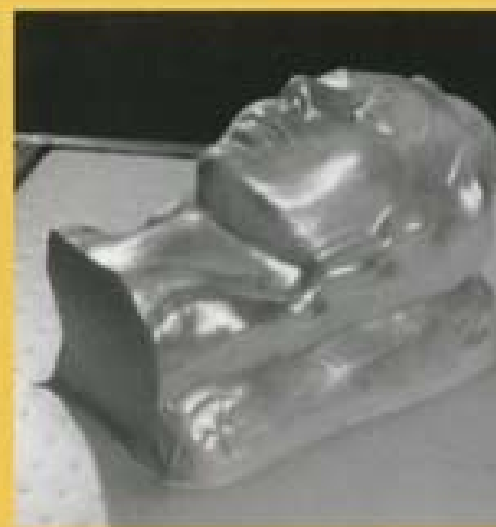
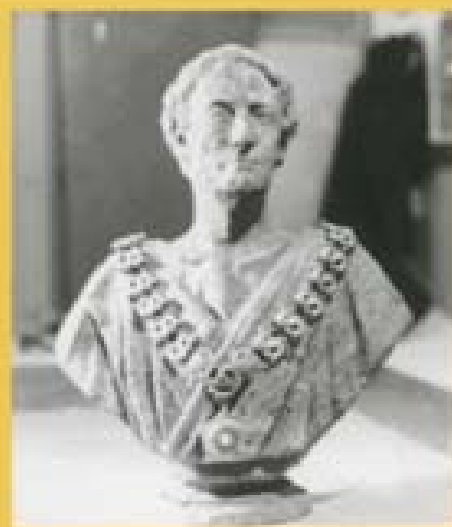




THE PROP BUILDER'S MOLDING & CASTING HANDBOOK



THURSTON JAMES (Author of *The Theater Props Handbook*)

■ A comprehensive guide to the use of more than thirty molding and casting materials in the design and construction of theater properties and scenic elements. ■ Includes a section on designing and building a vacuum forming machine for use in constructing theater props. ■



THE PROP BUILDER'S

MOLDING & CASTING
HANDBOOK

THURSTON JAMES



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Every precaution has been taken in preparing *The Prop Builder's Molding & Casting Handbook* to make these projects as safe and successful as possible. However, neither Betterway Books nor the author assume any responsibility for any damages or injuries incurred in connection with the use of this manual.

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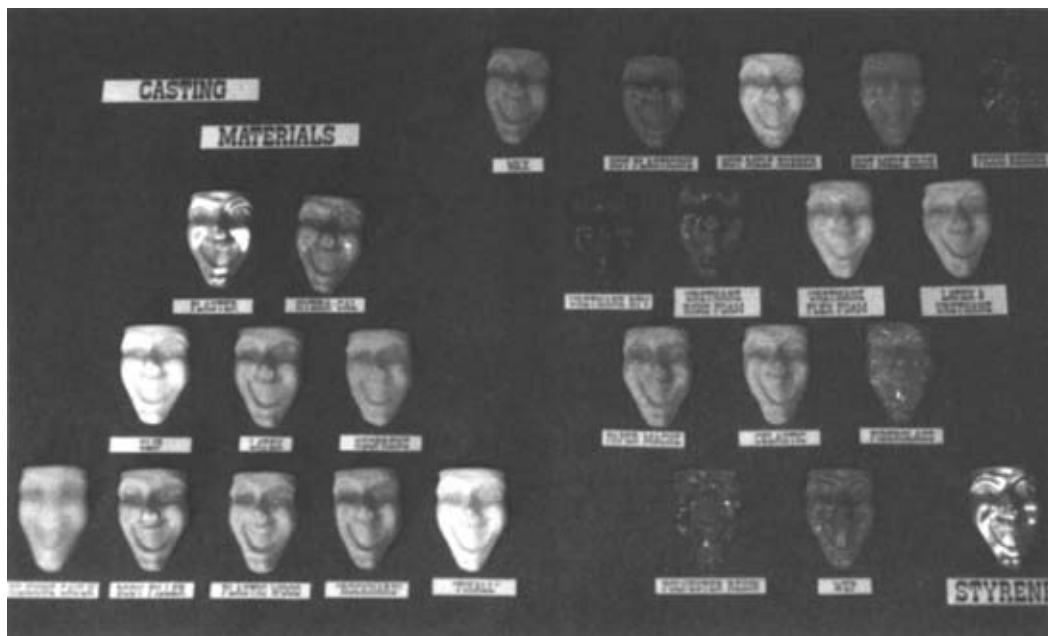
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Where to Get Your Supplies

The mold-making materials include plaster, two kinds of alginate, two forms of silicon rubber, latex, and hot-melt rubber.



