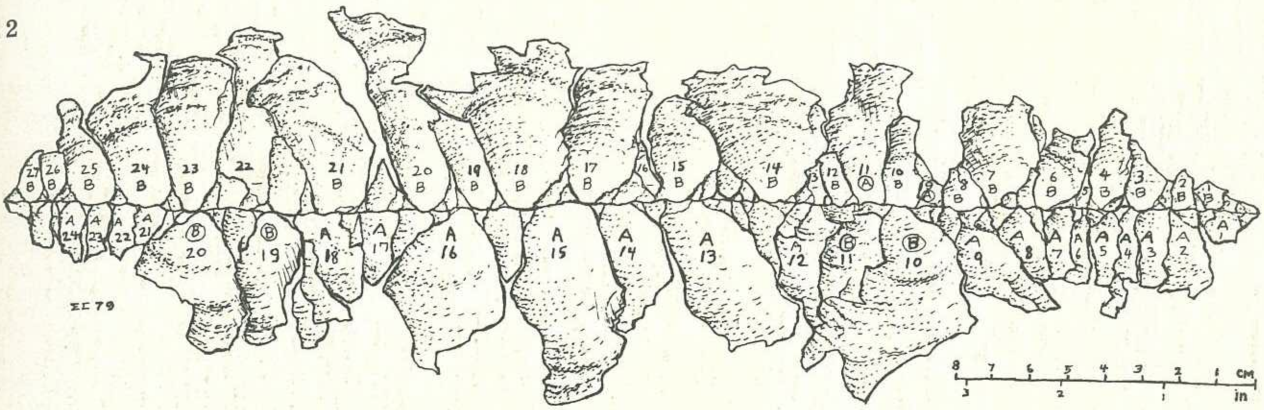
l. 3, No. 2 May, 1980



FLINTKNAPPERS' EXCHANGE

AN EXCHANGE MEDIUM OF, BY, AND FOR LITHIC TECHNOLOGISTS

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FE is published three times a year (Feb., May, Sept.) as an informal medium of exchange among flintknappers and lithicologists in all walks of life. Controversial issues will not be discouraged. Letters, comments, and other contributions on any aspect of lithic technology may be sent to the managing editor, Penelope Katson.

The Illustrations: both faces of one margin of a Solutrean laurel leaf #2 from Volgu, France. "Craftsman" illustrations are by Errett Callahan; "The Denver Series" illustrations are by Bob Patten; others are submitted by the authors, as noted.

LETTERS AND ANNOUNCEMENTS

It is critical that you inform us of any change of address. Since we use 3rd Class mailing, *issues sent out are not forwarded to any new addresses.* Unless otherwise notified, issues will be sent to those addresses received when you subscribed or renewed. Please keep us abreast of your whereabouts.

I want to take this time to thank every one who has written for *FE* because a bit of what you all said has had some influence on me in one way or another, and to take this space to give a special thanks to Errett for his fine review of my book. In the past he has been a big help, from his critique of the first edition of *The Art of Flint Knapping* to the xeroxes he sent to me, as well as other information that I was unable to obtain anywhere else.

Now I'm going to comment a little on some of the things mentioned in the review and in the editorial in order to give you a little more insight into the problems faced by this old boy when it came time to write such a thing as that book.

First of all, a little background information. When I started pressure chipping window glass with a nail at fourteen years of age I had not read a single scrap of literature on the subject. All I knew was what my Uncle Monty told me, "To chip out arrow heads the Indian pressed or struck one stone against the other." It was two years later that I anxiously awaited the arrival of my very own copy of Howell's *Early Man*, and in that same year my Biology teacher gave me my first set of antlers after I got an A on her final. Everybody had their heroes and standards of excellence, the Beatles, football stars, and fast cars. My hero was Francois Bordes and my standards of excellence were the laurel leaf blades and fluted points. Later on I heard of Don Crabtree. I have to admit, this all added up to a pretty weird kid, and some people avoided me like I had the plague or something.

A bigger obstacle than the flak I had to fly through was that of obtaining raw material. Flint Ridge was only 90 miles away from Norwalk, Ohio. Except for a once-a-year field trip with the local rock club, do you think I could get any one to take me there? When I got an automobile I took myself. This seemed to be the only place I could find some peace and quiet and the spirits of the long dead Indians were always there to encourage me.

Gradually flint knapping became an obsession, then later a business as I started selling and trading my points to rockhounds and collectors for money or raw stone. I wasn't very welcome at collectors' gatherings. Though they all knew of me and due to the quality of my work, which at that time was nothing spectacular, they figured they could tell one of my points from an original easy enough. In spite of the feelings of some collectors I made friends among others as I did demonstrations for them and shared my knowledge freely with them.

In the spring of 1974 I married Valerie and moved to Branson, Missouri. Here we had a little hole in the wall booth called the Flint Shop. It was in the winter of that same year that I wrote the first edition of *The Art of Flint Knapping*, which was published in early 1975. It was based on notes and ideas for an earlier book that I had worked on through high school and college.

As the book started selling it wasn't long before we got tired of the tourists and shifted to mail order which was more profitable. In 1977 we left town for the quiet of the country and changed our name to Mound Builder Arts and Trading Co., P.O. Box 702, Branson, Mo. 65616, so please use the correct name and address when writing to us for books and information. The telephone number is 417-546-4063. Also, Errett forgot to mention to include $1.00 for postage and handling when ordering our book. (Thanks to those of you who did include postage).

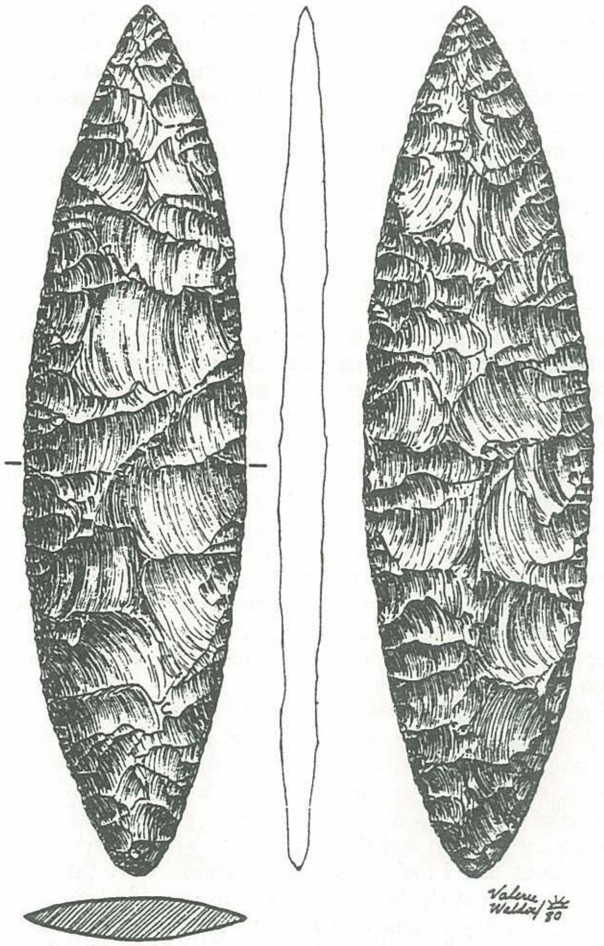

Fig. 1. A Waldorf Willow Leaf Biface (7" Long)

Because I had more contact with collectors than with academic flint knappers and archaeologists, my views were slanted in their favor. Since then I have visited camps on either side of the river and occasionally have paddled my canoe down the middle only to be fired upon by both sides. It is my hope that some day we will all meet together for a powwow.

One can't imagine what I went through during the last winter while writing the new edition. I had promised my customers a slightly revised book with a few color photos and some additional information. I had no idea what was to come. This would be eight months of hand to hand combat through the worst winter ever recorded in Southern Missouri. We were snowed and iced in for a month and I about drove Valerie crazy. When I thought I had the manuscript just right I would re-read it only to find out that it had me.

I found the original text to be so defective and out of date when it was compared to all the new literature that I had collected and the experience that I had gained since its first printing that nothing less than a total revision would due. After reading the rough draft of Errett's magnificent paper on eastern fluted points, and also being in contact with Jim Spears and other knappers I was amazed by how little I really knew about something I'd been doing for so many years. Thanks to their help, along with a more scientific and mature approach on my part I was able to analyze my work and the work of others more clearly. The knowledge I didn't have or couldn't find had to be gained through more study of available literature and through a series of replicas that were made for this book, many of which appear as illustrations. These replicas helped me double check my data as well as allowing me to write from first-hand experience.

The biggest problem came after I had gathered all that information, how to put it all together succinctly. In order to teach the beginner you have to start with the simple techniques first and work towards the more complex, which brought me to the problem of chronology and several techniques developing at the same time. In other words, which comes first, the biface or the core? This was solved by first discussing the mechanics of fracture, percussion and pressure flaking and making simple bifaces, after which the reader would have enough understanding as to how to go about working down larger pieces of flint in order to get his spalls for those bifaces. That's why the chapter on cores and handling raw material comes toward the end of the book instead of at or near the beginning.

About those minor drawbacks that Errett mentioned in the review. Some of them were born out of real headaches, and later I hope to make some corrections and additions.

First, the typographical errors. You should have seen the copy when we got it back from the printers. Their linotype machine was malfunctioning at the time, and because there was no time to wait for the repairman and a better copy, we had to correct the hundreds of errors by hand. We had to do all of this ourselves, and make the book camera ready as we did not have the funds to pay someone else to do the layout. I think under the circumstances we did a pretty good job. At any rate there are only a couple of the typographical errors that we missed.

Flint knapping as two words-I've always thought of it as two words and this is how it is written in most of the older literature that I have read. A glossary of terms and their correct spelling and use is badly needed, perhaps the editors of *FE* would take it upon themselves to provide us with one. Part of an issue could be devoted to this purpose.

Some of the points were illustrated "upside down" for artistic purposes, or to save space. I have to admit, the one on page 42, the serrated points, should be shown point up. However, the caption was wrong, so we put them in with the base end up.

A poor photograph of the author, yes. I was so busy positioning the flint nodule in my hand I wasn't worried, at the time, about how I looked. The photographs were taken in the curators office at the Ralph Foster Museum, and I think he did a pretty good job inspite of his only having three hours and three roles of film. I tried for weeks to find a professional photographer but there were none in the area. The curator offered to take the pictures in exchange for doing some work for the museum.

On heat treating, I think it is very important, especially to the beginner and the commercial knapper. First of all the beginner needs some fairly easy to work material or he will get discouraged. The commercial knapper needs high grade flint to work because he can't spend all of his valuable time and energy wrestling with difficult stone.

For the literature that was available to me, I thought I had a good bibliography. I would really appreciate receiving some xeroxed copies of articles currently available that concern flint knapping, especially those written by Don Crabtree, Francois Bordes, and others, or any information on interesting books that I may not have. As there is no large library close to me, I have to buy any book or publication that I need.

It must be mentioned here that there was no outside funding for this entire project. We simply saved up the money and absorbed the bill ourselves. This is why we were so cost conscious. What we saved by doing a lot of the work that would normally be done by our printer's art and layout department was later spent on a beautiful color cover and high quality paper.

Enough said about the book, the illustration that accompanies this letter is a promise kept. When I heard that Errett was going to Denmark I asked him, as sort of a joke, if he wouldn't bring back a piece of Danish flint. Knowing full well the problems of air travel I didn't really expect anything, but sure enough, two months later I was the proud owner of a genuine Danish flint nodule. Thanks again, Errett.

Now I'm keeping my end of the deal; here is the drawing of the 7 inch willow leaf blade that I made from that piece of flint. I had some difficulties with it, not being used to the stone, so it's a little thick and one side is rougher than the other. It was made using a heavy moose antler billet and a smaller stag antler billet, about 85% percussion and the rest was pressure. (see Fig. 1)

D.C. Waldorf
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* * * * * * * * *

I have read the miscellaneous notes on various platform treatments and resulting morphologies with great interest, both personal and professional. Personally as a "late Archaic early Basketmaker" level knapper, and professionally as the analyst in charge of some twenty thousand lithic artifacts from excavation, and forty or fifty thousand artifacts from systematic survey of about 80,000 acres in northwest New Mexico.

In general, platform preparation/selection was of much greater concern to the Archaic folks than to the Puebloans, represented by consistently less cortex and more retouch on the platforms remaining in earlier assemblages. This is all well and good - BUT - the greatest proportion of flakes in assemblages from all time periods do not retain platforms in monitorable condition. This is (I suppose) logical, as platforms are basically chosen or prepared for destruction, but where does this leave the analyst?

I might add that there is a "steady" decrease in platform absence from early to late...so I have a diagnostic "undiagnostic". I feel sure that this is a reflection of changes in technique over time, and at least partly results from the narrower platform angles and thinner flakes used/produced during biface manufacture in general; but I don't have much information to support this statement.

Have any of the knappers or analysts in the audience paid particular attention to the debitage platforms/platform remnants resulting from production? I would especially appreciate input on which stages or techniques of knapped stone production result in platform and/or flake fragmentation.

Platform Abrasion:

In my own rock breaking, I quite often grind (abrade) the platform edge(s). This is generally a perfunctory swipe or three with the percussor, and leaves little visible evidence. I suspect that this level of abrasion is/was very common in knapping; but because it leaves such miniscule evidence on the platform, it is effectively unobservable. Are Patterson (*FE* 2#3) and Bradley (*FE* 3#1) referring to such platforms abraded as a "finishing touch", or is grinding the major factor in producing the platform (angle and size)?

Jump on the Bandwagon:

It is good to see the rush of discussion on soft hammerstones. I agree with Callahan and Patten that they are extremely useful, and they are generally much easier to come by than antler. It is my personal observation that a soft percussor can be used freehand to produce series of flakes that are at times difficult to tell from pressure flaking (understatement). With good control and some changes in holding, soft stone (likewise antler and seasoned wood) percussion saves a lot of the effort (and blood) expended in pressure flaking. As Patten mentions for western Colorado, I (subjectively) believe that most of the bifaces in northwest New Mexico were produced by soft stone, freehand percussion.

On Quartzite:

A lot of the quartzite flakes we have recovered must be "hammerstone blowout flakes", is anybody else watching for them? (I have personally produced a good number.) They generally have produced "textbook" flake morphology, and have sharp, durable, edges that make fine tools; but are so hard that even repeated heavy use doesn't produce observable wear. Also, in this corner of the world, the prehistoric knappers thought quartzite made fine points--yet I've heard very few present day knappers discuss working the stuff. Are we stuck in an Obsidian-Flint-Chert dreamworld?

