On the Cutting Edge: New Methods and Theory for Analyzing Stone Tools

A symposium dedicated to improving understanding of stone tools was held at the Amerind Museum in Dragoon, Arizona, on September 20–23, 2013. The symposium was organized by Mark Collard (Simon Fraser and Aberdeen), Briggs Buchanan (Simon Fraser and Missouri), and Mike O'Brien (Missouri) and was jointly sponsored by the Amerind Foundation, Simon Fraser Human Evolutionary Studies Program, and Missouri. Fourteen researchers from North America, Europe, and Australia took part in the symposium, 13 of whom gave talks. Steven Kuhn (Arizona) ably led two discussion sessions.

For the last 30 years or so, the study of stone tools has been dominated by two approaches—the technological organization approach, which developed in North America, and the *chaîne-opértoire* approach, which arose in Europe. These approaches have yielded important findings, but they are poorly equipped to deal with many key questions in human evolution. Consequently, researchers across the continents have begun to develop new ways of analyzing stone tools, with a view to complementing or, in some cases, superseding the existing approaches. These new approaches operate at a range of different scales of analysis, from flake production to the global classification of lithic technology. The goal of the Amerind symposium was to bring together exponents of these new approaches to identify areas of overlap and difference, and to work toward developing a synthetic approach to understanding stone tools — one that is rooted in science and evolutionary theory.

Several presentations focused on the basics of stone-tool production. Harold Dibble (Pennsylvania) set the tone for the meeting, arguing for the importance of quantification and hypothesis testing. Dibble presented findings from a set of controlled experiments designed to isolate key variables in the flake-production process. He finished by arguing that there is a pressing need for further controlled experiments to understand the basic principles of stone tool production.

Peter Hiscock (Sydney) also emphasized the importance of quantification and hypothesis testing. Hiscock expressed concern about the widespread tendency to assign stone tools to types without taking into account the effects of resharpening and reuse. He cautioned about the equally widespread assumption of inevitable progress from simplicity to complexity in the production of stone tools, arguing that the Australian archeological record shows no evidence of a gradual, directional movement in complexity. Rather, it is more complicated, being a consequence of population size, adaptation to local conditions, and the like.

Dietrich Stout (Emory) also concentrated on the basics of stone-tool production, discussing several related projects that focus on the relationship between hominin brain anatomy and the complexity of Palaeolithic toolmaking. His research into how people learn to make stone tools benefits from the use of structural and functional MRI. Stout argued for the continued and expanded performance of experiments using the various techniques available for neuroimaging in order empirically to identify links between the brain and stone-tool production.

Several other presentations highlighted the power of combining experimental replication and quantification. Jay Reti (California, Santa Cruz) discussed the quantitative reconstruction of differential stone-tool production behaviors among Oldowan hominins. His approach, "behavioral lithic analysis," uses replicated stone-tool assemblages to identify variables that accurately identify tools produced using known behaviors, which are then used as a baseline model to compare archeological material of unknown behavioral origin.

Gilbert Tostevin (Minnesota) also highlighted the usefulness of experimental replication and quantification, arguing in favor of using gene-cultural coevolution or dual inheritance theory as a framework for understanding the spatial and temporal variation present in the Palaeolithic record. He then demonstrated how he uses knapping experiments to identify quantitative traits in stone tools that are likely to have been visible to apprentice knappers and therefore transmitted from one generation of knappers to the next.

Metin Eren (Kent) made a case for the combined use of experimental replication and quantification to understand stone-tool manufacture. He supported his argument with a case study that focused on whether controlled overshot flaking was a deliberate strategy used by the earliest inhabitants of North America to thin bifacial tools. Overshot flaking is a key element of the hypothesis that sometime during the Last Glacial Maximum, roughly 26,500–19,000 years ago, human populations from southern France and the Iberian Peninsula made their way across the North Atlantic and colonized North America. Eren pointed out that experimental and archeological data demonstrate that the most parsimonious explanation for the production of overshot flakes is that they are accidental products created incidentally and inconsistently as flintknappers attempt to thin bifaces rather than a shared, derived, culturally transmitted trait linking the Solutrean and Clovis archeological cultures.

Several presentations showed that the discipline of biology offers a source of analytical techniques that can be usefully applied to stone tools. Stephen Lycett and Noreen von Cramon-Taubadel (Kent) argued that the

DOI: 10.1002/evan.21383
Published online in Wiley Online Library (wileyonlinelibrary.com).

cultural-evolutionary analysis of lithic variability must reconcile heritable and nonheritable sources of variation under a single coherent framework. Lycett and von Cramon-Taubadel argued that the solution lies in the application of an approach rooted in quantitative genetics designed to solve analogous problems in biology. This approach models multiple sources of variation simultaneously and provides a logical rationale for how evolutionary forces such as drift and selection can operate when only part of the variation is potentially heritable.