Casting materials long familiar to theater technicians—plaster and its cousins and Celastic—are covered with the same thoroughness as the more recent flexible plastics which have been developed: latex and three variations of polyurethane.

Thermosets are discussed with an emphasis on the polyester resins, fiberglass, and water extendable polyester.

A series of materials which become liquid when heated to their melting point is thoroughly demonstrated. The “hot melt” materials include wax, hot-melt rubbers, and hot-melt plastic resins used in the manufacture of breakaway glass.

The section on slipcasting shows how a newer product, neoprene, uses an age-old pottery process to great advantage in the theater.

Products found at local hardware stores in the form of putties and caulking compounds are included, showing their unique features and how they can be pressed into service as casting materials when nothing else is readily available.

Near the end of the book is a section devoted to the construction of a vacuum forming machine. The instructions are intended to aid an experienced electrician and metal worker with the special problems encountered in building this large tool. This is the only portion of text that is not directed to an inexperienced person. The final chapter explains some techniques of using this machine or any of the commercially made vacuum forming machines being found

How to Get Started

How does a person go about learning the techniques of casting and mold-making? Here are some of the ways:

1. Attend workshops
2. Apprentice with an “old timer”
3. Jump in, experience trial and error, and learn by doing
4. Read product literature and experience new materials as they come along
5. Read a book

Begin with any of these and work your way through them all. Maybe all of the ways will not be open to you. That’s probably O.K. —do what you can. These are all good ways, and they all have their limitations. Let’s touch on each of these methods, and discuss some of their advantages and disadvantages.

Workshops

In most cities, hobby shops and plastic suppliers conduct workshops as a means of showcasing their products. If your supplier does not have this service, you might at least arrange for the demonstration of certain specific products you are interested in. The problem with even a well-organized workshop is that there is limited time provided in which to demonstrate a time-consuming subject. In three or four hours you can only be introduced to three or four products, and these only in the most basic fashion. But at least you will have been introduced.

Apprentice with a Working Craftsman

This is a good idea if you have the time and really are serious about learning the craft. Search out a mold maker with some experience, spend some time with him, and pick his brain. Count yourself as very fortunate if you can place yourself with a mold-making craftsman.

Keep your mind open, realizing that even experts have prejudices and favorite methods, and very frequently they do not agree with other experts.

I do not believe that mold-making and casting experts are an endangered species. They have just become more specialized. You will find them in the porcelain and ceramics field, in aerospace, as tool and pattern makers, in plastic toys, plastic packaging, and plastic products of all kinds. The motion picture audiences' thirst for the bizarre has produced a market for a wide variety of aliens and extraterrestrials. Most of the designers of these monsters are not old timers, they are comparative youngsters. And speaking of youngsters ... I was recently in the curators' workroom at the Museum of Natural History in Los Angeles, where the staff was working with junior high schoolers making latex impressions of delicate tropical ferns for use on the museum's wild animal exhibits. The museum was getting a large volume of authentic-looking plastic foliage, and the kids were getting a hands-on experience in the technique of mold-making.

Jump In and Try

Experience is a great teacher. After you have picked up a little knowledge of a material, use it. Make sure you understand its hazards and how to use it safely; then pile in. If you have had little or no previous experience I suggest you begin with plaster, latex rubber, and neoprene. These are relatively safe materials to work with, they are inexpensive, and the chance of success is high. As you gain confidence with these materials, branch out into other materials, building on the knowledge you have acquired with these first experiments. Always keep alert to the toxic potential of the product you are about to use and guard against its danger. You will soon become your own expert. It won't be long before you can pick up literature on a newly introduced plastic product and use it more comfortably than the chemist who developed it.

Read a Book

Not a bad idea. Don't overlook this resource. There are some very good books on the market. Most of them are specialized. You will find books devoted to the subjects of plaster casting, polyester, moulage, and several on fiberglass casting. The book you hold in your hand provides a broad-based introduction to the craft. Reading has its limitations too; it's got to be

A Word About Failure

If your personality is one that cannot run the risk of failure, you may be in for some psychological trauma. Frequently, your early work will be failures. If you are working with someone who has had previous experience with the materials, perhaps he can tell you what to expect. Don't look to your mentor expecting godlike qualities—he will have failures too. Usually the “old timer” will know enough to use an untried system or process in private until he is comfortable with it. Then he can show it off without spoiling his reputation as an expert. Well, good for him! That technique is, in itself, one that is acquired as the result of experience.

