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Clay Pattern Styling and Rigid Surface Casting In Today's Composite Industry

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By: Jack North

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Chavant assumes no responsibility for any technical advice contained herein or for recommendations supplied by any representative. The information in the following article is based on the best available information.

Acknowledgements

Chavant extends a sincere thank you to all of the modelers, designers, mold makers, artists, accessory manufacturers and other supporters of Chavant products for sharing ideas and methods for the "Art to Part" process. The following discussions are based on articles, interviews and direct experience provided by worldwide sources.

In particular, special thanks go out to our friends:

Mr. Steve Stringer
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Mr. Fred Hoadley
Hoadley Associates, Inc.

Each of these companies offered design consultant services of the highest quality at the time of the original writing of this article. Currently, Mr. Stringer is semi-retired and sadly Mr. Hoadley is deceased.

A very informative book was published by Hoadley Associates, Inc. prior to retirement. "Automobile Design Techniques and Design Modeling" will expand, from the prospective of a professional clay stylist, on each and every process contained within this article. In addition, a concise history, a detailed procedural chronology, troubleshooting and many other items of automotive design interest will be explored.

Selected portions of "Automobile Design Techniques and Design Modeling" by Fredrick Hoadley, published by TAH Productions, have been incorporated into this article.

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Forward

Styling clay and its use by various design industries is recognized as a very traditional medium that has proven to be an extraordinary challenge to replace. Harley J. Earl, undoubtedly the father of clay usage by automotive designers, therefore setting the framework for modern automotive design, began using clay from the rain-soaked California ground to create car models in the year 1914. By exerting extraordinary vision, Harley J. Earl successfully introduced the concept of using an intimate and unlimited amount of expression available through clay products to communicate style. Without doubt, styling, inside and out, is what sells cars and an infinite number of other consumer products.

The advent of affordable Rapid Prototyping systems includes 3-D imaging/scanning, complex CAD/CAM/CNC systems, stereo lithography, virtual reality, haptic feedback tools, Holography, CAVE (Cave Automated Virtual Environment), 3D Printing and a host of other systems that have all been introduced in the name of efficiency. Initial sales presentations are often made with the intention to replace the basic existence and necessity of clay as a modeling medium. In many cases these same technologies have claimed to eliminate the need for any physical three-dimensional models at all.

Admittedly, these technologies are extremely impressive and they provide immeasurable value at several stages of any design and or manufacturing function. It is difficult to read a design-oriented trade publication without some mention of the newest version of a tool that claims to replace the need for physical models be they in clay, wax, foam, plaster, wood or any other model making medium.

During the past decade and for years before, related articles on this subject have appeared in highly recognized publications such as Wards Auto World, Automotive News, The New York Times, Business Week, The Wall Street Journal and even National Geographic. My personal favorite was a boldfaced Front-Page Headline in the January 16, 1995 issue of Automotive News: “Ford to Replace Clay Design”. In the first paragraph the author writes “Ford plans to switch from clay models of new cars to computer generated ghosts – called Holograms – within a few years.” The author concludes the same article with “Holograms will not eliminate clay models. Car People like to run their hands over a vehicles curves and creases.” Here we are in 2018 and clay is as popular as ever.

So, what is the point of the Headline? Only to grab attention, and in this sense the Headline was effective, but it was clearly not representative of the featured text’s validity. The bottom line is that physical models will continue to be built for the foreseeable future. Clay and clay modeling will likely remain very important tools because the final surface results are simply far too critical. Clay as a design surface provides superior accuracy and that continues to hold true for the Automobile, Fine Art and Specials Effects industries.

This supposition was stated well in the February 1999 publication of Fortune Magazine (Industrial Management Version) where the author begins: **"The Digital Age has not eliminated legions of largely unsung craftspeople who employ digits of another kind; their fingers. The manufacturing jobs these men and women perform can't be automated because they are complex and require human dexterity, patience and judgement."** The article continues by profiling several professions, the first of which is automobile design - featuring clay!

This concept remains just as valid in 2018. Today there is nearly unanimous sentiment, by designers, modelmakers and decision makers, who consistently and understandably acknowledge that projects can certainly be completed using only advanced 3D technology, however, the results are noticeably inferior to anyone with a trained eye when clay is not used.

Clay offers the user unlimited freedom of expression on actual surfaces, it is reusable, non-dusty, non-toxic, can be machined or worked by hand, it is very tolerant of time, shapes can be modified 1000's of times, there are no limitations of size, molds can be taken, or surface data scanned, and some clays can be liquefied and cast. Most importantly, common to any sculptor, the critical and irreplaceable tools are the modelers hands. Some specialized equipment is necessary but most of these items can be constructed in reasonable workshops.

Today, not only are Chavant's Hard Styling Clays used for design studies within industries ranging from transportation to aerospace to marine and from special effects to children's toys to professional sculpture but these clays can be machined, scanned, finished, painted and used as presentation models or as actual tooling patterns. The following pages attempt to demonstrate the basic theories, methods and terminology used in developing a clay model and further describe how to use today's composite materials to create perfectly finished patterns, molds and production parts – all by beginning with clay.

Clay itself can be styled into almost any shape and made quite smooth. By taking advantage of the improvements in the available composite materials, "Class –A" surfaces can actually be generated after the clay model surface is approximately 90% perfect. Surface preparation of the clay is generally required prior to pulling production molds, one-off splashes or when simply preparing a presentation model by painting the surface.

By blending the available old and new technologies we can introduce a unique synergy for the design process. Value, just in the savings of time, from scanning digital surface information from a loosely created, although reasonably accurate clay model, is incredible. A designer or modeler with a reasonable understanding of clay can create a three-dimensional model, from a two-dimensional sketch, in a short period of time and then scan it to collect surface data.

Once the early stage model is complete, millions of general surface data points that may take weeks to input manually can typically be captured in a few moments after a clay model is made. The manipulation of the surface data is then quickly electronically modified from the collected data. Electronic images or prototypes in other media, including additional clay models, are easily attained through various output options.

Technological advances will continue to improve everything we do. But when it comes to design, human nature will continue to drive decision-makers to demand something they can touch, move around, observe true reflective highlights and shadows on, put outside in natural sunlight and clearly express desired changes on. Communication between designer and modelmaker is one of the most important and difficult functions in project development. Clay models provide a universal language. Chavant styling clays, past, present and future will fit in well from start to finish in these processes and will help the creative industries accomplish their goals most efficiently. Clay remains one of the most valuable tools in the box, even after 125 years.

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CLAY MODELING

Chavant Hard Styling Clay can be modeled by hand, extruded, machined/milled and in some cases actually cast. The following discussion will concentrate primarily on the use of hand held tools.

SURFACE PLATES

Modeling with Styling Clay, as with any other medium, requires dimensional accuracy. To accomplish measurement stability, a working area known as a surface plate should be used to construct the model on. The size of the surface plate must naturally be larger in length and width than the model to be constructed. It is critical for the surface to be flat and rigid so that it can be used as a working guide for the placement and movement of templates, angle blocks and measuring tools.

Plywood or HDF (High-Density Fiberboard) alone can be used for the base of small surface plates. For larger models a plywood or HDF surface plate should be reinforced and braced from underneath. HDF is available with a smoothly finished, sealed surface, suitable for working on directly.

An accurately marked dimensional working grid should be applied to the top of the surface plate. Gridlines can be marked directly on the surface plate. Adhesive backed measuring tape and grids are available from various pattern/supply companies.

It is recommended to fasten a straight edge, running on the grid lines, around the outermost dimensions of the project. The straight edge will guide assorted tools in a controlled fashion. Typically, a height gage, an angle block and a depth gage will be necessary to establish basic dimensions.

Clay models can be built directly in contact of the surface plate. More often the clay will be applied onto an armature that is supported by some method over the top of the surface plate / workspace. In this way the model itself is not in direct contact with the surface plate although complete access to the measurement "tools" is retained.

High quality, precision surface plates and advanced systems of rails, bridges, pillars and trammels can be purchased from specialty manufacturers. Try Norton Equipment https://www.nortonequipmentcorp.us/or feel free Contact Chavant for information.

ARMATURES

It is presumed that some sort of rendering, ranging from sketches to accurate 3-D CNC generated shapes, have been created to approximate all dimensions of the project. These conceptual presentations will be referred to during the construction of an **armature**, which will approximate the final clearance points, less some known distance, of the desired finished model surface.

An **armature** (also known as a buck) will usually be assembled to support, stabilize, move and more or less roughly shape the major components of the clay model. It will act as a solid framework to apply clay on top of. An armature can be built or machined from many materials including but not limited to wood, metal or foam. It is very common to use a combination of these and other materials to achieve a specific preliminary shape that will act as a base for the clay application. It is a good idea to shellac the surface of an armature to improve the surface for the clay to adhere to. Should the armature shift, the clay surface may crack. Therefore, the overall integrity of a final model will depend largely on the soundness of this understructure. After the armature is complete it will be attached to the surface plate in a manor that will achieve measurement accuracy.

Some type of armature is typically required for most designs being developed in clay although some projects may be completed without an armature. The materials most commonly used are wood and foam. If a very large model is being created steel may be required in order to ensure the stability of the armature. Your construction judgment must be based on the estimated size and weight of the total project, where it will be stored and whether or not it will be moved. It is critical that the armature remains stable in order to avoid cracking in the clay model either from its own weight or when moving it. Cracking is also likely if large gaps exist between foam joints, therefore appropriate fillers are recommended in these joints.