Parent Materials:

After running through the mass of rocks from excavations here, one archaeological myth is supported: the earlier (Archaic) populations did use more of the "good stuff" than the later (Puebloan) populations. In this case there is a steady decline in the percentages of chalcedonics and jasperiods from early to late. I'm still a little bothered by the subjectivity of my "good stuff" determination, but the difference is real. Where can I get a copy of Callahan's "Lithic Grade Scale"?

P.S. Just in case Bradley thinks he is all alone - I do try to avoid using "lithic" as a noun, it's hard but I try. "Lithics" also include ground stone, grave stones and jewelry . . . .

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Navajo CRMP
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Callahan's "lithic grade scale" is discussed in his thesis, "The Basics of Biface Knapping in the Eastern Fluted Point Tradition." Refer to F.E. 2[3]. Ed.

* * * * * * * *

My first issue of *Flintknappers Exchange* was *very* enjoyable. The articles on technique were particularly interesting.

I recently made what may be an original discovery. Noticing that the high setting on my new crockpot was equivalent to a 300-degree oven setting, and recalling from a recent conversation with Bruce Bradley that many lithic materials would heat treat from 8 hours in a 300-degree oven, I experienced an "a ha!" reaction. I removed the crock from the appliance, lined the cavity with tin foil, and placed alternating layers of sand and flakes of Pedernales "flint" from New Mexico into the appliance. The material heat treated very nicely when left on high overnight. This method would be more energy efficient than using an oven. I thought that some of your readers might be interested in experimenting with this.

Bruce Bailey
Univ. Sta. Box 43662
Tucson, AZ 85719

* * * * * * * *

I am presently examining the prehistoric use of crystal quartz within lithic assemblages and would be most appreciative of any data pertaining to such material, particularly in the east. Provenience, temporal association, percentages of assemblage represented by crystal quartz and chert, and metrics are requested.

George Peter Nicholas
Box 565
Exeter, N.H. 03833

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This summer the Northwestern Archeology Native American Studies Program will offer two four-day Lithic Technology Workshops under the direction of Greg Thomas. Workshop dates are July 20 - 24 and August 10 - 14. Participants in the second workshop may wish to arrive early to see flintknapping demonstrations on August 9 and 10 by some of the country's foremost flintknappers. These sessions will be the culmination of a week-long Flintknapper's Symposium in Kampsville where noted flintknappers will exchange ideas on stone tool manufacturing techniques.

For more information, write:

Northwestern Archeology
P.O. Box 1499
Evanston, Illinois 60204

The Lejre Research Center has now hired me for the whole year to take care of the archeological research, to register results, and to update the archives here in Lejre. Especially I will work on problems and do research about flint and the stone age. We are very interested in getting in contact with archeologists and lithic technologists from other countries. We are available with information and other help in return. In addition, interested visitors shall be well received in Lejre--just give us appropriate prior notice, if you can.

The International Flint Seminar has given our work with stone age a push forward, but we will try to get further on and hope to arrange more international seminars about flint in the future.

We are now planning research work for this summer, including the establishment of a working stone age site. We are also establishing a study room and study collection for the results of the research (objects and reports). This shall be at the disposal of interested persons. We should be pleased if flintknappers from different countries would offer some samples of their work (with matching descriptions of the used technique and fabricating tools) for the comparative collections. I thank you in anticipation.

Nils Hyberst Kjeldsen
Lejre Research Center
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DENMARK

* * * * * * * *

During the past five years I have noticed a distinctive wear pattern, or plaining, developing on my hammerstones. It appears to be a direct result of my right handed percussion technique. Using my left hand, I have produced a similar but distinctively opposite pattern. The drawings below indicate the nature of the patterns. Notice that the patterns appear to be the result of the same actions no matter how they are turned (see Fig. 2).

I would be interested in learning of any alternative knapping methods that could produce this kind of pattern. Additionally, I would appreciate knowing if anyone else has noticed such a pattern in the archeological record.

Mike Johnson
2842 Franklin Walk
Falls Church, Va. 22042

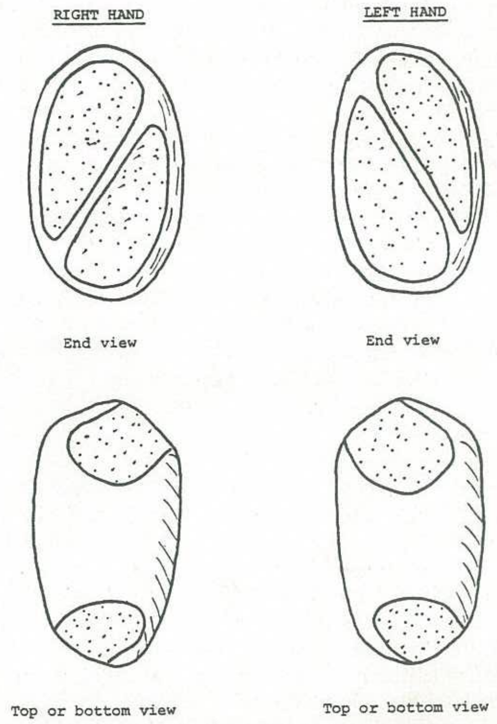

Fig. 2. Hammerstone Wear Patterns

I am a graduate student in anthropology at the University of Colorado, engaged in studying use-wear patterns produced on metates and manos from corn grinding. I am attempting, with the aid of binocular and scanning electron microscopy, to determine the differences and variability in wear on four materials. I wondered if any contributors to *Flintknapper's Exchange* have conducted formal or informal studies on ground stone, or could direct me to other people or references. Thank you very much.

Anne Zier
P.O. Box 1043
Eagle, Colorado 81631

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KNAP-IN NEWS

LITTLE LAKE KNAP-IN

During the weekend of April 19 and 20, 1980, a neo-archeological site was born when some of the world's foremost flintknappers gathered together for a knap-in near the northern shore of Little Lake. The participants included:

Errett Callahan, Virginia
John Fagan, Oregon
Jeffery Flenniken, Washington
Betty Goerke, California
Bob Patten, Colorado
J.B. Sollberger, Texas
Gene Titmus, Idaho

Locals included Rod Reiner and Steve Carter from San Diego, California.

Don Crabtree took ill just before the event and, sadly, could not attend. He conveyed his regrets to Ms. Nichols during a phone call after the knap-in. From the reports he had heard concerning what had transpired during that weekend, he told Jackie that it sounded like something more had been staged than a run-of-the-mill knap-in. We think so too.

There were many aspects to the knap-in we feel deserve in-depth coverage. This we plan to do in our fall issue, 3(3). However, a brief encapsulation is in order.

First of all a structure to the activities was attempted. This included a format containing defined sessions concerned with specific aspects of flintknapping. Basically, these sessions dealt with boulder reduction, fluting techniques, and early man technologies.

Second, it was decided to hold these sessions in different areas of the knap-in site so as to prevent contamination of the by-products of one session with another. Also, knappers were spread apart in each sub-area in order to (or at least attempt to) prevent each of their individual refuse piles from over-lapping. (One area was set aside for non-structured knapping where anyone could do what they wanted.) This feature was suggested by Errett and will facilitate future analysis.

Third, the knapping area is currently in the process of being recorded as an experimental site. According to Bill Sidell, State Historic Preservation Officer, this is the first such designated site in California.

For those unfamiliar with California prehistory, the Little Lake region contains a wealth of cultural resources - including hundreds of petroglyphs - dating back at least five thousand years. Precautions were taken not to contaminate surface resources, including staging the event on a previously bulldozed area and using only non-local materials. Additionally, several pits will be dug and filled with recent charcoal, coins, etc., to insure that future archeology in this area will not be mis-interpreted.

Mother Nature could not have given us better weather. A soft breeze off the lake was generally consistant, except for strong gusts on Sunday morning. About a hundred people attended, primarily archeologists from California and Nevada. Several members of the Little Lake Duck Club, the owners of the property, were also present. The Saturday evening dinner was catered by the Little Lake Hotel -- an establishment with a long history, having once been a stagecoach stop along the route known today as Highway 395.

Without question, the major enemy we faced during the weekend was *time*. Each planned session would have been worthy of three days of discussion and experimentation as opposed to the three or four hours that were actually spent. The knappers are to be commended for their heartiness considering their post-midnight arrival to their motel rooms and the few hours of rest they were able to steal before the start of the Saturday morning session.

The schedule, in brief, for the knap-in was as follows:

Saturday Morning:	boulder reduction
Saturday Afternoon:	fluting techniques
Sunday Morning:	Review of Calico Early Man site artifacts and demonstrations of early man technologies.
Sunday Afternoon:	open session

In our next issue we will examine in greater detail the aspects mentioned above and others not touched upon in this brief overview.

Chris Hardaker

* * * * * * *

FIG. 3. Sollberger Using His Lever Fluter, Flenniken Looks On

FIG. 4. INTRODUCTION: Clockwise-J. Fagan, B. Patten, G. Titmus, J. Flenniken, C. Hardaker, S. Carter, E. Callahan, J. B. Sollberger, R. Reiner

FIG. 5. G. Titmus (Left) & J. Flenniken, Performing Indirect Percussion On A Large Biface

Fig. 6. Saturday Afternoon

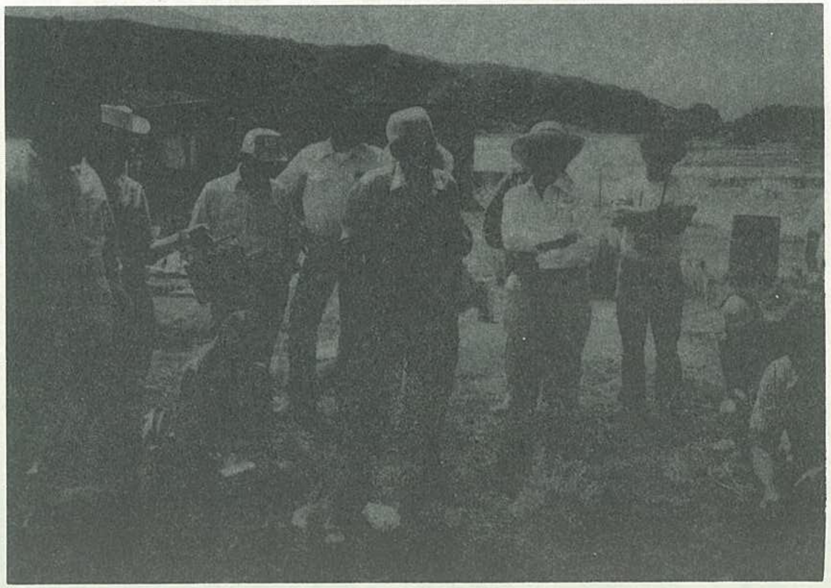

Fig. 7. Calico Forum. Flenniken, Solly, Titmus

Home again, sorta rested (almost), and pondering over the Little Lake meeting. I would like to think on the Calico display we saw: first the knappers made verbal reports. With mine, I asked, "Where was the special man that seemed to be needed in order to call Calico a human workshop?" Such a special, low-technology man, seems necessary because: Olduvai Man's tools are recognizable as tools -- okay he was hominid. Homo Erectus made cleavers, choppers and handaxes. By 300,000 years ago, the formal scraper tool was throughout the Old World. It was everywhere! It is beyond reason that inside the past 300,000 years a Man would have entered the New World without the common scraper. Yet, not a single example of that formal tool could I recognize among the 200 ± examples of stone we viewed from Calico. Others have recognized at least one blade core from Calico. Has there ever been a developed blade culture without chipped stone scrapers? I think not. If Calico is a "site", we were shown the wrong tool debris. Or the geology is wrong -- Calico was a site pre - 1,000,000 years ago. More probable, Calico is not a site of man's debris.

I was much impressed by Gene Titmus. He is one first class obsidian boulder reducer. His straight-line calculated force delivery gave far better results, i.e. longer, straighter, cleaner fractures, than we witnessed by those who chopped (arced) the hammerstone against the boulder. The "Titmus show" was the best because he maintained compression in the boulder by "pushing in" on the hammerstone at the instant of contact. Others had less spectacular results because they allowed the hammer to bounce "up and away". This bounce shortened the time of force contact and therefore transferred less energy into the obsidian boulder. Thus shorter, more erratic fracture planes were produced.

I was disappointed that Don Crabtree was not well and not an attendee. I wanted to show him that I have attained the classical Folsom longitudinal cross-section he described in 1966: that no bolts, nuts, copper, or other hardware is necessary to demonstrate such fluting.

Bob Patten turned out to be a gentleman and a scholar. I am attracted to those who also "look into flints" to see the reaction of stones to flaking forces.

Flenniken was a pleasure. He radiates good will, and the confidence of firm convictions. Given the opportunity I could have some really beautiful discussions with him.

Callahan quietly exposed to us knappers that we are not yet masters of our work. If we were, then we should be able to do work on tough stones (like quartzite) with the competance that his Virginia Indians did. He's right, you know. Replicators, no doubt, have numerous techniques and skills yet to be rediscovered.

The value of the meeting at Little Lake can be measured by how far we have come and realizing how far we must go in order to be true replicators.

J.B. Sollberger
8515 Forest Hills Blvd.
Dallas, Texas 75218

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THE THIRD TEXAS KNAP-IN

The third Texas knap-in was held at Lake Belton on April 4 to 6, 1980. Good weather again favored this event, and activities were also aided by ample Cajun coffee. As usual, a variety of raw and heat treated flints were provided, with slag glass as an unusual additional material.

Professional archeologists attending included Glen Goode (Texas Highway Dept.), and Grant Hall and Paul Lukowski (University of Texas at San Antonio). Amateurs included J.B. Sollberger, W.B. Carrol, L.W. Patterson, D.R. O'Dell, T.H. Herndon, Carey Weber, Wayne Brown, Bruce Ellis and E.C. Stacy. Out of state visitors were Chris Hardaker (Great Basin Foundation) of California and John Sinclair (amateur) of Indiana. There were good discussions among attendees, due to the small group size and variety of experience.

The following are some of the activities that occured:

1. Demonstrations were given with a variety of wood and antler billets.
2. Sollberger fluted Folsom point replicates using his lever pressure device.
3. Patterson made concave bit gouges for University of Texas at San Antonio wear experiments.
4. Weber showed results of drilling a hole in hard stone by rotating a wood stick with wet sand on the tip.
5. Sinclair brought specimens of Indiana and North Dakota flints.
6. A variety of flints were quarried in nearby areas.
7. Several knappers manufactured prismatic blades.
8. Hardaker showed results of hard anvil secondary force flaking of porphyry.

