Playing Devil's Advocate for Adze Flakes: A Theoretical and Experimental Reinterpretation

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Introduction

In Polynesian archaeology, the adze head is undoubtedly the archetypical lithic artefact of the prehistoric archaeological record. The systematic study of adze forms was pioneered by Roger Duff (1977) with the introduction of his adze typology – an important epistemological leap forward in the study of Polynesian lithic technology and has still been the subject of contemporary studies (Shipton et al. 2016). In Europe and North America, however, the methodology of lithic studies had moved beyond morphological typologies and toward replication; this allowed for the systemic study of both finished products *and* waste flakes. Although replicative technological studies exist for New Zealand adze technologies (see Turner and Bonica 1994), it is by no means conventional practice. The pioneers of this replicative approach, namely François Bordes in France and Don Crabtree in America, created a new standard of research orientated on the lithic *reduction sequence*, which allowed them access to a 'high-resolution' behavioural photograph of prehistoric activities expressed in a language of stone (see Bradley 1975 for an excellent primer to this approach). Studies in lithic technology fixated on reduction sequencing have many monikers, such as the *chaîne opératoire* in the French tradition, and *gihō* in the Japanese tradition referring to the preparation of microblade cores (Takakura 2011: 332). (The theoretical underpinnings for these ideas vary amongst each other, but from a methodological perspective they are identical). Applying this approach to archaeological assemblages is only possible if researchers commit to understanding lithic technologies by attaining mastery in the craft, and in so doing replicative work then has the power to modify and inform the *concepts* we invoke for archaeological interpretation, as well as the assemblages themselves. Here, I would like to play devil's advocate regarding the archaeological interpretation of adze flakes, often interpreted as 'reworking' or 'repair' flakes (see Turner 2000: 260). These are flakes that often exhibit other 'later' manufacturing methods of the dorsal surface – grinding, in particular – but the definition will be expanded to include evidence of hammer-dressing. Since these flakes contain evidence of reduction strategies thought to occur at the end of adze manufacture, and since flaking is seen as the first reduction strategy, they have been deemed 'reworking' flakes because the preform has reverted back to its initial reduction stage of flaking. However, I argue instead that such flakes can be produced during the initial manufacturing episode of the adze head, and that these flakes are really responses to overlapping risk/time thresholds between different reductions strategies. The argument will be made on two grounds: 1) A theoretical argument is made by imposing the basic premises of optimisation theory over a conceptual production scheme, and 2) the results of several adze head replications are discussed to couple the theoretical ideas with potential archaeological observations.

Optimisation theory offers a framework that allows concepts like risk management and time expenditure to inform researchers as to how lithic toolkits were designed in antiquity. The premise of optimisation, as applied to stone tools, can be simple: If we were to consider the range of variables that affect the means of stone tool production, then the observed archaeological conditions should reflect a response that will optimise the success of the toolkit designer(s). In other words, people in the past would adopt technological solutions that provided the greatest returns for the least amount effort. Without delving too deep into the intricacies optimality theory, I present three constituent ideas for a basic application: 1) Goals, 2) Costs, and 3) Currency (Foley 1985). For example, suppose a master wanted to teach a student how to make stone tools: We can say that the *goal* is to teach the next generation. The teacher must use viable stone to teach the student how to make tools: The stone, or raw material, becomes the *currency*. Perhaps the student is unsuccessful and exhausts large amounts of raw material while learning: We can say that the *goal* of teaching comes at a high *cost* of *currency* (stone). Therefore, the optimal solution in this hypothetical scenario is to teach the student in an area where the currency is high (i.e. a quarry site); thus reducing the *risk* of pursuing the same *goal* in circumstances where the *currency* is much lower.

Archaeologists will probably agree that there are three major reduction strategies used to manufacture adzes: flaking, hammer-dressing, and grinding. As mentioned earlier, however, a conceptual issue emerges from thinking about these manufacturing strategies as discrete stages. An adze preform simply does not pass onto the next reduction strategy when all of the work from the preceding reduction strategy is deemed complete. This means that the conventional definition of adze flakes necessitates a unilinear uncritical transition from flaking, hammer-dressing, to grinding. The conceptual issue in focus is the interpretation of adze reworking based on attributes of waste flakes. When these reduction strategies are no longer viewed as discrete, they can be modelled using a tweaked version of optimisation theory and can reveal distinct advantages to minimise risk of failure and time expenditure. Torrence (1983; 1989) was one of the first researchers to consider variables such as time/energy costs and risk as causes for the design of lithic toolkits in the archaeological record. These variables have been used to express the three major reduction strategies of adze preforms in New Zealand (Figure 1).

