Lithic Technology and Artifact Analysis

Stone (lithic) artifacts are important in archaeology because they are often one of the few types of artifacts that preserves well. As you will notice in lecture, most of the archaeological record through the first few million years of human prehistory is made up of stone tools. Here we will provide you with a brief introduction to the description and analysis of lithic artifacts. This will help prepare you for the next two labs.

Lithic Raw Materials

There are many natural materials that can be used for making stone tools. Examples of these will be in your lab so that you can learn to recognize them. Flint knappers choose materials that are fine-grained and homogeneous enough that they can control the flaking process and have good results. In many cases they went considerable distances to acquire good materials, and stone was commonly traded in prehistoric times. The more common materials include:

> ***Chert***: This is a fine-grained silicate mineral that occurs as nodules or stream-worn cobbles. This is probably the most commonly selected material because it can be of high quality and is quite common in many regions (but not at all in the Dallas-Ft. Worth-Denton area!)
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> ***Quartzite***: This material is much coarser-grained than chert, having the feel of sandpaper. However, it was often preferred because it is very hard and can be used for a long time without resharpening. This material is very common in north-central Texas.
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> ***Obsidian*** (volcanic glass): This material produced very sharp edges and, because it is glass, can be flaked very finely. It was traded extensively in both the Old World and the New World. The Maya and Mexican cultures loved obsidian and used it for ceremonial pieces and made long blades for edging their battle swords.
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> ***Basalt***: This is a black volcanic rock that formed from lava. Its crystals can be seen with the eye. Basalt is very hard, and difficult to knap, but nonetheless makes excellent larger tools. It was the most common raw material in many Oldowan sites in Africa.
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> ***Rhyolite***: This volcanic rock, and many similar varieties, also formed from lava, but is much finer grained than basalt. It is usually red, but other colors can occur.

All of these raw materials weather chemically, leaving a softer outer "rind" called **cortex** around the outside of the piece. This has to be removed to get to the unweathered **interior** material that flakes better and produces sharp edges.

Cores

Cores are the pieces that are struck to remove flakes or other debitage. There are many different kinds, and below we’ll discuss the two main kinds, for producing debitage and those that were the object of manufacture, like we see for bifacial tools such as handaxes or spear points.

Debitage

Debitage includes the larger pieces that were intentionally removed from cores. Sometimes they are waste, and sometimes they were produced as products intended for making other tools such as scrapers or knives. The major kinds of debitage are flakes and blades (which are elongated pieces).

Tools

The main goal of lithic reduction was usually to make tools. These can be generally classified as unifacial tools, made on flakes or blades, including scrapers, knives or serrated tools called denticulates.

Lithic Reduction Systems

Lithic reduction systems are behavioral systems that involve the procurement of stone raw materials, their fabrication into tool blanks and tools, and the discard of the tools and manufacturing waste. Lithic reduction systems all have the following components:

- ***Raw material procurement*** - quarrying or collection of suitable stone raw materials
- ***Core blank selection*** **-** choosing or making blanks for the cores
- ***Core reduction*** **-** removing debitage from the core, for the purpose of shaping the core-tool, or for producing debitage blanks; this also generates significant amounts of debris, usually small pieces that are byproducts of core reduction
- ***Manufacture of tool blanks*** - these are either cores or debitage that are intended to be shaped into final tool forms
- ***Final tool shaping*** **-** this involves final shaping of core-tool blanks (e.g., a spear point) or the modification of a debitage blank by secondary retouch (e.g., making a scraper on a flake-blank)
- ***Tool maintenance*** - resharpening or otherwise re-shaping a tool during its use life

