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The Stages of Clay: From Dry Raw Materials to Glaze-Fired Wares

Among the biggest challenges when learning to work with clay is in quickly developing sensitivity to the stages of drying, and what parts of the process are best completed at different stages. That's just part of good craftsmanship, and if you quickly develop an understanding of and sensitivity to the stiffening and drying of clay, the whole process will go far more smoothly. To enhance your understanding of the material and the process, this handout explains the stages of clay all the way from dry raw materials to glaze-fired wares.

Raw clays and other ceramic raw materials are mined from the earth, processed, and sold in 50-pound bags as dry powder. To make the moist clay used in class, we combine dry clays and other raw materials into **claybodies** that have particular forming and firing qualities. The materials are mixed with water in large mechanical mixers to produce clay of an appropriate moist, **plastic** working consistency. The moist clay is bagged in 25-pound portions and stocked in the clay cage.

Clay particles are submicroscopic flat, smooth, crystals called **platelets** approximately one to two **microns** across (a micron is 1/1000 of a millimeter). One cubic inch of clay contains over two trillion platelets. Clay platelets have a natural chemical affinity for water, and when moistened tend to maintain a water coating or **water hull** that lubricates the particles. It is the combination of the flat shape, submicroscopic size, smooth surface, and affinity for water that makes clay workable in the plastic state. Too much water separates the particles and eliminates friction, and you have a **slurry** that won't hold its shape. Too little water provides inadequate lubrication and too much friction and the clay is stiff and non-plastic.

As water evaporates from moist plastic clay it begins to stiffen and lose its plasticity and flexibility and passes through the stages of **leather-hard** including **soft**, **medium**, and **hard-leather-hard**. Finally as the last moisture leaves the clay it begins to **bleach** or lighten in color as it reaches the **bone-dry** stage. There are forming and decorating processes that are best done at each stage and some can only be done at a specific stage. Every clay-worker faces the challenges of controlling the drying and identifying and taking advantage of the appropriate stages to complete the necessary steps in producing successful work.

The Moist Plastic Stage – Almost all shaping of clay is done at the moist, plastic stage right out of the bag. This includes pinching, coil-building, slab-forming, and throwing. Other than cutting, carving, or shaving clay from the surface, or assembling stiffened component parts, if you attempt to alter the shape of clay that has passed beyond the moist plastic stage it will set up weak zones that subsequently develop into cracks. It might feel like the clay is still flexible at the soft-leather-hard or medium-leather-hard stages, but it is important to realize what is happening at a submicroscopic particle level. If you

flex a piece of moist, plastic clay, the platelets are still mobile and can move around easily to accommodate the change of form. At the soft or medium-leather hard stage the platelets are locked in place, and if you flex a piece of clay that is any stiffer than the moist plastic stage, it pulls apart the platelets on the outside of the bend, setting up weak zones that ultimately open into cracks during drying or firing. All forming processes where the clay is modeled or flexed in the creation of a vessel or sculpture, including wheel-throwing, rolling and bending slabs, pinch-forming, smearing coils together in coil construction, or shaping coil vessels with the rib-and-hand method are completed at the moist plastic stage. When planning any sort of multi-piece vessel or sculpture that involves individually-modeled or formed components, it is important to anticipate all the parts you will need, form them from moist, plastic clay, and then allow them to stiffen to soft- or medium-leather-hard before joining them together to complete the piece.

The Soft-Leather-Hard and Medium-Leather Hard Stages are ideal for trimming wheel-thrown pieces, for cutting, trimming, and joining component parts to be assembled into more-complex wheel-thrown or handbuilt pieces. This including cutting shapes from stiffened clay slabs for stiff-slab construction of geometric pieces. As a general guideline, if you score the surface of a piece with your toothed rib and the clay rises in ridges along the score marks or is smoothly cut away from the surface, the clay is fine for joining. If instead the surface feels very scratchy and the clay falls away as fine grit, it is too stiff for joining. As long as the clay has not started to bleach it can be rehydrated by draping with a damp rag or by gently spritzing with water a little at a time to restore the moisture level. Don't over-wet the clay at any time, and don't ever let a piece sit with water accumulated around its base or in any recesses.

This is the stage when handles, feet, spouts, modeled additions, and other appendages are added to the surface of a form. Soft-leather-hard is appropriate for doing slip-decoration. Medium leather hard is good for rough-carving or shaping using a knife, a band-loop trimming tool or a Surform tool. Whenever joining parts together, always score both surfaces thoroughly so it looks "fuzzy," and there is no flat surface still visible in the scored area. Add a generous amount of slurry, press the parts together firmly to expel all air bubbles and excess slurry, and remove the excess slurry. The one exception to scoring both surfaces is when attaching a freshly-formed plastic clay handle or other appendage to a leather-hard piece. In that case, you need only score the surface of the leather-hard clay, add slurry, and then press the end of the handle/appendage into place, working it back and forth until you feel it grab.

When joining parts, always remove extra slurry and never allow slurry to fill an existing gap or crack or to fill the edges of the joint to create a smoothly-rounded connection, because that "filler" slurry will shrink far more than the surrounding clay and almost invariably develop into a serious crack. If you want to achieve that effect, leave some slurry in place along the joint, roll out a very thin coil of clay, and work it in along the joint to get the smoothly-rounded effect you seek.