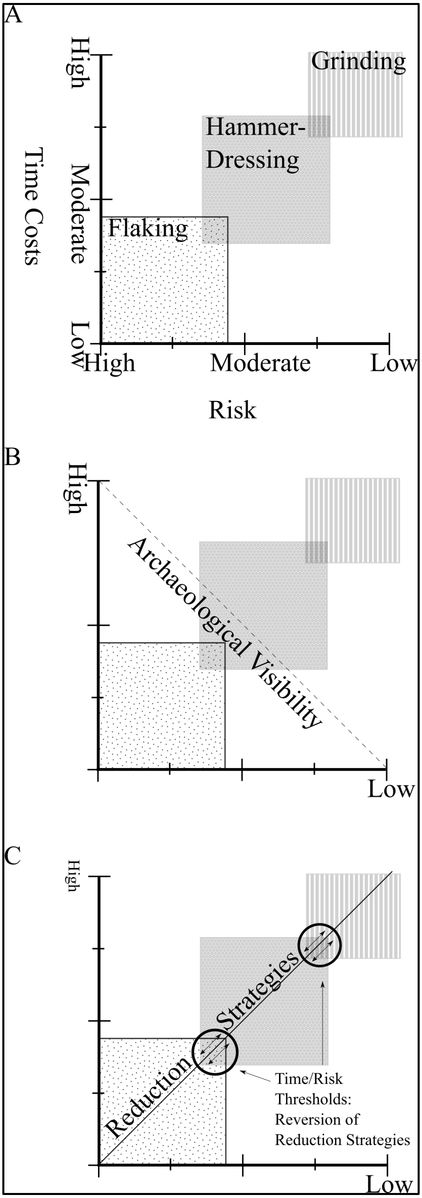

Figure 1. A) Reduction strategies modelled in terms of risk and time. B) The visibility of each reduction strategy in the archaeological record. C) Overlapping risk/time ratios, or thresholds at which reduction strategies can alternate (hence the bidirectional arrows).

Figure 1 conveys abstract assessments of risk/time costs for flaking, hammer-dressing, and grinding. The purpose of the chart is to convey the risk/time 'thresholds' – areas in the chart where the ratios of **risk of failure** and **time expenditure** overlap. I contend that these overlapping areas provide a unique chance for the artificer to alternate between adjacent reduction strategies to mitigate risk and time costs (see Figure 1). Moreover, responses to the risk/time thresholds can be archaeologically visible: The waste products from the alternation between different reduction strategies can produce waste materials identical to those expected of a 'reworking' event: these two scenarios could, in principle, convey identical archaeological signatures.

Lessons from Replication

All of the replicated adze heads were carried out using tools that could have been used archaeologically, all of which were sourced from the Otago region in the South Island. The raw material used for the replications was basalt from Blackhead, Dunedin, which was not ideal due to large phenocrysts that had formed within the stone (Figure 2). Below, some interesting observations are presented from adze replications, particularly the unique advantages that arose from alternating between reduction strategies, and how this alternation mimics the archaeological visibility of adze reworking events.

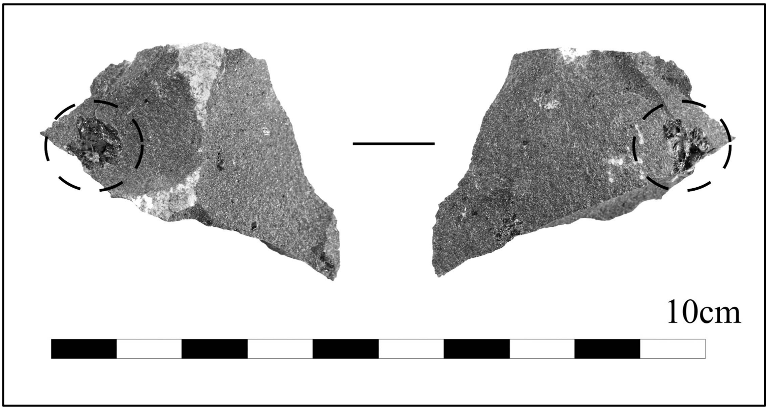

Figure 2. Basalt flake with large phenocryst (dotted circle)– dorsal (L) and ventral (R) surfaces.