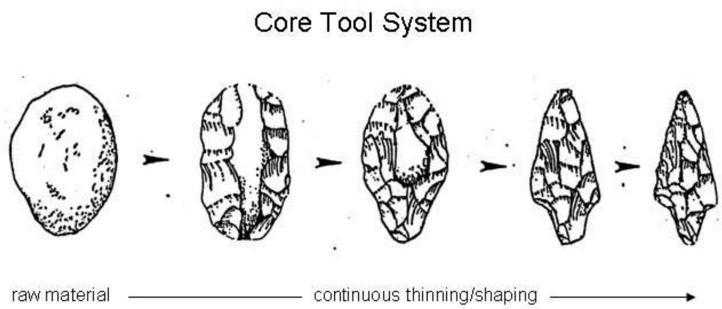
Reduction Techniques

Removing pieces from a core requires that force be delivered to the platform. This can be done by percussion or pressure. **Percussion flaking** consists of striking a stone with a hammer to remove a flake. There are two major types of percussion tools used, a hard and a soft hammer. A **hard hammer** (or hammerstone), usually a cobble, is generally used for removing large flakes. A **soft hammer,** usually made of antler, bone or wood, is used in finer flaking, especially for thinning of bifaces, but also for making blades. **Pressure flaking** is usually done with an antler tine (much thinner than the antler used for soft hammer percussion). Pressure flaking removes small flakes in a very controlled manner, and is often used for the final stages of thinning and shaping a tool.

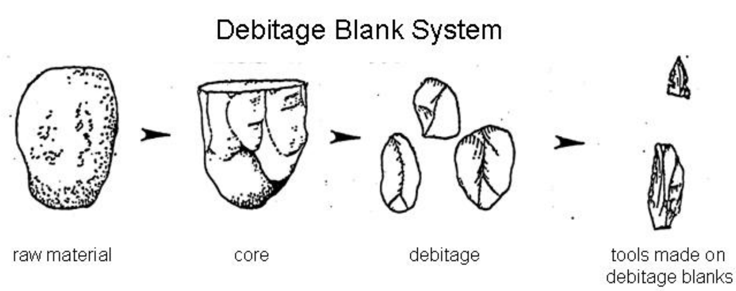
Core and Debitage Systems

Lithic reduction systems can be classified into two categories, based on the end products of the system:

- **Core-tool systems -** the final product of this type of reduction is a core-tool (see figure below).. This is usually a biface, such as a handaxe or a spear point. In these systems, the core-tool is the final product, and the debitage is waste. However, some of the debitage may be selected for tool blanks.



Debitage blank systems - The intermediate products of these systems are debitage blanks for tools. Although many variations are known, the main categories are flake-blanks and blade-blanks. The debitage blanks are subsequently retouched into tools such as scrapers, knives or burins. [Note: debitage blanks were often shaped into bifacial tools. This strategy was expedient, since the shape of a large flake closely approximates the shape of a biface.]



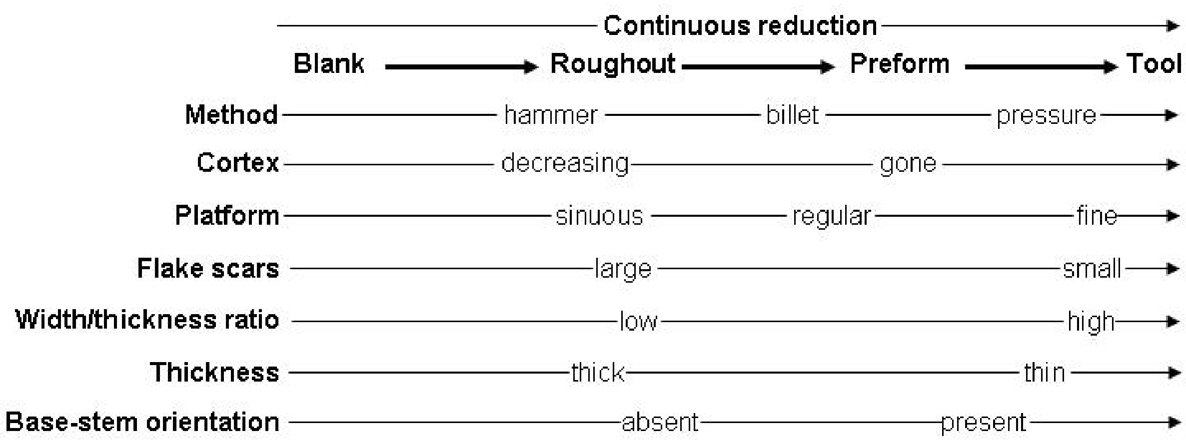
Cores

Debitage cores are the blocks of raw material from which debitage is removed. The *core platform* is the surface that is struck; the *core working face* is the surface from which the debitage is removed. *Blade cores* have elongated working faces. *Flake cores* have a variety of platform-face orientations.

