Quantifying Lithic Reduction: A Reexamination of the Scar Density Index

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Introduction

The quantification of lithic reduction is a central issue to the study of lithic technology. As stone tools are reductive in nature (mass must be removed to make them), methods for quantifying this lost mass would prove useful throughout the field, impacting studies of all stone using cultures everywhere.

The Scar Density Index (SDI) seeks to quantify the reduction of a flaked artefact by correlating the ratio of flake scar number and total surface area to the amount of material removed through reduction (eq. (1))(Clarkson, 2013, Shipton and Clarkson, 2015, Clarkson et al., 2014).

The SDI should increase as the amount of reduction increases.

This poster presents the results of a replicative experiment, using photogrammetrically captured data to calculate the SDI for uniform blanks.

$$\frac{Scar\ Number}{Surface\ Area} = Scar\ Density\ Index \qquad \text{Eq. 1.}$$

Methods

14 cast ceramic blocks (the core) measuring 21 x 15 x 3cm were reduced through freehand knapping. Knapping was executed by the author up to exhaustion or failure of the core.

Knapping was separated into distinct stages and treatments. Each stage was defined as the removal of ten flakes from a respective side of a treatment, and each treatment is defined as the number of and location of sides to be knapped (Fig. 1.).

After each stage the number of flake scars was counted, the core was weighed and the surface was modelled using Agisoft Photoscan (now Metashape) and Meshlab (Cignoni et al., 2008). This allowed for the calculation of the SDI.

Results

39 data points were produced from the 14 blocks with each block eventually failing due to lateral fracturing. A simple scatter plot illustrates the complex relationship between the SDI and lost mass (Fig. 2.). The relationship is heteroscedastic and non-monotonic. As such, no positive universal relationship between the SDI and lost mass was found.

A consistent sized flake was removed as there was a strong, significant correlation between number of flakes and lost mass (r^2 = 0.90, $p<0.001$) and surface area and lost mass (r^2 = 0.87, $p<0.001$).

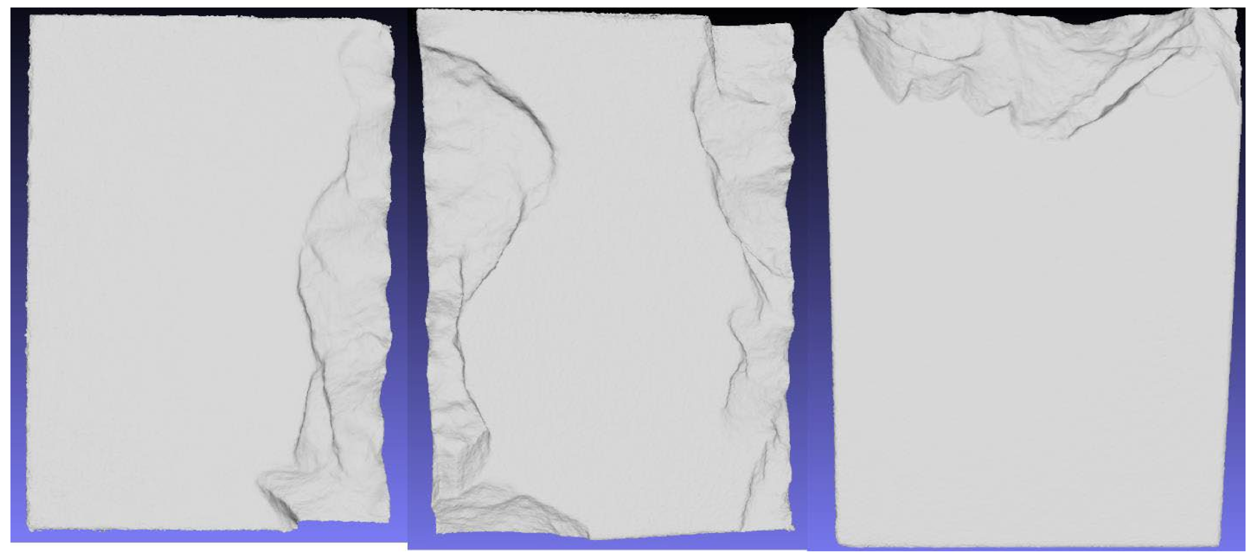

Fig. 1. Example of specimens after first stage of knapping. Notice different treatments.

