



We Give a Hoot!

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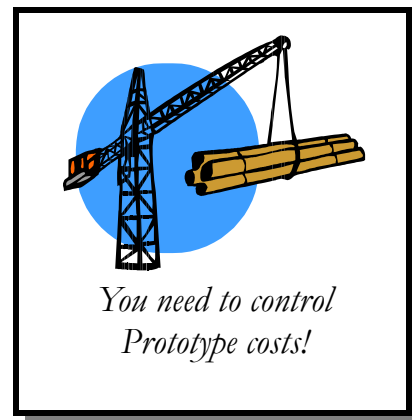
## CONSTRUCTING PROTOTYPES ON A TIGHT BUDGET

*This article is for individual inventors and small firms needing prototypes and mock-ups.*

Constructing prototypes and mockups is an essential part of developing inventions and new products. Prototypes are used to illustrate "Fit and Form", "Proof of Concept" or major features of the product. Prototypes must be economically and effectively constructed. Models range from virtual prototypes, to scale models, to full scale models. Functionality ranges from zero to fully operational. Fully operational prototypes are the most effective, but they are expensive and difficult to construct. Usually it is faster and more economical to move your idea through several iterations using readily available easily modified materials. Your friends may have special skills or tools you can utilize in prototype construction or you may be able to enlist the assistance of a local architecture student (they frequently build models).

In addition to prototyping the product itself, a mockup showing the product being used in its environment is often useful. Prototype construction methods described in this article can also be applied to mockups as well as products.

Many low cost prototype construction methods are available. Several can be used for low volume production runs. Those methods allow testing the market (limited sales) and provide income for future expansion or prove marketability to potential licensees.



*You need to control  
Prototype costs!*

### Off the Shelf Parts

Many inventors envision prototype and early production parts manufactured on plastic injection machines. Very high startup and tooling costs prevent moving these ideas beyond the concept stage.

Prototypes are often composed of several components. Use as many "off the shelf parts" as possible. Some major sources of off the shelf parts are discussed below.

Thomas Register is available in most major libraries. The green, several volume set lists manufacturers of tens of thousands of items and includes catalogs for many of them. It is also available online and on CD, but the bound version is the most useful for locating prototype components.

Grainger, known for its thick red industrial supply catalog, stocks over 500,000 parts. They even operate a large online site for a coalition of industrial suppliers called Orderzone.

Omega has a series of several catalogs with temperature, flow, level, PH, pressure, strain and force sensors along with data acquisition components.

Stock Drive Parts (Sterling Instruments) produces over 64,000 drive components, many of them in miniature.

Radio Shack has long been a source of electrical prototype parts and Edmund Scientific has a similar status for optical components.

Most major industries have one or more trade journals. Often, these journals print an annual buyers guide. You can find them in major libraries (shelved with the journal). Several journals now post their buyers guide online as well.

### Online Parts/ Component Searching

If you know exactly what you are looking for, an online search may be useful. Most major manufactures post catalogs on line. You can also use them to determine standard sizes and options.

### Talk to Others

Discuss your needs with others familiar with the field. You do not have to describe the details of your invention, just describe the details of the part or component you need. Often, they can refer you to a source.

### Be Flexible

Be willing to adapt off-the-shelf parts not exactly the right size or color. You will be glad you did.

**Safety Notice:** When constructing prototypes pay special attention to safety. Read and obey safety instructions provided with the tools, receive proper training in their operation, leave guards in place, wear proper safety protection (gloves, safety glasses, steel toe boots, etc), study MSDS (Material Safety Data Sheets) and use all proper safety precautions. Use special care with electrical devices.

Remove children from the area. Secure or properly dispose of small parts and debris. Promptly and clean up the area upon completion.

## Making Your Own Parts

If you are unable to find off the shelf parts, there are methods for constructing the components yourself. We will address both temporary and longer lasting prototype materials.

### Temporary Prototype Materials

After the napkin sketch phase, many inventors wish for a media to rapidly construct prototypes and better formulate their ideas. At this phase, prototype materials need to be easily shaped and do not have to be long lasting.