Flaking

Flaking has been classified here as a high risk/low time reduction strategy; as such, there are clear advantages and disadvantages to flaking. Large amounts of raw material can be reduced in a short amount of time, but the adze roughout or preform is susceptible to ‘amputation’ or ‘end shock’ (Crabtree 1972: 24). This is a phenomenon in which the raw material abruptly breaks; thus causing the knapper to prematurely discard the raw material (Figure 3). There are many causes of end shock, some of which include: a) striking the stone too hard at incorrect angles, b) by not utilising an appropriate holding position to absorb percussive vibration, c) selecting raw material with inclusions or other internal flaws, etc. Also, flaking can only be utilised if specific geometric requisites are satisfied. In most cases, platform angles exceeding 90° will be unsuccessful in detaching flakes via hard hammer percussion; however, other methods of flake detachment (i.e. pressure techniques) can detach flakes from exterior platform angles approaching 113° (Callahan 1984: 84). Most of the archaeological adze roughouts and preforms have been flaked using direct percussion, but Steuber (2010: 325) has empirically demonstrated the occasional use of indirect percussion on adze preforms in New Zealand. Accordingly, I have incorporated greywacke punches as well as other percussors in my personal toolkit for adze head replication (Figure 4).

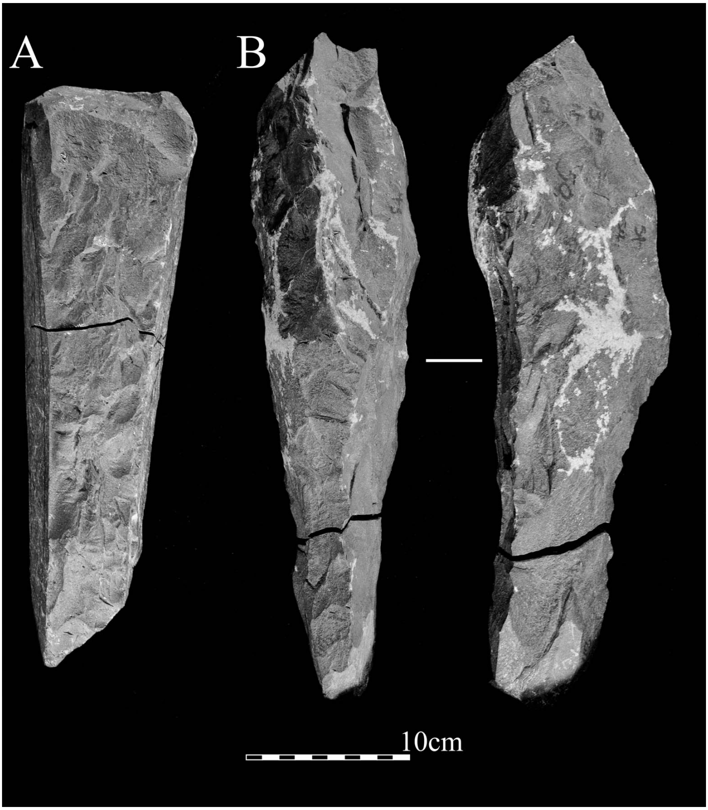

Figure 3. Two examples of adze roughouts destroyed by 'amputation' or 'end shock': A) Type 1A roughout aborted during an experimental flaking sequence: The nodule was selected so its thickness would ultimately become preform width. B) Duff Type 4A, a triangular roughout made using a combination of direct percussion, indirect percussion, and hammer-dressing. Views: obverse (left) and profile (right).

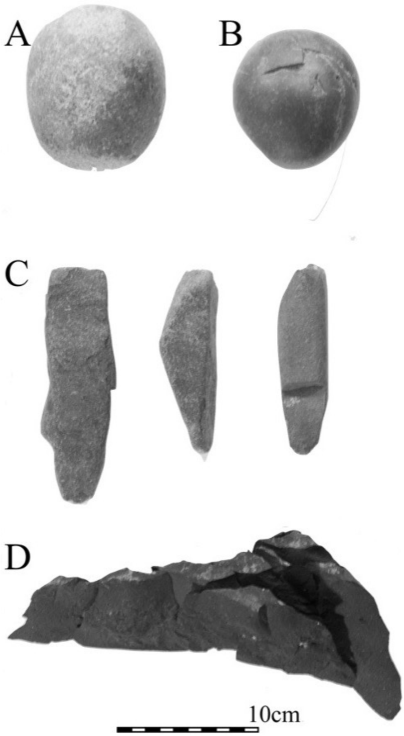

Figure 4. Tools used for adze head replications: A) Hammerstone, B) Hammer-dressing stone, C) punches for indirect percussion, and D) refitted Class A and Class B flakes as featured in Leach and Leach (1980:114).

