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

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Contents

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.

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Acknowledgements

Chavant extends a sincere thank you to all of the modelers, designers, mold makers, artists and other supporters of Chavant products for sharing ideas and methods for the "Art to Part" process. The following discussions are based on articles contributed from these various sources. In particular, a special thanks goes out to our friends:

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Each of these companies offers design consultant services of the highest quality.

Most importantly, watch for a very informative book that Hoadley Associates, Inc. is expected to publish in the near future. 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 the unlimited amount of expression available from clay products to communicate style. Without doubt, styling, inside and out, is what sell cars and an infinite number of other consumer products.

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

Admittedly, these fantastic technologies are extremely impressive and they provide immeasurable value at several stages of any design 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 to name a few. 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.”

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 validity. The bottom line is that physical models will continue to be built and that clay and clay modeling will likely remain as very important tools.

This supposition is 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 on to profile several professions. The first profession reviewed by the author is automobile design - featuring clay!

Clay offers the user unlimited freedom of expression, it is reusable, can be machined on milling equipment, is very tolerant of time, shapes can be modified 1000’s of times, there are no limitations of size, some can be liquefied and cast and the most important tools are the modelers hands. Some specialized equipment is necessary but most 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 but these clays can be machined, scanned, finished, used as presentation models or actual tooling patterns. The following pages attempt to demonstrate the basic theories, methods and terminology used in developing a clay model and continue to describe how to use today’s composite materials to create perfectly finished patterns, molds and production parts – all by beginning with clay.

The 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 models surface is only 90% perfect. Surface preparation to some degree is generally required prior to pulling production molds, one-off splashes or simply to prepare 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. The value, just in the savings of time, from scanning coordinate digital 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.

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. 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.

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CLAY MODELING

Chavant Hard Styling Clay can be modeled by hand, extruded, machined 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 rules 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, on top of the surface plate. More often the clay will be applied over an armature that is supported by some method over the surface of the 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. Contact Chavant for information.

ARMATURES

It is presumed that some sort of rendering, ranging from sketches to 3-D computer outputs, have been created to approximate all dimensions of the project. These conceptual renderings will be referred to during the construction of an **armature**, which will approximate the final clearance points of the desired finished model.

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 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 flucations.

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.

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ESTIMATE CLAY USAGE

How can you determine how much clay to use on a specific project? 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.

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 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 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. 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, 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. If the clay is made too soft 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 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 sensitivity.

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 so that they are applying hot clay to a warm clay surface. Clay, in this respect, can be 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 Sulphur below). Some Chavant clay formulas, that are sulphur-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!

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 through a series of light bulbs controlled with a dimmer switch, installed in an insulated box. Refrigerators work well, so do milk boxes, beverage coolers or even file cabinets. Even a simple bucket with Saran wrap will work as a container. Fans, thermostats, light deflectors and shelves can all be built in. Be cautious of " hot spots" which may result in melting or worse burning the clay.

Convection ovens and restaurant bun warmers also make fine ovens. Convection ovens have heating elements and a fan in the roof of the oven. Farberware makes one unit that will heat approximately 10 pounds of clay at a time and is reasonably inexpensive. 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 build 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.

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. It is better to either leave the oven on or cycle it down to a point that the clay will 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. 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.

Sulphur, from sulphur based clays, (sulphur 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 sulphur 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 the clay is excessively overheated, in excess of 200° F, sulphur 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 sulphur 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, sulphur will emit a very dangerous gas. In its normal state sulphur 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.

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STYLING CLAY HAND-TOOLS

The surface of a clay model is dragged as smooth as possible and to the desired shape with various tools including Rakes, Wire Loops, Finishers and templates. Rakes, Wire Loops and Finishers are specially designed tools having hardwood handles and hardened steel cutting surfaces.

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 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 off 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 a surface finish.

Chavant manufactures and distributes these specialized tools. Photos of the tools can be found on the Chavant web site and their use is demonstrated in the Educational Video Series, videos one and two.

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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 and Scales
- Styling Bridges
- Measuring Systems
- Rotary Display Tables
- Extruders
- “Bulldog” Clay Mixers that warm and extrude clay
- 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
All types of equipment

Lamerson
21844 Wyoming Place
Oak park, MI 48237
Phone 248-548-0676
All types of equipment

Tarus Industries
38100 Commerce
Sterling Heights, MI 48312
Phone: 810- 977-1400
Milling systems

Chief
Box 1368
Grand Island, NE 68802-9747
Phone: 308-383-9747
Measuring systems

Chavant will be pleased to provide quotations and information on this type of equipment.