The objectives of the armature are to reduce the amount of clay required, speed the process of clay buildup and reduce the overall weight of the finished project. To achieve all this, armatures should be constructed in "space frame" (hollow where possible) design. One of the least expensive alternatives is to use Blue or Pink extruded polystyrene insulation sheets. These are stable in normal temperature, inexpensive, readily available in many sizes, easy to shape, glue together nicely and if heat is applied with a hot air gun the foam will shrink back and harden. Urethane boards, which will provide greater characteristics in almost every respect, can also be used although they are significantly more expensive. Urethane boards are far more stable throughout temperature fluctuations and come in a wide range of densities.

One exceptional method of building a sound armature is:

- Build the armature on wheels. This will eliminate the necessity to lift the model to move it;
- Use some type of thin wall tubular steel (Monocot?), or aluminum tubing (Alufix) to construct a space frame;
- Attach high grade ¾" + plywood to space frame;
- Attach 6 pound (or greater) high-density urethane foam to wood;
- After gluing the foam, shape it with various tools. (Surform scrapers and hot wire cutters will work on polystyrene foams);
- Shellac the surface;
- Drill holes into foam to provide a mechanical holding place for the clay;
- Apply clay.

Often, in lieu of an armature, working on top of an existing part may be adequate for completing a design modification of an existing project or model. Clay will adhere to many materials such as painted metal or plastic. For protection of the surface of the existing part, masking tape can be applied on top of the existing part with the intention of applying the clay to the tape. Double-faced tape can be used, for instance, on the hood of a car where an air scoop is being developed. The clay can be feathered out to a seamless joint interface.

ESTIMATE CLAY USAGE

How can you determine how much clay to use on a specific project? Traditional Chavant clay has an approximate weight to volume correlation of 90 pounds per cubic foot. This ratio holds true only in an absolute sense. In other words, if there are no air pockets within the clay and the compression factors of the clay billet is uniform, then 90 pounds will fill a cubic foot. When clay is manufactured, there is typically some air entrapment and generally when clay is built up on an armature, pockets of air will be introduced. DeAired clay formulas will minimize air entrapment in the billet itself and actually makes the clay somewhat smoother.

Chavant also offers a line of Industrial Styling clays called AutoStyle that are sulfur free and lightweight. The weight to volume correlation is approximately 60 pounds per cubic foot, 30% lighter than traditional clay bodies.

To calculate the amount of clay required for use in a solid object, a user must estimate how many cubic feet or what volume of clay is required. The standard formula is **Volume = Length x Width x Height**. Enter the length, width and height measurements in inches and divide the answer by 1728" (the number of cubic inches in a cubic foot). Multiply your answer by 90 or 60 (depending on which clay you will be using) to obtain the number of pounds required for a solid clay object.

Most Industrial Design Projects will not be created in solid clay but with a little innovation, the same formula can be used. Input the Length and Width of the surface area of the model and input the desired thickness of clay as the Height. Irregular projects should be estimated in individual sections and added up.

It is recommended that the amount of clay required be estimated and that an additional 10% be initially ordered. Over time clay can change simply due to age or depending on how the clay has been handled. If a project is started today, worked on for six months and additional clay is required the new clay may be slightly different than the clay originally ordered. This is rarely a serious problem but slight differences may be noticed.

CLAY APPLICATION (Priming the Buck)

Styling clay is warmed to approximately 135° F to soften. This temperature is not hot enough to burn your hand but when handling a lot of clay we recommend using work gloves with rubber palms and fingers. Because most clays are wax based the warmer they are the softer they are. Different clays will have different softening points depending on the actual formulas. After reaching an appropriate temperature where the clay is malleable (this will take a few hours), the first layer of clay must be rubbed, firmly and deliberately, onto the armature surface to obtain a sound bond. This is best accomplished when the clay is soft enough to spread easily but is not too hot or too soft. If the clay is too soft out of the oven it will have very little body and your hand will push through the clay preventing any real pressure from being applied. When the clay is too hot the consistency of the clay has very little integrity so some experience is called for to find the correct temperature and viscosity required for individual users and each of the various clay bodies.

The gloved palm of your hand or your thumb is most often used to apply the clay. When using your thumb, pull your thumb toward you or slide it sideways towards or away from yourself. The thumb should be parallel to your chest, not perpendicular. If you push your thumb directly away from yourself, after a while, you will begin to separate the skin from the under part of the nail, a very uncomfortable result. Also, don't overdue the work with your thumb at first because the skin on your hands is probably not accustomed to working as a tool. Experienced clay modelers will have built up a tolerance against this type of sensitivity and again gloves will minimize friction blisters or other effects.

For smaller projects or in smaller areas of a large project it is good practice to rub the clay onto the armature or previous lamination of clay in the same direction as you expect to pull the templates. This will help to prevent fillets or laminations from peeling away from the base as the template is dragged over the model. The total thickness of the clay on the armature will vary. Typically an armature will have a clay skin of between 1/8" to one inch although there is not a maximum thickness. Some projects may require the clay to feather out to nothing and in some cases clay may be several inches thick

The warmed clay should be applied to the armature in consecutive thin layers, allowing the retained heat to escape, minimizing the possibility for surface cracking related to shrinkage as the warm clay returns to room temperature. Extreme or rapid changes in temperature may cause cracking even in a finished model. This fact should be considered

if a model is built in an area of direct sunlight or where heat and air conditioners are used during the day and shut off at night.

Roughing up previous clay laminations using a toothed clay rake or a brass wire brush will help to create a mechanical bond between the layers of clay. Also, some modelers prefer to heat the surface of the previous lamination with a hot air gun or lamp so that they are applying hot clay to a warm clay surface. Clay, in this respect, can be loosely viewed at as a hot melt adhesive. At room temperature it is not sticky but as it is heated and cools the adhesive factor will change accordingly.

Clay is sometimes "overheated" to a consistency that can be troweled onto an armature but do not heat the clay to a point where it will burn, typically 200° F. (see Sulfur below). Some Chavant clay formulas, that are Sulfur-free, can actually be liquefied and poured onto an armature for speed or cast into an existing mold to save modeling time. A small number of clients have successfully sprayed clay! Generally though, a warming box to hold temperature at 135°F – 140°F is most appropriate.

CLAY OVENS

How can I heat clay to a desired working temperature? **Clay warmers (clay ovens)** may be purchased or, less expensively, constructed.

As a rule of thumb, good working temperatures will range from 110°F to 150°F. This temperature can be achieved in a number of ways: using a series of light bulbs controlled with a dimmer switch, electric oil circulation space heaters, ceramic space heaters or silicone heat pads, installed inside an insulated box.

Old refrigerators work well as a cabinet, so do milk boxes, beverage coolers or even file cabinets. Just a bucket with Saran wrap can work as a container or a 5-gallon steel bucket with a lid is fine. Simple boxes can be made from extruded foam panels or plywood. Fans, thermostats, lightbulb heat deflectors (foil or thin sheet metal), laminated sides and shelves can all be built in. Be cautious of creating "hot spots" from lesser controlled heat sources which may result in melting, or worse, burning the clay. If a light bulb or spot light is used, don't allow the light to shine directly onto the clay, introduce some sort of deflection barrier so that only the heat reaches the clay. Some sort of venting is a good idea to assist in controlling a range of temperature.

Some inexpensive convection ovens have heating elements and a fan in the top of the oven. Look for units with a "Warm" setting or a "Dehydrate" setting because many convection ovens have poor heat control below 170° F. Or look for a heat setting dial that provides for temperatures of 130° F, but these have been difficult to find.

A crock pot can also be used for small quantities of clay. Place a small amount of water in the bottom, use a wire rack and a small tray that does not touch the sides of the pot and place the crock pot on the low setting. Adjust the lid to allow steam and heat to escape to control temperature.

Bread Proofing Ovens work well and are intended to maintain low heat. These can be found new and used.

Restaurant Bun Warmers also make fine ovens. Bun warmers may have heating elements on the sides or in the bottom, have the option of several drawers, since heat rises you can have different temperature (therefore different consistency) clay in different drawers, are stainless steel and these warmers can be purchased new or used. Don't trust the thermostat on most of these ovens. Instead, put a thermometer in the oven next to the clay.

Many companies offer Laboratory Ovens in sizes ranging from tabletop units to walk-in sizes. Keep in mind that clay only needs to be warmed, not cooked, so low temperature ovens or ovens with good low temperature control should be used. These are often referred to as warmers not ovens. They must provide constant even heat and not cycled heat.

Incubators can also be used quite effectively.

One of the most common violations in clay design studios is for modelers to turn the oven temperature up drastically in an effort to speed the clay softening process. Usually this will result in burning the clay, discoloring the clay or a formation of a skin on the outside of the clay billet. Low steady heat is recommended therefore it is better to either leave the oven on or cycle it down to a point that the clay will still remain warm. Hot – Cold cycles will accelerate the life cycle of the clay, therefore it is better to keep the clay warm or to heat what you can expect to use in the next day or two.

Microwave ovens are not recommended as you may get a liquid filled piece of clay, similar to an egg with a shell on the outside but with molten material inside. That can be dangerous because the molten clay may squirt out onto the user. Microwaves can be used but proceed with extreme caution. Toaster ovens with exposed electric coils, which are either red-hot or off, do not supply good even heat and gas ovens with open flames are considered potential fire hazards and are not recommended. Lastly, due to emitted odors and residue build up, the device that you select should be used only for heating clay and not cooking.