It is planned to continue these knap-ins on a bi-annual basis. The enthusiasm of attendees continues to be high, and this knap-in appears to have been another successful event. Aside fromt he old master, J.B. Sollberger, Texas now has a significant additional group of skilled flintknappers, with a wide range of experimental interests.

L.W. Patterson
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TWO NEW BOOKS ON EXPERIMENTAL ARCHEOLOGY

John Cole's masterpiece, *Experimental Archaeology* (Academic Press 1979, 274 pp.) is the long-awaited definitive book on the subject, tying together the whole field and its history. He covers lithics (sic) more soundly than he did in his 1973 book, discusses house building projects, experimental research centers around the world, boat building and sailing, experimental ceramics, cookery, music, etc. And most importantly, lays down the operating ground rules for doing any experiment -- lithic or otherwise. It's great reading with an excellent bibliography.

Jeff Flenniken's PhD dissertation, *Replicative System's Analysis: A Model Applied to the Vein Quartz Artifacts from the Hoko River Site* (Washington State University, 1980, 206 pp.) Jeff takes one aspect, lithics, of this rich, mud-covered site and traces it from beginning to end. He provides updated definitions of technology, lithic technology, flintknapping, and replication. For the latter, he insists upon duplication of all aspects of the life history of the tool -- from selection of raw material, through heat treatment (not applicable at Hoko), reduction technolgies, hafting, function, to disposition in the archeological context. Reduction of the Hoko microliths entails the bipolar technique and Flenniken gives us the best definition and no-nonsense discussion of same I've yet come across. This alone makes his work of critical importance. He also has a chapter on the Hoko flintknappers and proceeds to demonstrate very convincingly that they were most likely female.

Errett Callahan

EXPERIMENTATION

FOLSOM STAGING ** A SPECULATIVE APPROACH

INTRODUCTION

Folsom technology commands attention because of its unique design and prestigious position in North American prehistory. The design is as refined and elegant as if it were the product of modern engineering. It was established, however, not in a single concentrated effort, but as a result of countless trials and experiences which cumulatively led to the Folsom heyday. With this background it provides an excellent vehicle for the comprehensive study of a lithic tradition.

My approach tends to be speculative in that I start with a few milestones and proceed to examine the possible ways of achieving them. Distinctive aspects of the constructed procedure can be compared to aboriginal evidence to provide correlations or define new milestones in an itterative process which leaves progressively fewer details in question. Earlier studies by Crabtree (1966) and Flenniken (1978) have served as valuable guide posts for later investigations. An attempt has been made to differentiate between those conclusions that are a product of hard evidence and those which are guesses but unless otherwise stated, they should be treated as speculation.

I have selected nine decision points in the process of making a Folsom point. Each of these decision points or stages represents a clear cut opportunity to evaluate the progress and either abort the attempt or select between alternate ways of continuing. Stages, as defined, represent discrete goals in the manufacturing process and should be represented by clusters in the aboriginal record if they are to be considered valid.

A note of caution should be voiced in that stages as discussed represent the normal situation and many exceptions can and will be found.

The dimensions I have included are *not* a result of statistically correct data gathering but do reflect ranges and trends as accurately as I could manage in a short examination of materials at the Smithsonian Institution. They should be treated only as indicators until more rigorous figures are available.

I. SELECT FLAKE PREFORM:

There may be some objection to this being a legitimate first stage but creating the initial flake tends to be very individualized due to the myriad forms in which raw stone occurs. The process of selecting a flake preform is where Folsom technology begins to follow ordained guidelines. The quality of stone must be sufficient to allow flakes to travel long and flat enough for the fluting stage. My experiments have included quartzite, cherts, agates and flint with substantially equal success. Observed aboriginal use covers an even wider range of qualities although the preference is for the highest available grade of stone. A flat face was a sought for characteristic since it could reduce later efforts substantially (Flenniken 1978). The closer the preform size to the intended form, the less effort needed in further reduction, and blanks would be easier to transport. Manufacturing techniques are expected to differ in relation to the distance from a quarry and conversation with Dennis Stanford of the Smithsonian Museum of Natural History bears this out. Large pieces probably would have been worked down by percussion at the quarry site and only pieces near optimum size would be carried a distance away. Transportation would be easy and reduction would be rapid with little wastage.

II. HEAT TREATING:

Heat treating is optional and can be used at any stage before fluting. If this stage could be avoided, the resulting artifact would be tougher and less subject to damage. Many stones must be heat treated before fluting is possible but some of my best results have been on tough, untreated stone.

III. MODIFICATION OF FLAKE PREFORM: (Fig. 8)

The first priority is to establish a flat face, which may simply involve removing a bulb of percussion as noted by Flenniken (1978). Baton percussion against ground nipple platforms can be used to establish flat faces but I have been having the best luck with a sandstone percussor. The advantage of a soft stone percussor is fourfold in that edge preparation is easier, less energy is required, abrupt edges are easily worked and smaller flake preforms can be utilized. The second face is easily flattened by first bevelling the entire edge and again using percussion against prepared platforms until a thickness of 5 to 10 mm is achieved. Width can be 30 to 40 mm but is not nearly as important as thickness since the edges are brought in at the final stage. An additional advantage of this method is that the preform will seldom be skewed. The outline of the modified aboriginal preform was usually roughly rectangular.

IV. DRESS FIRST FACE BY PRESSURE:

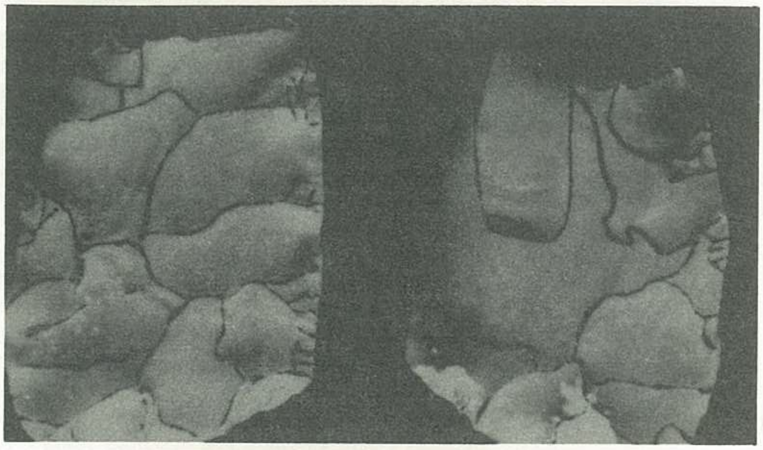
The flattest face was left as is, at least partially to provide economy of effort. If the attempt at fluting the first side failed, the piece could be abandoned with a minimum investment of time. The entire edge appears to have been bevelled prior to facial dressing although the same effect could have been produced by lateral bevel flakes from the forward ridge of the previous flake. Regularly spaced sequential pressure flakes insure that the fracture front has a uniform width from one increment of advance to the next. Facial dressing flakes have characteristically high ridges near the edge because of the bevelled platform and the wide spacing between flakes. Bevelling allows easy shaping of the preform so that after a single sequence of dressing flakes, the resulting outline is established as a bowed rectangle. Width is reduced near the base so no damaging stress is generated by the fluting restraints. Since the face has already been flattened, it may not be necessary to chip all the way to the median. In fact, too steep a median will cause a high walled channel because the fracture cross-section tends to mirror the surface. Dressing flakes usually don't extend much beyond the median, indicating that the thickness was mostly established by the percussion preform. An exception can be noticed near the tip where the preform often was thinned to the target thickness yet the very tip is left thick and bulbous.

Once the edges were dressed, the direction of the flute was chosen for the greatest chance of success. An adequate fluting platform can be insured by a simple series of steps. After making a steep bevel across the base, a longitudinal flake with a deep trough on each side of the centerline defines a guiding ridge. Chips angled toward each other on the back face isolate the platform which ends up projecting about 2 mm from the basal concavity. Preparation is finished by touching up the bevel and then heavily grinding the forward edge of the nipple. While sharp or unprepared tips can be found, usually they were squared off. The easiest way of squaring the tip was bevelling but I can detect no apparent preference toward either face and many tip bevels seem designed to align force along the centerline so as to avoid bending stress. The tip is then abraded for stability and to avoid stress concentrations which could cause fracture to feed from tip towards base.

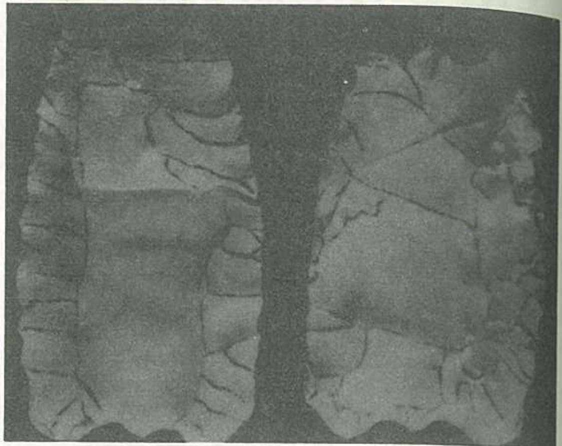
V. REMOVE FIRST FLUTE:

There are an increasing number of devices available for fluting, but only a limited amount of mechanical approaches are available. Combinations of edge, face and tip support as well as various ways of applying force can be used as common denominators to compare methods on a meaningful basis. Once an acceptable mechanical basis for fluting is decided upon, there is the additional problem of determining how aboriginal constraints would have influenced design of a fluting device. Availability of materials, transportability, simplicity, and high chances of success would all be part of the design considerations.

Fig. 8. A Folsom Staging Sequence

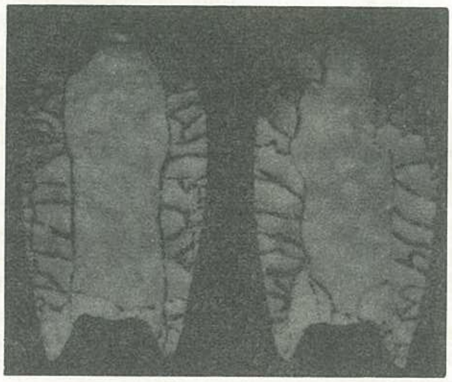


STAGE III
Heat treated Colorado chert
Softstone percussion
Thickness = 8 mm
Note: Minimal effort stategy

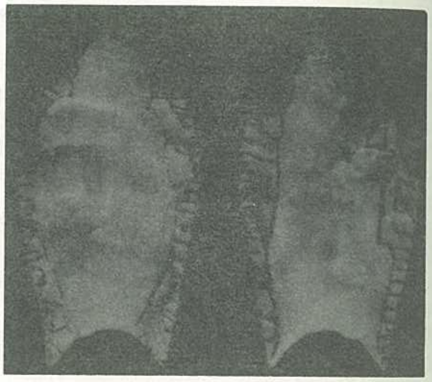


STAGE V
Heat treated Colorado chert
Pressure dressed by antler
Thickness = 4 mm
Note: Uniform flake spacing, work on one face only

C



D



E

STAGE VII
Heat treated Colo. chert
Thickness = 3.5 mm
Note: Uniform channel width

STAGE VIII
(D&E) = Heat treated Colorado chert
(D&E) = Pressure retouch by sharp antler
Thickness (D) = 3.5 mm (E) = 3 mm
Note: Minimal retouch on D, finer retouch on E, lack of encroachment by dressing flakes on channel

F

STAGE VIII ABORIGINAL EXAMPLE
Cast from Lindenmeir Folsom site
Original of jasper
Thickness = 2 mm
Note: Extremely fine retouch

An examination of unfinished Folsom material reveals that edges are too uneven and fragile for clamping while the ground tips would indicate a substantial load there. Flenniken (1978) has demonstrated that successful fluting can be achieved with no edge support but, since his second worker doubles the effective time requirement, a single party technique seems more likely to me.

The simplest workable means left seems to be a restraint at the tip and of the face with a slot provided for the flute to fall through. Sollberger, Bradley, myself and others have found this way a successful method from the mechanics viewpoint although the details of our devices differ greatly in form. If another method is prefered, it would not effect the proposed staging sequence to an appreciable degree.

My most consistent method to date is to incline the flaking tool at about a 20 degree angle and use foot pressure to take out the channel flake. This seems to insure the proper combination of downward and outward forces. The tip rests on wood in my fluting but the often severe grinding on aboriginal tips argues that a more solid rest, such as antler, may have been used. If the flute is complete, it will bisect the ground surface of the tip regardless of the direction of bevel. The contention of Crabtree, Flenniken and others that the purpose of bevelling is to allow clearance between the anvil and the desired point of flute termination is obviated by this fact as well as the observation that collected samples do not show a preference of bevel direction. An alterntive explanation for the bevel is offered in conjunction with the next stage.

Breakage can occur by bending if the preform is very long and has internal flaws but a more prevalent failure is ear-splitting when the restraint serves concentrated pressure to the ears. If platforms are narrower than 3 mm, there is a possibility of platform collapse or too shallow flutes. These sorts of mistakes can usually be corrected with only minor loss of length.

Aboriginal channel flakes seem to remain just under 2 mm thick whether they are narrow or wide and maximum bulbing occurs about 4 or 5 mm from the base. Widths of flutes vary from 10 to 25 mm but it is more common to see 15-25 mm widths. Trajectories can veer to one side although the aboriginal examples look like the fracture usually fed straight and true. Occasional examples also occur which demonstrate use of fluting as a thinning process after which the flute scar is chipped away and the point refluted.

Even if the flute is aborted to the extent that a new platform is impractical, the preform can be reversed because the tip is simply a mirror image of the base. With such an option, abortions should be rare at this stage.

VI. DRESS SECOND FACE BY PRESSURE:

As for the first face, the edge is steeply bevelled before dressing so the flake trajectories can be reasonably long and flat.

If the tip has been damaged, it needs to be squared and beveled again. Rather than allow it to intrude on the flute, the bevel is directed away with the result that there appears to be a deliberate reversal of bevel. My experience shows that successful flutes are independant of tip bevel direction, but that reversal promotes a convergence of channel trajectories at the tip. Tip bevelling in the opposite direction would insure that the flutes could not meet (Fig. 9). Since flutes often *do* meet at the tip, we are left with three possiblilities: 1) tip bevels were deliberately formed with the intent of producing a sharp tip; 2) procedure caused the tip bevels to be placed so that converging flutes were common but not a design feature; 3) considering that arced blades are natural forms, it may well be that tip bevels were designed to avoid flat trajectories when fluting. Until the problem is resolved by experimentation and observation my personal preference is for the second explanation.

