. Obsidian saw (b). "~~Bakx~~ "Backed" obsidian flake (c).

Procedure: a) Both sides of a small log were faced flat by supporting it on wood and using a medium bevel (30 degrees) chopper as a hatchet, cutting with the grain. b) The oak billet was then split parallel to its dressed faces, using an antler wedge; this wedge was inserted into a slot made by driving in half of an agate biface. c) Splitting the billet produced 2 small boards, approximately 13.0 cm long, 7.0 cm wide and 2.25 cm. in thickness. One face of each was smooth while the other was shaggy, covered with fibre and splinters. d) The board selected for paddle #1 was now dressed on its rough face with a chopper. e) A self handle was shaped by chopping and all surfaces were smoothed with a burin-blow scraper (square edge). f) Butts of handle and paddle tip were ground on a coarse, abrasive stone until rounded. g) A hole was drilled through the handle , using a pump-drill with a fluted bitt of chalcedony. The hole was biconical.

Time: 2½ hours

Experiment B

Problem: Make pottery paddle #2, using both stone and fire

Wood: As in experiment A

Procedure: The rough surface of this piece was left in its original condition. b) Sides of handle were roughly shaped with a chopper, leaving as much of the wood shaving attached as possible to facilitate burning. c) Fire of charcoal was kindled in a small hibachi and controlled fire-shaping commenced. d) The specimen was quenched in water at frequent intervals, the charcoal was removed with a chalcedony burin-blow scraper and remaining, sound wood was inspected for shape and degree of thinning. e) This paddle was finished by scraping to hard wood, using a chalcedony burin-blow scraper first and then a small, core-plane of obsidian shown in Fig. 2c, (the flat riding surface of this latter imparted a high burnish to the oak). A biconical hole was drilled through the handle, working from both sides with the same home made pump-drill used for paddle #1.

Time: about 1-3/4 hours.

Comment: Although faster than the non-fire method, fire produced a somewhat less shapely and symmetrical object than stone by itself.

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MATERIALS AND TOOLS

Some flakes were used freshly struck; others were modified into burins, saws and scrapers. Cores were used as choppers when of medium bevel or as planes when the bevel was steep. Many tools were of a chopper-cleaver style. The lithic materials included a wide range of textures from vitreous and glassy to rough and granular: man made glass; ignimbrite from several sources; basalt from Panamint Valley California; chalcedony, including varieties which had been artificially altered by thermal treatment (4); several kinds of silicified sediments; quartzites formed by deposition of chalcedonies in a matrix of sand grains and meta-quartzites formed by metamorphism loosly binding particles of quartz by heat and pressure. Working properties of these stones are shown in Table 1.

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Table 1. Stone used in the experiments

Manufactured glass	Homogeneous, vitreous, keen, brittle
Obsidian	Homogeneous, vitreous, keen, brittle; some has inclusions
Ignimbrite	Homogeneous, vitreous, keen. Subject to crushing
Basalt	Homogeneous, partially vitreous, tough. Edges not as sharp as glass
Chalcedony (untreated)	Homogeneous, tough, matt surface; sharp but not keen
Chalcedony (heated)	Homogeneous, vitreous, waxy surface; sharp edges; tougher than obsidian
Silt Stone	Cleavage planes and weak edges; lacks toughness
Silicified Quartzite	Semi-granular, tough; irregular edges; well suited to abusive work
Meta-quartzite	Very granular and tough; resists percussion; saw-like edges; unsuited ~~for~~ to pressure-shaping

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For working hard wood, a chopper was made by cleaving a large cobble with a hammerstone and a single direct percussion blow, then flaking the edge created by the first plane of fracture. The result was a plano-convex implement resembling an incomplete core (Fig. 2a). The plano face of this chopper was flat along a margin opposite the bulb of percussion, becoming increasingly convex as the bulb was approached. This gave the worker a tool with a diversified cutting edge--flat at the distal end but curved at the bulbar end. What segment of the chopper edge was used depended on the type of cut desired.

