ELSEVIER

Journal of Archaeological Science 35 (2008) 2164–2170

Journal of Archaeological SCIENCE

http://www.elsevier.com/locate/jas

# Experimental investigations into edge performance and its implications for stone artefact reduction modelling

Sophie Collins*

*Department of Archaeology and Natural History, Research School of Pacific and Asian Studies, Australian National University, Coombs Building 9, Fellows Road, ACT 0200, Australia*

Received 28 November 2007; received in revised form 21 January 2008; accepted 22 January 2008

**Abstract**

This paper details an experimental investigation into stone artefact performance and use, and examines the implications for maintenance and rejuvenation activities. Controlled experiments testing the performance of differently shaped working edges reveal that rates of use attrition are not constant; they are dependent upon the blank morphology's suitability to particular tasks. The evidence contributes to a broader understanding of the principles of reduction analyses by showing that morphological differences in blanks are accompanied by differences in the artefacts' functional capacity. These differences in turn affect the rate at which maintenance and rejuvenation activities will be required and therefore the extent of reduction exhibited at discard.


*Keywords:* Lithics; Experimentation; Performance; Use; Reduction

## 1. Reduction analysis

Lithic technologists emphasise the reductive process as a means of understanding technological variability in the archaeological record (Villa, 1983; Dibble, 1984, 1987, 1995; Van Peer, 1992; Hiscock, 1993, 1994b, 1996a,b, 2006; Boëda, 1995; Shott, 1996; Bisson, 2000; Bleed, 1996, 2001; Hiscock and Attenbrow, 2002; Clarkson, 2002a). The processes of edge rejuvenation and maintenance in stone artefacts result in the essential properties of size, mass and form changing and reducing with successive rejuvenation events (Shott and Weedman, 2006). In most cases, the morphology of an artefact at discard is argued to indicate the amount of reduction the artefact has sustained, with some forms represented by earlier stages of reduction and others by more intensively reduced forms along a continuum of reduction (e.g. Goodyear, 1974; Jelinek, 1976; Villa, 1983; Baulmer, 1888; Hiscock, 1994b; Dibble, 1984, 1987, 1995; Hoffman, 1985; Flenniken and Raymond, 1986; Holdaway et al., 1996; Hiscock and Attenbrow, 2002). Substantial work has now been done on both the development of accurate measures of reduction (e.g. Shott and Ballenger, 2007; Hiscock and Clarkson, 2005, 2007; Shott and Weedman, 2006; Jefferies, 1990; Kuhn, 1990) and the characterisation of reduction sequences for artefact classes found all over the world (e.g. Australia, Hiscock and Veth, 1991; Hiscock, 1993, 1994a, 1998, 2003; Clarkson, 2002a; Hiscock and Attenbrow, 2002; Libya, Hiscock, 1996b; south west Asia, Neeley and Barton, 1994; Japan, Bleed, 1996, 2002; Yugoslavia, Baumler, 1888; North America, Goodyear, 1974; Hoffman, 1985; Morrow, 1997; Israel, Marks and Volkman, 1983; Gordon, 1993; McPherron, 2003; Egypt, van Peer 1992; Europe, Bietta and Grimaldi, 1990–1991; Italy, Kuhn, 1992; and in particular France, Villa, 1983; Dibble, 1984, 1987, 1995; Rolland and Dibble, 1990; Kuhn, 1995a; Holdaway et al., 1996). However, while quantifying *amounts* of reduction has received some attention, the idea that different shaped blanks and different types of reduction may be accompanied by different *rates* of use and therefore different *rates* of reduction, is yet to be examined.

* Tel.: +61 414306762.
*E-mail address:* sophie.collins@anu.edu.au

0305-4403/$ - see front matter 
doi:10.1016/j.jas.2008.01.017

This paper explores this aspect of reduction by describing the results of controlled experimentation showing how artefact use influences edge rejuvenation on three blank morphologies. Artefact function is intimately related to retouch by dictating the point at which retouch/resharpening is required and whether or not it is necessary at all. The greater the amount of work an edge is able to sustain, the lower the frequency of retouch required, and the longer its use life. Data on the effectiveness of various functional edges in performing particular tasks is therefore necessary to allow some understanding of how much use may be reflected by a particular stage of reduction. The goal of this paper is to determine whether different blank forms have different performance characteristics; which would in turn imply that artefact reduction rates are influenced both by blank form and use rates.