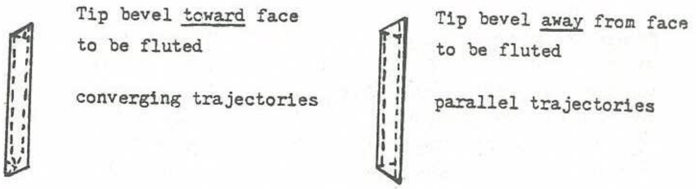


Fig. 9. Tip Bevelling

VII. REMOVE SECOND FLUTE BY PRESSURE:

This stage is accomplished the same as for the first flute. Occasional examples may be found which demonstrate reversal of flute direction, presumably to recover from a situation where a flaw prevented the normal flute direction.

Acceptable thickness seems to have been limited at about 4 mm as evidenced by second generation flutes on otherwise serviceable points. Allowing for the standard 1.75 mm flute thickness gives a starting thickness of about 6 mm although 4 and 5 mm thick preforms have been found. Points have been observed up to 90 mm long and up to 30 mm wide, but the thickness remains standard at 2 or 3 mm.

VIII. MARGINAL RETOUCH:

Misalligned flutes would not be cause for concern since subsequent trimming would allign the finished point correctly with the flute. For the first generation shape, the sides bulge slightly in simple arcs which turn in near the ears and parallel each other for the last 5 mm. Edges appear to have been worked one face at a time by sequential, evenly spaced flaking as close as 1 mm and often exactly offset to scars on the opposite face. Chipping varies in quality from coarse to fine and may intrude on the channel but that is unusual. In order to keep flakes from impinging on the channel, the stone must be held immobile while pressure is applied. Lifting the chips off the face as described by Flenniken (1978) allows the knapper precise tool placement and control so that each flake is like the next, but I have trouble maintaining the plane edge so characteristic of Folsom. Sollberger (personal communication 1980) has developed a technique of rocking a sharp edged antler onto the edge which is easier to control. Retouch is steep (up to 90°) for a sturdy edge. The base is given the same bevel treatment as the sides except that overhangs left from fluting are removed by long, shallow flakes which blend into the channel. Heavy abrasion of the hafting portion of the edge completes the point for use.

IX. REWORK:

Once a point was put into use, the possibilities for damage would be endless. Shapes would begin to diverge widely from the first generation norm, as would the quality of workmanship. It is common to find points which show re-tipping with absolutely no regard for niceties, indicating a possible specialization in the community. The armorer's touch can be seen where repair is effected with the most delicate of chips and the ultimate in conservation. Steep retouch becomes a means to retain the greatest width and seems to reach its extreme in used-up pieces discarded near a quarry, where fresh stone was being worked. The replacement points at such a site are less refined, as the cycle begins to repeat.

Tables of measurements will tend to be very misleading unless the dynamic nature of the projectile history is taken into account. When stone was readily available, the tendancy to pitch a flawed point would have been much more pronounced than when broken pieces were the prime source of replenishment. Context obviously becomes an important ingredient of dimensional analysis.

CONCLUSION

At each of the nine stages discussed, there was an option to discard the preform without spending any more effort than was absolutely necessary. The temptation to stress economy of effort should be tempered by the realization that nine opportunities to quit must be greater than for most other styles of projectile points. Maybe the paleo-indians were squandering their resources as we do with ours presently.

An important item to note is that the means of making Folsom points were so structured that it would have been relatively easy to train members of a group to provide the effective spear tips so essential to survival. From this perspective it must have been a fantastic design.

Design is also superb in the utilitarian aspect. Hafting would be simple and standard. The uniform thickness characteristic of the design means that any retouch or repair would need to remove only a minimum of stone.

All in all, the only serious shortcomings of Folsom design seem to be in the dependance on quality stone and apparent wastefulness of that limited commodity. Perhaps that is as good an explanation as any for the disappearance of such a distinctive style.

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DORSET FLUTING

The Dorset point emerged from about 1000 to 800 B.C. and has been traced to Greenland and from Newfoundland to James Bay to the Great Lakes. Since no traces of bow and arrow have ever been found in association with the Dorset culture it is assumed the point was used for spear fishing. The Dorset culture lasted approximately two thousand years (See Jŏrgen Meldgaard).

The points were made from a light colored flint and are usually small in size and triangular in shape, however, I am familiar with at least one type with pinched shoulders.

The points were rather carefully hand pressure flaked. Two flutes were pressed off from the tip, leaving the tip intact often with a triangular platform remaining; this proves that the flute was taken off very slightly to either side of the slightly abraded tip.

The pressure flakers were sometimes made of seal penis bone. I personally believe the point was restrained in a clamp and lever fluted in an upward direction. This particular method was worked out by Raouel Ibarra and myself and David Jaret worked with me on the point. I have also fluted with a twist flaker but with much less precision and accuracy.

I consider the two points pictured to be replicas. The "Folset" is a theoretical point I developed, Dorset fluted on one side Clovis or Folsom fluted on the other.

The larger of the two Dorsets is made of a very tough basalt much more difficult to work than the average flint or chert. The smaller point is made from red glass, a very fragile substance. Both fluted rather easily. There is no retouch after fluting. The point is a rather fat point compared to Folsom with characteristics almost entirely opposite of the Folsom in that it is triangular in shape and fluted twice on one side from the tip instead of once on either side of the base.

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Editor's Note: As I recall from Crabtree's Folsom paper (1966:5), the Dorset is as delicately made as the Folsom. I have examined Wellman's points and feel they could in no way be compared to Folsom for delicacy. Furthermore, I suspect the distal fluting would be so oriented that it would leave a sharp cutting edge. Only 2 of Wellman's 6 edges would contribute significantly to increased cutting ability. This is speculation as I have seen no original points. I have wondered about this point type for years and would really like to see a good photo, drawing, or replica. Any takers?

P.S. - The "Folset" has no attributes of a Folsom. A Clovis perhaps but not a Folsom. Shouldn't it instead be in the "Closet" category?

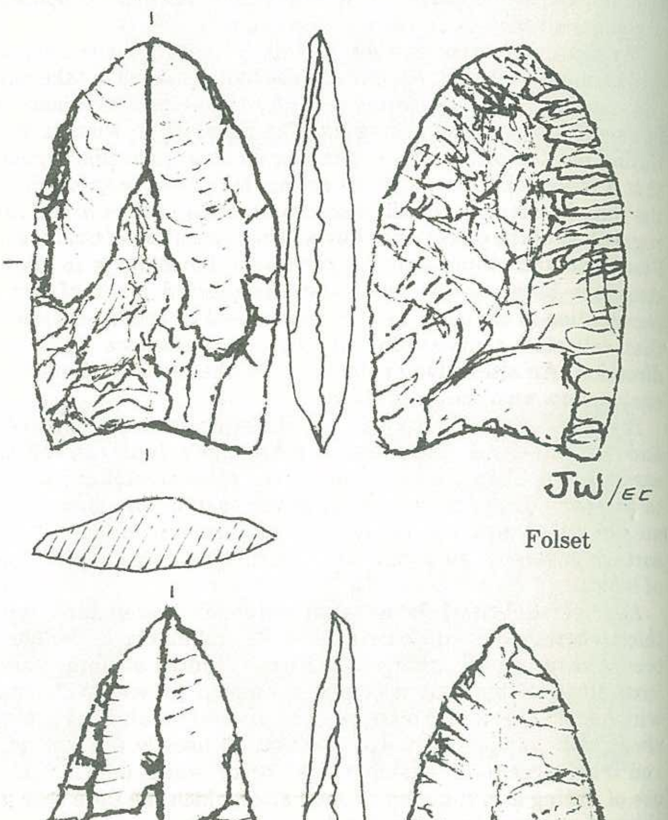

Fig. 10. Dorset Replicas

PROBLEMS/SOLUTIONS

THE FINENESS SYNDROME

Many flintknappers seem to inevitably choose as their primary goal the production of larger, thinner bifaces. Many knapping sessions turn into contests to see who can do this best. I refer to this as the "fineness syndrome". There is nothing wrong with pride in craftsmanship, and learning to make very large, thin bifaces can teach one valuable lessons in flintknapping. However, when production of refined bifaces becomes *the* primary goal, much is lost in the potential contributions of experimental flintknapping to archeology. The major goal of experimental flintknapping for archeologists should be the production of useful information for the analysis of lithic materials from archeological sites. Of course, some people do enjoy flintknapping as a hobby, without deep interest in archeology.

My good friend J.B. Sollberger has many varied interests in flintknapping, but he still suffers a bit of the "fineness syndrome" once in awhile. He occasionally becomes convinced that Indians were superior craftsmen because of some yet to be discovered techniques. My reply to him is always the same. That is, there is a wide range of skills to be observed in both prehistoric Indians and modern flintknapers, for several reasons. Factors can include items such as coordination skill, training, amount of practice, etc. . For example, I can make bifacial dart points as good as the average Texas coast prehistoric Indian, but not as good as the best Indian. It took me two years to arrive at this skill level.

While there is nothing wrong with the production of very refined bifaces, if this becomes the primary goal of a flintknapper, it can detract from other worthwhile goals as follows:

1. Beginners and general archeologists become discouraged when they can not immediately produce perfect bifaces. It should be emphasized that one can learn something at all levels of skill, if good observation practices are followed.
2. Many archeological reports suffer from the "fineness syndrome", where only the best specimens are discussed. The study of the full range of craftsmanship is necessary if complete lithic analysis is to be done.
3. Flintknappers who have the "fineness syndrome" usually do not engage in qualitative and quantitative studies that can contribute to lithic analysis of archeological materials.
4. There are many types of flintknapping other than bifacial reduction that need to be studied.
5. Concentration on the production of refined bifaces leads one to perfect a set of favorite techniques, which is good for the immediate goal. However, well rounded flintknappers should learn a variety of techniques as background for lithic analysis.

I feel that for flintknappers with archeological interests, concentration on "fineness" of items produced should be an important but not overwhelming consideration. After all folks, there is always a "faster gun" (or more skillful flintknapper).

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MEASUREMENT OF STONE ARTIFACT EDGE ANGLES

INTRODUCTION

The measurement of edge angles is of interest in lithic analysis for a variety of reasons. Edge angles of stone tools are studied in relation to functional uses (Wilmsen 1970). Scrapers

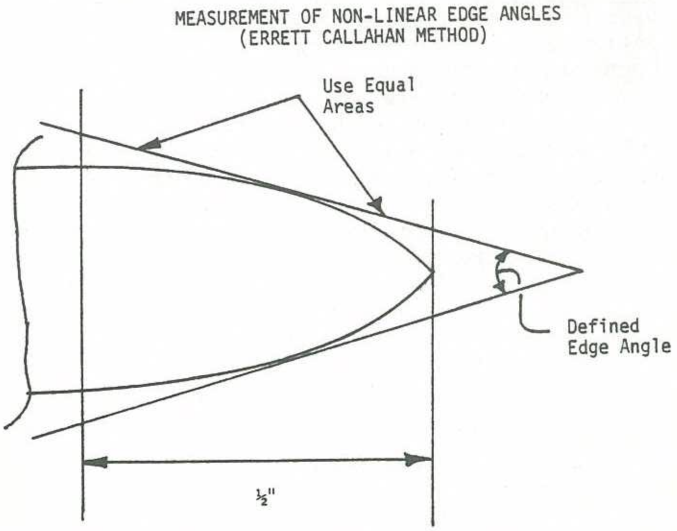

Fig. 11. Measurement of Non-Linear Edge Angles

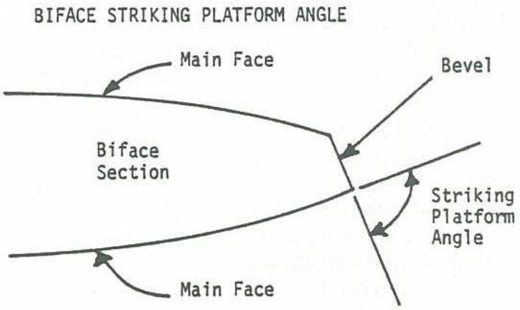

Fig. 12. Biface Striking Platform Angle

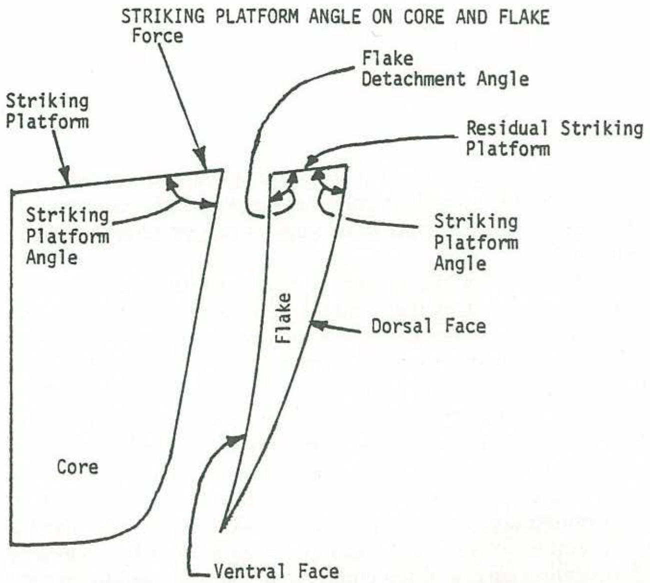

Fig. 13. Striking Platform Angles on Core & Flake

tend to have higher edge angles than cutting and whittling tools. Edge angles of projectile points and other bifaces may provide data on manufacturing techniques, technological traditions, and preferences of individual craftsmen. For example, some prehistoric groups show a strong preference for steep bevelling of projectile point blade edges. Callahan (1979:table 11) has illustrated the relationship of striking platform angles to the lengths of bifacial thinning flakes. Edge angles are also useful in the study of flake production from cores other than symmetrical bifaces, with higher angles used in producing longer flakes.

Some of the data presented in the literature on artifact edge angles is rather confusing due to types of measurement techniques and lack of consistency in geometrical definitions. This article will describe some techniques used for edge angle measurement and will then discuss the geometrical problems involved.

MEASUREMENT TECHNIQUES

One of the best known publications on edge angles of stone tools is by Wilmsen (1970), concerning Paleo-Indian tool assemblages. Here, edge angles were measured by sighting onto a target of polar graph paper. Except for very short edges, this is not an accurate measuring technique. On edges of any significant length, the eye cannot focus on both the edge angle and the graph paper. Also, this method cannot account for variations in edge angles along the overall edge. This technique is mentioned here only because it is widely known, and should be avoided because of inherent inaccuracies.

The most widely used method of edge angle measurement is the use of a swing-arm protractor (goniometer). These are inexpensive instruments (about $7), usually made of stainless steel, that are sold by a number of specialty tool vendors. The Sears Model 9-4029 is a good example. Angles can be measured directly with this type of instrument, at any point on an artifact edge. Calibration is generally in one degree increments.