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TEMPLATES

TRUE SWEEPS

Templates are some of the most important tools you will use in clay modeling. Predetermined common radius shapes known as True Sweeps are available. 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. These tools are available through Chavant.

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 modlers)

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.

SURFACE ENHANCEMENT

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 purchased Blue Tempered Spring Steel. This material is often available in prepackaged assortments containing assorted thicknesses of spring steel sheets that are 6" x 12". 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. Once made or purchased they should last forever.

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 Skin-so-Soft!

Many of these topics are covered in depth in Chavant's educational video series, tapes number one, Introduction to Clay Modeling and number two, Advanced Clay modeling Techniques.

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MOLD MAKING

When the clay model surface is finished and satisfactorily approved, a negative can be cast directly off of the clay model using **Chavant's MDM** (Model Duplicating Media) for constructing the mold. **Polyester or epoxy negatives** can also 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. For information on these materials visit the suppliers area of the "Links" page on the Chavant web site.

MDM – Waste and Limited Production Molds

Two Steps To Perfect Model Duplication

Rayite ™ MDM (Model Duplicating Media) is a technology originally developed by Chavant. Production and further development has been turned over to United States Gypsum. MDM is a unique two-component duplicating process specifically designed for use with all model and pattern materials, especially oil-based clay products. The formulation of Rayite MDM provides for exacting replication of detail, while minimizing model distortion normally associated with heat-generating duplication products. Co-developed Chavant, Inc. and USGC, it is quick, safe and easy to use.

Rayite ™ MDM-S (Surface) media replicates minute surface detail, while Rayite MDM-R (Reinforcing) media provides reinforcement to the surface coat. Together, these two combine to form a lightweight and strong casting from a variety of pattern materials with minimal model preparation. And removal is easy -- unique "self releasing" properties allow the cast to virtually pop off the model or pattern.

Here is how it works:

1. Prepare model surface: oil based clay or wax patterns need no preparation. If using porous patterns or models that require sealing, such as wood, use a sealer as described in IG326.

2. **Mix Rayite MDM-S**: Follow the mixing instructions in IG739, outlined below. Apply the Rayite MDM-S with a disposable brush or by spray apparatus at a thickness of $^{1}/_{8}$ " or less. Rayite MDM-S media is specially formulated to "hang-up" on vertical surfaces with minimum drag.

3. Allow the MDM-S coat to stiffen (approximately 35 to 45 minutes): Rayite MDM-S media will begin to "dull out" at this time, going from a shinny wet surface to a matte appearance. Begin preparation of the Rayite MDM-R media.

4. **Mix Rayite MDM-R**: Follow the mixing instructions in IG739, outlined below. Apply the Rayite MDM-R media by hand or by trowel to a nominal thickness of about 1". Allow about 1 hour to completely harden.

5. **Remove cast**: Carefully pry the cast away from the model or pattern. If necessary use compressed air to assist. The unique "self-releasing" properties of Rayite MDM media allow the cast to be removed easily.

The casting is now ready to use.

Bulletin IG739

Detailed Mixing Instructions: The Rayite™ MDM model duplicating system is safe, easy to use, extremely accurate and specially formulated for use with all model and pattern materials, especially oil based clay products. When used properly, the Rayite MDM duplicating system will not cause clay model distortion. It is lightweight, yet strong, enabling large casts to be made and handled easily.

The unique formulation of Rayite MDM, developed with Chavant, Inc., also eliminates the need for parting agents normally applied to non-porous models or patterns. An ultra thin film of water, actually a hydraulic barrier, develops between the Surface Coat and the model or pattern. This self-releasing mechanism allows for easy removal of the Rayite MDM casting from the model or pattern.

Successful mixing and use of Rayite MDM Model Duplicating Media products require following specific standards and procedures. To obtain the full benefit of this product, shop practices and procedures must be standardized. An ideal Rayite MDM Surface (S) or Reinforcing (R) mix is one in which the powder particles are completely dispersed in the water to produce a uniform, homogeneous slurry. Such a mix should be the goal of every shop, and extreme care must be taken to control variables such as batch size, mixer design, mixing time, water purity, and water temperature. The following information will cover many of the factors that determine production of an ideal Rayite MDM mix.