#### Block Ice

Ice picks, hot wires and other tools can be used to sculpt block ice into complex shapes. The resulting prototypes can be stored outdoors in cold weather or in the freezer.

#### Foodstuffs

Potatoes, cheese and frozen butter can be easily carved.

#### Play Dough

Children's play dough can easily be formed into very complex shapes. Different colors can be used to illustrate separate components. Sections can be joined by tooth-picks.

#### Sandcastles

Water and sand can be used to form easily altered complex shapes.

#### Snow & Crushed Ice

They are easy formed or sculpted into complex shapes.

### Longer Lasting Prototype Materials

As your idea begins to solidify, move to longer lasting prototype materials. They usually take longer to form into the needed shapes..

#### Cardboard

Cardboard can be cut with scissors or a utility knife. Several pieces can be glued together to increase the thickness. Slots can be cut to provide for interlocking cross pieces. Other pieces can be glued on.

#### Foam & Styrofoam

Hobby stores have many sizes and shapes of foam and styrofoam. They are also easily shaped.

### **Foam board**

Foam board is composed of a flat still foam, skinned on both sides by thick paper. Some versions even have a “peel & stick” side (Quick Stick). Foam board is easily cut with Exacto knives, glued into assemblies and painted. It can also be used as a base for a mock-up. Architecture students frequently use this medium and might be able to assist you.

### **Sponges**

Hobby stores have colored sponges in many shapes.

### **Expandable Polyurethane Foam**

This foam is frequently used as packaging or insulation. Some versions can be cut with a saw, sanded and painted. You can create a mold, spray in the foam and it will take shape, or you can whittle a large block.

### **PVC Pipe**

PVC pipe can be used to construct many prototypes and prototype parts. “Furniture grade” PVC pipe is available in colors, UV light resistant, and has several special construction components.

### **Pipe**

Pipe can be used in threaded lengths with pipe fitting to construct heavy duty parts and load bearing frames. Unthreaded pipe segments can be welded into an almost any shape. Custom fittings for constructing railings and other structures from pipe without using threads or welds exist.

### **Metal Tubing**

Tube fittings can be used to form several pieces into a shape. Special quick grip and release components allow onsite assembly and disassembly of prototype frames. Tubing can also be welded.

### **Aluminum Sheets & Flats**

Small aluminum parts can be easily shaped. Many hobby shops sell aluminum tubing and small sheets.

### **Soap**

Common household soap bars are easily carved into many shapes.

### **Paraffin**

Hobby stores have several candle molds or you can construct your own. Paraffin wax is easily colored. You can even carve large candles into many shapes.

### **Resins**

Most of the products come as a two part mix. They are clear or can be colored. Molds are available or you can make your own. Materials are available in most hobby shops.

### **Cement**

Many parts can be formed in cement. Construct a wooden mold, mix and pour the cement, break the mold off and paint the part.

### **Ceramics or Pottery**

Area hobbyists or small ceramic production firms may be able to assist you in firing small parts.

### **Construction Toys**

Legos, Erector Sets (still available on Ebay) , Lincoln Logs and Tinker Toys provide great prototype construction opportunities. If presenting to potential licensees, make sure the use toy components does not distract from the presentation.

### **Mindstorms**

The new computer brick Lego set deserves a special listing here. Many computer / logic control systems using a variety of sensors can be demonstrated using this toy. In addition to the somewhat limited computer language supplied with the toy, hobbyists have written much more effective tools available online.

### **Wood & Plywood**

Both large and small components can be made of wood. Nail and screw construction are easy to master. If you or a friend have shop tools (wood lathe, table saw, router, glue clamps, drill press) very complex shapes can be formed. Hobby stores sell many pre-cut wood shapes. Wood can be sanded and varnished or painted to create very attractive parts.

### **Balsa**

This light weight wood especially lends itself to carving. Many hobby stores have a rack of various shapes and sizes.

### **Chicken Wire & Kleenex**

These basic components of parade float design can be useful in larger models and mock ups.

## Glass

A glass cutter can be used to cut out very complex shapes. Be sure to use proper safety procedures. Glass blowers in an area crafts school may be willing to make very complex parts.

## Plastic

Several firms supply small quantities of plastic in countless variations. United States Plastic Corp. has a catalog of over 17,000 items. Many of these basic shapes can be easily modified.