To test the reproducibility of edge angle measurements made with a swing-arm protractor, I manufactured a bifacial dart point and took edge angle measurements at several locations. These locations were marked and the point was sent to Errett Callahan to make duplicate measurements. The following is a summary of results:

	edge angle, degrees		differences	
Location	Patterson	Callahan	degrees	%
1	35	35	0	0
2	24	25	1	4
3	38	45	7	18
4	54	64	10	19
5	57	60	3	5
6	34	37	3	9
Average			4	9

The average difference in reproducibility was 9%, with a range of 0 to 19% on individual measurements. Callahan used the Sears Model 9-4029 protractor and I used an almost identical instrument.

An edge angle measurement technique that can be used for short edges, such as flake residual striking platforms, is the use of an optical comparator with a protractor reticle. These instruments usually have a 7 power magnifier and cost about $20 to $30. This technique cannot be used on long edges, due to focusing limitations of the instrument. It is good for applications such as measurement of residual striking platform angles on prismatic blades (Sollberger and Patterson 1976:518).

An optical comparator can also be employed for edge angle measurements in an indirect manner, as described by Burgess and Kvamme (1978). Here, an impression of the edge is made in soft modeling clay, and the comparator is then used to measure the angle of the impression. This technique can be used at any point on a long edge with acceptable accuracy. I would judge that this method is somewhat slower than the use of a swing-arm protractor, and therefore may be somewhat less useful where large numbers of measurements are required. This method should not be overlooked, however, when accurate measurements are required.

GEOMETRICAL PROBLEMS

There are several problems involved in edge angle measurements, even when suitable instruments are being used. These involve the basic geometry of edge angles and definitions of which angles are being measured.

One of the most basic problems in angle measurement is that many edges are formed by the intersection of curved instead of plane surfaces. There is no way to rigorously define non-linear angles. This is one of the reasons for comments, as by Cantwell (1979:5), that edge angle measurements are difficult. On edges with slightly curving surfaces, the curvature can sometimes be ignored without sacrificing a large percentage of measurement accuracy. On highly curved surfaces, edge angles can be measured only by arbitrary definitions. One such definition has been given by Errett Callahan (personal communication), as shown in Figure 11. An arbitrary edge depth has been chosen here for orientation of the contact points of the protractor with convex surfaces. This method may have some application for large bifaces, such as celts and handaxes, but would be difficult to apply to small bifaces and edge angles involving shallow retouch. This method also could not be applied equally to a concave curved surface.

Another problem to recognize is the measurement of angles on irregular edges. There is no good way to measure angles involving irregular surfaces. Occasional irregularities on an edge can simply be avoided, after close observation.

Shallow retouch on edges presents another problem in edge angle measurement, due to the small dimensions involved. The swing-arm protractor is generally too coarse an instrument to use for this application. The clay impression method noted here may be useful for this situation, if impressions are made carefully with thin sheets of clay.

I have seen examples where the striking platform angle of a biface has been incorrectly defined. In biface manufacture, the striking platform angle is controlled by beveling the edge to obtain the desired angle. The correct striking platform angle is, therefore, the angle formed by the bevel on one face and the normal surface on the opposite face, as shown in Figure 12. A fairly common mistake made by lithic analysts who are not flintknappers seems to be to measure the angle between the two main faces and call this the striking platform angle. This ignores the beveled surface that forms the true striking platform.

There is sometimes confusion in the literature on the definition of the striking platform angle. The striking platform angle is the core edge angle, controlled by the knapper to obtain desired flaking results. This is the angle of the residual striking platform surface to the adjacent *dorsal* surface on a flake, as shown in Figure 13. Some authors have incorrectly referred to the "flake detachment angle" as the "striking platform angle." The flake detachment angle is here defined as the angle of the residual striking platform surface to the adjacent *ventral* surface on a flake. This can also be measured as a flake attribute, but is not the striking platform variable angle that the knapper controls.

To obtain controlled flaking, the striking platform angle must be less than 90 degrees. I have often been puzzled by references to obtuse striking platform angles. One answer is that flake detachment angles were really being used, instead of striking platform angles. Another reason for obtuse striking platform angles being cited is that the main dorsal face was not used in measurements. Instead, the short beveled surface on the dorsal face, resulting from striking platform edge preparation, was used in measurements. This error can easily be avoided by using a reasonably long length of the dorsal surface of a flake.

SUMMARY

While the study of edge angles on artifacts is potentially useful to the lithic analyst, caution must be used in assuring that these angles are being measured correctly and with an acceptable degree of reproducibility. Several angle measurement techniques have been discussed, but none of these methods can be used universally without reservations. As noted, there are basic geometric reasons why not all edge angles can be measured accurately.

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TOWARD A TAXONOMY FOR LITHIC REDUCTION TECHNIQUES

1. Introduction

A taxonomy of lithic reduction techniques is necessary in order to permit a standardized nomenclature of stone artifacts (tools, cores and flakes) that is applicable on a world-wide basis encompassing the span of time beginning with the dawn of hominid development to the present day. Though it is generally true that "the purpose of classification is not problem solving but organization" (Knudson:299) the very task of organizing stone artifacts has generally been quite problematic.

When such a systematic nomenclature is established and validated, archeologists, ethnographers and lithic technologists will have a common point of reference enabling a uniform dissemination of information. A systematic taxonomy will also allow investigators concerned with technological change the ability to chart through time the presence - absence of specific techniques, providing one is aware of the nature of the range of by-products associated with each technique. Plotting the arrival, refinement and/or abandonment of a given technique or cluster of techniques in a given regional cultural context would be of inestimable value for the archeologist concerned with culture change, cross-cultural influences, and may provide methods of cultural identification.

This paper is focussed on the concern that before interpretation of this kind can get underway, the "facts" themselves, i.e. the reduction techniques and the nature of their by-products, must first be scrutinized.

The question remains, "What attributes of a specific artifact or artifact assemblage are valid, and how can we be sure these attributes are sound?" Until recently it has been very difficult to apply "non-subjective" and "non-intuitive" attributes to the multitude of stone items we collect year in and year out--that is, attributes which are quantifiably measurable. Just because a certain artifact could have been used for a certain task does not insure that it was: a "projectile point" may have been, in reality, a knife, a tool for boring or drilling, or even a ceremonial item. Along similar lines given a certain artifact can be fabricated in a certain way does not necessarily prove this was the method employed: a chopper may have been made through direct percussion, block-on-block or bipolar techniques. Generally, attempts to classify and describe stone tools have been based upon opinions of how we "think" these items were used and/or what they look like and/or made and even on the basis of how they fit in our hands (i.e., left-handed or right-handed). This produces confusing, variable classification. An illustration of the confusion may be the "hand-axe" = coups de poing - ovate biface = percussion biface.

It is the contention of this paper that the study of how an artifact was made and how an artifact was used represent two separate, though ultimately complementary, domains of investigation. If this is the case, then it follows that the set of criteria employed for classifying types of functional use-wear must be of a qualitatively different nature than the set of criteria used for classifying the methods of lithic reduction. When we investigate how a tool was being used and how a tool was made, we are actually investigating two completely independent, though interrelated, sets of behavior patterns: "Before I can use a knife I must make a knife." There are many shapes a knife may assume, e.g., a "simple" unretouched percussion flake, a blade off an obsidian prismatic core, a bifacially thinned core, etc. Another set of behavior patterns (cultural choices) determine how the implement was used.

The difficulty of determining lithic use-wear is slowly but substantially being abated thanks to the pioneering work of Semenov (1964) and others who have followed his lines of research regarding the analysis of the microtopography of the edges of stone tools (see Keeley, 1977; Hayden, 1979). Not only does this research attempt to measure how and on what material a tool was used, it also enables the substantiation or rejection of the findings through controlled experimentation. Important to note, the information being obtained in relation to a tool's function is chiefly *inherent* in the artifact itself; that is to say, the use-wear pattern is determined solely by the evidence located on the surface of the tool and by those experiments designed to replicate that pattern. It is not dependent upon the cultural, regional or temporal context in which it is found. And, to repeat, the data, is in no way directly dependent upon how the tool was made. (Rather, it appears that the definitive factors in use-wear analysis are the material of the tool, the force applied during use and the environmental context from which it is collected (Hayden:28-37; Keeley, 1977).

The classification of lithic reduction techniques is of a different nature though it is suggested that the information necessary to accommodate the proposed taxonomy must also be inherent in the artifact assemblages themselves regardless of cultural, regional or temporal contexts. Such a system of classification must be based upon a fundamental attribute which is shared by every single member within the class of techniques, must possess the capacity to be measured and tested, and ought to be represented in all by-products (artifacts) generated by those techniques. A common denominator, subsuming variability of kind and variability of degree, must be established before a valid taxonomy can be engineered and applied. This common denominator must adequately account for differences and similarities among the various techniques, both known and unknown. In essence, such an attribute must support an organizational structure permitting the systematic classification of a specific class of phenomena (namely, lithic reduction techniques) and provide a standardized system of nomenclature which ought to embody the nature of the attribute in question. The structure ought to accommodate potential techniques as well--those which are experimental, unproven, and/or unknown at the present time.

The taxonomical classification that follows proposes that all lithic reduction techniques may be classified under the attribute of *force*; that is, a force which is intentionally applied. The designation "taxonomical" simply implies a hierarchal system of organization. In this instance it is illustrated as follows:

FORCE

Force is here defined in terms of energy harnassed and intentionally exploited by hominids in general. It represents a primary set of knowledge coupled with those patterns of activity (motor habits) which are implemented in an intentional and voluntary framework. The use of the term "force" is here applied in a humanistic sense rather than one based upon the physics of stone fracture. The types of forces described below are here referred to as cultural patterns of knowledge/behavior and indicators of human choice and habits.

METHOD (Strategy)

Method refers to the varieties of strategies (or types of forces) capable of being employed during culturally induced reduction-modification of lithic materials. The types of forces included here are percussion, pressure, bi-directional, abrasion, and thermally induced fracture.

TECHNIQUE (Tactics) [1]

Each technique is a specific expression of a single force and thus classified under the type of force being generated.

BY-PRODUCT

Finally, the by-product, the artifact itself, is here regarded as the material expression of a specific technique or set of techniques that were implemented toward its production.

This train of thought may be reversed. A stone artifact that has been culturally (intentionally) reduced (or modified) represents a subset of the technique or set of techniques which produced it. In turn, each technique represents a subset of the type of force it generates during its application. Finally, each type of force represents a subset of the full range of forces that is recognized, understood and exploited in a specific cultural milieu, and represents the understanding that it is more advantageous and profitable to intentionally reduce rocks on a voluntary basis that to rely on Mother Nature to provide ready-made items which will adequately serve the purposes of survival.

One final point. Please note that "force" refers to energy that is harnassed. This is not to say energy that, when applied, is precisely and explicitly predictive and controllable in relation to by-product morphology. This type of prediction and control is culturally relative. All techniques of stone working are here regarded equally in that the nature of this classification is based upon the premise that the variety of techniques and the respective forces generated during their implementation represent general sets of shared patterns of knowledge and behavior, the expressions of which are isolated in the artifact assemblages themselves. It is not the purpose of this taxonomy to explain how and why certain techniques developed the way they did, nor to judge what a "refined" technique is as opposed to a "crude" one. That is, this taxonomy does not inform us as to the significance of the differences between assemblages (Binford, 1972:p. 247). Rather, the sole purpose of this classification is to supply a logical structure that accommodates all techniques under one roof and then places them unambiguously, if possible, into the appropriate rooms.

2. Structure of a Taxonomy for Lithic Reduction Techniques

2.1 The Forces

Since the key attribute used to sort out the myriad of techniques is the nature of the force employed to fracture or otherwise modify stone, the first task is to factor out the different types of forces employed in lithic reduction, and then plug in those techniques peculiar to each.

A. The forces are:
1) Percussion
2) Pressure
3) Bi-directional
4) Abrasion
5) Thermally Induced Fracture

B. Given:
1. A core is a stone which is the focus of reduction/modification.
2. A fabricator is an object or objects employed to reduce a stone core.

C. 1) *Percussion:* a force initiated by striking one point on a core with a fabricator of stone, bone, antler, wood or a suitable combination of these, for the purpose of removing a flake, blade, section or chunk from the specific area being struck. The force generated by percussion travels in essentially one direction beginning at the point of impact and diffusing through the core material, i.e., a uni-directional or one-way force.

2) *Pressure* A force generated by the gradual building of pressure by a fabricator lodged against the edge (platform) of a core until the flake is pushed or pulled off. Also uni-directional in nature.

3) *Bi-directional:* A method which generates and exploits a secondary or "rebound" force capable of removing flakes from a point of contact other than that struck by the percussor. Usually used with a hard anvil or stablized protuberance upon which the core's distal end is placed. An initial force is delivered to the proximal end of a stablized core. This impact generates a secondary force via the anvil's resistance to the initial blow, generating a rebound force which travels upward through the core detaching flakes from the distal end of the core, as well as from the proximal end.

4) *Abrasion:* A category including all those techniques employed in shaping stone materials by rubbing or grinding and incising or cutting.

5) *Thermal:* Variations of temperature employing the forces of expansion and/or contraction which flake or otherwise fragment the core material. (Heat-treating used to upgrade the core material does not apply here in that it is designed to process the stone rather than to fracture it.)

2.2 Rationale of Technique Classification

For each method (genus) it follows that there must exist at least one technique (species) which generates that particular expression of force. Techniques which share a particular force are thus similar in kind. The classification of techniques within a single genus of force will be determined solely by the particular force which is implemented. The techniques included here do not represent the entire range, but rather serve as examples of each method.

It must be kept in mind that this system is not directly concerned with the by-products resulting from the techniques in the sense they be used as diagnostic variables (at least not yet). This is what is being avoided in consideration of the possibility that two separate forces may be responsible for a similar by-product. Occasionally various by-products will be mentioned for illustrative purposes only.