Key findings

- The SDI is not an effective measure of reduction.
- Scar number only relates to the number of reduction events rather than amount of reduction.
- Flaking obscures the process of reduction.

Discussion

As more flakes are removed from a core, previous scars are obscured, removed or otherwise modified.

Flakes can be short, long, thin, thick, curved and everything in between. The size of the core does not correlate to the size of the removed flake in any way other than providing a maximum size for the flake (Lin et al., 2016).

Given this, there are at least three cases where the SDI will fail.

The SDI Failure Cases

1. A large thin flake removes many prior flake scars whilst removing a small amount of surface area. Causing the SDI to decrease despite reduction increasing.
2. Multiple small flakes massively increasing the number of scars whilst removing a small amount of surface area. Causing the SDI to increase disproportionately to the amount of mass removed.
3. Multiple small flakes are removed from one core, removing a set amount of surface area. On an identical core one flake removes the same amount of mass and surface area. Despite the same amount of reduction occurring, the two cores have significantly different SDI values!

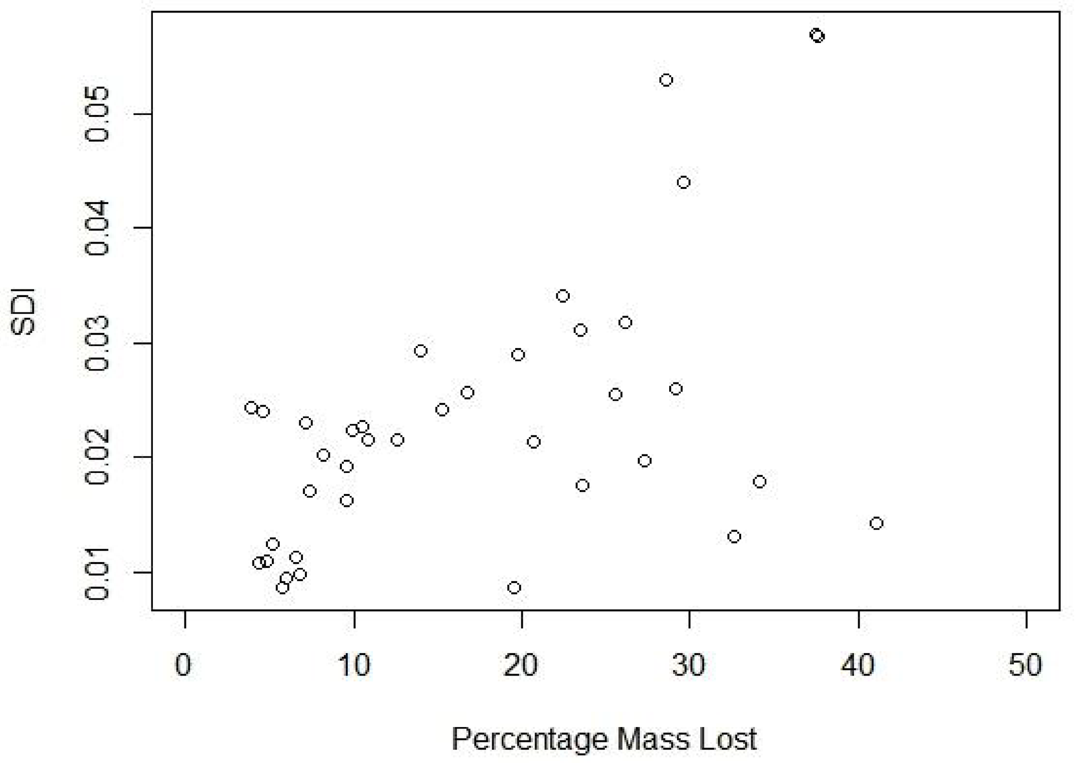

Fig. 2. Scatter plot of measured SDI values against percentage mass lost. Note the high variance as mass loss increases.

Conclusions

The SDI suffers from multiple issues and should not be used as a method for quantifying lithic reduction. Due to its reliance on scar number it is extremely sensitive to outliers. The only cases where it can be used is if specific research contexts can provide convincing arguments against the specific failure cases.

Agisoft Photoscan, combined with Meshlab, proved extremely useful in providing high quality, accurate models for the study of the specimen's surface area which would have been otherwise impossible.

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