You must expect occasional unusual results.

They happen. If the shelf life of some products is exceeded, they may not give the expected results. If some plastic chemicals become contaminated, they will not work as expected. If you work for a long time with resins, the time will surely come when you forget to use mold release, or you will use the wrong catalyst, or you will forget again and use no catalyst at all. These mistakes will bring predictably unsuccessful results. You will be able to understand immediately why your casting failed as soon as you realize your mistake. But there will also be the times that you will run into freakish, unreasonable problems that defy explanation.

Protecting Yourself from the Effects of Hazardous Chemicals

The Surgeon General has determined that smoking cigarettes is hazardous to your health. Many people have quit—some of the public is stubborn, however, or suspicious of authority, or naïve, or gullible, because this element of the public continues to smoke with a confidence. “We have been doing it for a lifetime without serious consequences, and therefore, the Surgeon General must have his facts confused.”

Thirty-five years ago, craftsmen began receiving similar warnings concerning the chemicals in the plastic materials they work with. Warnings concerning the toxic effects of some of the new polyester and epoxy resins, solvents, lacquers, aerosol sprays, and dyes. The attitude of the artists and craftsmen to whom these warnings were directed was, at first, very much like the attitude of the smoking public: “I know what I am doing, I have been doing it for a long time without any problems, and these threats are being published by a bunch of alarmists. The term *chronic long term effects* was not widely known then, and those who did know, chose not to deal with it.

Becoming Aware of Health Hazards

Some of the products which have “been around for years,” such as asbestos, were actually proven to be doing fatal damage to the lungs. Cancer became linked to specific carcinogenic chemicals such as benzene. Skin rashes broke out as a direct result of some of the other solvents that were being used. Slowly, an awareness dawned upon these craftspeople that the warnings were perhaps more than just threats. **Too often, however, the attitude continues that the danger is for those others, and not myself.**

Do You Need an Attitude Adjustment?



What do you think? Are these labels put here by the manufacturer with a serious concern that you might be injured with improper use of the product? Or do you, the consumer, look suspiciously at these clear warnings as disclaimers that the manufacturer must make for his own protection on the rare chance that someone might be injured?

Who should be most concerned about potential risks to **your** health? Society at large? Government agencies? Manufacturers of useful chemical products? You yourself? Who can you trust to be most responsive to your health needs? Without removing the responsibility from others, I propose that you selfishly become accountable for yourself. Take the steps necessary to make yourself aware of the dangers of chemical products. If you are unaware of the dangers of the chemicals of molding and casting, or if you are guilty of using these chemicals without proper safeguards, please read the next few paragraphs with a self-concerned, open mind. I will outline some of the dangers of the chemicals used in molding and casting and propose ways of using them safely. You, the user, must then take the necessary precautions to protect yourself from their ill effects, which can, at their worst, be life threatening.

The Toxic Assault on Our Bodies

Toxic substances can enter your body in three ways: by contact with skin, by inhalation, and by ingestion through the mouth. We are familiar with the dangers of taking poisons through the mouth. We have known since childhood that arsenic, cyanide, strychnine, and hemlock are likely to kill if they are eaten in any quantity, so we are careful not to do that. We have learned that babies will get sick if they eat paint, bleach, or gasoline, so we don't do that either—or do we? We have habits that cause harm to our bodies that we are unaware of. I have known people to pick dried Celastic from their fingers with their teeth. Some artists have been taught to put a point on their paint brushes by taking them into their mouths. The practice of having a filled coffee cup at the work table where it is sure to become contaminated is common. The published warnings on chemical packages warn us to wash our hands and refrain from smoking. Part of this warning has to do with fire dangers, but the other part is to reduce the possibility of transferring these poisons to our mouths and then swallowing them.

The most frequent way that toxins are introduced into the body is through the nose. Dusts, fumes, gases, and vapors can cause direct damage to the respiratory system just as smoking can, except that the dangers from chemicals can be greater. All solvents and aerosol cans admonish the user to use the product in well-ventilated places. Why don't more people do it? Maybe we don't know that when they say "well-ventilated," they really mean "use in a spray booth," or "use by an exhaust fan." Inhaled toxic gases can also be absorbed into the bloodstream. In exactly the same way that the life-supporting gas, oxygen, is absorbed and transported, poisonous vapors are absorbed and distributed where they can do their dirty work on their favorite body organ. This organ usually turns out to be your liver, heart, lungs, kidneys, or brain.

