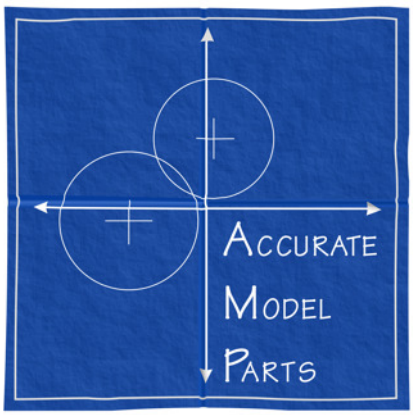


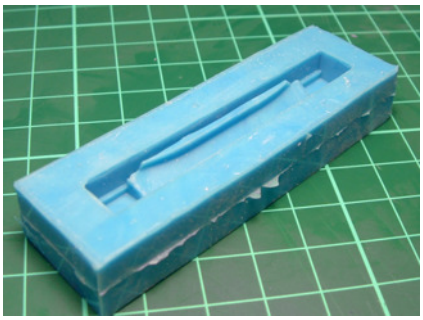
IT'S EASY!

Resin casting is a simple but powerful modeling tool you should have in your skillbox. Yet mention the word "casting" and we run about like Dr Zoidberg from *Futurama*, claws thrashing above our heads, screaming "It's scary! It's expensive! It's comp-lee-caaated!"

The good news is, it's none of these!

Resin casting is a simple 3-part process: make a master part (*master*); make a rubber mold or cube-like box with a negative impression of the master (*mold cavity*); and fill the mold cavity with resin. The hardest part is often creating the master! Though we will focus on resin casting for the modelmaker, the principles apply to other types of casting. When you have mastered resin you can go on to metal and more complicated sub-types.

BASIC MOLD TYPES



BLOCK MOLD - ONE-PIECE: (aka *OPEN* or *OPEN FACE*). Suitable for any part that has at least one flat side with no detail, or a flat side that will never be seen on the finished work. The master is placed flat-side down on a base, then surrounded by a box. Rubber is poured over the part, filling the box. When cured, the base becomes the top, where resin will be poured. This is one of the most common molds in modelmaking.

PRO: *easy and fast, no seams.*

CON: *the base, which becomes the top during casting, can't have any detail. Depending on how the resin pours each time, this "flat" piece will actually be slightly dipped* (concave)*, or slightly raised* (convex)*. If dipped, this won't matter as a base. If raised, it must be filed flat. Open face molds are generally not suitable for parts with sharp undercuts (shapes that make pulling the part out of the mold difficult), but some strong undercuts are very possible.*

BLOCK MOLD – TWO-PIECE: Use a two-piece when your master has double-sided detail, no flat base, or sharp undercuts. The master is pressed into modeling clay, burying it halfway. A box is built around, and rubber is poured over. When cured, the mold is flipped and the clay peeled off. Rubber is then poured over the existing half mold. This is also one of the most common molds in modelmaking.

PRO: *allows casting of complex shapes.*

CON: *always leaves a seam* (parting line)*, is more time consuming and complicated to make than a simple one piece mold, and requires pouring and venting channels (more on those later).*

SKIN MOLD: A thin skin of flexible rubber over a detailed master, which is usually very large or attached permanently to something. The rubber is brushed onto the master and built up in layers. The thin skin is supported by adding thicker material, such as latex, foam urethane or plaster, and sometimes by an additional mold called a *mother mold*.

PRO: *good for fiddly, in-place originals.*

CON: *must be supported and appropriate for the job.*

PLUG MOLD: a mold with a void-filling plug that supports and captures detail. Think of a a tube master part, with interior and exterior detail. That interior has to be filled, but the plug must be removable (and without damaging the part or itself).

PRO: *the only way to cast some complex shapes.*

CON: *can be tricky to design, build, and use.*

HOLLOW MOLD: (**aka SLUSH MOLD**). This can be a one or two-piece mold. The casting material (often metal) is slushed around inside to cover all detail nooks and crannies, and then the excess is poured out. The result is a thin-skinned casting. This is very useful if casting something large, because you save on weight and material. You can make fake metal castings this way, by adding various metal powders and colorants to the resin, then adding a filler for weight, such as inexpensive plaster or sand.

PRO: *saves on material and weight.*

CON: *must be appropriate to the project, can be weak if not filled.*

GLOVE MOLD: This is a solid mold that *completely encases* the master part! After the mold cures, it is cut open. This cut becomes the casting seam, so it is usually at the back or along an angled edge/join.

PRO: *Easy to cast, hidden and faint seams*

CON: *Tricky to cut without damaging the master, or missing the spot and opening the wrong place. Mold must be held tightly closed but without distorting the mold cavity.*

COMPOUND MOLD: A more complex glove mold. The part is encased, but instead of a simple enclosure, you cut multiple "flaps" and keep them rigid with rods. The flaps make it easy to take the cast resin part out or *demold*, and the rods keep the flaps tight so the mold isn't distorted.

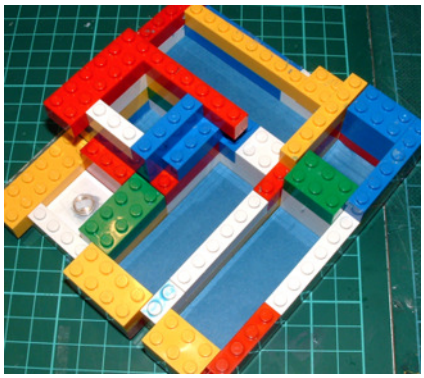
PRO: *as above in Glove Mold*

CON: *as above in Glove Mold, but much more complex.*

The best choice? It will depend on your part and project, but typically, you will make both two piece and one piece molds.