As mentioned, aside from cutting, carving, shaving, and assembling, we do almost all the forming and shaping of the clay at the moist plastic stage. One exception is when we use a wood paddle against the outside and sometimes a corresponding rounded **anvil** on the inside to resolve the shape and eliminate minor variations in profile. This is best done at the medium-leather-hard stage. Because this process aggressively compresses the clay rather than opening it up, it rarely causes problems. When using this technique to resolve the shape of a piece, stay away from the rim, because that would likely cause cracking.

The Hard-Leather-Hard Stage is too stiff for assembling parts, but is appropriate for carving surface details, scraping or shaving clay from the surface with a trimming tool or a metal rib (not a Surform tool – the clay is too abrasive at this stage and will quickly dull the tool), or for drilling holes with a standard drill-bit twisted between the fingers. Hard-leather-hard is an ideal stage for painting colored **slips** or **underglazes**. If a piece breaks at the hard-leather-hard stage it is usually possible to rehydrate the parts and reassemble the piece. Note that if the clay has begun to bleach or lighten in color it has passed beyond this stage and cannot be slip-painted, shaved, joined, altered, rehydrated, or repaired. In that case it is usually best to recycle the parts or the partially-completed piece and start over.

As long as you are still working on a piece, no portion should ever get so dry that it begins to bleach. We have spray bottles filled with water for spritzing any surfaces that are drying too fast. If you have a piece that is hard-leather-hard and want to make sure that it gets no dryer before the next class meeting, drape it with moistened rags or paper towels and seal in a plastic bag or keep it in a snap-lid storage box with moistened fabric in the bottom. Once a piece has started to bleach do not attempt to bring it back to a softer consistency.

The Bone-Dry Stage – When clay has dried to the point of bleaching or lightening in color, it is still possible to carve, scrape, or sand the surface, but in a gritty claybody like the ones we use in Intro to Clay, these techniques will produce a rough, stone-like finish. Normally, once the piece is bone-dry we go ahead and bisque-fire it and proceed from there. As is the case at the hard-leather-hard stage, don't ever use a Surform tool on bone-dry clay because the abrasiveness of the grit in the clay will dull the cutting edges almost immediately. If a piece breaks at the bone-dry stage it cannot be repaired except in the case of complex forms in which you have invested a lot of labor. In that event we can sometimes repair a piece with **paper-clay** slurry – a special slurry that contains paper pulp.

As mentioned, at the bone dry stage the surface of the clay can be scraped or sanded, but only when a scraped or sanded surface is desired. We normally never finish clay surfaces by sanding because it leaves a distinctly sanded surface that is rarely desirable. Most slip-decorating techniques are done at the medium- or hard-leather-hard stage and we normally would never apply such decoration to bone-dry clay, but the one exception is terra sigillata, an ultra-refined polishing slip that is best applied to bone-dry clay in repeated thin layers.

Any rejected pieces or scraps can be recycled into fresh moist clay as long as they have not been bisque-fired. This is accomplished by immersing the damp or dry pieces or scraps in water and allowing them to **slake** down to slurry. The small amount of scraps produced in your daily work should be put in the recycle barrels to the right of the sink. Larger quantities should be put in the recycle barrels below the windows in the claymixing room. Students at the intermediate and advanced level generally save their scraps in five-gallon buckets, slake it down to slurry, and incorporate it into subsequent batches of clay in the mixer.

The Bisque-Fired Stage – Bisque-firing permanently transforms the clay by bonding the particles together in a porous matrix, altering its molecular structure and eliminating its particle affinity for water. Once the clay has been bisque-fired it cannot be slaked down and recycled into fresh clay and generally cannot be joined or repaired. When something breaks at the bisque stage it usually goes in the trash. In rare situations a broken bisque-fired piece can be glazed back together if the broken piece will sit in place by gravity, or occasionally can be repaired using the **refractory cement** we use for repairing kilns, but this is never a desirable situation and is often impractical. Be careful with your bisque-fired work.

Regular colored clay slips and terra sigillata cannot be applied to bisque-fired clay. Underglazes or engobes are special slips formulated to be applied at any stage including to bisqueware before glazing. The primary advantage of bisque-fired clay is that the porous surface is ideal for glazing. When a bisqued piece is dipped in glaze, the water content of the glaze immediately soaks into the clay and the glaze is dry on the surface almost immediately.

Lowfire Glaze-Firing – This is a popular glaze-firing range for vessels and sculpture, and matures at around 1950°F, which is considered low in the range of ceramic firing temperatures. We mix different ceramic raw materials to create glazes that mature at a particular temperature and give desired qualities like color and a matt or gloss surface. At lowfire temperatures the claybody remains porous and firing shrinkage is minimal, but the glaze fuses to form a glassy coating. This glaze-firing temperature is often used for larger sculptural forms where the greater shrinkage of higher firing temperatures could cause problems.

Midrange and Highfire Glaze-Firing – These are the firing ranges of porcelain and stoneware, and cause considerable shrinkage as the pores in the clay close up, giving a dense, durable, impermeable **vitrified** product. Midrange firing to around 2200°F is very popular today because it can be accomplished in reasonably-priced electric kilns like the ones we use for bisque-firing. We don't do much midrange firing at the Craft Center and most students seem to prefer the results available only with highfiring to around 2400°F in a gas or woodfired kiln. Think of ceramic firing as natural geological action drastically sped up. Highfiring produces visual effects in the clay and glaze that are closer to the desirable surfaces, patterns, and colors we admire in natural rocks and minerals.