When cutting wood, the cortex back of the cobble served as a hand-grip, the plano side or riding surface facing the black oak stave. Because of the hardness of this oak, a cutting edge of the chopper with a rake angle of approximately 45 degrees to the plano face was used. This style of chopper makes a smooth cut--either flat or curved. The working edge of such a tool withstands considerable abuse when shaping hard materials. The flat, or riding side showed no damage nicks until it was accidentally struck on the supporting anvil. After this, the flat side had lost a few flakes, less than ½ inch in length and terminating in step fractures into the body of the chopper. Generally, such use flakes were formed at the bulbar parts of scars of sharpening flakes. However, to a great extent, dulling of the tool was due to its edge having become clogged with crushed wood fibre.

Weight of the implement had to be preserved; therefore when resharpening it we could not remove large flakes. Renewing the edge had to be accomplished by removing thin flakes which, because of their thinness, could not terminate by

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feathering but hinge-fractured instead, causing the edge to be thickened at their point of termination. Scars of this sort have previously been considered results of use, but are really only products of resharpening. When the working edge of a chopper became too obtuse to be sharpened further, it was abandoned and a new chopper substituted.

True use-flakes on the ventral side of a stone tool are generally accidental --either due to improper use of the implement or to striking the support. These flakes are irregular in size and spacing, have diffused bulbs of force, ~~and~~ are rapidly expanding and terminate in a hinge or step fracture. ~~These~~ Use-flakes in no way resemble scars left by backing (blunting) an edge, or by intentional retouch. When a scraping or planing tool is unhafted and hand-held, only small use flakes will be removed. They will terminate in a step fracture ~~instead of~~ but not in the same way as those removed individually by either pressure or percussion.

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Descriptions of tools

Chopper of Calico Hills chalcedony. Tools was used to ~~perform~~ reduce split oak boards to a rough shape but was not used for finishing. No functional scars were detected on the flat side of the chopper and along the upper margins of its edges, short flakes might have resulted from slight crushing during percussion resharpening.

Chopper of Panamint Valley basalt. This was an even more useful tool than the chalcedony chopper, due to the toothy edge and tough qualities of basalt. Because of improper use, this chopper struck the support and 3 use flakes resulted on the flat surface. They were short, rapidly expanding and terminated in step fractures.

Side Scraper of Harrison County, Indiana, flint. Working edge made by simultaneously serrating and pressure retouching on a primary flake. Used to scrape oak paddle by applying pressure and drawing scraper toward the operator. Use flakes were removed from the ventral to the dorsal side. They were short, small and terminated in step fractures. When the tool is held improperly at an angle less than vertical to the objectivepiece, a complete flake will be removed. It was determined that no use flakes are pressed off when scraping leather and hide.

Backed obsidian knife. A backed knife is used in whittling like a pocket knife, but direction of the cut must be kept in line with a stone knife's edge. If twisted, short deep flakes will be removed from its edges at nearly right angles. When the knife is repeatedly pulled either toward or away from the user, flakes which are concave to the edge will be snapped off. As each concavity is formed, it establishes a new platform. Therefore, subsequent strokes will pull off additional flakes, damaging the edge and making it useless.

<u>Chalcedony drill</u>. Drilling was done with a chalcedony point, fluted on both faces to facilitate hafting to the pump-drill shaft. Penetration of the wood was accomplished by alternately drilling each side of the paddle handle. In a short time, drilling blunted the drill tip due to microflakes detaching and embedding in the wood, causing a double abrasion. Drill had to be resharpened once to penetrate handles of 2 pottery paddles. Use flakes were diminutive and usually terminated in hinge fractures.

SUMMARY COMMENTS

Our tests suggest a number of probabilities in archaeology:

1) That working wood uses up stone tools at a fast rate and that, for this reason, a considerable amount of aboriginal roughing-out of wooden gear may have been done at quarry workshops, near an abundance of material for primary tools (5).

2) Therefore, much of the quarry litter which archaeologists have dismissed as "quarry blanks and rejects"--or just scrap--is an accumulation of rough-and-ready implements. We noted that some of our own best tools would be classed as junk or detritus.

3) Unless the craftsman makes a mistake in direction of cut, or misses the mark and hits another stone, his tools show little or no sign of damage except for a gradual smoothing and rounding of the edges, best perceived tactilly. Use should also be visible under a binocular microscope (6), but this will constitute a separate study.

4) Our tests suggest that there are readily discernible differences between 3 kinds of deceptively similar flake scars: those produced by intentional pressure retouch; by secondary shatter associated with removal of larger flakes; and damage nicks caused by misuse of the tool--it is likely that these very different scar types have been confused by archaeologists, resulting in loss of information.

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