Water Purity
Water used in mixing Rayite MDM should be as pure as possible. If water is drinkable, it is probably suitable for the mixing of Rayite MDM slurries. In many cases, water for

industrial use is taken from contaminated sources and is high in organic impurities that lengthen the setting time. Other contaminates could negatively affect the slurry and ultimately the finished cast.

Water Temperature
Since Rayite MDM has maximum solubility at 100º F, variations in water temperature will affect setting time and can cause difficulty in the control of mixing time. The rule-of-thumb to remember is that cold water retards the set, while warmer water accelerates the set. It is recommended that the water and Rayite MDM Surface or Reinforcing powder combined have a slurry temperature of between 65º F and 80º F. Wide variations in water temperature can be corrected by using a tempering tank to balance extreme temperature differences. Tank types can range from an automatic system, which blends hot and cold water, to a simple container warmed by waste heat or by air temperature in the shop.

Water to Rayite MDM Ratio
Variations in water-to-Rayite MDM Surface and Reinforcing ratios will affect various performance characteristics of the final cast such as viscosity, ease of application, porosity and overall strength. It is important to control this ratio by carefully measuring each component. Both the Surface and Reinforcing products can be used in a range of ratios, as specified below (refer to the Specifications chart below for use consistency). It is important to stay within these ranges. Keep in mind that an increase in water to either Rayite MDM-R or S media will make the products more fluid and decrease the strength of the cast.

Soaking
When manufactured, Rayite MDM particles are surrounded by an envelope of air. Part of this air is removed from the Rayite MDM powder particles during shipping and handling, part during soaking. In addition to removing air, soaking allows each Rayite MDM particle to be completely saturated with water so that it is easier to disperse. However, Rayite MDM particles are influenced by additives that may not easily disperse in water. It is recommended that Rayite MDM powder is allowed to soak for a minimum of 1 minute. Any powder that does not sink into the water should be hand dispersed into the water prior to mixing.

Mixing Rayite MDM Model Duplicating Media
Mixing Rayite MDM Surface and Reinforcing media is the most important function in producing casts with maximum strength, hardness and exactness of detail. Any changes in mixing procedure will have greater effect on the finished product than any other phase of the entire operation. It is also vitally important to always weigh the water and Rayite MDM Surface or Reinforcing powder. Incorrect water and Rayite MDM powder ratios will negatively affect the quality of Rayite MDM casts.

Mixing disperses Rayite MDM particles in the water. Also, the strength of the Rayite MDM cast is partially determined in mixing since there is a direct relationship between energy input during mixing and strength development of the cast.

Equipment Requirements:
Clean Buckets
Electric Drill ($^{3}/_{8}$" chuck or larger)
Mixing Blades (Jiffy ® brand wood or metal stick, or kitchen wisk)
Scale (electronic, Balance or Spring)
Disposable Paint Brushes
Cup Gun (Model ES-100, Manufactured by ES Manufacturing or R2 All materials Spray Gun, Manufactured by PSH industries).
Trowel

Prepare the model or pattern, clay or wax patterns need no additional preparation. Porous models or patterns such as wood require sealing -- follow sealing instructions per IG326.

Mixing and Using Rayite MDM-S media
Use the Rayite MDM-S estimating chart, Fig. 1, for approximate quantities of water and Rayite MDM-S powder. Weigh Rayite MDM-S powder and water in separate containers.

Slowly sift the Rayite MDM-S into the water. Let soak for approximately one minute. If the total mixture of powder and water is greater than five pounds, mix using electric drill and mixing blade. Otherwise use a mixing stick or a kitchen whisk to blend. Mix for approximately two minutes. Be sure slurry is lump free. Rayite MDM-S media should have a consistency similar to pancake batter. Try not to introduce air into the system. Bubbles at this stage may lead to holes in the mold surface.

The application of Rayite MDM-S media can be by paintbrush or by spray gun (using equipment made by ES Manufacturing or PSH Industries). Both methods provide excellent results, although the spray application is best suited for large areas.

Using either method, apply Rayite MDM-S media at a thickness of approximately $^{1}/_{16}$" - $^{1}/_{8}$". Apply more Rayite MDM-S media at corners, edges, or highly detailed areas. The "pot life" of Rayite MDM-S media is approximately 20 - 25 minutes.