Because one piece molds have no seams, and because they are quick and easy to make, it is worth using them whenever possible. If you have detail and undercuts you can often still use one piece molds. The rubber is stretchy and allows parts to pop out. The extra stress may decrease the life of the mold, but it is often faster, cheaper, and easier to go through three or four one-piece molds than two two-piece molds. For some types of parts you will only need a few copies anyway.

MOLD CONSTRUCTION



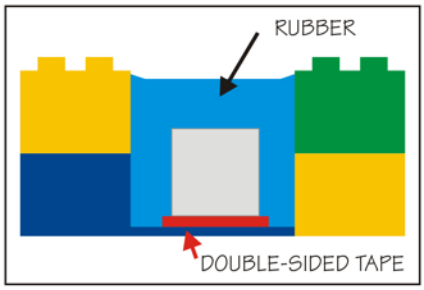
Lego Mold - 6 molds in one

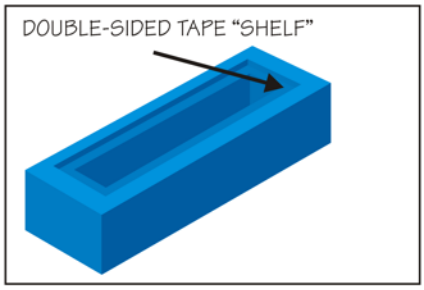
Almost anything can be a mold box. A paper cup, a plastic container, clay, plastic and Plexiglas/Perspex strips, anything to contain the rubber.

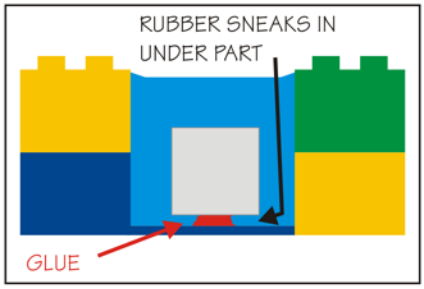
One of the easiest systems to use is Lego blocks. Strangely, they can be hard to find in plain old block style. When I was a kid back in ancient times, BCE, you used the blocks and rare special bits to build an airplane or house or anything you could imagine. But new Lego kits are *already* shaped like something, made up of special curved and angled and rounded pieces. Which of course are no good for building mold boxes. If you hunt you can still find small, mostly-block kits for about US$15.00.

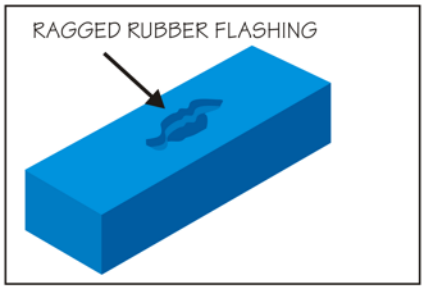
Assemble a wall of blocks around your part. You should leave at least 10mm (roughly .5”) of mold all around the part. You can place the Lego walls on any flat and smooth surface. *MDF* or Medium Density Fiberboard works very well. It is smooth, and quite rigid even in thinner sizes. Masonite is good if it is thick (the thinner tends to bow). Heavy card and plastic also work. Regular masking tape in an “L” at the edges will hold the mold securely.

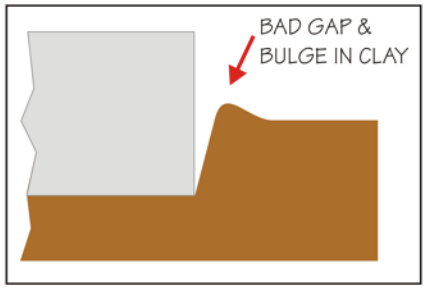
(If you use the Lego flat base plate, cut a piece of card to cover the bumpy bottom.)

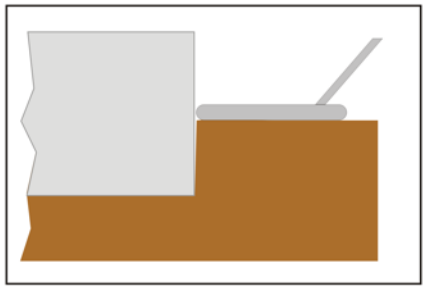












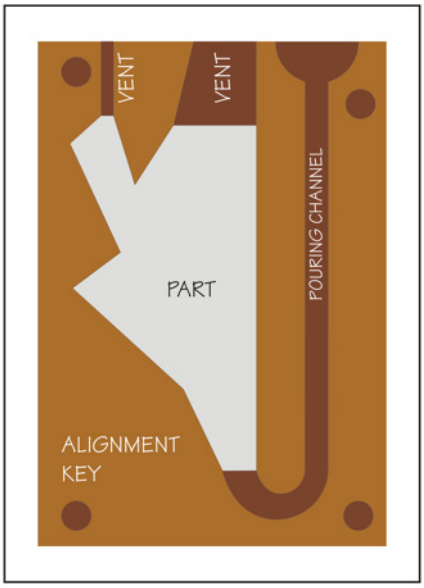
For a one-piece, open mold, mount the part to the base with thin double-sided tape. Leave the tape wider than the part bottom by about 2mm+ (1/8th inch) all around. This creates a thin shelf in the top of the finished mold, the thickness of the tape. Though the shelf can take resin spill during casting, the main purpose is to stop rubber from *flashing* (spreading out in a thin skin, leaking under seams) at the seam. You can increase the depth of the shelf by putting a thin strip of sheet plastic as the very base. Sometimes it is helpful to fill this shelf with resin, it makes the very edge of the finished part clean, turning it into a base.