## Rubber Sheets

Several chemical compositions and hardness grades (durometer) are available in a wide variety of sizes and shapes. Easily cut thin sheets are available from industrial supply houses. Rubber is easily glued to other materials and is often used as a shock absorber or bumper in prototype parts.

## Rubber Tubing

Rubber tubing comes in all sizes, shapes and colors. It can be used to convey air or fluid and is occasionally used as a belt drive or tire. Several sizes are often carried by hardware stores.

## Textiles

A wide variety of techniques including cutting, sewing, stapling, gluing, pinning and the use of elastic and velcro can be used in shaping textiles. The resulting shaped can be filled with shot, marbles, beans, sand, cotton or other materials to add shape. Textiles are available in many textures and color designs making them a great prototype material.

## Flannel Board

Use a large sheet of colored flannel and cut parts from other colors. Attach the large sheet to the wall, easel or blackboard and place the parts on the flannel board to tell a story. This process can be used to illustrate the assembly of your product or to show how it is used.

## Leather

Leather is very easily cut, shaped, punched, and dyed. It can also be cut into durable rawhide strips for tying objects together.

## Model Railroad Parts

Model railroad parts are available in several scales. Entire cities, signs, trees, people performing various tasks and hundred of items are available. They are excellent mock up/ scale model parts.

## Doll House Parts

Many household items are created in miniature by doll house furniture suppliers. Often they are useful for prototype and mock up parts.

## Jewelry Components

Hobby stores sell a wide variety of small parts, beads, and connectors in their jewelry craft section.

## Paper Matche

This mix of paper and glue is easily formed into complex shapes.

## Heavy Wire Construction

Heavy wire can be bent into complex shapes, even welded if need be. The resulting frame can be covered with cardboard or fabric.

## Engineering Design Contest Parts

Straws, Rubber Bands, Paper Clips, Stick Pins, Tongue Depressors, Popsickle Sticks, Fishing Line, Dental Floss, Bungee Cords, Duct Tape, Feathers, Tooth Picks, Balloons (can be twisted into shapes), Golf Tees, Thumb Tacks, Surgical Tubing, Clothes Pins, Chip Clips and other common household items are frequently used in engineering model building contests. They make great prototype construction components.

## One Last Chance to Find That Missing Part

After reading the list of methods above, we suggest "walking the aisles" for additional ideas. Major hobby stores such as Hobby Lobby and Michaels plus Home Builder Stores like Builders Square, Lowes and Home Depot carry hundreds of basic construction materials. Radio Shack has thousands of electrical components including science fair kits with bread boards allowing complex electrical systems to be simulated. Local hardware stores are another excellent source of prototype parts.

Antique malls are a great source for mock up and prototype parts. Online auctions, such as Ebay are also an excellent source for prototype parts.

## Putting It All Together

Many parts will need modification. One tool used by thousands of modelers bears mention here. Dremel's MultiPro Tool, available in most hobby shops, is a variable speed rotating device with hundreds of small attachments. It can be used to drill, sand, and shape many small parts.

If your prototype is constructed from several components you can fasten the components together with glue, string, thread, twine, rope, tape, nails, screws, bolts, staples, tape, masking tape or duct tape. Sewing, soldering and welding are also frequently used.

JB Weld and wood putty are great for smoothing out rough areas of metal and wood parts respectively.

A little paint, food coloring, nail polish, dye, some model or computer generated decals can brighten up most prototypes and increase their authenticity.

3-D computer models constructed on new, easy to use CAD programs might serve as prototypes in some situations.

## Evaluate Your Prototype

Does the prototype meet its goals? Crudely constructed prototypes may allow you to better visualize the device and/or explain it to others during the early design stages while prototypes used in presentations to potential licensees or investors need great attention to detail. Think ahead when selecting components and materials to make sure your prototype will meet your needs. Once it has been constructed, evaluate it in terms of meeting your needs. Reconstruct it if necessary.

Be sure to consider the culture of your audience. In today's global economy you may be presenting to an audience from an entirely different culture or of a religious group with strong beliefs. Be certain your model and its components in no way offends them.