Allow the Rayite MDM-S media to stiffen on the surface of the model. This takes approximately 35 - 45 minutes (from beginning of mixing time). Rayite MDM-S media begins to "dull out", from a wet, glossy appearance to a matte appearance, during the hardening process. Begin preparation of the Rayite MDM-R media as the matte finish begins to appear.

Mixing and Using Rayite MDM-R media
Follow the Rayite MDM-R Estimating chart for approximate quantities of water and Rayite MDM-R powder (Fig. 1. below) Weigh Rayite MDM-R powder and water in separate containers.

Slowly sift the Rayite MDM-R into the water. Let soak for approximately one minute. If the total mixture of powder and water is greater than five pounds, mix using electric drill and mixing blade. Otherwise use a mixing stick or kitchen whisk to blend. Mix for

approximately two minutes. Be sure the slurry is lump free. Rayite MDM-R media should have a consistency of dough or mortar. Air introduced here due to mechanical mixing will not cause harm since there is no contact between the model and the MDM-R.

Apply Rayite MDM-R onto the Surface Coat by hand or trowel. MDM-R must be applied before MDM-S has totally dried or delaminating may occur. It is best not to leave the premise after MDM-S is applied. This will assure that it does not dry out. Basically you want the MDM-S to be firm enough not to allow the MDM-R to push through the MDM-S whereby coming in contact with the model surface.

If the Surface coat appears totally dry, turning a whitish pink often seen around edges first, moisten with water. Firmly press the reinforcing material onto the Surface. This minimizes air entrapment. Ideally you want a 100% contact to contact ratio between the MDM-S and MDM-R. If there is an empty pocket between the MDM-S and MDM-R, this will be a weak spot that may break during demolding and would require a patch before casting a part. If a patch is required, remove all loose debris, drill a few 1/32” holes in and around patch area, mix MDM-S and apply to area. Remove excess prior to total drying by splineing. After the patch is dry, sand to desired surface. Occasionally the patch is harder than original mold so sand with caution.

Build MDM-R up to a thickness of $^{1}/_{2}$" - 1". Rayite MDM-R has an approximate "pot life" of 30 minutes.

If necessary, frames, handles or additional support should be added before the Rayite MDM-R media has hardened. This allows the Reinforcing coat to harden around the mechanical additions and provides maximum strength. Use sealed wood, metal, or fiberglass reinforced material. Allow the Reinforcing coat to harden approximately 60 minutes. This will also lighten in color as it dries.

Fig.1
Unit of measure: Pounds (lbs.)

Coverage per Square Foot	**Rayite MDM-S**			**Rayite MDM-R**		
	Total Mix	Powder	Water	Total Mix	Powder	Water
1	1.25	0.89	0.36	7.5	5.64	1.86
2	2.50	1.79	0.71	15	11.28	3.27
3	3.75	2.68	1.07	22.50	16.92	5.58
4	5	3.57	1.43	30	22.56	7.44
5	6.25	4.46	1.79	37.50	28.20	9.31
6	7.50	5.36	2.14	45	33.83	11.17
7	8.75	6.25	2.50	52.5	39.47	13.03
8	10	7.14	2.86	60	45.11	14.89
9	11.25	8.04	3.21	67.50	50.75	16.75
10	12.50	8.93	3.57	75	56.39	18.61

Removing the cast

When the Reinforcing coat has completely dried, the cast can be removed. Begin by

prying the cast away from the model or pattern by using a chisel or putty knife. Wedge the cast at several points along the edge. Wedges, some with air valves built in, can be built into the project ahead of time if required. If necessary, use compressed air to assist in the demolding. The cast should easily pull away from the model or pattern.

A thin film of water should be apparent on the surface of the model or pattern. This is what provides the unique "self-releasing" property of Rayite MDM Model Duplicating Media and is normal. If more than one hour passes before demolding is done, the cast may be slightly more difficult to remove. Use care when removing the cast under these conditions and under no circumstance should you leave the mold for extended periods unless you have removed it first.

MDM molds will be “green” with moisture immediately following mold removal. After removing the mold do not place large molds on their edges because the mold may actually twist under its own weight. When additional drying is required place the mold on several stands and allow air from a fan to blow over the mold surface.

Using the MDM Cast as a Temporary Tool
Casts made from Rayite MDM Model Duplicating Media are extremely strong and durable and 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 Rayite MDM tool.