2.3 Skeleton of the Classification

Key for Symbols:

F = Fabricator	P = Punch
C = Core	R = Rest
→ = Applies force to	A = Anvil as Fabricator
T = Temperature	

2.3.1 Percussion

A. Direct (F→C; F→C +R)
1. Rock throwing
2. Hard hammer
3. Soft hammer

B. Indirect (Punch) (F+P→C; F+P→C+R)
1. Hard punch
2. Soft punch

C. Block-on-Block (C→F; C→A)
1. Rock throwing
2. Hand-held

D. Sculpturing
1. Direct (pecking) (F→C)
2. Indirect (chisling) (F+P→C)

2.3.2 Pressure F→C, F→C+R
A. Hand-held
B. Crutch
C. Indirect (lever)
D. Supported

2.3.3 Bi-directional F→C←A or P
A. Bipolar
B. Reverse percussion
C. Reverse punch

2.3.4 Abrasion (F→C; C→F)
A. Rubbing (grinding)
B. Incising (cutting)

2.3.5 Thermally-induced fracture (T+C)
A. Heat (fire)
B. Heat+cold (fire+water)

2.4 Explanation

For the sake of simplicity the forces and techniques are limited to and apply to cores of stone only. However, if the structure of the classification is judged valid, there is no reason not to include cores of non-stone materials.

2.4.1 *Percussion*

A. Direct percussion is the use of a single fabricator striking a core to remove a portion of that core which is struck.

1. Rock throwing, or boulder smashing, is a direct percussion technique *when* the rock thrown is the fabricator and the target is the core. Though generally considered not a "controlled" technique, it is a technique nonetheless.
2. Hard hammer percussion involves stone fabricators, and covers at least two subclasses:
   a. Hand-held core is struck with a stone fabricator;
   b. A stone fabricator is struck against a core supported on a rest or in a vice. A stone anvil used in this context refers to the "Hard Anvil Technique" as discussed by Patterson, (1979:22).
3. Soft hammer percussion is bifurcated into similar sub-classes as hard hammer. Its distinction lies in the material used for a fabricator, which includes antler, bone, wood and tusk.

(The distinction here concerning hard and soft percussion is admittedly simplistic. Callahan (1980:17) is probably closer to the mark in his 1 - 5 scale dealing with hardness grades of hammers. This area of plotting distinctions between "hard" and "soft" still requires much work.)

B. Indirect Percussion techniques require an intermediary, object, or punch, placed between the core and fabricator. The end of the punch is placed on a selected point of a stabilized core. Once it is set, it is struck on its other end by a fabricator.

1. A Hard Punch is one of stone and may be used to derive macroflakes. Morlin Childers (1977; Personal Communication 1979) uses this technique to produce "ridgebacks" -- large prepared flakes -- by flaking boulders embedded in the ground.
2. A Soft Punch is softer than the core material it contacts; usually of bone, wood, antler and copper. (Well illustrated in Crabtree, 1972; and Bordes, 1968). See Fig. 5.

C. Block-on-Block percussion techniques require a stabilized fabricator, usually of stone, which is struck by the core. This species is distinguished by the fact that the core is the element in motion, while in the other manifestations of percussive forces the core remains relatively still.

1. Rock Throwing is a block-on-block technique when the thrown rock is the core and the target is the agent of fabrication.
2. Hand - held techniques are carried out when a core is struck against an anvil stone while maintaining possession of the core.
   a. Generally this technique is carried out by striking a core against a stablized fabricator or stone anvil.
   b. Crabtree (1972:47) illustrates another variant in which the core is struck against a hand-held fabricator (anvil?).

D. Sculpturing applies to pecking and chiseling.

1. Pecking--"The percussive technique used to form overlapping superimposed cones, usually with the direction of force being applied to the surface of the material in a perpendicular direction. Commonly used in grooving and shaping of hammerstones" (Crab-

tree, 1972, p. 80). The fabricator is as hard or harder than the core material. Also used in the production of milling tools, certain types of petroglyphs, and ground axes.

2. Chiseling is a term for indirect pecking, utilizing a hammerstone and an intermediary stone punch to chip away or shape the core. Employed in quarrying operations when a wedge is needed and also in the fabrication of detailed reliefs on stone materials.

2.4.2 *Pressure*

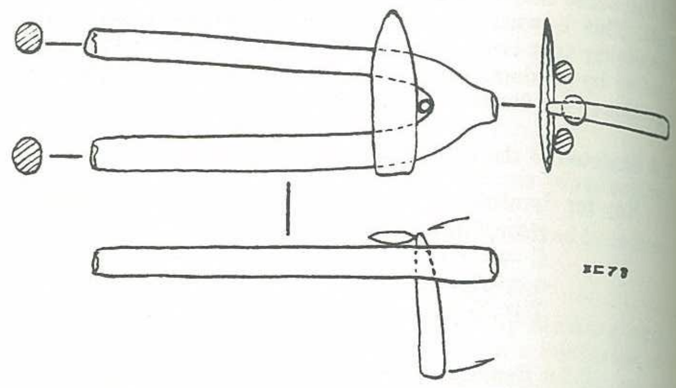
A. Hand-held core is modified by a fabricator of bone, antler, or copper held by the other hand. Also cover those instances when teeth are used to shape and retouch the core.

B. Chest or Shoulder Crutch Technique: "A wooden shaft of varying dimensions with a chest rest cross piece at the upper end and a pressure tip inserted at the working end. The shoulder crutch is a small version of the chest crutch. Size and construction depends on individual preference and type of work to be accomplished. Usually used as a pressure tool, but can be used in a combination of pressure and percussion" (Crabtree:57; also in Reiner 1979:5-7).

C. Indirect Pressure is a technique developed by J.B. Sollberger using an antler fork (Flintknappers' Exchange, 1(1):6 (Fig. 14).

1. "In using the fork and lever, I placed the flake blank on top of the fork close to the crotch. The thumb held it in place while four fingers held the fork and immobilized the preform. The lever point was then inserted from the bottom, seating the point at the flake edge for spot loading. The pressure flaker was then pushed hard to prevent slippage prior to any leverage against the fork

Fig. 14. Illustration of Sollberger Lever Fork



crotch. Flakes were removed by holding the lever tool in one hand and the fork and preform in the other with the distal ends of each implement placed across the top of my legs (seated) and then pressing downward while moving the legs outward. The device was an immediate success."

2. Another lever device developed by J.B. is used for fluting and blade manufacture (Sollberger, 1980: pers. comm.). (Fig. 15+3)

D. Supported pressure techniques include those which support the biface on the lineal edges, a single face and both faces, to name a few (Callahan, 1980: pers. comm.).

2.4.3 *Bi-directional*

This is a rather unexplored and confusing force as are its techniques. The term has no immediate bearing on Crabtree's usage of it in his description of a type of core (1972:38). Three techniques are suggested for this category: bipolar, reverse percussion, and reverse punch.

Fig. 15. Lever Fluter & Its Inventor

A. Bipolar flaking is carried out when the distal end of a core stablized on a stone anvil is in direct opposition to the percussor's point of impact (contact) on the core's proximal end. (Fig. 16). The opposition of the proximal and distal points is necessary to generate the two forces utilized by this technique. Whether or not a "bipolar flake" -- one possessing a bulb or sheared cone at each end -- is produced is irrelevant at this point of the classification. Though in agreement with Patterson (1979:21-22) and his discussion of "true bipolar fracture", a bipolar flake is not the only feature of bipolar flaking nor is the production of bipolar flakes considered here to be the only valid by-product of this technique. What is being considered important *at this stage* of the classification is that the usage of the term "bipolar" ought to be applied when the proximal and distal points of contact are in direct opposition during the reduction process.

B. Reverse percussion is a tentative label which could be changed to "secondary force flaking" Patterson, 1980: pers. comm.) or "counter-retouch" (Semenov 1964:44). This technique exploits the rebound force and offers a level of control not available during bipolar reduction. Tixier demonstrated this technique to J.B. Sollberger during a recent visit to Dallas. He placed an edge of a flake horizontally on a ridge of an anvil and struck the upper middle face of the flake (core) with a light percussor, removing small flakes from the edge placed on the anvil's ridge and producing a sharp denticulated scraper. (Sollberger: Personal Communication) The author has used this technique in the manufacture of "dome scraper-planes" and burins.

C. Reverse punch. (Fig. 17). This technique entails a punch that is stablized in an anvil (wood or bone anvils work fine). The prepared platform of a blade core is placed on the punch (the rest of the core's distal end rests upon the anvil). Using one hand to stablize the core, the proximal end of the core is struck with a heavy, soft percussor held in the other hand. This action initiates blade production from the distal end originating at the point of contact of punch and platform. Betty Goerke (1980:pers. comm.) stated that this was a popular blade-making technique in India until thirty years ago.

2.4.4 *Abrasion*

Abrasion is distinguished by those techniques utilizing a fabricator designed to wear away the core by rubbing and/or incising via the application of repeated pressure in a rotational, back-and-forth, or similarly patterned manner.

A. Rubbing includes sanding, polishing, and grinding of an abrasive fabricator against a core. Illustrations of this force are: 1) shaping soft stone like steatite; 2) abrasion of platforms for controlled flaking; 3) add finishing touches to reliefs and other types of cores previously roughed out by pecking or chiseling techniques; and 4) abrasion of a core with sand in a leather pad (Callahan, 1980: pers. comm.)

B. Incising refers to cutting or drilling operations carried out generally on soft stone cores. Here the fabricator is either a harder material than the core or sand may be used to assist the cutting or drilling.

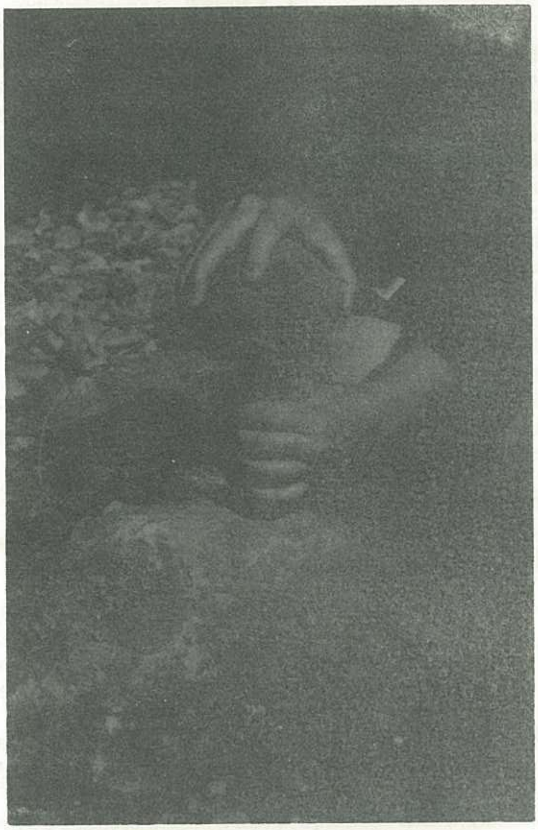


Fig. 16. Bipolar Technique

2.4.5 *Thermally Induced Techniques*

Thermally induced fracturing techniques cover methods employing heat (fire, hot coals, etc.) or a combination of heat and cold (water, ice, snow) to accomplish core reduction.

A. Heat may be used by direct application of fire to stone to instigate fracture of the material in order to break it loose from its parent vein during quarry operations.

B. Heat and Cold is a rumored but rarely substantiated reduction technique, at least in the literature. May represent a myth. Two popularly expressed methods utilizing temperature extremes are presented here. They may represent rumors and myths.

1. After being heated to a high temperature, the core is dropped into a body of water whereby spalls are produced as a response to rapid cooling.
2. After a core is heated to a high temperature, water is dropped on specific areas to be removed through the use of a wet feather or stick. (Acknowledging this as a generally ill-regarded method of myth, there still may exist the need to experiment with a wide variety of lithic materials to be sure such a technique is truly invalid, i.e., not culturally relevant.

3. Validity

The nature of the force generated by a technique was selected as the fundamental attribute on the assumption that it represents the primary mental template operating inside the minds of *stoneworkers*. The knowledge of lithic reduction forces and the wisdom to exploit them involves patterns of thoughts, theories, activities, and expressions directly related to ancient adaptation strategies. While force is here regarded as the unifying principle or common denominator representing those sets of choices motivated by the will to survive, and methods as the incorporation of sets of theories applicable of stoneworking strategies, the patterns of activities (the actual implementation of those forces) and the patterns of their expressions constitute the lithic reduction techniques and their by-products, respectively. Thus, since the principal forces were implemented the world over, they represent general sets of shared beliefs and behavior.

3.1 Experimentation as Verification

Before a working nomenclature can be applied with any confidence, a few questions must be answered.

1. What is the range of by-product variation of a specific technique in relation to a single type of core material? A single class of fabricator material? (This must be applied to all techniques in each class of force limited by a constant range of core materials.)
2. How can we measure and distinguish the manifestations of a specific force generated by a specific technique on a specific type of core material?
3. By which techniques can a single artifact be produced, be it a type of flake, chopper, scraper, projectile point, etc.?

These are examples of the types of questions we need to ask. The answers are available only through structured replication experiments designed to explore and measure the limits and variations peculiar to each force in general, and to each technique's expression on a specific core material in particular.

3.1.1. Following is an attempt to illustrate an experimental program.

A. Given a specific region
B. Given the artifact assemblage and materials found in the archeological assemblages of that region (e.g., chert, quartz, rhyolite)
C. Given a working knowledge of the motor habits required by each technique.

1. Apply each technique to each type of core material. Core material ought to be locally obtained and in its raw state (e.g., cobble, vein, float, etc.)
2. Isolate by-products according to specific technique and core material it represents
   a. Examine range of variation in terms of the presence, absence, variability of technical attributes (force features) and/or the wear patterns of production found on the core, fabricator, and by-products. (In the case of abrasion, analysis is limited to core and fabricator; with thermal analysis we examine the core, spall, and environment.) At this stage by-products ought to be primary or simple forms, i.e., flakes, sections, spalls, etc.
3. Formulate graphs by which productive ratios can be applied to a set of technical attributes according to frequency.
4. Compare variability of technical attributes in relation to the range of lithic materials worked (e.g., chert, quartz, and rhyolite) by a single technique preferably by a single type of fabricator material.
5. After each technique in each genus has been examined and computed, the data can then be applied to investigate possible diagnostic attributes peculiar to each force and/or attributes which are shared by different forces.

Essentially, then, experimentation and examination of the results will be necessary in order to:

Fig. 17. Reverse Punch with Core & Blades. Note: Copper Inserted in Log in Front of the Core

1. Isolate any and all diagnostic attributes peculiar to each force, and hopefully to each technique in relation to the material being worked;
2. familiarize ourselves with those techniques or complexes of techniques which are capable of accomplishing similar tasks; be it the production of blades, choppers, channel flakes for fluted points, split cobbles, scrapers, or statues and reliefs; and
3. provide the data necessary to evaluate the negative evidence implied in a particular assemblage by accounting for those techniques and artifacts which are absent, and thereby providing information or clues regarding the nature of the choices a particular cultural complex had to work with.