Hammer-Dressing

This technique is also referred to as *pecking*, and this reduction strategy is classified here as moderate risk/moderate time. Reduction occurs by repeatedly striking the preform surface in a controlled manner, and can generate artefacts with distinct attributes in the archaeological record (Swieton 2018: 92). The main advantage to hammer-dressing is that reduction is not limited to the same strict geometries required for flaking. The risk/time ratio involved in hammer-dressing is considered moderate compared to flaking and grinding; repeated percussion can reveal flaws in the raw material or, if stuck too hard, can form Hertzian cones that expand deep into the preform and, in some case, cause destruction. The ideal goal in hammer-dressing to execute a controlled surface crushing on the preform without compromise.

Hammer-dressing can be used as a complementary problem-solving strategy for optimising flaking. Consider step and hinge fractures, both of which are a common manufacturing error in flaked stone technologies: if a knapper accidently created a large step or hinge fracture on an adze preform, and the power required to detach a correction flake could put the preform at risk of end shock, it would be advantageous for the artificer to switch reduction strategies to hammer-dressing before any further flaking can be carried out (see Figure 1B). Removing additional flakes in the direction of a hinge or step fracture can compound the initial error, a technical error called 'stacking' (Whittaker 1994: 109). After the hinge or step fracture is hammer-dressed and the preform surface topography accommodates flake detachment, the knapper can then revert to the previous reduction strategy and detach a flake with evidence of hammer-dressing on the dorsal surface (Figure 5).

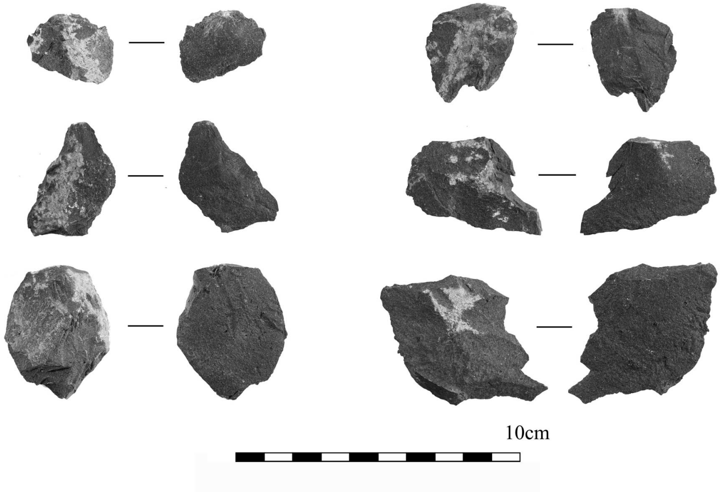

Figure 5: Dorsal (L) and Ventral (R) surfaces of replicated 'risk/time' threshold flakes made of basalt from Blackhead, Dunedin. Note: flakes with hammer-dressing produced before roughouts or preforms were completed.

Grinding

Grinding is classified here as a high time/low risk activity, and should not be confused with the term 'polish.' The former is a technological reduction strategy whereas the latter is a *traceological* phenomenon; the term polish should be reserved to describe a form of usewear that accumulates on tools and has little to do with the *technology* of adze production. Grinding often occurs on a stationary slab with the preform being ground atop, thus making grinding slabs a subset of *netherstones*, a kind of passive or stationary stone (Adams 2014: 94). In the replicative sessions, it was observed that a unique advantage had presented itself when flaked preforms had skipped hammer-dressing and went directly to grinding. The last series of flakes removed from the preform become a kind of 'grinding tool'; these flakes– all refittable to the preform surface before grinding– can indicate to the artificer the effectiveness of the grindstone. This was a trick that I used to gauge the quality of my new grindstone– a gauge of how long the grinding process should take for the preform in question. After several strokes across the grindstone, I could easily refit a flake to its corresponding scar to see how much of the preform mass had been ground away over varying durations of time.