Mike O'Brien, Briggs Buchanan, and Mark Collard discussed phylogenetic methods and stone tools. They noted that over the past several decades there has been a growing appreciation among anthropologists that the techniques biologists have developed to reconstruct the evolutionary relationships of species are useful tools for building and explaining patterns of human cultural diversity. They reviewed a series of studies in which they and their colleagues have applied phylogenetic methods to stone tools to address questions concerning the colonization and early history of North America.

William Banks (Bordeaux) discussed recent archeological applications of ecological niche-modeling software, which was developed to predict the impact of climate change on biodiversity. Banks was interested in the range of anatomically modern humans (AMHs) and Neandertals in western Europe, and used the genetic algorithm for set-rule prediction (GARP) to match numerous lines of evidence, including radiocarbon dates, climate data, and locational information, against site locations to show that both groups were exploiting almost identical ecological niches before and during the cold period, Heinrich Event 4, ca. 39,000 years ago. Analysis showed that the subsequent southerly contraction of Neandertal range in southwestern Europe was not a result of climate change or a change in adaptation, but rather was caused by a geographic expansion of concurrent AMHs, which produced competition that led to Neanderthal extinction.

Buchanan, Collard, and O'Brien reviewed the application of geometric morphometric (GM) techniques to stone tools. GM methods were developed by biologists to analyze shape variation in such things as primate crania. These methods use coordinate data as opposed to the interlandmark distances of traditional morphometrics and allow the investigation of patterns of variation in shape within a well-understood statistical framework that yields relatively easily interpreted numerical and visual results. Buchanan and colleagues presented a case study in which they used GM to test predictions of two hypotheses concerning the extent to which Clovis peoples adjusted their technology to the local environment. They found that there are significant shape differences between Clovis points from east and west of the Mississippi River, as well as some significant shape differences among subregions within the east and west. Buchanan and colleagues argued that this supports the hypothesis that Clovis people modified their points to suit the characteristics of their local environment and refutes the claim that Clovis hunters did not have to adjust their technology as they migrated across the continent.

The remaining two presentations outlined ways of approaching comparisons among stone tool assemblages. John Shea (Stony Brook) discussed improvements to Grahame Clark's well-known framework of modes for describing stone-tool assemblages. Clark's framework, which extends from the pebble tools and cores of the Lower Paleolithic to the retouched microliths and other retouched components of composite tools of the Later Upper Paleolithic and Mesolithic, was intended to serve as a simple way to describe major contrasts in stone-tool technology. As such, it has seen wide use in Old World archeology but, over time, Shea argued, problems and weaknesses have become apparent. Shea reconfigured Clark's framework to nine modes, A through I, to allow more effective global-scale comparison of technology and better integration of new methods for understanding variation in lithic technologies.

Collard, Buchanan, and O'Brien's presentation focused on the drivers of technological evolution in small-scale societies. They summarized several studies in which technological data from recent hunter–gatherers have been used to test the hypotheses that have been put forward to explain among-group variation in toolkit richness and complexity. The main hypotheses invoke environmental risk and population size. Collard and colleagues explained that, collectively, results of the studies suggest that toolkits of hunter-gatherers and food producers are influenced by different factors. The richness and complexity of the toolkits of hunter–gatherers appears to be governed by environmental risk and not by population size, whereas the toolkits of food producers appear to be governed by population size and not by environmental risk. They presented several possible explanations for this contrast.

In summary, the symposium produced excellent discussions of exciting new avenues of research that have opened up recently in the broad field of stone-tool analysis. To collaborate in further exploration of these avenues, participants agreed to stay together as a working group and to invite the participation of other researchers who perform hypothesis-driven science.

Papers from the symposium will be published by the University of Arizona Press, with a target release date of 2015. On behalf of all the participants, we thank John Ware and the Amerind Foundation for their unflagging interest and support.

Michael J. O'Brien
Department of Anthropology
University of Missouri
Columbia, MO 65211, USA
E-mail: obrienm@missouri.edu

Briggs Buchanan
Human Evolutionary Studies Program
and Department of Archaeology
Simon Fraser University
Burnaby, BC, V5A 1S6, Canada

Mark Collard
Human Evolutionary Studies Program
and Department of Archaeology
Simon Fraser University
Burnaby, BC, V5A 1S6, Canada