Sulfur, from Sulfur based clays, (Sulfur free clays are available) will accumulate on oven walls and doors due to SUBLIMING (the process of going from powder to gas to crystal). This will occur even at lower temperatures. Basically when you can smell Sulfur you have an airborne gas. In an oven, where you have increased temperature and some low level of increased pressure, the gas released is increased and the gas will look for the coolest spot to accumulate in a crystal form, thus the yellow build up on ovens! This process is similar to that of water and condensation.

If sulfur-based clay is excessively overheated, in excess of 200° F, Sulfur may create two potential problems:

First and most commonly the clay will discolor and small sand-like granules will become present in the clay. You can see them and feel them and you will never be able to develop a smooth surface if these granules are present. This is the result of the Sulfur transforming from a powder to liquid to a crystalline solid. At this point the clay is useless and should be discarded.

The second more serious problem is that if the clay should ignite, Sulfur will emit a very dangerous gas. In its normal state Sulfur is not a health problem. Please refer to our Material Safety Data Sheet for further information. Also see the Health and Safety section at the end of this article.

STYLING CLAY HAND-TOOLS

The surface of a clay model can be dragged rough to show basic definition, as smooth as possible for finishing and or to the desired shape with various tools including Rakes, Wire Loops, Finishers and Templates, Steels and Slicks. Rakes, Wire Loops and Finishers are specially designed tools having hardwood handles and hardened steel cutting surfaces. Steels and Slicks are made from sheets of Blue Tempered Spring Steel and Polycarbonate sheets.

Rakes are used to remove larger amounts of clay on initial passes over the clay. A great deal of form can be achieved with this often-toothed tool. Rakes are usually notched on one side to provide a readable textured surface. The notches required by different modelers will vary in size, shape, depth and spacing, therefore the Rakes that Chavant supplies are delivered without any notches at all. Notches can be put on the rake, as the modeler requires, with good files, a Dremel cutting wheel or a band saw with the proper blade. Common “notch” shapes are “V”, “H” or “U”.

A Rake should be used on warm or room temperature clay in a crisscross (crosshatch) pattern working towards the predetermined shapes. Templates may be pulled over the textured surface to smooth it further. The untouched crosshatched areas will indicate low spots that will be filled with warm clay and resurfaced.

Wire loops are used in tight areas, to make parting lines (such as those found between doors and pillars on a car) and reveals or to insert the predetermined wire bend shapes into the clay. For example, these can be handy when you need to introduce a series of screw head recession points. These recession points can be achieved by spinning a rounded end of wire loop into the clay.

Finishers are used to blend progressive modeled sections together and for other delicate work such as cleaning up a newly applied fillet of clay. Fillets of clay may be applied to a low spot or damaged area.

Each of these tools can be guided “Freehand” or can be used in conjunction with modeling tapes or templates as a guide. Chavant’s imported Rice Paper Tapes are porous, breathing tapes that are exceptionally thin and smooth. They are perfect for guiding tools or templates, masking and for peripheral line qualification studies. Rice Paper Tapes leave minimal adhesive residue after removal and will not pull off the finish of a clay surface.

CLAY SURFACE ENHANCEMENT

Steels

After the clay surface has been modeled and the clay has completely returned to room temperature tools made from blue tempered spring steel, called **"steels"**, are used to smooth the clay surface further.

Steels require care and maintenance. To function properly they must have a 90° honed edge that is kept sharp. Steels are available, or can be made, in various thicknesses and shapes. A stiffer "steel", 0.040" to 0.060", is used to smooth out flat, smooth contours. Thin, light steels, 0.005" to 0.020", are used to smooth rounded contours or delicate edges. The purpose of "Steels" can be viewed in the same as the way you might use different grit sandpaper on wood.

Steels can be made from Blue Tempered Spring Steel. The numbers of shape alternatives are unlimited but various rectangles and cucumber shapes are common. When shapes are determined, the spring steel can be cut by hand with good snips or on a bandsaw with the proper blade. Sometimes it is best to sandwich the sheets between some plywood to assist in the cut. The edges must then be cleaned up with files, a belt sander or a sharpening stone to remove all burrs.

Steels are held by hand at a 45° angle to the clay surface. The direction of movement of the steels, with even pressure from your fingers, is across the face of the clay, also at a 45 ° angle, from opposing corners of a square for example. Do not pull the steels repeatedly along the same path since this will result in undulations on the surface of the clay. Areas touched by the steels will change color and low spots will remain unchanged.

Keep your steels sharp. A sharpening jig in show on the following pages. Pass the edge of the steel 2 or 3 times across the surface of the file to sharpen and remove any blemish. After filing on the jig, use a ceramic wet stone to remove any burrs. Once made or purchased they should last forever.

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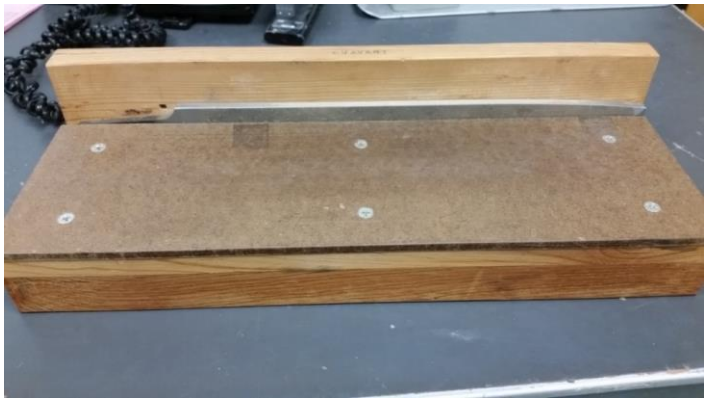
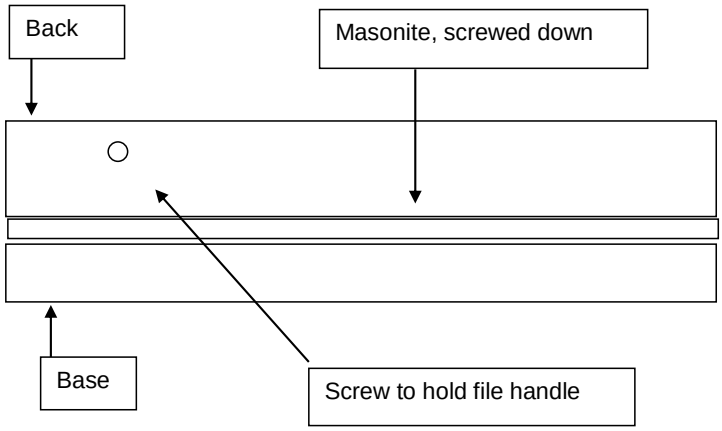
Pass the edge of the steel 2 or 3 times across the surface of the file to sharpen and remove any blemish. After filing on the jig, use a ceramic wet stone to remove any burrs.

Steels Sharpening Jig - Front View





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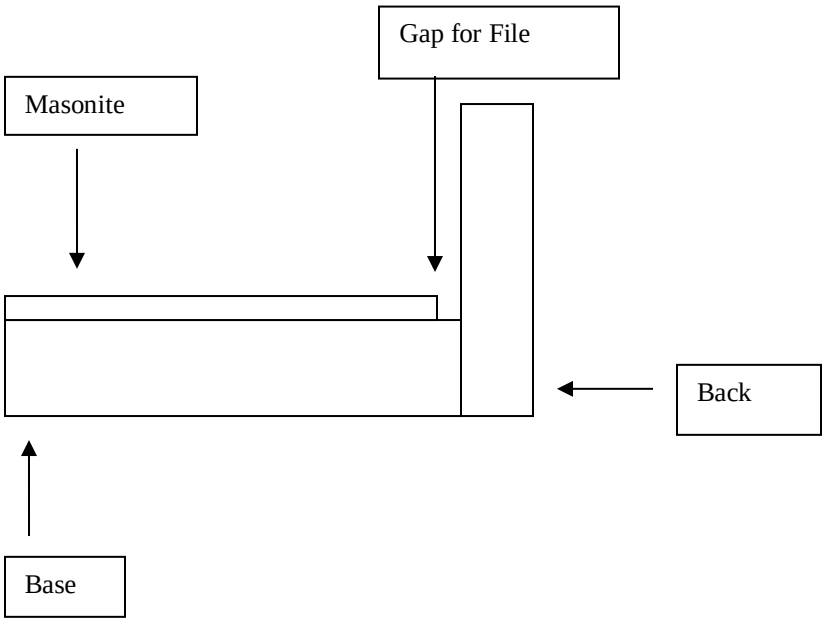
Steels Sharpening Jig - Side View



Slicks

Surfaces can be further polished or burnished with the use of **"slicks"**. Slicks are variously shaped pieces of lexan or polycarbonate, which is available in many thicknesses. Clay slicks can range from 0.005" to 0.050". Slicks must have their lengthwise edges rounded off by polishing with wet-dry sandpaper. The polishing process can begin with 360-grit paper and should be completed with 1200-grit paper. At room temperature slicks will remove little to none of the clay surface but will burnish the clay surface to a shine. A little bit of water or WD-40 applied to the clay prior to slicking will improve the surface results.

There are many other solvents that can be used to modify the surface of a clay model. These liquids include water, WD-40, lighter fluid, turpentine, mineral spirits, citrus based multi-purpose cleaners or Avalon Skin-so-Soft!