The idea of retouch as resharpening necessarily equates retouch with use; the more heavily an artefact has been reduced, the greater the amount of use attributed to it. This point has been illustrated by many studies calculating the reduction sequences for traditional archaeological 'types,' in which the type of each class of artefact represented at discard is argued to be subject to the amount of reduction the artefact has sustained – through use (e.g. North American and Australian projectile point typologies, Ahler, 1971; Hoffman, 1985; Hiscock, 1994b; Flenniken and Raymond, 1986; bifacial handaxes, Jones, 1994; McPherron, 1995, 1999; notched tools, Holdaway et al., 1996; and additional scraper types, Shott, 1995; Morrow, 1997; Clarkson, 2002b, 2005). Importantly, in order to allow comparisons between different artefact morphologies and the amount of reduction evidenced, the relationship between use and retouch is assumed to be fixed. This has allowed artefacts exhibiting equivalent amounts of retouch to be attributed with similar amounts of use and means the technologist need only identify reduction intensity at a site to also understand use intensity. *Rates* of use and reduction are assumed to be constant; however this constancy is yet to be demonstrated, representing a gap in the knowledge required for making reliable statements about prehistoric technology.

Technologists recognise that any reduction process is subject to a large number of extraneous variables. It has been noted that reduction is necessarily dependent upon the size of the blanks manufactured for use (e.g. Kuhn, 1992, 1995b; Hiscock, 1984, 1994b; Dibble, 1995; Brantingham et al., 2000; Hiscock and Attenbrow, 2002); that different shaped blanks will give rise to different reduction processes (e.g. Villa, 1983; Van Peer, 1992; Bleed, 1996; Inizan et al., 1999; McPherron, 1999; Hiscock and Clarkson, 2007; see also Frison, 1968, p. 150); and that different reduction processes require different methods of measurement (e.g. Shott and Ballenger, 2007; Hiscock and Clarkson, 2005, 2007; Shott and Weedman, 2006; Jefferies, 1990; Kuhn, 1990). Likewise, the ability for certain blank morphologies to lose greater overall mass with successive resharpening episodes than others (Shott and Ballenger, 2007; Shott and Weedman, 2006), indicates that different levels of reduction may not, therefore, reflect different levels of use, but rather differences in the amount of reduction experienced by an artefact at each resharpening episode. In combination, these observations highlight the possibility that different shaped blanks and different types of reductive processes may also be accompanied by different *rates* of use and therefore different *rates* of reduction.

The growing concern with the effect of blank morphology on artefacts' capacity to resharpen is to be encouraged for its ability to enhance our understanding of archaeological assemblage variability; however the functional characteristics of blanks at the beginning of the use process and their effect on ongoing rejuvenation and resharpening processes have yet to be addressed. This paper seeks to complement current reduction theory by exploring the little understood relationship between the functional capacity of different shaped blanks and edge rejuvenation thresholds.

## 2. Experimental practice

A highly controlled experimental program was conducted using 36 flakes made from Brandon Flint. All edges were used to scrape a single contact material, Baltic pine, a soft wood that had been oven seasoned prior to use in the experiments. In order to isolate the specific effects of the individual variables being tested and avoid including the effects of any uncontrolled variables in the data produced, experimentation was mechanised using a machine designed by the Department of Engineering at the Australian National University, purpose built for testing transverse motions. Built into the machine was the ability to control the length and speed of the stroke and an inbuilt feed mechanism on the table which allowed the contact material attached to the table to be moved along at a constant increment, always providing a fresh workable surface for the implement. A holding device for the artefacts themselves enabled the relief-angle to be controlled as well as the downwards pressure on the artefact. The number of strokes performed by each artefact was recorded by an electronic panel designed to disconnect contact between the material and working edge at the end of each use period (see Collins, 2007 for full details of the machine used).

Mechanisation ensured that experiments were conducted in the same way and that results were therefore comparable. All experiments were conducted on unretouched, decorticated flakes which, along with speed, pressure, contact surface, stroke length, contact material and action were held constant throughout. This allowed edge shape, edge angle and the duration of use to be varied and the individual effects of each to be isolated and quantified. Edge shape was determined relative to points of contact between the flat timber worked and the functional edge. On convex edges, contact between the working material and the edge occurred at the central point of the convexity. Conversely, concave edges made contact with the worked material at either side of the concavity, while straight edges showed a consistent length of contact between material and edge along a length exceeding 14 mm (see Fig. 1). Edge angles were required to fall within one or other of two categories; high (60–65 degrees) or low (20–25 degrees). Measurements were taken at each of 3 points along