4. Conclusion

By their structural nature, lithic artifacts represent the single most populous category of evidence by which we are able to chart the evolution of adaptational strategies exercised during the entire course of hominid existence and development (evolution). This taxonomy attempts to provide a system which will not only offer a workable nomenclature for lithic analysts but will at some future point allow us to evaluate and compare the patterns of human behavior which are represented by and implied within the artifact assemblages themselves.

If and when the varieties of forces and their respective techniques can be measurably defined and distinguished archeologically, then perhaps we can begin to inter-relate both aspects contained within lithic assemblages -- the methods of their manufacture (the means) paired with the nature of their functions (the ends). If these two aspects can be accounted for in a measurable way and the information applied confidently to complexes of artifact assemblages, we may begin not only to measure differences and similarities between all assemblages, but develop some criteria concerning the significance of the differences between mankind's various technological strategies as well.

1. Technique as it is used here is similar in meaning as the term "mode" in Newcomer (1975) and has been broadened to cover all aspects of lithic reduction/modification.

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CRAFTSMAN. . . .
BO MADSEN

INTRODUCTION BY ERRETT CALLAHAN

With this issue we feature an interview with Bo Madsen, Denmark's premier flintknapper. Born April 11, 1951, and holding a Prime Degree in Nordic Archeology (like our B.A.), Madsen (pronounced "Massen" in Danish) is currently finishing up the equivalent of his Ph.D. at Arhus in Jutland, Denmark, while serving as a part-time archeologist and instructor at the Kulturhistorisk Museum in Randers. His publications on flintknapping include a paper (in Danish) on a Late Mesolithic, Ertebølle or "Kitchen Midden" complex in *Arsskrift for Sønderhald Kommune, 1977-78.*

I had a thoroughly enjoyable time interviewing this amiable Viking flintsmith. During our first evening together, we tried to avoid talking lithics--a mutual effort at attempting to get at the person behind the billet. After 4 or 5 notably unsuccessful attempts at so doing, we gave it up and dove into lithics for all it was worth. I discovered that Madsen had just been the subject of a TV special on flintknapping for Danish educational TV, a special that aroused considerable interest in the schools. We spent a number of days at his flat in Randers and travelling all over Denmark looking for flint for the upcoming seminar at the Lejre Research Center (see *FE* 3(1):4-5).

We taped the following interview Oct. 7, 1979 while knapping flint at Lejre. While Madsen has an excellent command of English, we have tried to keep as much of the original flavor of his "Accent"--his word expression, his verbal idiosyncracies--as we could. For we look upon these interviews as means of documenting the way a knapper communicates as much as on the way he knaps. This is particularly pertinent to the present discussion. We favor this over a mechanical, tightly edited, synthesis of the original expression. That is, we believe the total person is of value, not just his by-products.

This interview is unique in a number of ways. We have here a professional but easy-going archeologist looking at flintknapping with an interest nearly equally divided between the two perspectives. Though he is well within the academic, avant-guard mainstream, Madsen is clearly in love with flint. Perhaps this stems from his working flint within his own genetic tradition--a Dane working on Danish lithic problems. (How many of us Paleo-Indian nuts are Indian?) He is following the tradition of the late Danish Master, Anders Kragh, whose 1964 book, *Mand og Flint* (Man and Flint), Crabtree helped popularize--except that Madsen is on top of the latest technological and archeological findings, having worked with Bordes, Tixier, and Pelegrin. The day following this interview, Madsen participated in the week-long multi-national flintworking seminar at Lejre, putting him in contact with numerous other knappers from around Europe and, subsequently, within Denmark.

E.C.: What are the influences that led you to make stone tools?

B.M.: It's something about the curiosity, I think, when I was a boy. I was very interested in finding tools. I participated very early in some excavations during my holidays from school -- when I was an undergraduate. I started looking for Mesolithic sites around the place where I lived. I was quite successful at finding a lot of nice Ertebølle and Maglemosean sites and so on. And of course I asked myself how these things were made. I think one of the things that really started me off was the Danish translation of the book about Ishi, written by A. Kroeber. I read that book and was deeply inspired by that. So I started a little percussion flaking with stones during high school. But I got out of it; I had many other things to do. So when I started studying European prehistory, I was asked to make a few stone tools for the museum where I was working, besides my studies. I was soon pursuing a level where I couldn't get any further. Well, in 1972 I received a few antler tynes -- not very much, but it started me well off in trying to duplicate some of the Acheulean tools. I made a few handaxes.

I think it was in 1973 or 1974 I saw for the first time the publication by Don Crabtree and Francois Bordes. That really put me on; it was really fantastic and interesting to read about. I remember the first publication I read was the Folsom paper. It took me months to go throught it -- first of all to understand the English and next going through the reduction properties. I started out trying a little percussion flaking with soft billets and started pressure with Roe deer antler. Of course my results were primitive, so I stopped for awhile; kept it as some sort of hobby until 1975.

In 1975 I was fortunate to be excavating along with a French medical student, Jacques Pelegrin, who lives in Paris. He was along and it showed soon that he was a very good flintknapper. He was a student of Bordes and Tixier. Besides some antler and stone, he used boxwood. Of course I've heard about it but never thought it was plausible to work with boxwood. Since 1975, Jacques and I have been working together twice a year -- reading and freaking out with flint more are less.

One of the very important years was 1977 -- we both spent a month in the south of France in the region around Bergerac close to Bordes home, sort of a country house; we worked together with Bordes and were very inspired by him. He showed us a lot of sites. We went around the countryside collecting flint for him in the Bergerac region. That really put me on to flintknapping. By that time I was able to make good, thin handaxes and sort of thick short leaves of the Danish Neolithic -- and a few pressure flaked points. Jacques taught me to use copper -- I'd never used copper before. I used iron tips and antler.

Since 1977, I started working more intensely with percussion flaking and with bifacial thinning. One thing that Jacques and I worked on together was the production of blades by percussion. So that was the natural thing for me, as he was working on French Mousterian and Solutrean and some specific Upper Paleolithic blade traditions. So I started with some punch techniques and am still working on trying other different techniques.

E.C.: How has the raw form of your favorite lithic materials affected your initial stages of biface or core reduction and/or your evolution as a knapper?

B.M.: Well, I first tried to work both in Danish flints which are very plentiful and to work in some Arab regions in South Arabia where there is very scarce resources. By those experiences I saw how plentiful the Danish flint is. It means a lot when you can pick up a tabular piece of flint 30-40 cm. long and 20-30 cm. wide. That's why I'm getting into larger shapes. On the other hand, I have the finished products of the Danish Late Neolithic, for example, some of the daggers. I've been looking at these since I was 14 or 15 years old. Certainly they are a lot to go for. I'm just learning the basic steps at the moment, I think.

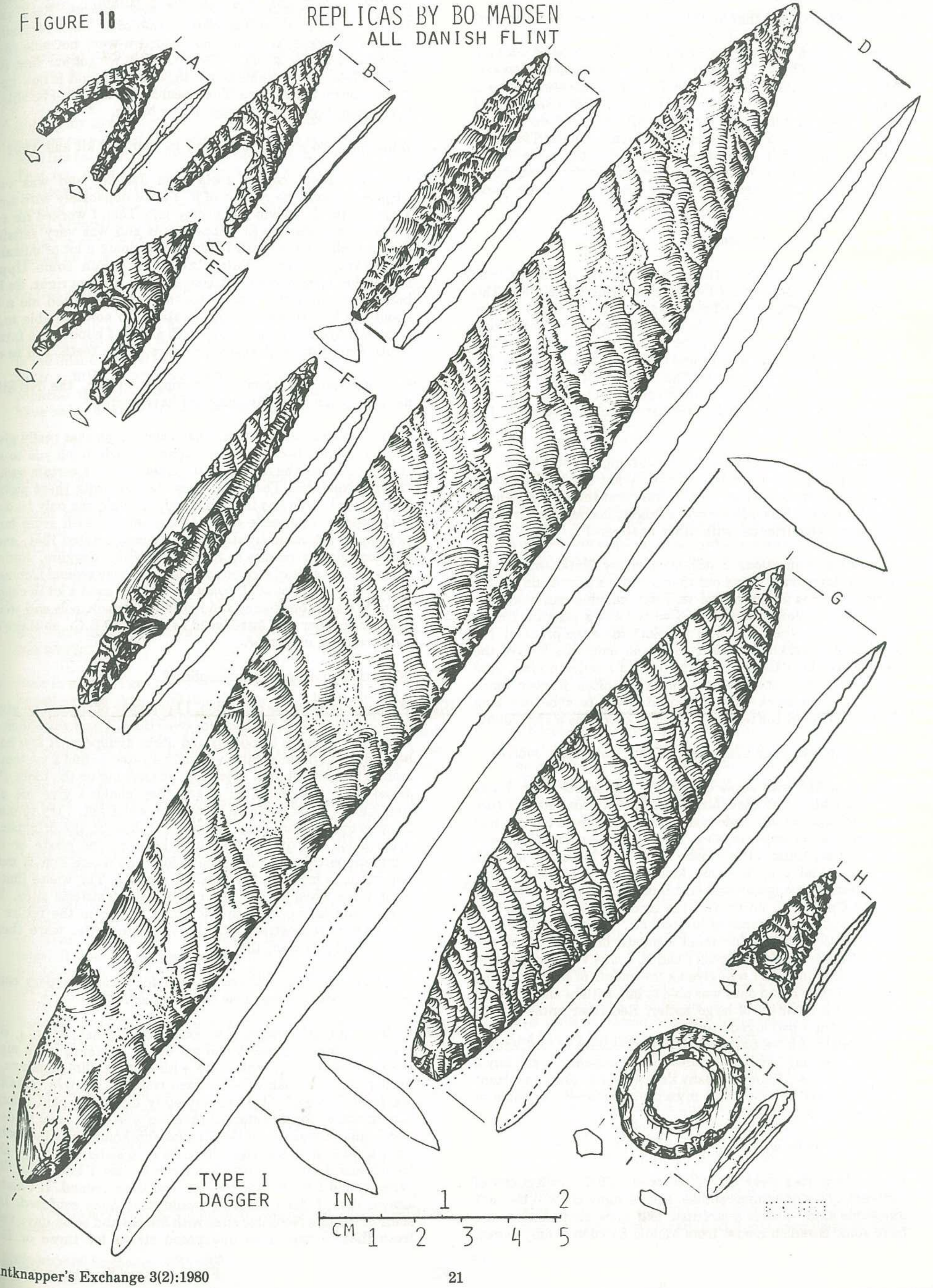
E.C.: How are the steps that you take in reduction of a biface influenced by the particular material you have here in Denmark?

B.M.: In the region where I work we have very few tabular flints. It's mostly rounded cobbles from the riverside and from the coastal side. It takes hours just to thin a piece before you can determine whether it is good for a dagger or a sickle or whatever it is you want to make. But around the region of Zealand and down in Falstar, I've been finding large tabular flint.

E.C.: Can you define tabular flint?

B.M.: Tabular flint is a slab-like flint, very large with soft shapes; thin with white cortex that has been rarely touched by ice or water transport. It is what I call "virgin flint". It is just out of a cliff, out of the chalk. It has a glassy sound when you hit it. It's really

FIGURE 18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very nice.

E.C.: How much time and flint and time do you invest in knapping?

B.M.: I have not been working very continuously. I've been working during my holidays. This year I've been working two weeks, this summer. Last summer also I worked something like a month and a half -- only when I have time, during weekends I do a little knapping. On Saturday afternoons I do a little pressure flaking, maybe a few flakes on a biface I've been working on. Or I try experimenting with some blade production. I learn more by going to sites, getting some stock, then for five days just working on preforms. I keep these preforms as stock to work on later in finer thinning.

E.C.: What do you mean by sites?

B.M.: Sites where you collect flints, not prehistoric sites. For example the Falstar site -- I've been working there a lot. This winter I was there at Christmas; it was freezing. I was collecting tabular flint along the coast. So I gathered something like 20 or 30 pieces and sat under a tree working there. Each five minutes I was running around the beach to keep warm. My hands were blue. So I reduced the blanks, with some luck, to fifteen pieces, into a preform stage. I put them into my backpack and took the walk back for 13 miles. You know the beach, you were there.

E.C.: You mentioned something about working on weekends. It brings up a question I'd like to ask. What is the context in which you prefer knapping -- for instance, weekends, weekdays, vacations, after work, at night, inside, the yard, the lab, alone, with friends, with other knappers?

B.M.: That's a lot of questions. I still consider my flintknapping as a plan of relaxation. I found out that if there's any strain on me, flintknapping is a way out of it. Flintknapping can also be a strain to you. Very often I reach what I call a plateau; I can't get off of it. I'm standing there and can't solve the problem. I'm working and working, I break more and more. So I leave the tools; I just don't think about them for a month, maybe. And then I return to the problem and very often it goes much better. I never work when I'm tired. I try to avoid working then. It gets to be too tedious. I want to keep it as a nice hobby.

E.C.: What comprises your knapping tool kit? How did it evolve?

B.M.: Well, I worked with stone during my highschool time. I was good at making just basic large flake production; sort of core axes, and some stone-made blades. So I got a good base in just stoneworking in large nodules. The first antler I received was the size of my thumb. But I made some good Middle Acheulean handaxes. And I made some Mousterian -- Acheulean-type Mousterian -- triangular-shaped handaxes. I was not able to go into the Upper Paleolithic with the blade-making and real thin bifaces. This was because of my tool kit. Then I got a piece of moose antler. I had it for about a month but I lost it on the beach. But for the few months I had it, I was very productive. It was great. In 1975 I was given a few pieces of boxwood from Jacques. I then found out I was able to buy antlers and in 1976 I purchased a quantity of large antler, Red Deer antler. From then on I felt I had a good toolkit.

The tool kit I have today is very fine because of that antler. Every late spring I go to that forest near Copenhagen and buy a few good pieces. I know for many knappers it's really important to have a good tool kit and I myself experienced the value of excellent tools.

E.C.: Can you describe what they are?

B.M.: I have these Red Deer billets, boxwood billets, collections of different types of hammerstones. I have some chalk -- the soft limestone kind --, some quartzites, and some basaltic stones. I have some Swedish moose from Middle Sweden -- only tynes, no big, heavy pieces. But I really experienced that the size of your tools determines the size of your bifaces. Each year Jacques and I move up something like 8 to 10 cm. I remember when we worked just with boxwood; we were not able to go further than 15 or 20 cm. in length. When we got our first Red Deer billets we were able to get to 30 cm. Jacques is now up to 35 cm. for maximum size. That means a lot to you to be able to take some large flakes across a long biface.

E.C.: What place do copper tools have in your tool kit and why?