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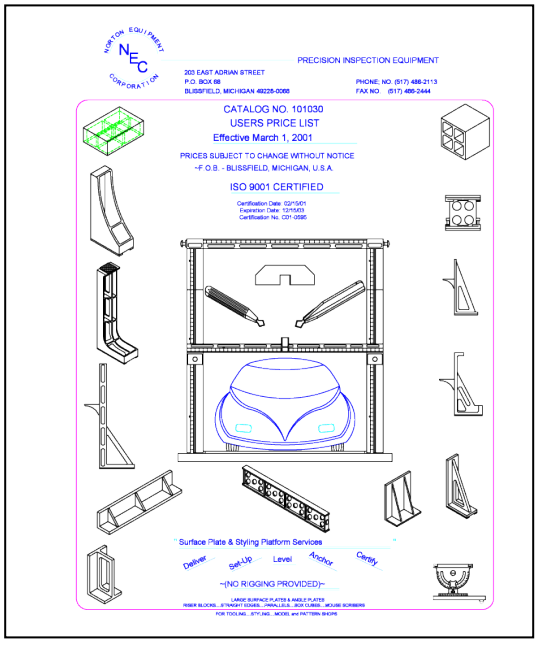
SPECIALIZED EQUIPMENT

Most major automotive design studios outfit the studio with the best equipment available. Smaller studios often will design equipment suitable for their respective budget. When the equipment required is "specialized" the following companies should be contacted as they are considered the best in the industry. Examples of this "Specialized" equipment include:

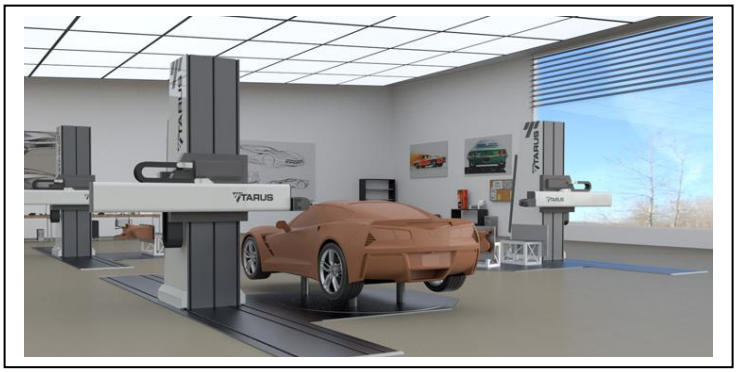
- Surface Plates
- Surface Angle Plates and Bridge Rails
- Portable Styling Platens
- Straight Edges
- Drag Rails
- Styling Bridges
- Measuring Systems
- Rotary Display Tables
- Extruders
- True Sweeps
- Milling and Scanning Equipment
- Mouse Scribers
- Ovens

Sources for this equipment include but are not limited to:

Norton Equipment
203 E. Adrian Street
Blissfield, MI 49228
Phone: 517-486-2113
https://www.nortonequipmentcorp.us/
Surface Plates/Bridges



Tarus Industries
38100 Commerce
Sterling Heights, MI 48312
Phone: 810- 977-1400
http://tarus.com/
CNC/Milling systems



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TEMPLATES

TRUE SWEEPS

Templates are some of the most important tools you will use in clay modeling when modeling by hand. Predetermined common radius shapes known as True Sweeps are available. http://www.faybutler.com/sweeps2.htm Sail makers and builders of railroad cars first used True Sweeps at the turn of the century. General Motors adopted and standardized a series of 85 template radius shapes to assist them in the development of compound curves in automotive body design. True Sweeps are used as guides or templates during the creation of key line drawings, templates and clay models. Most shapes on automobiles will match the radii of a True Sweep or a combination of two or more True Sweeps.

Manufactured sweeps are hardened anodized aluminum, machine cut and hand finished. Two styles are available:

- Standard: two radii numbers on each sweep - top and bottom radii are consecutive numbers or;
- Parallel: equivalent radii numbers on top and bottom of sweep. (most commonly used by clay modelers)

Numbering System:
Sweeps are each numbered from ½ to 100. Each whole number of a sweep signifies a rise of 1/8" in true radius, relative to a straight line equaling 60 inches in length, with number ½ equal to a radius of 7200 inches (182,880mm) and number 100 equal to a radius of 42.25 inches (1073.15mm). Numbers ½ through 8 are available in ½ increments, 8 through 50 are available in whole number increments and 50 through 100 are available in even numbers only.

True Sweeps can be purchased as described or can be made in a shop from MDF (Medium Density Fiberboard). Obviously the radius must be accurate and consistent throughout the entire length of the sweep. They can be cut with a router or band saw in whatever length is necessary and then finished by hand. Today, computer guided cutting systems are available and affordable. These systems can be used to cut all types of template shapes.

In most cases it won't be necessary to follow the numbering system used by the automotive industry so you can develop sweeps using your own number system. Of course, it will make sense to have a common relationship from and between each of the different sweeps.

One method of making Sweeps is to cut a length of 3/16" MDF to 3" by 24" for example. The first piece must be cut, square and straight. Drill a hole through each end of the cut MDF. Secure a piece of wire through each of the holes and connect the wire ends to a turnbuckle at the middle of the Sweep. Tighten the turnbuckle one turn and notice that the MDF begins to bend. Trace the outline of the curve onto a new piece of MDF. Trace another line, parallel to the first line, at the distance that you would like the Sweep to be in width. Cut along the lines and clean up the edges and you have a parallel Sweep. Give the turnbuckle another turn increasing the "bend" and follow the same procedure for as many sweeps as you need.

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CUSTOM TEMPLATES

If True Sweeps are not available or where complicated non-uniform shapes are required, templates will be made to represent sections of a model. Templates are crafted in many ways. Methods of transferring information for developing templates can include but are not limited to:

- Tracing key line drawings onto paper, glue the paper to the selected template material and cutting out the desired shapes;
- Simply cutting available scale models into sections, placing the cut pieces on an overhead projector and tracing the projected outline onto paper on the wall. Moving the projector back and forth from the wall can modify size. Glue the paper to the selected template material and cut out the desired shapes;
- Transferring shapes from existing models with contour gages and other various drafting tools;
- Cutting cardboard templates;
- Using CAD systems to develop an image of a template shape and cutting the shape with a computer-controlled router or printing out the shape with a plotter.

After creation, don't throw templates away. When you are finished using the template on the original model you will find a new use for it somewhere down the road.

Many surfaces in clay modeling, as in with other modeling mediums such as plaster or putty fillers, are be developed implementing the use of a **drag template**. Aluminum, Lexan or Masonite are all good materials for template construction. It is very important that a template's cutting edge must be at a 90° right angle to the template's face. The cutting edge must be shaped to the sectional silhouette desired using a bandsaw, files and sandpaper.

Obviously, the resulting shape on the clay surface will be only as accurate as the template so scratches and roughness noted in the templates required "contoured line shape" must be eliminated. The template's cutting edge should be finished with fine grade sandpaper. The sanding action should be lengthwise to minimize scratches that would run perpendicularly to the templates front and back faces. These types of perpendicular scratches would show up on the surface of the model.

Templates will be made in many shapes ranging from large sweeps to small tabs. Large templates may be used for working areas of a roof or door while small templates may serve to form router groove shapes in areas such as door parting lines or window reveals.

Because larger templates may flex when being used as a cutting tool, the template is often braced by screwing a piece of wood, shaped somewhat like the template, to the backside of the template. Of course, the cutting edge is left completely exposed.

When setting up a **template drag** path to create a modeled section in the clay, two independent **guide sections** must established, following the objective of the drag, regardless of the axis, for the template to slide along. On a finished clay surface, the guide sections can be steel tape (feeler and thickness gauge stock available in rolls) or adhesive drafting tapes. Steel tape can be laid on a finished clay surface as one or both of the guide sections.

Or actual templates can be set into the clay surface by removing a gouge of clay from the model, inserting and accurately positioning a template, then pushing hot clay into the gouge to hold the template in place. In either case, the drag template would be set and pulled maintaining a right angle to the steel tape, internal templates or base absolute clearance guide.

Internal "hard" guide templates or absolute clearance guides could also be incorporated into the armature. Internal templates, built into the armature, should be shaped as required using regular shop tools. After the template is cut and finished to the desired shape, cut it again with a band saw, following the parallel contour of the true edge, approximately ½" below the true edge. After cutting the ½" edge off of the template, spot glue it back onto the original template so that the shape and size is as originally required is returned.

Build the template into the armature, filling areas between multiple Internal Templates with foam. After the clay is applied to the foam and the internal fixed template is used as a guide template for the external drag template, the modeler will snap off the ½" outermost edge of the Internal Template along the spot glued seam. Removing the outermost piece of the Internal Template will leave a gouge in the clay. Fill the gouge with warm clay, pressing the clay well into the gouge. Place thin steel feeler gage tape onto each finished side of the gouge where the template dragged surface is. Then model down to the steel tape on the final clay surface by using a hand tool or small template riding on the steel tape, leaving only a clay surface after the tape is removed.

If changes are later required to this modeled section, the ½" cut off piece will provide a guide to trace the inside "glueable" edge onto a new template section. Once this shape is transferred onto another piece of template material, a new outer "guide" edge can be added with the required modifications. Cut out the new template, locate the portion of the template still inside the model and re-glue the new piece to the permanent remainder of the internal template where the original ½" piece was snapped from. The glued seam fit will be perfect since you used the same ½" piece to trace the gluing edge. Now you have a new internal hard guide template to use with your external drag templates. Build up clay, drag the template over the new internal template and snap off the guide template as before.