Some casters tack the part down with PVC white glue or a drop of superglue (*cyanoacrylate* or *CA*). This leaves a ragged gap and almost *ensures* rubber flashing. If you choose this method, make sure you cover the entire part with glue to stop any flashing.

For a two-piece mold, the walls are built around special casting clay, available from casting suppliers and hobby stores. The clay is made to work with rubber without harming it, and comes in a few hardnesses.

Press the part halfway into the clay. As you press down, you push clay away at the edge, and create a gap and bump, like a mini ocean wave or snowbank. If left untreated the molding rubber will fill this gap, and when resin is poured, you will have a big, bad seam with extra flashing. Smooth this edge back down and tight against the part edge. Sculpting spatulas (also useful in general plastic modeling for applying putty) are perfect for this. Use isopropyl (rubbing) alcohol/methylated spirits to remove any clay that has touched your exposed master.

To keep the mold halves aligned, press short furniture dowels or hex nuts (or similar) into the clay. This creates cavities and later corresponding pins to lock the halves together (*keys*). Two will do (opposite corners), four are best. Note that air bubbles may be trapped in these keys, but it doesn't usually matter (more on air bubbles later.)



POUR & VENT CHANNELS

Two-part molds require *pouring* and *vent channels*. If you just put a simple pour channel at the top of the mold and pour resin, air will be trapped, causing great holes and gaps in the finished piece. Side branches and odd shapes away from the main part will never get filled.

Instead, make a long "J" pouring channel, off to the side. It should go from the top of the mold down *below* the bottom of the cavity, and curving up into the lowest point. Now when the resin is poured it flows up from the bottom, pushing air up and out. Add vent channels to any high, angled, and offshoot branches.

At the top of the pouring channel create a mini funnel shape. This is usually about two to three-times the diameter of the pouring channel itself, and in a V-shape. But if you make it even bigger, and more of a bowl shape by using something spherical like a marble, you will have an easier time pouring resin (less spilling).

Old sprue and even rolled clay will help construct these channels. Some casters cut channels in the rubber *after* it has cured, but this makes rough and constricted pouring channels, and it's difficult to cut. It is easier to build your channels and vents into the mold before pouring.

MOLD MATERIAL

Molds are usually made from silicone rubber, called *RTV*, short for *Room Temperature Vulcanizing* (it cures without additional, high heat). There are many other types of molding rubber (like urethane rubber and foams), but we'll concentrate on a very common type for resin casting, available with slightly different specifications in different countries. For illustration we will use the brand *Ultrasil*.

Ultrasil is a medium hardness silicone rubber, mixed in two-parts in a 10:1 ratio of rubber to *catalyst* (activating part

that starts the liquid curing into a solid). Many casting starter kits offer a simple 1:1 mix that seduces many new casters. What could be easier than two equal parts? Just pour into cups, no scale or tools required! But there are two problems: It's *not* so easy to be precise when pouring without measuring equipment; and the 1:1 mix is more expensive. (Some casters also report the 1:1 is not strong.) The 10:1 ratio is not rocket science and is no reason to stay away from good rubber.

The base rubber is usually white, and the catalyst some color (often blue, purple, pink, green, or red). The mix is right when the white rubber uniformly turns the color of the catalyst.

MIXING TOOLS

DISPOSABLE GLOVES: Keep clean and protect your skin from chemicals. Stretchy latex or less stretchy vinyl, so long as they are inexpensive, flexible, and thin.

STIRRER: Craft sticks (popsicle sticks, paddle pop sticks, tongue depressors, coffee stirrers) are cheap and easy stirrers for mixing. They are a good size with rounded edges and made of smooth wood, and very disposable.

CONTAINER: Paper cups (no wax on inside) are the best choice for mixing because the have smooth sides and a flat bottom, and are disposable. (There's no cheap, easy, efficient way to clean up rubber and resin dregs.)

DO NOT use Styrofoam cups. They seem smooth, but actually have billions of tiny holes, each filled with air waiting to jump into your rubber or resin. Plastic cups are also bad, they often have reinforcing ribs and a grooved bottom. The channels trap unmixed material, waste material, and even add air.

A digital scale is the other key mixing tool. They are easy to get, easy to use, and inexpensive. A US$20 kitchen scale will work fine, provided it can register just 1 gram (.035 ounces) or less. Though most kitchen scales are made for 0-1,000 grams (two pounds), some handle the low end

better than others. Postal and diet scales are not always accurate enough. You don't need an expensive scale, just the right scale. If an empty paper cup registers, it will be suitable.

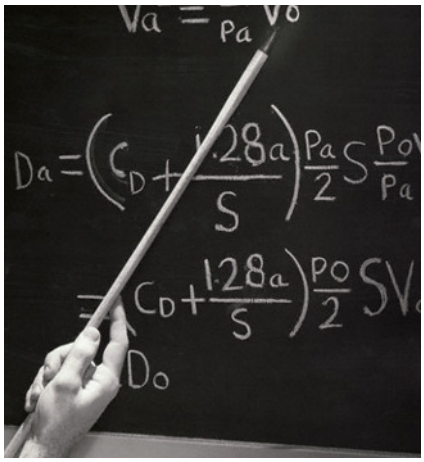
Most scales easily switch between Metric and Imperial scales. Even if you are an Imperial caster, you may want to switch to the convenience of a 10-base, digital system: we have 10 fingers, why did we create a 12-base system like Imperial? We don't really care what the units are, as long as they are easy to use!

How much rubber to mix? The two basic figuring methods are *Measurement* and *Calculation*. This is one of those scary parts modelers think about when casting is mentioned. But it's *easy*!...