Bifacial cores have two working faces in the same plane, and debitage is removed from a bifacial platform that extends around the thin plane of the piece. Because the core itself is the end-product of biface reduction, the shape and the flaking style usually change as the piece approaches completion. We can recognize the following gradational stages of biface reduction:

- ***Roughout*** - the piece still has cortex, may have few flaking scars, and the scars are deep and/or irregular. Many cores in this stage were abandoned because of errors or flaws in the raw material.
- ***Early preform (Preform I)*** - except for traces, the cortex is gone, and the piece is much thinner relative to its width. A base-tip orientation may or may not be evident. Flaking is still dominated by larger removals, and the biface edge is usually irregular.
- ***Late preform (Preform II)*** - There is no cortex; the piece is very thin relative to its width, and it may have the basic form of a finished tool; flaking is now quite fine, but final pressure flaking is usually absent. A base-tip orientation is clear, and a stem or other hafting shape may be evident.
- ***Finished bifacial tool*** - The tool outline is finished, often with pressure flaking. Otherwise, the piece has the overall shape of the late preform.

Overall, these trends can be seen in the sequence of biface reduction shown below.



Biface reduction sequence.

Biface Attributes

We will record both metric and non-metric attributes of bifaces for analysis. **Metric attributes** are *continuous* variables- that is they vary in gradational fashion. **Non-metric attributes** are *discrete* variables in that they fall into categories. Discrete variables may be nominal (having no particular order, like colors) or they may be ordinal- falling into a sequence such as light--medium-dark.

The metric variables we will measure are width and thickness. Width is measured at the widest part of the biface and thickness is measured at the thickest part. These measurements give us an idea of the size of the artifact.

We will also combine these measurements and calculate the ratio of width to thickness (width/thickness). Width/thickness is a shape index that tells us how wide the piece is relative to its thickness. The larger the value, the wider the artifact is relative to thickness. Notice also that this ratio is independent of the absolute size of the specimen. In other words, you can have an artifact that is 10 mm wide and 5 mm thick and another one that is 5 mm wide and 2.5 mm thick. The second one is smaller overall, but both have the same width/thickness ratio of 2.0 and thus are the same shape in terms of width and thickness.

As seen in the sequence of biface reduction above, the width-thickness ratio should change during biface manufacture. The closer the artifact gets to being a finished tool, the larger the width-thickness ratio should be. This is because during the manufacturing process, most of the reduction in size is in thickness. The width of the artifact should stay relatively similar. For example, early on in the reduction process, the blank may be pretty chunky with the width at 10 mm while the thickness is 5 mm, which makes the width-thickness ratio 2.0. The finished tool may end up being 9 mm wide but only 2 mm thick. Thus the width-thickness ratio for the tool is much larger at 4.5.

Because we cannot refit the pieces from a single biface to see how its shape changed during manufacture, we study a *sample* of bifaces from an assemblage. These were, we presume, abandoned at different stages of manufacture because of errors, breakage or other causes. From this sample we will make inferences concerning the pattern of biface manufacture in our "site."

Debitage Analysis

Pieces of debitage bear attributes that are remnants of the core. We can use these characteristics to understand the manufacturing process. Below are some examples of the metric and non-metric attributes that can be recorded in debitage analysis.

Non-Metric Attributes

Striking platform

This is part of the core platform. It can have the following attributes:

- ·***Cortex***: all or part of the platform has cortex
- ·***Unfacetted***: the platform is one interior surface
- ·***Facetted***: the platform has two or more scars

Dorsal Scar Pattern

Dorsal scars are the negative scars on the back of a piece of debitage that were created before the piece was removed. These expose the “interior” of the raw material and also show how many earlier flakes were removed and the direction of their removal.

Dorsal Cortex

The dorsal side of the debitage may be completely or partially covered with cortex; if so it is called a **cortical** piece. If no cortex is present the piece is referred to as an **interior** piece.

Metric attributes

- ***Length***: the dimension of the debitage from the platform to the distal end.
- ***Width***: the dimension perpendicular to the length at the widest part of the piece
- ***Thickness***: the dimension perpendicular to the length-width plane, at the thickest part of the piece.

Quantitative Lithic Analysis

We will analyze lithic data, using both metric and non-metric attributes. These analyses will consider summary statistics that measure central tendency as well as variability or dispersion around that central tendency. The statistical parameters we will record for metric analysis are:

Central Tendency: The Mean

Measures of central tendency are summary statistics that provide an estimation of the central or typical value in a sample. To calculate the mean, we start with a sample of **n** specimens, each of which has a number (label) **i**.