Normally the section that is being worked on is 18” wide or less. Length is normally not an issue unless the template shape changes. When the current section is completed the next section is begun using the end of the first section as the first hard guide of the next section.

The drag template is held in place and pulled through the clay by hand, an angle plate or precision bridge. An upright angle plate is a device that the drag template can be fixed to by various methods of clamping. It has a stable flat base and extends at a 90° angle straight up from the base. Angle blocks are made from several materials ranging from milled magnesium or aluminum or they can be homemade from oak in any required height. The base of an angle plate will ride along a base absolute clearance guide, or some other guide, controlling dimensional coordinates of the drag template. The sectional drag template can be made of aluminum, a straight edge, a true sweep or a lexan template of the required longitudinal section.

Clay is applied approximately to the profile of the drag template but should not exceed the template profile at this point in time. When this sub-layer of clay has returned to room temperature, leaving it firm, hot clay is rubbed onto the model, exceeding the profile of the template. Then the template is dragged through the warm or room temperature clay, riding on the guide sections provided by the steel tape, the internal guide template and or the absolute clearance guide. Remember, in order to maintain a uniform shape, there must be two points of contact between the drag template and the guide sections.

Router type channels may be put into the clay surface, following any contours, using a unique trick. Scribe a shallow line, with a knife blade or similar tool, which follows the outline of the channel required. You might follow a paper template that is placed onto the clay surface. Into this shallow line impression, run a piece of 30-pound fishing line. Don’t just press it in, rather in a flowing continuous motion pull the line down into the channel. Pull with one hand while pressing the top of the line with the other hand. After the line is secure in the clay surface, the clay surface can be steeled or slicked to completely cover the fishing line. You have now created an internal contact point (the fishing line) that a template or other hand tool can be guided by. You will feel the fishing line when your template or tool hits it. Your tool will follow the shape of the initial router type channel that was scribed.

If depth control is critical, a template with the proper channel shape is created. The contact point, between the template, the fishing line and the clay surface will be cut to a 90° angle. This will allow the template to exactly follow the fishing line without going any deeper. The entrance and exit point of the channel may need to be modified using hand tools.

MOLD MAKING

When the clay model surface is finished and satisfactorily approved, a negative can be cast directly off of the clay model. **Polyester, epoxy or plaster negatives** can be cast following the application of various surface preparations. Depending on the desired result some type of release system, barrier coat or sealer, including primers, PVA (poly-vinyl-alcohol) and wax can be used for the clay model surface preparation.

Flexible molds in urethane, silicone, latex and polysulfide are commonly made but are not covered in this article.

Using plaster as a Temporary Tool

Casts/molds made from plaster make excellent temporary tools, check patterns and molds for use with fiberglass/resin lay-ups, plaster and gypsum cement products, epoxy and many other castable materials.

Surface finishing, if necessary, is easily accomplished using common tools and supplies such as silicon carbide paper (dry) and hand or power sanding. Once the desired surface finish has been achieved, the casting must be sealed, and a release agent must be applied. Use sealers and parting compounds appropriate to the material to be cast into the plaster tool.

Sealing: Plaster casts should be sealed before the parting agent is applied. Sealing is particularly essential to prevent retained mold dampness from interfering with water sensitive laminating or casting compounds. A quick-drying lacquer applied by brush or spray gun is an excellent sealer for plaster. Two coats of lacquer provide more resistance to moisture than shellac. Other sealants include polyurethane, acrylic sanding sealers and shellac.

Release or separating agents: for most applications, wax is recommended. Use a wax type and brand appropriate to the material to be cast into the plaster tool.

Alternate sealing methods for preparing the plaster mold.
Some literature suggests sealing the completed mold with two coats of lacquer. The following alternative suggestions are summaries and are not specific instructions. Contact the manufacturers to discuss actual applications.

Two alternative methods for sealing the mold, which must be done prior to the addition of a parting/release agent, are the Chemlease USG-1 and Duratec 800-A. The plaster mold will have some retained moisture. These sealers will prevent the moisture from interfering with the release system and or the cast part.

Chemlease's USG-1 is a very thin liquid that is applied by wiping a cotton cloth over the mold surface after saturating the cloth in the USG-1. This can be applied shortly after removing the plaster mold from the plug. The initial coats of USG-1 will soak into the mold very rapidly. Allow a 15 minute flash time between coats and build up 8 - 12 coats. The last coat should be allowed to cure overnight. The beauty to this system is that the moisture in the plaster will not negatively affect the curing of the USG-1. Once dry, a release agent is applied and the part can be cast. Keep in mind that the USG-1sealer is not meant to be sanded so the dried surface is the final surface.

Duratec's Plaster Sealer, 800-A, is a polyester sealer that is catalyzed and applied onto the plaster surface. Because it is a polyester system it is very sensitive to moisture. It is recommended that you wipe the plaster mold with Acetone to drive the moisture away from the surface prior to applying the 800-A. The 800-A is not meant to be sanded. A Duratec Surfacing Primer, #707-002, can be added on top of the 800-A so that a polished surface can be attained.

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Class "A" Surfacing Techniques for PRODUCTION MOLDS

Preparing Clay Surfaces for Polyester F.R.P. Negatives

When making molds with polyester resin, from a clay pattern, a barrier coat must be applied between the clay surface and the polyester or epoxy resin. One method of surface preparation is to apply strippable vinyl onto the surface of the clay model / plug / mule / master / pattern. Follow with several light coats of PVA, which are sprayed onto the surface of the vinyl coated clay model. Each coat of PVA must dry thoroughly before the next coat is sprayed on. After these have dried, mold release wax is applied over the PVA. The wax must be applied with care so that the PVA is not disturbed. Now an epoxy or polyester mold can be taken from the clay model and the mold will have an adequate surface.

The only trouble with incorporating this basic surface preparation system into typical clay modeling is that the industries using polyester resins for mold making prefer a "Class-A" polyester gel coat finish on their pattern of choice. Obviously, negatives made from a model with a "Class-A" finish will be able to produce positive cast parts maintaining the "Class-A" finish.

Today it is possible to achieve a polyester gel coat finish on models constructed with styling clay. To realize this finish the surface of the approved styling clay model is first sprayed with a few coats of an **adhesion promoter** commonly used for automotive parts such as flexible bumpers or as a refinishing product. Following this step, after the adhesion promoter is thoroughly dry, the surface is sprayed with several coats of a **water-borne barrier coat**. Each coating should be allowed to flash-off only long enough to prevent sagging. The final barrier coat application must be thoroughly dry before proceeding.

There are several product brands available that can be used to create a barrier coat to seal the clay. Suppliers of Adhesion Promoter or Water Borne primers can be found in the Suppliers section at the end of this article or by a Google Search.

A water-borne primer-sealer is not a solvent-based material. As such, there is no solvent sensitivity to the undercoats or topcoats and there is no reaction to the styling clay. <u>All sealers should water-borne</u>.

The cured Barrier Coat surface is then sprayed and built up to the desired thickness with Featherfill, Duatec or other **polyester sandable primer** and sanded as instructed.

Krylon also makes three colors of an all-purpose sandable primer in an aerosol, which can be applied directly on top of the clay. Either way, this barrier seal must not be broken. It is a good idea to apply two different colors of sandable primers so that when sanding is taking place you will have a built in warning system. When you see the second color you will know that you are very close to the clay surface.

A polyester tooling gel is then sprayed over the sanded primed surface or it can actually be sprayed directly on top of the barrier coat, reducing the number of steps required. The polyester tooling gel coat is then dry or wet sanded as instructed by the manufacturer. Care must be taken to avoid sanding through the undercoats and disturbing the clay. Always use the largest sanding block possible to avoid sanding holes or low spots into the surface.

Typical polyester finishing techniques are:

Allow adequate time for post curing. Lightly sand with 600 – 1200 grit sandpaper.

After sanding, machine buff using appropriate buffing compound. Buff the whole area evenly with extremely light pressure since you do not want to heat, by friction, the prepared surface with the buffing wheel. Continue buffing process until a satisfactory luster is obtained.

Provided the clay model surface was properly developed using steels and slicks and the sanding of the various surface preparation coats was done correctly, there will be no distortions or undulations in the reflective highlights of the surface of the finished model. If low spots are seen polyester fillers can be applied and finished accordingly. The results will render a “Class A” finish.

There are variations on this surface preparation system and there is an additional step, which can be quite valuable. Following the application of the Barrier Coat on the clay model, the surface can be laminated with a polyester resin and a very fine fiberglass such as a surfacing veil or surfacing mat (sometimes called angel hair). When this has set up, sand off any high points of this laminate but do not sand through the fiberglass veil. Spray the surface with the Fourseal or other sandable polyester primer. Build up with the polyester tooling gel coat, sand and buff to a high luster. This thin fiberglass shell will protect the clay surface, provide a harder surface for sanding and buffing and assure a crack free polyester gel coat finish.

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ALTERNATIVE METHOD FOR PRIMING OVER CHAVANT CLAY

The clay model should first be coated with an adhesion sealer, or similar product and allowed to completely dry. This will provide a stronger bond between the clay and the first light coat of a Lacquer Base Primer. Allow approximately a 10-minute flash time between the following two coats of additional Primer. When the primer is dry, apply three light coats of a different color primer, again allowing a 10 minute flash time between coats.