Method 1 - Measurement: use either water or uncooked rice. Though water is popular with casters, it is very messy and your mold and part must be dried thoroughly before pouring rubber. Rice is the cleanest and simplest method. Just buy a bag of cheap rice and keep it in your workshop in a plastic container. It's reusable! (Cooking the rice after is not recommended.)

Fill the *empty* mold with rice then pour the rice into a cup and weigh. Rice, water, and RTV have roughly about the same *specific volume* (weigh about the same for the same amount of material). Always add a heaping bit, to account for any material left in the sides of mixing containers, and to make sure you have enough to make the mold. By not counting the volume displaced by the part we already have some safety built-in. Mixing too little RTV could mean a frantic extra mix while things start to cure or *kick*. This is not critical with most rubber (20 to 30 mins working time usually), but it *is* critical with fast-curing resin. A little bit extra is just right, too little is really a waste!

Let's say the rice weighs 31-ish grams. (Mold plus heaping, this covers our 10% extra for slippage.)



Method Two - Calculation: use high school math (aaargh! That IS scary!) to calculate the volume of the mold box: volume = length x width x height. Our sample mold box is 5 x 2.5 x 2.5cm = 31.25 cubic centimeters (or 2 x 1 x 1 inches = roughly 2 cubic inches).

The mold will take 31 cubic centimeters, but how much does that weigh? For rubber, the cubic volume equals grams. $31cm^3$ = 31grams.

However you got it, the easy rice-way or the scary math-way, we have 31grams. But 31 is inconvenient, let's make it very easy to use in a 10:1 ratio, and call it 33. This is now a "double number" or *decimal palindromic* number! Yay!

Why is a decimal palindromic number "easy"? Because we know **just by looking** that we'll use 30 grams of rubber to 3 grams of catalyst. That fits the 10:1 ratio: 30 + 3. Or a unit, 3, and ten times that, 30, added together.

The same applies for other "double" numbers: 11 = 10 + 1, 22 = 20 + 2, 44 = 40+4, 55 = 50 + 5, etc. EASY! If possible, adjust your mix to a nice double number.

If you are between decimal palindromic numbers and jumping to one would give you too little or too much RTV, you'll have to divide by 11. Instead of changing to 33, say mold volume was the original 31. 31/11 = 2.82. So 2.82 x 10 = 28.2. In 10:1 = 2.82 catalyst + 28.2 rubber (31.02). It can be hard to get that accurate even on a digital scale, and it bothers the brain, so you may want to go up a tad to get a better number.

We'll stick with 33 for now. Place a paper cup on the scale and zero/tare the meter, then add 30 grams of rubber. It is thick and goopy and pours in ribbons. The catalyst is next, but many casters recommend shaking it first to make sure it is mixed with the dye. Be warned, this almost certainly will cause AIR BUBBLES. These are BAD, as we will find out soon enough. An alternate method to ensure even colorant catalyst mixing is to swirl it gently.

Add the watery catalyst, in this case 3 grams, bringing your total to 33 grams (3g catalyst, + 10x3g = 30g rubber, = total 33 grams). Stir thoroughly to mix. Though rubber mixes easily and quickly in about 45-60 seconds, the industry advice is to mix thoroughly, and then mix again. Adam Savage of *Mythbusters* says, "mix until you think you're done, and then mix another 3 minutes." The color catalyst tells you when you are evenly mixed: the swirl of color and white blends to one even color.

When mixing, though, *don't whip* or even use too much speed. You want to avoid introducing air into the mix. To be clear, DO NOT GET AIR IN THE MIX! Air is BAD! It is EVIL! This is a scary part of casting.

You *can't* stop air from getting in. As you fold and stir you trap air. But you *can* reduce air. And you should! AIR IS YOUR ENEMY! AIR = VOIDS and ruined molds!

If that too, wasn't clear, DO NOT GET AIR IN YOUR MOLD! And one more time for those in the back: DO NOT GET AIR IN YOUR MOLD!

Air bubbles try to rise to the surface. It's what they do, being lighter than the RTV. That's fine when they make it out, they rise and burst like bubbles in hot pancake batter and the thick RTV levels itself smooth.

But some bubbles settle against your part and the rubber dries around them, leaving voids and pinholes. This makes the mold USELESS! Who wants to cast parts with great gaping holes and missing corners? This is also why the master part is placed on the *bottom* of the mold and the rubber poured over. If the part were suspended from above in a pool of rubber, the air bubbles underneath the part would rise and stick against the bottom of the part. Remember this because some masters will be prone to catching bubbles in odd angle/cut spots.

Air bubbles come from two sources: adding air during mixing, and from displacing and trapping air during pouring. It is just as important to combat both. Some methods:

TAPPING/VIBRATING: Mix and pour, *then* worry about bubbles. Either constant tapping for a few minutes, or using something that vibrates, like a small palm sander or any motor that will shake the mold. Many report success. It can be violent to the mold, so some casters vibrate *before* pouring.

RIBBON POURING: Pour the rubber slowly from a height in thin ribbons, working from the lowest point in the mold to the highest. This breaks bubbles on contact as the rubber hits, and displaces air up and out of the mold.

PAINTING and POURING: Paint a coat of rubber over the part with a brush, then ribbon pour. The thinness of the painted rubber prevents bubbles from forming, and the brush-dragging breaks any existing bubbles. This method also insures that rubber gets into nooks and crannies, and is *preferred*. (Use an old brush and clean it with something powerful like Lacquer Thinner.)

DEGASSING: Put the mixed rubber in a vacuum chamber. With no atmospheric air pressure, the air inside the mix expands the rubber to three or four times its normal volume, then foams out of the rubber, like a draft beer head. After a few minutes the air is out of the rubber and the rubber settles down.