Finally, poisons can get to your organs through your skin. Cuts, abrasions, and open sores that allow blood to leak out of the body will also allow chemical poisons to get in. Some solvents, however, do not even need this kind of doorway to get into your living space. They can work their way into your bloodstream through the pores of your skin. Other chemicals—battery acid, lye, and gasoline—attack the skin itself, causing burns or rashes. There are also many less offensive but nonetheless noxious chemicals, some of which you will encounter while working with the materials explained in this book.

Degree of Risk

Industrial hygienists have recently been devoting time to studying the dangers that plastic workers are exposed to. They have worked out some definitions useful in explaining these dangers. They say that there are three factors which contribute to your “degree of risk” in working with chemicals.

First, there is the amount of exposure to a single toxic substance. There are three things which contribute to this exposure. They are:

1. The quantity of the material you are exposed to
2. The duration of the exposure
3. The frequency of the exposure

The cumulative effect of all the separate exposures to chemicals is called your “body burden.” When your body burden exceeds your capacity to eliminate the encountered poisons, injury to some part of your body takes place.

Another factor that must be considered in figuring your degree of risk is that some chemicals are much more dangerous to the body when combined than when either one is encountered alone. A good example of this complication is the case of smokers who are exposed to asbestos fibers. Smokers have about ten times the chance of getting lung cancer as non-smokers; however, the risk is multiplied again by nearly ten times when these smokers are exposed to asbestos fibers. Their risk of getting lung cancer is ninety-two times greater than people who are exposed to neither. The last factor you should consider in figuring your danger or risk in working with toxic materials is your own susceptibility or sensitivity to chemical injury. Some people are more sensitive to the harmful effects of chemicals than others. A problem with this is that people who are not sensitive have the idea that they are immune to the dangers. This is a mistake! It just means that your body’s protective systems are not yet overloaded. Keep it up, and you can overtax your body’s abilities to protect you. Injuries will certainly result.

You probably already know by experimentation whether you are skin sensitive to the exposure of harsh chemicals. It is not as easy to detect your sensitivity to liver or kidney damage or to cancer. And it is not wise to experiment till you know the limit.

Now, all of this has been said to instill a respect for the problem, not to frighten you unduly into a resolve to never again come in contact with another chemical. You could drive yourself crazy trying to eliminate this contact. In this world we live in today, we are

constantly in contact with potentially dangerous materials. But you can become aware of the more dangerous products, and choose not to use them. You can use the less hazardous consumer products, and use them with precautions, thus greatly reducing your body burden.

You can read and heed the warnings published on the cans of chemical products. Most warnings can be summarized in the following list:

1. Use solvents and sprays in well-ventilated places, and away from flames.
2. When working around dusts, mists, sprays, and vapors use properly fitted respiratory protection.
3. Use non-porous gloves or barrier creams.
4. Wash your hands well after working, especially before eating.
5. Wear overclothing (a lab coat or apron) to avoid taking toxic dusts home to your living and eating spaces.

This list contains good advice, but obeying the can warning is only a beginning.

If you are really interested in becoming responsible for your own health and well-being you can take some, or all, of the following precautions.

1. Request Material Safety Data Sheets from the manufacturers of products you have any questions about.
2. Do some reading. Research the chemicals in the products you are using, and learn how they are evaluated for relative toxicity. See the bibliography at the end of this book.
3. If you choose to use a material which is advertised as potentially hazardous, provide all of the engineering controls you can. Install spray booths and/or exhaust fans. Make sure you have and use personal protection: safety glasses, respirators, gloves, and aprons.

Personal Protection Equipment

Let's take just a moment, and talk about some of the equipment that can protect your eyes, lungs, and skin.

Glasses and Goggles

Eye protection is available in the form of safety glasses or goggles. Eyeglasses are usually clear, non-prescription, and primarily designed for protection from dust and sparks. Some safety glasses come equipped with side shields which make them more effective against the flying particles. Goggles, however, provide the best defense against chemical spills.

Gloves

Many kinds of gloves are available, each is useful for protection against a particular harmful material.

A very inexpensive glove made of polyethylene is sold in paint stores to protect the painter from getting his hands soiled. These gloves are not good for much except painting. The chemicals of molding and casting very soon dissolve these thin attempts at protection.