Allow the primer coats to dry completely insuring that all possible shrinkage transpires before any sanding or spot filling takes place. After the primer coats are cured, holes, small dents or undulations can be patched with spot filler and allowed to dry.

The dry prepared surface is sanded as instructed by the primer manufacturer. Additional topcoats can be sprayed or filler can be added to obtain the required finish. Thinners may be introduced as recommended by the primer manufacturer.

The surface is then sprayed and built up with polyester tooling gel. The tooling gel coat is dry or wet sanded as instructed. Machine buff the surface area evenly and with very light pressure. Do not heat the surface with the buffing wheel. Continue buffing until a satisfactory high luster is obtained.

THIRD ALTERNATIVE METHOD

Krylon, the spray paint available from many locations, produces a Sandable Primer in three colors. This can be applied directly to the clay surface with reasonably good adhesion. After two coats are applied sand, and topcoat with polyester tooling gel as described above.

It is important to be confident and familiar with the system you have selected. It is highly recommended that a test sample or samples of molds be made off of a test clay model prior to casting an important mold from a valuable clay model.

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Summary of
Surfacing Clay for Mold Preparation

The following procedural summaries are to be applied over the steeled, slicked clay surface will help assure a "Class-A" surface. Always test compatibility of specific system components prior to beginning the sealing / mold-making process. The number of coats for any step can be manipulated as required. Normal FRP mold making processes will follow.

METHOD #1

- Any universal adhesion promoter (commonly used for Automotive Plastics)
- Any water borne sealer/primer
- Polish as instructed
- Any sandable primer
- Polish as instructed
- Any polyester gel coat
- Polish as instructed
- Appropriate release wax or system

METHOD #2

- Gel coat or sandable primer directly onto clay (test compatibility)
- Polish as required
- Appropriate release wax or system

METHOD #3

- Krylon Sandable Primer directly on the surface of the clay.
- Apply finishing coats of any material and polish as required
- Appropriate release wax or system

F.R.P. Negatives

Making a negative off of a model finished with a Polyester Gel Coat system is similar to making a negative off of a wood and Bondo model finished with a polyester gel coat. The buffed surface of the model, as described previously, should be cleaned with a mold preparation cleaner/pre-sealer glaze two times. Obviously there are many release systems incorporating the use of strippable vinyl, part-all films, PVA and release waxes. As a minimum requirement wax the surface with 10 – 20 coats of a good mold release wax.

Following the application of a release system normal FRP Casting techniques are used in making the negative. Consider providing a means to vent the mold for removal from the model by attaching an air vent hose fitting that can later be removed. On large molds this will greatly assist in the demolding process. Thirty-five pounds of pressure is generally enough to break the seal between the mold and the model.

Spray tooling gel onto the waxed or otherwise prepared surface. Apply resin and 1½ ounce fiberglass cloth in successive layers. Roll out each layer and allow time between layers to avoid excessive exothermic heat build-up. Build up 7 to 12 layers of resin and fiberglass cloth.

When the resin has cured, attach an air hose to the air vent hose fitting that was cast into the mold and apply air through the vent to release the mold from the model. Carefully remove the mold from the model. If no vent is used, and sometimes when it is, the clay model may be destroyed so be sure to get it right the first time.

There are an unlimited number of release systems currently available and new systems are being introduced on a regular basis. Experienced modelers often remove molds without damage to the clay. Testing is recommended. Hiring a consultant for an on site demonstration is highly recommended.

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Following are a few **Release System** methods for use over a surfaced clay model or directly from the clay surface.

METHOD #1

- Shellac the clay surface (3 light coats that must be sprayed not brushed)
- PVA (Poly Vinyl Alcohol) Part-All Film
- Appropriate release wax or system

METHOD #2

- Use PVA (Part-All Film) directly on surface of clay (test compatibility)
- Appropriate release wax or system

METHOD #3

- PVA
- Strippable vinyl
- Appropriate release wax or system

METHOD #4

- Part-All (PVA) Film
- Strippable Vinyl
- Appropriate Wax
- Mica (small particle silica release)

METHOD #5

- Part-All (PVA) Film
- Strippable Vinyl
- Silicone dispersion agent

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Painting Chavant Hard Styling Clay

Hard Styling Clay can be painted in a number of different ways. First the user must determine whether or not they want to be able to remove the painted finish.

Don't remove the finish:

- Most acrylic paints will work acceptably by themselves directly on the clay surface;
- Shellac, lacquer or acrylic clear coats can be applied to "seal" the clay prior to painting*;
- Adhesion promoters can be applied to the surface of the clay**;
- Water borne barrier coat then;
  Sandable surfacing primer
- Krylon paints and sanding primers will work with no surface preparation.

Remove the finish – these items may be stripped off by hand or you can get air under it and blow it off:

- Chavant Clay Modeling Film. The Clay Modeling Film is an adhesive backed membrane, available in pre-pigmented, hi-gloss metallic silver, used specifically for checking the highlights of a clay model or in a clear form. Both films have excellent elasticity for application onto corners. There is no need to paint the pre-colored film, as required with Di-Noc, therefore you won't experience a color variation on the film. After soaking the film in warm water for a few minutes, the modeling film can be used instantly. It is easy to remove the film, in one piece, after application without any damage to the clay model.
- DiNoc film – available in only one color that must be painted. DiNoc is a thin adhesive backed membrane that acts like a decal. Peel off a protective coat, cut to shape, paint, soak in water and peel off adhesive backing, stretch and smooth over surface;
- Use a water based primer, by itself, without adhesion promoter, and topcoat with an automotive paint with a flex promoter;
- Apply "Part All Film" (PVA), a water soluble spray film. Make sure it dries, paint over it;
- Apply a strippable vinyl before paint.

* Spray shellac (Bullseye) on smooth clay, do not brush it on. It dries hard but will not create a surface that will hold up under fine sandpaper work at edges or in detailed areas. Over-coating the shellac with enamel paints produces an acceptable finish as long as you don't use a gloss, which reveals dust and surface modulations. The recommended paints are automotive lacquers applied by spray gun. These paints can be sanded and buffed. It is very important that clay model surface be properly developed and primed.

** The clay model is first coated with an adhesion sealer to form a bond between the clay and first light coat of Water based or Lacquer Base Primer with a 10 minute flash time between coats. **Tip**: use several light coats of two different colors of Primer, Gray and Red for example. When the Gray Primer is dry, three light coats of Red Primer are added, allowing a proper flash time between coats. This way, when you begin sanding the red surface and pass through it you will see the Gray Primer providing a visual indicator that you are nearing the clay surface.

Primer must dry sufficiently to assure that all shrinkage that occurs is completed before any sanding or filling can be done.

Holes and small dents are now filled with spot filler and allowed to dry.

Surface is water sanded with 320 wet/dry paper followed by 600 grit paper. Additional red primer and spot filler may be used as necessary to obtain a good finish. Paint as required.

** THE FOLLOWING PAGES PROVIDE AN EXTREMELY DETAILED PAINT PROCESS THAT SHOUD BE FOLLOWED EXACTLY AS WRITTEN. OUR THANKS TO:

ACADEMY OF ART UNIVERSITY

IDS 217 MODELMAKING 3

HOW TO PAINT A CLAY MODEL

By Paul Wilczynski

"This set of instructions was written by Paul Wilczynski, who is the IDS 3D Manager for the Industrial Design Department at the Academy of Art University in San Francisco. It is based upon Paul's 35 years in the design prototyping business. It has been used to finish over 150 clay vehicle models since 2003, with no failures in any paint job. In order for it to work, the materials and methods must be followed exactly, with NO SUBSTITUTIONS."

ACADEMY OF ART UNIVERSITY
IDS 217 MODELMAKING 3
HOW TO PAINT A CLAY MODEL

By Paul Wilczynski

FIRST THINGS FIRST…

Follow the procedures carefully and TO THE LETTER. Do not try to rush suggested drying times. So-called “shortcuts” such as using forced hot air to shorten drying schedules, will actually cause more problems than they will solve. PLAN TO ALLOW AS MUCH TIME AS NECESSARY TO ACHIEVE A CLASS “A” FINISH. To go through all the steps called out in this paper, and to give each step its proper attention before moving on to the next, will take a minimum of 30 hours, spread out over approximately five to six working days!

Do NOT substitute materials, no matter what the guy in the shop, fellow students, your girlfriend’s uncle, etc., tell you. We teach this painting as a SYSTEM here at the Academy. Ask yourself (and him, if necessary!) how many clay models they have painted, before accepting them as authorities on finishing YOUR time-intensive and easily-damaged model.

BEFORE WE BEGIN:

Your model needs to be steeled carefully and free from any loose clay bits. Be sure that all inside corners and edges, highlights, peaks, etc. are just as you want them. Once you have begun painting your model, you will NOT be able to make any corrections whatsoever!

Slicking the model is unnecessary and actually can be counterproductive. NOTE: DO NOT SLICK THE MODEL WITH A SOLVENT (especially WD-40). You will experience serious paint adhesion problems. A surface which has been slicked with water only, may be painted, but possibly could have a finish which is less durable that a surface which is merely carefully steeled. In the case of painted clay models, “slick” is usually “too smooth”!

Please note that in no case do I EVER recommend attempting to finish a 1/5 scale clay model using spray cans, or “rattle cans”. There are two very good reasons for this insistence:

1. The products available in spray cans are formulated for hobbyists and homeowners, not professional designers or painters. These paint formulations are usually enamels which use either mineral spirits or water as solvents. Neither is suitable for any sort of a durable model finish.