Degassing is the Rolls Royce method of tackling mixing bubbles, because it works very well and costs very much. New chambers come as one or in chamber/vacuum pump combos, from about US$750-1,500. You can rig up your own setup for about US$150-250 with cheap food-storage vacuum containers, some bits from the hardware store, and a second-hand vacuum pump. The pump is the trick and the most expensive part, much of that overall price. It seems expensive and a lot of work, and it is, but worth it if you will do a lot of casting.

Though degassing takes out bubbles, it doesn't help with pouring. The ultimate method is to degas, paint, and ribbon pour. Painting and ribbon pouring generally work well and cost nothing.

ACCELERATE!

You can speed up the cure time for RTV by adding an accelerator, usually to part B by weight. This reduces curing time without much affecting the life and strength of the RTV, but it really cuts down your working time.

STRETCHING RUBBER

Very large molds use a lot of RTV, which can be expensive. One solution is to add chopped up chunks of old rubber molds to increase volume.

MOLD RELEASE

Mold release is a lubricant to stop mold halves from sticking together, and to stop molds from sticking to parts. Most casters will tell you RTV doesn't need a mold release for the resin stage, because resin pops out easy. True, but there is a hidden reason why mold release is absolutely necessary...

Air bubbles. A good release agent will discourage bubbles from forming on the part surface. (The mold becomes too slippery for the bubbles to stick). And with release there is even an extra benefit: prolonged mold life. After about 20 casts or *pulls*, molds can tear and break (your results may vary!). Detailed parts with undercuts slip out much easier when lubricated.

Whether you plan on using your mold once or 50 times, use a release to fight bubbles. Two-part molds definitely require a mold release, at least during moldmaking. A lubricant stops the rubber halves from sticking together both during moldmaking and during casting.

There are three major release agents.

1 - Commercial release agent: a spray-can liquid much like cooking spray;

2 - Petroleum jelly (dilute with mineral spirits to be watery, about 1 part jelly to 10 parts spirits);

3 - Talcum powder.

Any release agent applied too thick can obscure detail. The commercial product is effective but expensive. The spray doesn't always reach crevices. Petroleum jelly can be difficult to apply evenly, and thick brush marks show. (Petroleum jelly won't hurt silicone rubber, just natural rubber.)

Professionals use...talcum powder! Talcum powder is like a dream date: cheap, easy, and works.

Dust the mold *thoroughly* with powder, heaping it in. Tap an end with your finger a few times and the powder will jump to the tapping. Tap again on the opposite side and the powder will jump there. Use way too much.

Then tip the talcum out. Flick the mold with your finger several times, snap-flicking it. The coated mold should look almost clean, *like you didn't coat it at all*. But whatever vibrant color your rubber is, it should now look dull.

Check the corners and nooks and crannies, you ***don't*** want any clumped powder hiding in there, it will ruin your casting.

RESIN

There are two basic types of resin: Polyester, and Polyurethane. Polyester is inexpensive but older technology and *shrinks severely*. We will ignore it.

Polyurethane (also just "urethane") doesn't shrink appreciably and is a superior casting material for model purposes. There are many types including foam, but we will focus on "regular" casting resin for most model casting. In the example we'll use *ProCast*.

ProCast is a two-part urethane resin, mixed in a 1:1 ratio. (1:1 *RTV* is inferior, but 1:1 *resin* is simply the best ratio for the product, much like epoxy adhesive, which is really just a hardening urethane resin that bites).

Common working time for resin varies, ranging from 90

seconds to several minutes. After that time, it starts to *kick* or cure, turning from maple syrup to a white or tan thick goop, on its way to becoming solid. Though it may take several minutes or hours for the resin to fully cure to hardness, once it starts it's not pourable.

Choose specific resin carefully, because the working time begins as soon as two tiny molecules of Part A + B touch in the mixing cup. You don't want to stir and stir and find your mixing paddle stuck in a bowl of half concrete/half goo just as your are ready to pour. ProCast has a comfortable working time of 5 minutes. This is about the minimum for most people, though many pros handle the 90 seconds.

How much to mix? Fortunately resin weighs about the same as styrene. If you made your master out of styrene, plop that on the scale, then add at least 10% for slippage. Remember, it is very important to have more than enough resin for the pour. If you only have 90% and try mixing more, you'll end up pouring fresh resin onto already kicking old resin. That doesn't work well (though it is not impossible to have success). *Mix more than you need*.

Let's say your part weighs 8.5 grams. If your part is not made from styrene, pile up scrap styrene on the scale in about the same size as the part. To include extra and make the number easy, call it 10 grams of resin needed.

MIXING

With the rubber, we poured both parts directly into one cup, because there is so much (relative) working time with RTV it doesn't matter if the two parts start reacting right away. With resin it is different. Here you have choices.

Method 1 – Pour Part A into one cup, Part B into a separate cup, THEN combine both simultaneously in a third cup and stir.

PRO: *precious curing time is not used – the clock only starts ticking when combined into the third cup, and since both parts are pre-measured, the combine-stage is quick.*

CON: *much material can be left behind in the cups, forcing you to mix lots extra.*

Method 2 – Pour Resin like RTV, BOTH Part A and B into the SAME cup, one at a time of course.