X_1 ***X sub i*** is a measurement of a specific attribute (e.g., width, thickness) on specimen number "i" in our sample.

$\overline{X}$ ***mean*** is the sum of the measurements, divided by n, which is the sample size. The formula for calculating this is:

$$\frac{\sum X_i}{n}$$

For example, the width measurements for five lithic artifacts are 5, 6, 4, 5, and 5 mm. The sum of those measurements ($\sum X_i$) is 5+6+4+5+5 = 25. That sum is then divided by the sample size (*n*) or the number of tools measured, which is 5. So, the mean is 25 divided by 5, which equals 5. Thus, the average width of the lithic artifacts in our sample is 5 mm.

Measures of Variability

These describe the variability or spread of our sample around its central tendency (mean). We must quantify this dimension of our sample, because variability is important in determining how similar two samples are. For example if flakes vary a lot in size and we have a small sample, then it may be difficult to accurately compare our sample with others. Also, the pattern of variability is in any case an important dimension of our lithic artifacts. Did people make tools very uniformly, suggesting very specific needs in terms of size and shape, or were they produced more casually, resulting in high variability. We see both cases quite commonly in the archaeological record.

σ^2 **variance** describes the variation of the observations about the mean. Notice in the equation below that the sample mean is subtracted from the measurement of each piece in our sample. That number is squared to make it positive, and then these numbers are averaged, providing the average of differences between each piece and the mean.

$$\sigma^2 = \frac{\sum (X_i - \overline{X})^2}{n-1}$$

The Greek symbol sigma squared (σ^2) is used to represent variance. The table below shows how the variance is calculated. The first column (X_i) lists the width measurements taken on the five lithic artifacts. The second column shows that measurement subtracted from the mean ($X_i - \overline{X}$), which is 5 mm. Those values are then squared to get the numbers in the third column. The values in the third column are then summed and presented at the bottom of the table. The values are squared to make all values positive.

X_i	$X_i - \overline{X}$	$(X_i - \overline{X})^2$
5	5-5 = 0	$0^2 = 0$
6	6-5 = 1	$1^2 = 1$
4	4-5 =-1	$-1^2 = 1$
5	5-5 = 0	$0^2 = 0$
5	5-5= 0	$0^2 = 0$
	$\sum (X_i - \overline{X})^2$	2

This value is the numerator (top) of the variance equation. It now needs to be divided by the sample size of the lithic artifacts measured minus 1. So, the variance for our sample is 2 divided by (5-1), or 2/4, which equals 0.5 mm. Thus, the variance of the lithic artifacts around the mean width is half a millimeter.

σ **standard deviation** is another measure of variation. The Greek symbol sigma is used to represent this statistic. It is the square root of the variance:

$\sigma = \sqrt{\frac{\sum (X_i - \overline{X})^2}{n-1}}$ Thus, the standard deviation for our example is $\sqrt{0.5}$, which equals 0.71 mm. Standard deviation is more commonly used over variance as a descriptive statistic because it takes the square root of the squared data, thus it is closer to the ‘true’ variability in the data. One way to think about the standard deviation is as the *average deviation* of the observations from the mean. As σ increases relative to the mean, the variability in the attribute within our sample is also increasing. The **coefficient of variation** (CV) is often used to compare the dispersion or variation around the mean of two samples. It is calculated by dividing the standard deviation (σ) by the mean ($\overline{X}$). This statistic allows you to compare the variation around a mean with different values. For example, let's say you measure the length of 100 items of two different types of arrowheads. For Type 1, the standard deviation is 50 mm and the mean is 100 mm; for Type 2, the standard deviation is 25 mm and the mean is 50 mm. The first sample appears to have twice as much variation (50 mm) when compared to the second on (25 mm). In other words it appears that there is a much broader range in the length of Type 1 arrowheads than Type 2 arrowheads. But in reality, the amount of the variation has more to do with the size of the artifact itself. The first artifact type is twice as big as the second one so the numbers are twice as large. To get around this problem, we need to calculate the coefficient of variation. Thus, the CV for both types of artifacts is 0.5 (Type 1 – 50/100; Type 2 – 25/50). So they both have the same variability in length measurements.