2. Spray paints have so many formulations that absolute compatibility is doubtful, even among products carrying the same brand name. The result is inevitably wrinkling or adhesion problems, resulting in the failure of the paint finish.

There are three exceptions to the “rattle can” rule, having to do with GUIDE COATING the model, and with painting the WHEELS and TIRES:

1. If you desire silver wheels on your model, Autoglym, a British Company which manufactures detailing products for luxury cars, makes the best silver wheel paint known to man. It’s called (of course!) Autoglym Wheel Silver, and it comes in a huge 20 ounce spray can.

2. For finishing scale model tires, there are two good products which duplicate satisfactorily the low sheen of new black rubber. The first is made by Spruce Paints, and it’s designated as their Flat Black Lacquer spray paint. It comes in a 12-ounce spray can. It blushes easily, so don’t spray it on cold or rainy days. The other paint which works well to simulate black rubber is Krylon Ultra Flat Black Enamel spray paint. It is much less sensitive to high humidity and low temperatures.

3. The Spruce Flat Black lacquer is also excellent for guide-coating your model to reveal surface flaws during dry or wet sanding procedures.

STEP # 1—SEALING THE CLAY SURFACE

Using a spray gun, spray on two thin wet coats of Zinsser B*I*N Sealer. This is made by Zinsser. It comes in a white can with a red and white bulls-eye on the label. If required, B*I*N can be diluted with a small amount of denatured alcohol.

B*I*N can also be procured in large spray cans. *Do NOT use a similar Zinsser product called “KILZ”! It will not work under the paint system described in this paper.*

Let the first coat of B*I*N flash dry (10 minutes) before applying the second coat. Now let both coats dry overnight.

Scuff the surface GENTLY and VERY CAREFULLY and thoroughly with fine Scotchbrite (brown color). Stay away from edges, and avoid overdoing this step, or you will cut through the sealer coat. The idea here is to slightly rough up the

sealer for better bonding of the next coats.

STEP #2—POLYESTER PRIMER

A medium coat of Duratec or Evercoat polyester primer surfacer (PPS--gray color, product # 707-002) is next applied. Use an HVLP gun, gravity feed, with a 1.4 nozzle and 25-35 psi air pressure at the inlet of the gun. Mix only enough for one coat at a time. A good rule of thumb is 8 ounces of paint and exactly 5cc of MEK peroxide catalyst. MEASURE—don't estimate! Spray a test panel first and, if necessary, dilute the mixed primer with acetone. ***The surface of the Duratec or Evercoat PPS should be smooth***, with a minimum of dry spray patches or orange peel. Adjust the gun and, if necessary, the viscosity of the primer (by thinning it up to 20% with acetone) in order to achieve this smoothness. NOTE: Don't worry about little air pinholes that might show up, where the clay may not have filled in completely. Up to about 1/16" (1.5mm) these can be filled with polyester spot putty (Evercoat product # 100416). This putty is used after the model is painted with PPS and sanded, but before the urethane primer (STEP #3) is applied.

Clean the gun thoroughly between coats of PPS, using acetone. WAIT 30 MINUTES and mix and apply a second coat of PPS. Wait another 30 minutes, and apply a third. If you wish, as many as 4 coats can be applied—just be sure the previous coat has "kicked-off" before applying the next. The PPS should be "green" (i.e., gelled and dry to the touch but still soft and not completely hardened), while these multiple coats are applied. Now clean the gun again after the last primer coat.

When the PPS coats are FULLY hardened (4-8 hours), guide coat and dry-sand carefully with #150 aluminum oxide paper. Use a rubber block wherever possible. This flattens the surface and allows you also to crispen up any details you want to get really perfect. Never use a wood block on a clay model. It will groove the surface of the clay! Now's the time to fill any imperfections with Evercoat polyester spot putty (PSP). There are several Evercoat products suitable for this operation. I prefer # 400, but #s 416 and 421 are suitable, too.

STEP #3—URETHANE PRIMER

Once the sealer and polyester primer-surfacer are used to prep the model, I strongly advise that the urethane primer, basecoat, and clearcoat should be from the same manufacturer, and that all three be recommended by the manufacturer as a compatible COATING SYSTEM. With this in mind, I will refer to PPG products by name and part number from this point forward. Each major manufacturer sells an equivalent system.

Re-prime the model with two coats of PPG NCP 280 Urethane Primer-Surfacer. This is mixed 2:1 with NCX 285 catalyst. This can be reduced if necessary to

improve flow, by adding one part of DT reducer to five parts of the catalyzed mixture. Spray with the same gun at the same settings as STEP #2 above. Allow 10-15 minutes between coats. This primer has a minimum 4 hour cure time. When fully cured, guide coat the model and wet sand with #600 Wet Or Dry. Now you are ready to apply the color coats.

STEP #4—COLOR COATS

I suggest PPG Deltron 2000(DBC) for the color coat (topcoat) step of the paint process. It is by far the easiest to apply of any paint topcoat I've ever used. Pick a color from the thousands available in solids, metallics, micas, and pearls. One pint each of window and body colors should be sufficient. The window color should be chosen to contrast with the body color. Lighter body colors are preferable to very dark colors, because they photograph and show off the contours of the model best.

You will also need 4 ounces each of the taillight and headlight colors, if you choose to paint them.

Begin by cleaning the surface of your model with a suitable wax and grease remover such as Grow Chemical # 1705 Grow Super Clean. We stock this in the IDS shop for your use. You should use a clean cotton cloth to soak the surface of the model and a second clean, dry cotton cloth to wipe the Super Clean off the surface of the model. ***Do not allow the wax and grease remover to dry on the surface of the model!***

When the model has been thoroughly wiped dry, wet again with 1705 and once again wipe the model's surface dry.

Next, lightly wipe the surface with a tack cloth. We also stock these in the IDS shop, at a very reasonable price. These can be re-used for many paint jobs.

We supply your color coat paint already mixed and reduced. If you wish to further mix or reduce it, or tint it to change the color slightly, pour it from the can into a clean paper or polyethylene mixing cup.

NOTE: DO NOT USE ordinary wax paper cups. The wax will migrate into the liquid paint and cause paint imperfections, primarily fisheye craters. Foam coffee cups are out, too--they will dissolve in seconds due to the solvents in the paint. Clear styrene cups also dissolve. They just take a little longer. These are not recommended, either.

Always strain the paint mixture as you pour from the mixing cup into the gun cup. A strainer/funnel with nylon screen is preferable to one with cheesecloth, because of dust and lint present in cheesecloth. Nylon is a finer mesh, too.

Now (finally!) you are ready to begin spraying!

ALWAYS SPRAY A COUPLE OF COLOR CHIPS BEFORE YOU SPRAY EACH COLOR, FOR PRACTICE AND TO CHECK COVERAGE AND COLOR.

Spray the window areas and headlight and taillight areas first and allow to cure thoroughly (at least 4 hours).

Mask these areas and paint the body color. Adjust the gun so that it puts out enough paint to be wet, but not enough to run or sag easily. Try 30 psi at the inlet, medium opening on the pattern, and then adjust the paint volume to suit.

Be sure to apply enough paint to completely cover the model's surface. A minimum of three medium coats are necessary. Wait ten minutes between coats. It is not necessary to scuff the model's surface between coats!

Wait 2 hours and carefully unmask the window and lighting areas. Detail these areas if necessary by touching up the paint with a tiny high-quality brush. At this point, you are ready to clearcoat.

STEP #5—CLEARCOATING

I have seen more models ruined by badly-applied clearcoat that by any other part of the painting process. There are three primary reasons for this occurrence.

The first reason: Failure to follow the manufacturer's instructions with regard to mixing and application of the finish. Always follow these TO THE LETTER.

The second reason: Poor time management. Since clearcoating is the very last step in painting a clay model, the process of clearcoating has acquired a mystique bordering on the magical. Students often are intimidated, and they will delay applying the clearcoating, waiting until the night before a presentation to spray it—a huge mistake.

The third reason: Simple fatigue. The application of clear topcoats requires a superior level of alertness, a careful attention to technical detail, and much patience. You can't stay alert and do your best work when you are exhausted.

A model should be clearcoated within 24 hours of the application of colorcoats. The clearcoating, in turn, should be completed no less than three days (and, if possible, five days), before the presentation. This is in order to give the clearcoat time to harden and shrink (at least 24 hours!), so that if final color sanding and subsequent buffing of the paint is desired, this may be accomplished comfortably prior to application of emblems, logos, INTs or tape lines.

If you have not clear-coated before, or feel the slightest bit intimidated at what is

undoubtedly the most critical and time-sensitive stage of the clay model painting process, by all means practice clearcoat spraying before painting your precious model! Spend several hours perfecting your technique, paying special attention to the amount of paint you are applying in order to achieve the gloss level you desire. It is most helpful to spray surfaces that are vertical, in order to learn how much paint is too much, and how much it takes to run or sag.

I recommend PPG Concept 2042 (DCU) High Solids Polyurethane Clear for clear coating a clay model. Mix the 2042 with the temperature-appropriate DT series reducer and DX catalyst at a ratio of 4:1:1 (2042/reducer/catalyst).

DO NOT ESTIMATE QUANTITIES! Measuring the quantities and ratios of paint, reducer, and catalyst is CRITICAL to success in this important step. The IDS shop sells special purpose clear polyethylene mixing cups. These are available in half pint or quart sizes, with mixing ratios printed on the side. These are disposable and a real time saver. They also allow you to work as you should—VERY CLEANLY!