PRO: *Material is not left behind, so mixing is more precise and less wasteful.*

CON: *the clock starts as soon as the first drop of Part B touches some Part A, so you waste precious "go" time just waiting for Part B to finish pouring (this might be 30-60 seconds).*

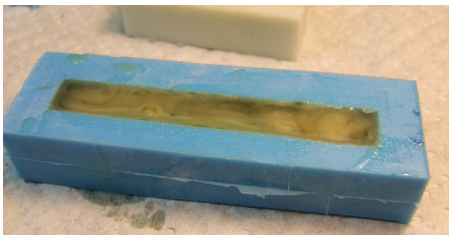
For our example we'll live dangerously and use Method 2. As with RTV, zero/tare the scale with a paper cup in place. Pour in 5 grams of Part A (half the total needed). Now add Part B until the total reads 10 grams. Be quick about it!

Using your craft stick, stir "not-fast" but don't stop for coffee. It doesn't take much mixing, but you must make sure the resin is completely mixed, otherwise your casting will be clumpy goo. A simple, continuous light stir (no whipping or fast action!) will combine the brown Part A with the clear Part B, until the mix is a golden uniform color. An exaggerated loose "C" motion, as slow as you dare, will mix nicely without adding many bubbles. Practice is the key!

You may get a few bubbles. These are as bad as with RTV. Gently break with the mixing stick. Since resin is more watery than RTV, it's easier to break bubbles.

Ribbon pour the resin slowly into the lowest part of the mold, working up and along to push air out, like when pouring rubber. The resin consistency is much thinner than RTV, so your ribbons are really just streams.

If using a two part mold, pour until resin spills up and out of the vents, then pour a bit more. That's it! The resin will start to set fast, turning cloudy and then in a short while white or tan depending on brand.



Since resin sets with heat (it generates its own, about 77°C or 170°F), some casters advise covering open face molds (treating the cover with a release agent of course). They fear the top of the resin will cool being exposed to so much air, and only half cure, remaining forever tacky and soft. This is an interesting theoretical point, but in practice, unless you cast in a room several degrees below standard room temperature (22°C/72°F), it shouldn't be a problem. If you get tackiness though, this could be a cause.

AIR BUBBLES

Air bubbles are a problem with resin, too. Good mixing, mold vents, and talcum powder help. If you do a lot of casting you may want to buy/build a pressure chamber for casting. This is a small container kept under about 4 atmospheres of pressure (415 kPa or 60 psi). The pressure stops bubbles from ever reaching the surface, and in many cases, from forming inside the part. As modelers with non-load bearing parts, we usually don't care about bubbles inside, weakening it. But some casters might need part strength.

A pressure chamber is little more than a tweaked air compressor and small chamber, much like the vacuum pump and chamber, but instead of sucking air *out* it packs it *in*. The important difference is that the pressure chamber can be dangerous. A crack in the chamber and suddenly its become a small but powerful fragmentation bomb, sending out hundreds of jagged plastic and metal bullets in all directions, ripping the caster to shreds (that's you). If you have air bubble trouble, or do a lot of casting and decide on a pressure chamber, make sure it is safe and you take precautions every time you use it.

Why not use vacuum with resin, then? Because the resin can kick well before degassed. Some casters *do* use vacuum (and some use pressure for both moldmaking and resin casting).

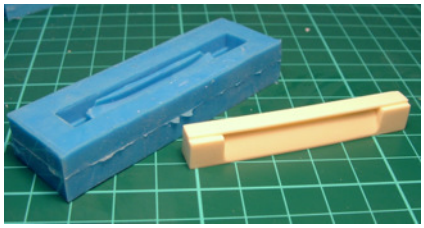
COLOR/TEXTURE

You can add color dyes and metal powders to really enhance your resin. But make sure you experiment before committing to a whole big batch. Also, add the color to either part A *or* part B *before* you combine the two resin parts. This way you will have have plenty of time to get the color right before the resin kicks.

DEMOLDING

You may have seen bent/warped resin parts in kits you've bought. Some kit manufacturers say "some warping may have occurred, heat the parts in warm water and bend back." What they really mean is, they didn't wait for full cure before demolding so they could cast again quickly, and the soft parts got bent pulling them out.

Depending on the specific resin, parts can be demolded in 10, 20, 30, 60, 120, or 240 minutes. 5-minute ProCast can be demolded in 60-90 minutes, depending on part thickness. As stated, parts are very, very soft at this minimum set time and can bend if you try to demold. Unless you are racing to build a device to save the world in 10 minutes, let the part(s) set 30 to 60 minutes *beyond* the minimum demolding time. The results are worth it.



When the parts are cured, pop them out. They should come out easily, even parts with undercuts. The part may have flashing where resin spilled and created a thin skin. This can be sliced off after demolding, but it is important to at least lift the flash away from the rubber before demolding. Otherwise the rubber sticks and you can start tearing your mold. (Old molds that get stiff can be lightly baked in an oven at 120°C/250°F for four hours to revitalize.)

Any flash that remains can be sliced off with a sharp #11 or similar X-acto blade. You may need to quickly run a very fine bit of sandpaper here and there.

Despite precautions, air bubbles/pinholes happen. If small and few enough, fill with a good creamy, hard and resin-friendly putty like Tamiya gray. If the part is deformed too much, scrap it and try it again. (Everyone gets bad casts.)

Now sit back and admire your handiwork! And of course, cast some more. See? It wasn't scary at all!

SCARY STUFF

HA! There IS scary stuff! It's...building a vacuum and/or pressure chamber! [Insert Evil Laugh]...

But...that's outside the scope of this article (whew!).

If you are going to do a lot of casting, these two tools are worth the effort. Future articles hope to address sourcing, building, and using vacuum and pressure chambers (cheaply!).

STEP-BY-STEP

RTV – OPEN FACE MOLD

1 Determine the "bottom" of the master - the side that will be unseen/have no detail.

2 BUILD MOLD BOX (Lego, strips of wood/plastic/etc.). Box should have at least 10mm (.5") clearance around part, and be high enough to have the same for a base.