B.M.: I learned about copper tools from Jacques and was very surprised about the results of it. I tried deparately with some antler -- Roe deer, which is pretty soft. Then I worked for two years, three years, with copper tools and was very satisfied with myself, that is, until I found I was doing a lot of mistakes in working Eskimo, Paleo-Indian, or even some Upper Paleolithic French tools with copper. That was not right. So I'm back in trying antler again. But the copper learned me a lot about the French ways of preparation. So now I'm able to do some satisfying pressure work with antler. I hope in the future to use more time with antler pressure, bone, teeth, and so on.

E.C.: How do you feel about using copper in say, the Neolithic daggers when they obviously did have copper?

B.M.: That's a very good question. That's something that really gives a specific thing because these daggers nearly temp you to say that you can see the influence of copper just at a certain spot in the late Neolithic. There are these daggers with these zig-zag lines in the handle and these certainly, I think, can only be done with copper. I've made a lot of experiments with some large pressure work in un-treated flint, un-heat-treated flint, and I get very similar results to the late Neolithic daggers. And we know there's a lot of copper and a lot of bronze around Denmark at that time. I'm not at all doubting that we used a lot of copper then. We have huge axes and hordes of copper tools and so on. The first copper was introduced here in 3300 B.C., so there's a long tradition of copper.

E.C.: What do you do with your replicas?

B.M.: Well, you've seen the collection. I keep most of them. I've given away a few of them for museum collections. I exchange some of them. I gave some to Bordes and other knappers. A few have been given to friends. But I've really wanted to find a system to make a permanent kind of writing or marking on the tools. I've asked some specialists on it and they couldn't give me any solution. So I just write on with some white ink. I try to mark them year by year. I try to keep the data on the originals. I make a lot of experiments but I keep all the waste or the complete percussion flake production. The waste flint is more important to me than the finished product. The waste flint is what I use when I'm going to compare prehistoric sites. We have a bifacial working site now and I hope in the future to compare or reconstruct exactly what properties were there, what traditions were there.

E.C.: What specific contributions do you feel that knappers could make by documenting their tools and activities?

B.M.: Well, I can tell you a few examples of that when I was presented with copies. One of my pupils -- I teach some night school classes -- presented me with a black flint handaxe, a beautiful Mousterian of Acheulean tradition. It was certainly not from Denmark, it was completely fresh. He paid a large sum of money for it. I started thinking who could have made it and I think it was one of the English flintknappers who visited Arhus. So I think somehow he gave it to some friend and this friend sold it. It was quite fortunate for me I knew the flint variety, and I knew this knapper had been around. If I hadn't known that, I don't know; I would have been confused. But some of the late Neolithic sites with bifaces and so on have very fresh flint. Lying in an unexposed strata for three or four thousand years, the flint is still fresh. So you could easily make mistakes. I think it would make a lot of archeologists suspicious of flintknappers if they did not have the right etic approach.

E.C.: Carrying that one step further, what debitage or quarry sites do you have, and how are they monitored to prevent future archeological confusion?

B.M.: Both of my sites where I collect flint are coastal sites with huge erosion each winter. One site I made some serious experiments with flakes/debitage. I kept it around a large rock on the beach. That was during the winter; and next summer I was there to register some of the remains of the workshop and there was nothing left -- it was all gravel. That's also good information about prehistoric knapping sites because they probably were lying the same way. We really miss a lot of these sites. There should be much more sites.

E.C.: So that was a year for the flakes and bifaces to turn to gravel?

B.M.: Well, I think it would have taken just one or two nice storms. Big rocks are drawn to the sea. I had a few spots where I work in the inland. I have a site close to a farm with a friend. There I keep a little experiment with patination. I sort of try to replicate the speed of patination. And I already, in five years, have seen the development of just a thin coating.

E.C.: Not the orange - red - brown?

B.M.: No, no. That's what we call "bog" patination. It appears only in an environment that contains a lot of iron. That's always an inland patination. Many sorts of visitors in Denmark think Denmark is rich of red, beautiful red flints, but all these red flints are all black or gray flints that have been patinated. So a lot of people infer that red Danish flint is similar to French Grand Pressieny flint; but that's something quite different.

E.C.: To what extent do you still practice the basic technologies you may have otherwise advanced beyond -- such as handaxes -- and why?

B.M.: Once in a while I get really serious. I sit down and try to make a Levallois core. And I still find out that I'm a beginner -- I'm still not able to do just good percussion work like the Neanderthals did. This spring I was in Israel and had a chance to see some of the collections in the Hebrew University in Jerusalem; some fantastic sites they have down there. I went through some large boxes of just debitage or Mousterian work -- a lot of little Levallois and large flakes, beautiful flakes, stone-made, I think. I tried to copy it in the locak flint. I think it's very important to go back and really try the original methods. I tried working the Australian way of sitting down on the hard skin of your heel and trying to train my body to use my feet and legs more. I have an idea about that. My tool kit, I have to carry it on me. I don't like sort of fancy equipment; just a basic tool kit -- hammerstones, a few soft billets, soft percussion billets, and so on. That is, if you are paleolithic, trying to copy paleolithic tools. If you are in the sort of Magdalenian environment, I would expect people to be nomads; I mean the nomad can't carry much on him.

E.C.: You had some thoughts on soft percussion Levallois. Do you want to talk about that?

B.M.: Oh yeah; I discussed it with Bordes and Jacques Pelegrin. We saw some very thin Levallois pieces and Bordes admitted that he thought he had seen a lot of Western French sites with soft percussion Levallois, where they detached a Levallois flake with, maybe, boxwood or a piece of tusk of some kind, maybe Rhinocerous. But you can use anything, even soft hammerstones.

E.C.: Do you do any hafting or functional experimentation with your tools?

B.M.: That's a very good question, because that is my bad conscience. I'm making a lot of tools that I don't know how it functions; they just look nice, sort of typical tools. I know nothing about the edge, the balance of the tools, or anything. I've done a lot of working with blades. I made an axe experiment and an experiment with projectile points. I would like to know the exact weight of those points -- which are points, which are lancets used for quite other purposes. I think there is a great need for some experiments with flint work in bone and wood and so on. I know that Mark Newcomer in England is making a lot of those experiments. And I really think that's a field that should be investigated much more. I would like to make some bows and try some spear-throwers and so on. I don't have time for it. But I hope when I get my degree that I'll be able to have more time. Well, maybe that's an illusion, but I really give it some valuable importance.

E.C.: Knappers in the U.S. seem to have a distinctive way of relating with one another by spending an intensive three or four days banging away on rocks in each other's company. Is this done much among the European knappers?

B.M.: So far as I know, Jacques and I are the only ones doing it. I don't belive that Bordes has any time anymore. And also Tixier is spending a lot of time on other things. Jacques and I have been knapping together ten or fifteen times during the last few years. I would like to get in touch with more flintknappers. I've been visited a couple of times by some of the other knappers around in Scandinavia. There's a Swedish flintknapper from northern Sweden; he was not a flintknapper then, that is he works in slates and quartzites. But he was down last year. He was really an inspiration to me. So we worked together just a couple of hours. But Jacques and I attempt to keep together. We have lots of plans about getting some house down in south France and working together. We try to establish some kind of workshop where we can work for a couple of times a year. But I get more and more squeezed together when I work here. I have no working place. I have a place to keep my tools and that's all. But another thing is that when you're around, like now, there'll be a lot of publicity of flintknapping. I know there will be at least five or ten new flintknappers inDenmark besides the two new ones you presented me with. I didn't know those two. And there may be problems with that. There will be resource problems. I mean these people will need flint, and some of the good sites will be, maybe ... I don't know. I hope we can split up the flint between us. Also we have very few sources of antler. You see the piles lying there? That's all we can get in one year in Denmark. So far as I can know, something like five racks or ten racks, and none of these have the size I need at the moment. These are just medium size.

E.C.: These are Red Deer that resemble our own elk so much.

B.M.: Yes. They say they once had Wapiti but it's gone. They have a few white Red Deer that produces extremely large antler. I really had to beg for them, to get these racks, and they're very expensive. But this year they shot a lot of moose in Sweden. So I wrote Tomas -- the Swedish knapper -- if he will be able to supply me with some. Well, another thing is, at the moment I'm trying to get specialized into flintknapping. I'm working on specific problems. I'm trying to learn myself to work just the basic skills of Danish Neolithic flintknapping -- dagger making. And I think I'm just beginning to learn to make the first basics.

Let's say in ten years we will have something like ten to fifteen good flintknappers in Scandinavia. We'll all be doing the basic stuff -- bifacial, blades, and so on. So it will be nice to get some more, what do you call them, knap-ins. Get together and discuss problems and start on some specific problems. For example, I should take a large area which has never been touched so far as I know by anyone, really; that's the technique of square-section axes. We have two types of square-sections in Denmark. We have one that's right angles, and one that has angles up to 100°. It's kind of an impossible angle to work on if you look at it for the first time. But you soon discover the trick.

This is a subject you can work on for ten years. I mean we really need specialists in that. All the square-section work I've seen so far is done with copper. There's a lot of persons either working obsidian or soft materials or they work in flint with copper. And I would like to see someone finding the right method to work with antler.

.: They had no copper in the early and middle Neolithic?

.: They had a little copper, but still you need a lot of copper because it's a hard work. It is really a work that demands hard tools. It's fantastic. You saw the collection in Randers, the uniformity of that work. That was a lot of specialists; it was not master's work. A lot of specialists were able to perform this many times a year. I think it's too late for me to start square-sections, really. I've been trying it, sort of playing with it. I don't know how. Someone else should try it.

We need some very good blade makers; people just concerned with working on production of blades, typical Mesolithic blades for example. There's still a lot to be done. All of the Maglemosean complex has not been touched yet. I think there's a lot of pressure bladlets being made in the Maglemosean. But I have to prove it. It will take one person a couple of years to make those experiments.

And another thing, that's about heat-treating: I once heard Bordes claim that there was a lot of heat-treating in the Danish Neolithic. I've not seen any. I've been trying heat-treating on a lot of Danish flint and find that a lot of it gets too soft. You really need some strong platforms and strong arms when you work pressure. I mean you should see some of these large daggers -- 40 to 46 cm long with 8 cm long pressure scars. Looks like, you know, the kind of ribbons you have on sand on a beach, something like that. Just so uniform. And it's from tip to tip on both sides. We have something like 2500 pieces that size. And they were all made during one or two generations, it seems, that kind of dagger.

E.C.: When?

B.M.: Well, something like 1200 to 1500 B.C.

E.C.: To clarify, you see the daggers as being a master's work or from a workshop?

B.M.: It's workshop production. I think that explains the uniformity you see. We have something like 300 years of dagger production five types; beginning with a basic short type of biface developing into large, large bifaces. And then they add this extreme large pressure on them. That is specifically in Jutland. All these daggers appear in normal sites -- sort of tombs, just for ordinary people. That is, dug-out tombs, small tombs, that are rather poor in comparison with other tombs. And there you find one or two corpses with the daggers sitting on the belt on the hip. It seems to be every man's possession, these daggers. We have five types appearing in 300 years. We see a rapid change of dagger types. It seems to be uniform all over Denmark, south Sweden, and northern Germany. When they start introducing new dagger types in Jutland, they'll soon introduce new types in Zealand shortly after. They really went for copying bronze daggers. It had some great status value. It has to be investigated.

(To be continued next issue)

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A SPECIAL EDITORIAL

As of this writing (May 17, 1980) it is about 90% sure that I will be moving to Denmark for a 2 - 3 year period starting Sept. 1. Therefore we are shifting our editorial policy somewhat. Send *all* submissions of any kind to Penelope Katson, not to me. However, if you would like to airmail a second copy of any item to me for my reference please don't hesitate. I am eternally interested in all aspects of flintknapping. I will do an occasional editorial, article, drawing, note, and/or interview. If you could do your own drawings, it would greatly help. The next few interviews may be on European knappers. I will simply be taking advantage of the opportunity of being in Europe, and not intentionally neglecting American knappers.

I will be leaving the Pamunkey Research Center after June 1, and hiding away for the summer while I write up my dissertation on the Pamunkey Project. After September 1, my address will be Lejre Research Center, DK 4320 Lejre, Denmark. For those interested, the plan is for me to conduct a series of interntional and regional seminars at Lejre; to continue the setting up and maintenance of a Late Paleolithic hunting camp complex for the public interpretation at Lejre; to produce a series of replica study collections for museums and universities; to serve as a consultant for some of the numerous experimental research centers throughout Europe; teaching local lithic technologies; helping them to set up lithic research programs and demo sites; and to help create at Lejre a focal point of European experimental lithic studies. My wife, Linda Abbey, meanwhile, will be setting up a pilot project of environmental-historical interpretation for the handicapped at Lejre.

As mentioned in the last issue of *F.E.*, I would like to take samples of the work of American knappers to Lejre to build up a reference collection as I did here at Pamunkey. If you missed (or caught) the last boat and would like to get on this one, send samples to me at the Lejre address anytime.

The Lithic Technology case in the Pamunkey Indian Museum is now finished; the museum should open in early summer. The case now has the largest display on contemporary flintknapping in the world, with 299 replicas representing 24 of the world's leading knappers. These include Crabtree, Bordes, Tixier, Pelegrin, Sollberger, Bradley, Titmus, Flenniken, Madsen, Paulsen, Waldorf, Patten, Fagan, Arch (Cherokee), Hayden, Kalin, Goode, McCormich, Mewhinney, Warren, a commercial knapper from Texas, Brown and Bradby (both Pamunkey), and a few by yours truly. The vast majority were generously donated by the knappers themselves. Another section details the step-by-step manufacture of a triangular Powhatan knife, illustrated by Kevin Brown. A third section shows samples of some of the high points of prehistoric knapping from around the world, some masterpieces of Pamunkey quartzite knapping in the Late Archaic, and samples of Old World tool types from the Lower Paleolithic through the Neolithic. Other sections show knapping tools (from my thesis experiments), flint types, fracture mechanics, and debitage. Other cases in the museum contain rich lithic information by cultural period -- especially the "Paleo" case where the Clovis spears used on the Ginsberg elephant are profusely displayed. I'm planning an article in an upcoming issue complete with photos. Till then, stop by if you are in Eastern Virginia.

On Bruce Bradley's comments on the use and misuse of the term "lithics": The fact is that the term is now in common usage all over the country and probably is not going away. It simply needs a definition. Here's one: Lithics is the study of anything lithic. Comments?

I have greatly enjoyed helping to put together *Flintknappers' Exchange* these past three years. To be able to meet through the written word so many knappers, to spread their thoughts and opinions, to watch seeds being planted and growing toward maturity -- these have been the deepest rewards. May your flakes never fail.

Errett Callahan

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