After you mix the paint / reducer / catalyst, stir thoroughly with a CLEAN stirring strip. Then cover the polyethylene mixing cup and let the mixture sit for about 10 minutes to allow the chemistry to begin to work. At 75 degrees Fahrenheit, you will have 60-90 minutes to apply the clearcoat for optimum results.

When you pour the mixture from the mixing cup into the gun, always use a new, clean strainer. You will get a free one with every can of custom-mixed paint from the IDS shop.

ONCE AGAIN, SPRAY A COLOR CHIP SO YOU GET ACCUSTOMED TO HOW THIS PAINT MATERIAL APPLIES.

Air pressure at the inlet of 30 psi with a medium pattern and medium thickness is recommended. Clear coating involves a certain amount of technique: move the gun smoothly, plan your pattern of coverage (DON'T BE RANDOM ABOUT THIS!), and don't apply too much clear—it runs and sags easier than color coats do, because HS clear is, to put it mildly, HEAVY.

My rule of thumb regarding clear coat application is: Put on a light-to-medium coat of 2042 and WAIT for it to "flow out" a bit—about 30 seconds to a minute should elapse before you evaluate gloss level and formulate an opinion.

A common mistake is to apply the clear so the surface of the model is high in gloss immediately upon application. This usually results in too much clear being applied in one coat, with the consequence of runs and sags in an otherwise competent paint job.

Better to proceed with caution and give the model a couple of lighter coats,

waiting only 2-3 minutes between coats. Once you've clearcoated a half dozen or so models in a short time, you will learn the tricks of nearly-perfect clearcoat mixing and application.

Allow the clearcoat to cure and harden at least 24 hours. Now you can color sand and buff the model—the final step to perfection.

STEP #6—COLOR SANDING AND BUFFING

This step is optional. The better the surface quality of your clear coat, the less important color sanding and buffing becomes.

In a clean quart-size polyethylene mixing cup, mix a pint and a half of water with 4 ounces of Windex and add a teaspoonful of vinegar. This wetsanding solution will lubricate the sandpaper and keep it from loading up with clearcoat dust.

Wet or Dry sandpaper should be used WET in this case. CUT a sheet of sandpaper into FOUR strips, working the "short" way. Fold each strip into THREES. This prevents the paper slipping under your block or fingers. Exchange paper frequently, as soon as you can feel the paper losing its cutting efficiency.

USE a rubber or stiff foam block for flat or low-crown surfaces. Use your fingers wherever they will fit.

STAY AWAY FROM EDGES—they will sand through very rapidly. DO NOT SAND THROUGH THE CLEARCOAT!

Begin color sanding with #600 paper. When the entire surface (except edges) is carefully sanded, wipe the model down with a damp paper towel. Allow it to dry a minute or two, then check again for areas you might have missed. Next sand the entire surface again with #1000, wipe and dry and finish with #1500. Your model is now ready to buff.

You can choose between hand-rubbing out and buffing, or doing it with a machine. A 1/5 scale model is at the bottom size limit for successful machine buffing. I don't advise using electric buffers on scale clays—electric buffers are too large, unwieldy, and difficult to control. Should you want to try machinebuffing your model, I recommend a right-angle air buffer with a 5" diameter lambswool pad for larger areas, and then switching to a foam pad for smaller details and inside curves and edges. Smallest details can be done with a 2" diameter buffing pad. If the idea of overheating your clay model with too much pressure on the buffing pad, troubles your mind, It is safer to take the extra time and effort and just do it by hand, If you do, a cloth diaper is by far the best applying and rubbing cloth you will ever find. You can find these at K-Mart, Target, or WalMart. Use a separate diaper for each grade of compound!

Next tip: prepare a spray bottle of Windex or plain water for occasional use to lubricate and cool the surface of the model during buffing. This prevents dry streaks of buffing compound or “burn-through”, which on a clay model is difficult to repair.

The buffing process involves three steps. The first step is called cutting, and it takes the 1500-sanded dull surface and buffs it up to a semi-gloss surface with lots of swirl marks. The second step is called highlighting. It takes the surface from semi-gloss to high-gloss with a minimum of swirl marks and surface “halos” around point highlights. The third step is waxing, to fill in the tiny random scratches which cause “halos”, and to protect and glaze the surface of the model.

For the first, or cutting step, I recommend 3M Perfect-It III white rubbing compound, product #05933. Work a small amount over the surface. NEVER BEAR DOWN ENOUGH TO HEAT THE CLAY, or the whole thing—model and all—will be ruined. As you continue to buff, the surface will change from dull to semi-gloss. A consistent semi-gloss surface is the clue that it’s time to highlight.

Highlighting is done with 3M Perfect-It III Machine Glaze (Product #05937—quart size.) Use the same technique that was used in the cutting step.

Any tape lines, INTs, decals, or labels MUST be applied prior to waxing. They will not stick otherwise.

To fill and protect the final surface, a good quality wax is needed. I recommend Zymol cleaner-wax (Product#z503), or Meguiar’s Gold Class Clearcoat Wax (Product # G7016), available at most auto paint stores. Apply with a soft clean COTTON cloth (t-shirt or diaper) and buff for a perfect shine. Both these waxes are solvent-free, allowing you to “build coats” for added shine and best protection.

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HEALTH AND SAFETY

An SDS is available directly from Chavant or from our web site, www.chavant.com

A common misconception about Chavant clays concerns the issue of the Sulfur content in the clay. Misinformation and unfounded rumors seem to circulate from time to time. It is not uncommon for new or existing clients to prefer Sulfur free clay only because they believe that Sulfur is a toxic product. This is simply untrue.

One real danger can arise from Sulfur-based clay when and if the clay were to be ignited. Molten Sulfur may produce Hydrogen Sulfide, a very dangerous gas. Burning Sulfur will produce Sulfur Dioxide also very dangerous. Use caution when heating the clay to its working consistency and never heat the clay to a point where it will smoke or burn.

It is important that users of Chavant clays understand that Sulfur in itself is not a danger. Chavant uses elemental Sulfur as a filling compound in many clay formulas. Sulfur of this type is found in medicine, soaps, detergents, shampoos used by veterinarians, for burns, in the Sulfur packs in Mash, hot Sulfur springs, food preservatives/processing, paints, plastics, cosmetics, some beer, as a component of black gunpowder, is used in the vulcanization of natural rubber and is a fungicide used extensively in making fertilizers, bleaching of dried fruits and paper products.

There are Sulfur compounds that are highly dangerous but Chavant uses only elemental Sulfur.

Realizing this, it is also important to recognize that some individuals may have genuine allergic reactions to products containing Sulfur or petroleum based components. Often these symptoms will first appear as mild skin rashes. Most often, practicing good hygiene, primarily washing hands and clothing will eliminate this symptom. On the occasion that a client is in fact allergic it may be best to switch the type of clay formula being used. Most importantly it is critical that the users educate themselves about Sulfur – it is not a toxic product as used by Chavant.

Clay Modeling Products
Since 1892, the finest name in modeling clay

Suppliers

We recommend to Search the internet for the most recent contact and product information

Chavant
5600 Lower Macungie Road, Macungie, Pennsylvania 18062
1-800-762-0744
www.chavant.com
Hard Styling Clay, Industrial Clay Modeling Tools, Instructional Information

Adtech
815 W. Shepard
PO Box F
Charlotte, MI 48813
1-800-255-9934
Epoxy and Polyester systems

Alto-Shaam
W164 N9221 Water Street
PO Box 450
Menomonee Falls, WI 53052
800-558-8744
Ovens (bun warmers)

Composites Technology
(303) 467-1776
Composite Materials Yellow Pages – everything you need in one guide

Despatch Industries
PO Box 1320
Minneapolis, MN 55440
612-469-5424
Lab ovens

Dupont Automotive Refinish Products
1-800-3-DUPONT or 610-458-6100
Adhesion Promoter #2322S, Velvaseal Waterborne Primer Sealer #2120S / 2125S / 2140S
Duratec
Hawkeye Industries
3050 Brookview Drive
Marietta, GA 30068
1-(770) 977-3336
Surfacing Primers #707-002, Hi-gloss Coatings, Sealers – Ask for bulletin # 9544

Fiber Glass – Evercoat
6600 Cornell Road
Cincinnati, OH 45242
1-513-489-7600
Feather Fill Polyester Filler, Spray Core 4200 Surfacing Primer

Grieve Corporation
500 Hart Road
Round Lake, IL 60073-9989
847-546-8225
Ovens

Krylon – Diversified Brands
1-800-925-3434
Krylon Sandable Primers

Moco Thermal Industries
One Oven Place
Romulus, MI 48174
800-421-MOCO
Ovens

Russ Simpson Company
21906 Schoenherr Road
Warren, MI 48089
800-448-7928
All related equipment

Toastwell
640 Tower Grove Avenue
St. Louis, MO 63110
314-371-2732
Ovens (bun warmers)

Transtar Autobody Technologies
2040 Heiserman Drive
Brighton, MI 48116
1-800-824-2843
Universal Adhesion Promoter #1023, Hydroflex Waterborne Flexible Primer Sealer #1231, #1234, #1235

To locate a Chavant distributor, please visit the Distributor Page of our web site.

As always, Chavant invites you to contact us with any comments, questions or suggestions.

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Web site: http://www.chavant.com