3 POUR RICE into mold box, heaping it high, then transfer rice to a cup.

4 WEIGH RICE. ADD extra to account for material left behind. Make the final number a decimal palindromic number ("double" like 11, 22, 33, etc.) if possible. (EG: final number 19, round up to 22).

5 Place a strip of DOUBLE-SIDED TAPE on MDF/base (whatever material you choose), making it a bit bigger than the bottom of the Master.

5 Peel away protective paper exposing adhesive. Place bottom of Master on double-sided tape, press down FIRMLY. (You may want to put a small scrap of sheet plastic on this first to form an exaggerated shelf.)

6 SECURE mold box around part, using MASKING TAPE.

7 PLACE CUP on SCALE, zero/tare.

8 POUR RUBBER (Part A) into cup to required amount. (If TOTAL 33, then 30, etc.)

9 POUR CATALYST (Part B) into cup (in 33 example, 3).

10 MIX with slow strokes, until white rubber and color catalyst blend to a uniform color. Mix slowly and thoroughly.

10A **OPTIONAL** – DEGAS RTV in VACUUM CHAMBER.

11 BRUSH RTV onto part. Use an OLD BRUSH and slide along any UNDERCUTS/NOOKS & CRANNIES first. Cover master Part completely.

12 POUR RTV into mold in RIBBONS, starting at low point. Pour until part is well covered and RTV is level.

12A **OPTIONAL** – VIBRATE/KNOCK to send air bubbles to surface. Some can be popped with a sharp toothpick.

RTV – TWO PART MOLD

1 BUILD MOLD BOX around CLAY. Clay must be flat and smooth. Box should be big enough (high/thick) to cover part, have some base, and cover the thickness of clay.

2 POUR RICE into mold box, heaping it high, then transfer rice to a cup.

3 PRESS MASTER into clay, HALFWAY. SMOOTH clay edges where it has "snowplowed", making it flat and neat and tight. Wipe away any clay that has gotten on Master, with isopropyl alcohol/methylated spirits.

4 Press KEYS into corners, add VENT and POUR tubes (use sprue or rolled clay, anything to form smooth, sufficiently thick channels).

5 WEIGH RICE. Make the final number a palindromic number ("double" like 11, 22, 33, etc.) if possible.

6 PLACE CUP on SCALE, zero/tare.

7 POUR RUBBER (Part A) into cup to required amount. (If TOTAL 33, then 30, etc.)

8 POUR CATALYST (Part B) into cup (in 33 example, 3).

9 MIX with slow strokes, until white rubber and color catalyst blend to a uniform color. Mix slowly and thoroughly.

10A **OPTIONAL** – DEGAS RTV in VACUUM CHAMBER.

11 BRUSH RTV onto part. Use an OLD BRUSH and slide along any UNDERCUTS/NOOKS & CRANNIES first. Cover master Part completely.

12 POUR RTV into mold in RIBBONS, starting at low point. Pour until part is well covered and RTV is level.

13A **OPTIONAL** – VIBRATE/KNOCK to send air bubbles to surface. Some can be popped with a sharp toothpick.

CLEAN the brush with Lacquer Thinner, or toss it away. WHEN CURED, make the second half:

13 Remove the clay CAREFULLY!!! You want to leave behind the PART, and the POUR and VENT CHANNELS, all still IN THE MOLD.

14 Build Mold Box around part again.

15 COAT the mold in release agent (so the 2 halves won't stick together, don't forget the keys).

16 PLACE CUP on SCALE, zero/tare.

17 POUR same amount of RUBBER (Part A) as before, into cup (unless this half of the part is drastically different).

18 POUR CATALYST (Part B) into cup.

19 MIX with slow strokes, until white rubber and color catalyst blend to a uniform color. Mix slowly and thoroughly.

20A **OPTIONAL** – DEGAS RTV in VACUUM CHAMBER.

20 BRUSH RTV onto part. Use an OLD BRUSH and slide along any UNDERCUTS/NOOKS & CRANNIES first. Cover master Part and keys and everything completely.

21 POUR RTV into mold in RIBBONS, starting at low point. Pour until part is well covered and RTV is level.

22A **OPTIONAL** – VIBRATE/KNOCK to send air bubbles to surface. Some can be popped with a sharp toothpick.

CLEAN the brush. When cured, peel away the box, peel apart the two halves.

RESIN – OPEN FACE MOLD

1 POUR RICE into mold, heaping it high, then transfer rice to a cup and WEIGH RICE. Make the final number a decimal palindromic number ("double" like 11, 22, 33, etc.) if possible.

2 COAT the mold in release agent of choice.

3 PLACE RICE CUP on SCALE, zero/tare.

4 POUR RESIN (Part A) into cup to required amount. (half of total). You can now pour Part B in same cup, but work fast, it will start the curing process. If you have allowed for extra resin, you can pour Part B into a SEPARATE CUP, then mix them together.

5 MIX with slow strokes, until the dark and clear liquids combine into light maple syrup, a bit thinner. Mix smoothly and thoroughly. Avoid air bubbles, but crush any against side of cup if they appear.

6A **OPTIONAL** – MAKE POUR IN PRESSURE CHAMBER.

6 POUR resin into mold in RIBBONS, starting at low point so it pushes air out. Pour until part is well covered and resin is level.

If any bubbles appear, use a toothpick to drag them to edge and up and out/pop them.

RESIN – TWO PART MOLD

1 POUR RICE into both mold halves, heaping it high, then transfer rice to a cup and WEIGH RICE. Make the final number a decimal palindromic number ("double" like 11, 22, 33, etc.) if possible.