Sealing: Rayite MDM casts must 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 Rayite MDM Model Duplicating Media. 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 Rayite MDM tool.

MDM - Alternate sealing methods for preparing the MDM mold.
The original MDM 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. (see suppliers)

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 MDM 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 MDM 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 MDM 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. Chemlease, International, Inc. (561) 994-8211

Duratec's Plaster Sealer, 800-A, is a polyester sealer that is catalyzed and applied onto the MDM surface. Because it is a polyester system it is very sensitive to moisture. It is

recommended that you wipe the MDM 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. Duratec - Hawkeye Industries, Inc. (770) 977-3336 Bulletin # 9540 explains this option.

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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** such as R&M 811 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** such as R&M HP-100. 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 other products available that can be used to create a barrier coat to seal the clay. Alternate suppliers of Adhesion Promoter or Water Borne primers can be found in the Suppliers section at the end of this article.

The R&M HP-100 is a water-borne primer-sealer and 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. Any substitute sealers should water-borne.

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 HP-100-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 R&M HP-100 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.

ALTERNATIVE METHOD FOR PRIMING OVER CHAVANT CLAY

The clay model should first be coated with R&M 811 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.

Many of these topics are covered in Chavant's Educational Video Series, tape number three, "Mold Making and F.R.P. Preparation from Clay Models".

A partial list for some the materials suggested above is included in the Suppliers section at the end of this article.

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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

If you choose to bring in an experienced consultant I suggest first reviewing the Educational Videos and book available through Chavant. The basic knowledge gained through these items will offer a solid understanding of the process prior to the consultant arriving. This step will save time and give you better questions to ask. For instance, there is no need to have a consultant build a clay oven for you, do it yourself ahead of time.

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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 R&M 811 adhesion sealer to form a bond between the clay and first light coat of DuPont 100S Gray Lacquer Base Primer with a 10 minute flash time between coats. When the gray primer is dry, three light coats of DuPont Red Primer are added, allowing a 10 minute flash time between coats.

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.

Chavant

HEALTH AND SAFETY

Chavant clays have all been tested and approved as non-toxic and non-hazardous by the Art and Creative Materials Institute. These clays are certified by a medical expert, through a program of toxicological evaluation, to contain no materials in sufficient quantities to be toxic or injurious to humans or to cause acute or chronic health problems. This program is reviewed by ACMI's Toxicological Advisory Board. These products are certified by ACMI to be labeled in accordance with the chronic hazard labeling standard, ASTM 4236 and Federal Regulation, P.L. 100-695. In addition, there is no physical evidence as defined within 29 CFR Part 1910.1200.

An MSDS is available directly from Chavant or from our web site, http://www.chavant.com/.

A common misconception about Chavant clays concerns the issue of the sulphur 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 sulphur free clay only because they believe that sulphur is a toxic product. This is simply untrue but since these misunderstandings existed it did motivate Chavant to have our products evaluated and approved by ACMI.

One real danger can arise from sulphur-based clay when and if the clay were to be ignited. Molten sulphur may produce Hydrogen Sulfide, a very dangerous gas. Burning sulphur will produce Sulphur 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 sulphur in itself is not a danger. Chavant uses elemental sulphur as a filling compound in many clay formulas. Sulphur of this type is found in medicine, soaps, detergents, shampoos used by veterinarians, for burns, in the sulphur packs in Mash, hot sulphur 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 sulphur compounds that are highly dangerous but Chavant uses only elemental sulphur.

Realizing this, it is also important to recognize that some individuals may have genuine allergic reactions to products containing sulphur 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 sulphur – it is not a toxic product as used by Chavant, Inc.

Chavant

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

Suppliers

(of composite surfacing materials mentioned above and or related clay modeling materials)

Chavant, Inc.
42 West Street
Red Bank, NJ 07701-1119
1-800-CHAVANT
Hard Styling Clay, Industrial Clay Modeling Tools, MDM, 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)

BASF – Inmont Corporation
R-M Automotive Products
1-800-825-3000
R-M 811 Adhesion Promoter, R-M HP-100 Sealer Primer

Composites Fabrication Association
703-525-0511

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

For additional supplies or one stop shopping and 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.

Chavant

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

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E-mail: mail@chavant.com • Web site: http://www.chavant.com