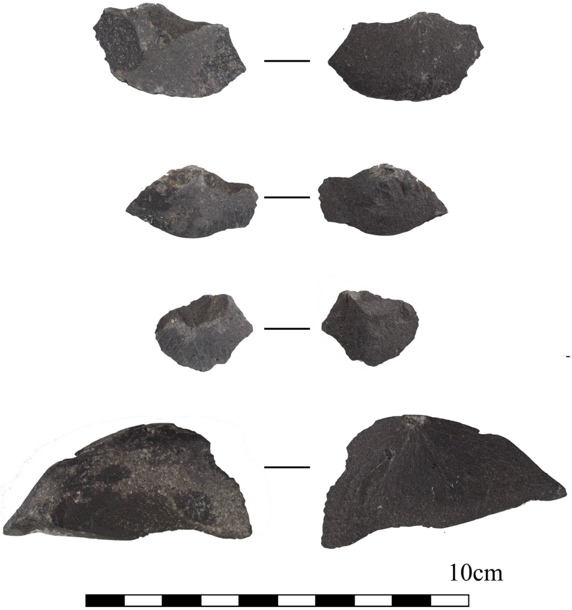

Figure 6. Dorsal surfaces of replicated adze flakes exhibiting varying degrees of grinding and hammer-dressing: Each depicted specimen is evidence that all three reduction strategies have been used before adze completion.

Based on the conceptual diagrams featured in Figure 1, it not inconceivable to think that some responses to risk/time thresholds can revert all the way back to 'flaking' from the later stage of 'grinding.' Evidence of grinding on the dorsal surfaces of flakes is a phenomenon that has been observed in other archaeological assemblages all over the world. One example is the production of flint daggers from the Late Neolithic. Flint dagger production requires a finely flaked preform that is then brought to the grindstone to establish a uniform surface topography from which parallel finishing flakes are detached. All of these waste flakes possess evidence of grinding on the dorsal surface, which has been identified as a type of 'neocortex' (Callahan 2016: 83). Moreover, Danish dagger production offers a unique archaeological case in which the reduction strategies are known to not move linearly from flaking and grinding; rather, they alternate based on the goals of the reduction sequence.

Archaeological Comparison and Conclusion

Adze flakes were among the lithic artefacts recovered from the coastal site of Shag River Mouth (J43/2) (Smith and Leach 1996: 106). Some of these flakes are featured in Figure 7 (compare with the experimental 'risk/time' mitigation flakes featured in Figure 6). Again, the flakes in Figure 6 were produced after hammer-dressing and grinding were both used minimise the risk of failure for a single flake detachment with rapid flake reduction in mind. Unlike Figure 6, Figure 7 only features the dorsal surfaces of adze flakes rather than both dorsal *and* ventral surfaces. The raw materials of the depicted flakes range from a coarse basalt to black and grey argillite. Notice: All of the flakes depicted in Figure 7 possess evidence of grinding, but there are also a few specimens with residual evidence of hammer-dressing, as well.

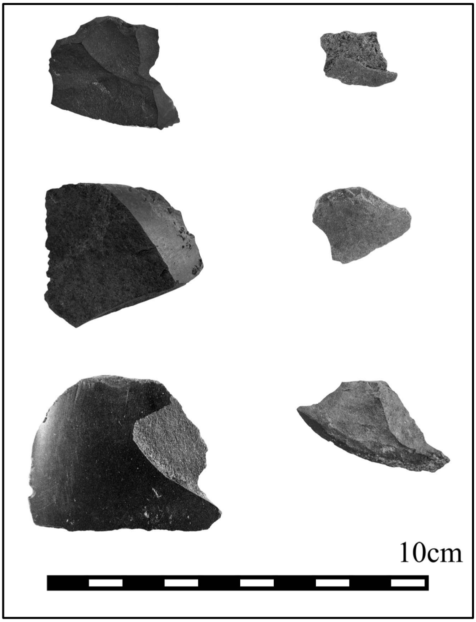

Figure 7. Dorsal surfaces of adzes flakes from Shag River Mouth exhibiting varying degrees of grinding and hammer-dressing.

As far as I am concerned, adze flakes can be produced either as risk/time management *or* as adze reworking. The ultimate goal of this paper is to serve as a philosophical thought experiment by coupling empirical datasets and theoretical understandings to revaluate the ways in which we think about the archaeological record. Additionally, brief replicative studies like this should convey to archaeologists *and* the general public the importance of creating conceptual lenses capable of detecting the breadth of human ingenuity in the archaeological record.

Acknowledgements

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