2 COAT both mold halves in release agent, close and secure with rubber bands/tape. (Be careful not to tighten too much and distort the rubber, seams will open up and the cavity will be distorted.)

3 PLACE CUP on SCALE, zero/tare.

4 POUR RESIN (Part A) into cup to required amount. (half of total). You can now pour Part B in same cup, but work fast, it will start the curing process. If you have allowed for extra resin, you can pour Part B into a SEPARATE CUP, then mix them together.

5 MIX with slow strokes, until the dark and clear liquids combine into light maple syrup, a bit thinner. Mix smoothly and thoroughly. Avoid air bubbles, but crush any against side of cup if they appear.

6A **OPTIONAL** – MAKE POUR IN PRESSURE CHAMBER.

6 POUR resin into mold in POUR TUBE, until the resin bubbles out the air vents. If you have tricky undercuts and shapes, you can pour ½ to ¾ full, then "slosh" the resin around by tilting the mold, coating everything, and then continue pouring.

Your resin will "kick" soon, and in an hour or so, you can demold.

DEMOLDING

Gently tease the rubber mold away from the resin, and once loosened, bend a little and the part will pop out. For two-part molds, gently tease the halves apart and then peel.

LEGAL

Since casting is in some form copying, law and ethics are important considerations. Note this is *not legal advice*, and certainly is not exhaustive.

You can cast original parts you design yourself.

You can't legally cast someone else's parts without permission (a kit or even just a piece), and you especially can't then sell the parts (known as *Piracy* and/or *Recasting*).

You can't do *anything that would take money from someone else with rights, or that would degrade their quality reputation*.

It's generally acceptable to cast parts from kits to replace or modify pieces. You might have opened the box to find some tank bogey wheels missing or damaged. No worries, grab one, make a mold, and start casting away! Or you might have a great idea for modifying a part, making it more authentic or mechanically sound for construction, but are hesitant to destroy the existing part. Cast it!

SAFETY

As with all chemicals, use caution and common sense. Keep chemicals and dangerous tools away from children. If using with children, supervise. Read the directions (it's not a crime) and be aware of any specific material dangers.

Generally, RTV and resin are safe for *practical* purposes. This means "safe" in the way turpentine/paint thinner is safe: very toxic, but limited exposure with standard caution will keep you out of most trouble.

Talcum powder is actually dangerous, because it is so fine and can damage the lungs.

Workshop accidents happen in microseconds, and though they are sometimes funny to witness and later recall, they are usually unpleasant to live through.

SUPPLIES

This is a simple list. I do not get kickbacks from these suppliers (if you're a resin supplier and want a mention, I will send you my bank details for direct deposit...) You should have no trouble finding other sources and similar products with a simple web search.

AUSTRALIA/NEW ZEALAND/ASIA

Adelaide Moulding & Casting (www.amcsupplies.com.au)

RTV
Ultrasil: 10:1, Shore25A (medium hard), blue, good detail

URETHANE RESIN
Procast: 1:1, Shore 65D (medium hard), tan, good detail, 5 mins

CANADA

SMOOTH-ON Casting Supplies Distributor: Coast Fiber-Tek Products Ltd. (www.fibertek.ca)

RTV
MoldMax 20: 10:1, Shore20A, light pink, good detail

URETHANE RESIN
Smoothcast 300/series: 1:1, Shore 70D, white, good detail, 5 mins, 10, 30, 120+

EUROPE

GERMANY

SMOOTH-ON Casting Supplies Distributor: Kaupo (www.kaupo.de/)

GREECE

SMOOTH-ON Casting Supplies Distributor: Abio (www.abio.gr)

SPAIN

SMOOTH-ON Casting Supplies Distributor: FormFX (www.formfx.es)

UK

Tony Maguire Plasterers Supplies (www.tomps.com)

RTV
RTV Silicone MM922: 20:1, Shore16A, light pink, good detail,

URETHANE RESIN
FastCast: 1:1, Shore 80D, white, good detail, 4-6 mins

SMOOTH-ON Casting Supplies Distributor: Bentley Chemicals (www.bentleychemicals.co.uk)

USA

Smooth-on (www.smooth-on.com)

RTV
MoldMax 20: 10:1, Shore20A, light pink, good detail

URETHANE RESIN
Smoothcast 300/series: 1:1, Shore 70D, white, good detail, 5 mins, 10, 30, 120+

TOOLS & MATERIALS

Prices (US$) are very approximate and vary up and down.

SETUP

Lego Blocks	15.00
Digital Scale	20.00
Casting Clay x 500g/1lb	5.00
Rice x 1kg/2lbs	2.00
Plastic Container LG	5.00

CONSUMABLE TOOLS

Craft Sticks x 100	1.50
Paper Cups x 100	5.00
Paper Towels – roll	1.50
Talcum Powder x 1	2.50
Double Sided tape x 1 roll	5.00

CONSUMABLE MATERIALS

RTV	
1kg / 2.2lbs	25.00
5kg / 11lbs	95.00
RESIN	
1kg / 2.2lbs	25.00
7kg / 15lbs	85.00

SHORE HARDNESS SCALE

The A and D scales overlap. The "A" scale is for soft things like RTV. The higher the number the harder. Molding rubber should be firm but flexible enough to capture detail and demold easily.

30-40 SOFT – Art Gum eraser, rubber bands

50 Pencil eraser

75 HARD – Tire Tread

The "D" scale is for hard things like resin. It should cure hard enough to resemble a soft plastic, like styrene (a balance between workability and durability).

60 Golf Ball

75 Hard Hat