Thin latex gloves are recommended for most molding and casting operations that could chemically affect your skin. These gloves are usually green (like surgeons wear), are very thin, and do not totally eliminate your sense of touch.

Thick leather gloves with high cuffs that completely cover the wrist are good protection against hot liquids. Care must be taken not to allow hot liquids to pour into the large, blouse cuffs. Leather gloves are available as standard equipment from welding suppliers.

Neoprene gloves are impervious to almost all harsh liquids, even acids, but are thick and clumsy, and not necessary for protection against any of the chemicals mentioned in this book.

Respirators

Breathing protection is of two distinct types, and if you are to operate safely you must understand the distinction. A respirator has a changeable cartridge and can be used in defense against both types of respiratory hazard.

The first type is protection against particles. A surgical mask is helpful in filtering mist and dust particles. A dust mask is better, and a respirator fitted with a particle filter is also quite good.

The other type is protection against vapors or fumes. It is essentially a gas mask. For a respirator to control the intake of fumes, it must be fitted with a fume cartridge.

If a respirator is going to be effective against anything, it must fit your face well and be

strapped securely to your head. A respirator is ineffective when worn over a beard. The craftsman who works constantly with polyesters or urethanes must sacrifice his facial hair.

In Conclusion

Once you are well-informed, you can make rational decisions about whether you consider a product dangerous, and whether you have the facilities to use it safely. Frequently you can substitute a safer product for a product you decide to be too hazardous.

When you select a material for a particular job, always look on the selection as being tentative— check to see whether you have the knowledge and special safety equipment (exhaust fans, fume hoods, safety glasses, respirators, gloves, aprons, and confidence) the process requires. If you cannot perform the necessary steps safely, choose another material!

You see, you really are not being forced to use potentially hazardous materials. If, however, you choose to use them, choose also to use them safely.

THE MODEL



Molding and casting is a process involving three distinct stages:

1. Selection and preparation of the Model (or pattern)
2. Making the mold
3. Making and finishing the castings

Preparing the Model

The first step in mold making is the consideration of the pattern or model. In the following pages you will be led through the steps of making a vase, a fish, and a milk pitcher. Each of these will be copied from a real, “found” model. On the other hand, you might want to make a thing that isn’t readily available, or perhaps that no one has ever seen before. You might need Aladdin’s magic lamp, or a space gun, or Excalibur, or Cinderella’s glass slipper. If you want a fantasy item, you must sculpt your own original.

Sculpting a Model

If you must design and sculpt the model from your imagination, wet clay and non-drying clays (commonly known as “Plasticine”—trade name held by Peter Pan Playthings Ltd.) are good modeling materials. Non-drying modeling clay is available in a wax base or oil base and in four grades of softness or workability. No. 1 is very soft. This clay is useful on large projects where you need to push around large masses of clay. It moves easily, but sometimes it moves so easily that it won’t hold its shape.



No. 2 and No. 3 are utility grades of modeling clay. They work well where you want to work

fast and the features you are trying to produce are not extremely fine.



No. 4 is the firmest. It works best with clay working tools. The smallest details will hold the shape while the mold is being made.

As you gain experience with the materials of mold making, you will find that some materials are not chemically compatible with others. For instance, the sulphur content in oil-based clay will inhibit the curing of silicone RTV rubbers. Therefore, you must not make a model of this oil-based clay if you plan to make the mold in silicone. I mention this because it is one of the considerations of model sculpting that must be dealt with.

If you are inexperienced, you should begin by sculpting your model from either wet clay or oil clay, and making your mold in plaster.

Keep the model simple enough that you can get away with a one- or two-piece mold. If you design your model with undercuts that appear in both the front and side views, the pattern cannot separate from the mold, and you will be in for some troubles. If you use a four-sided object as a model, you may find it necessary to alter the original, filling in undercuts with modeling clay, and definitely patching over holes that pass completely through it.

The more complex shapes can certainly be accomplished with multiple part molds, but they are not easy and in my experience they are rarely necessary. You will be well advised, as you start out, to make some simple compromises in the figure you sculpt or select, so that it can be accommodated by a two-part mold.

Defining Some Terms

The words *mold* and *cast* have become somewhat intermixed by common usage. But the dictionary assures me that *mold* has a preferred meaning which is: "A form that gives a particular shape to anything in a fluid or plastic condition." *Cast* has a preferred meaning

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