We suggest showing your prototype (under proper intellectual property protection) to several people representing the area and culture of your client. Ask for feedback to questions like, Does it

represent my concept? Is it easily understood? Did anything feel out of place? Were you offended in any way? Make the adjustments now. It is too late to make them after the real presentation.

If you plan on traveling with a prototype, be sure to package it properly. The best constructed prototype can easily be destroyed in-route to a presentation if not packaged correctly. You may need to build a special box for it. Box it up, move it, un-box it and set it back up to test your packaging and to make sure you have everything you need inside before the real trip.

## In Closing

Many inventors stall out at the prototype stage because they do not have the money for an expensive prototype. It is our hope that by using the methods described in this paper you will be able to move on to the next step of the invention process.

If your idea continues to show promise you can move up to more costly prototype methods such as Rapid Prototype services and multi-axis metal machining. Hopefully one day we will see your product in the marketplace.

Good luck with your invention!

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Polson Enterprises  
[www.virtualpet.com](http://www.virtualpet.com)

## URLs of companies mentioned

Dremel (rotary model tool)  
[www.dremel.com](http://www.dremel.com)

Ebay  
[www.ebay.com](http://www.ebay.com)

Grainger  
[www.grainger.com](http://www.grainger.com)

Hobby Lobby  
[www.hobbylobby.com](http://www.hobbylobby.com)

Home Depot  
[www.homedepot.com](http://www.homedepot.com)

Lego Mindstorms  
[www.mindstorms.com](http://www.mindstorms.com)

Lowe's  
[www.lowes.com](http://www.lowes.com)

Michaels  
[www.michaels.com](http://www.michaels.com)

Omega  
[www.omega.com](http://www.omega.com)

Orderzone  
[www.orderzone.com](http://www.orderzone.com)

Thomas Register  
[www.thomasregister.com](http://www.thomasregister.com)

United States Plastic Corp.  
[www.usplastic.com](http://www.usplastic.com)

MGIC Canada—polyurethane foams  
[www.mgicanada.mb.ca/polyurethane.htm](http://www.mgicanada.mb.ca/polyurethane.htm)



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Links to all web sites mentioned in this flyer can be found at [www.virtualpet.com](http://www.virtualpet.com)

Gary Polson, has extensive research experience at a fortune 500 firm. He has masters degrees in both Mechanical Engineering and Physical Education from Oklahoma State University, holds two patents, is a licensed professional engineer and a Certified Strength and Conditioning Specialist. He is strongly involved in the boat building industry and webmasters the industry's premier web site, RBBI (Recreational Boat Building Industry Home Page).

Major U.S. and international corporations, local companies and state technology development agencies regularly call upon him for assistance with their new product development, market research and technical research needs. He has assisted new product development efforts in the following industries:

Boating Industry	Medical Devices	Pet Products
Boat Building	Digital Photography Industry	Equine Products
Marine Drives	Augmented Reality Products	Rodeo Accessories
Propellers	Sensors	Wildlife Management
Propeller Guards	Corrosion	Law Enforcement Devices
Fish finders	Hydraulic Systems	Correctional (Prison) Equipment
Construction Equipment	RC Airplanes	Water Rescue Devices
ATV's	Novelties	Tornado Shelters
Motorcycles	Virtual Pets	Highway Construction
Snowmobiles	Beverage Industry	Products for the Disabled
Personal Watercraft	Restaurant Industry	Sports Equipment
Aviation Industry	ERP Applications	Toy Industry
Engines	Internet Tools	Funeral Industry

Besides our own extensive research library and many online research tools and databases, we have local access to 2 major university libraries (Oklahoma State University and the University of Oklahoma), one large metropolitan library (Tulsa City County Library), a federal depository (Oklahoma State University), a Patent Library (Oklahoma State Patent and Trademark Library), a medical library (Oklahoma State Veterinary Medicine Library) one of the largest law libraries in the southwest (University of Oklahoma Law Library) and several other local special collections.

### Pricing and Billing

Normally, job completion time is estimated and the job is quoted at \$100/hour plus expenses. We accept purchase orders and credit cards. Payment is to be made in U.S. funds. We can arrange payment methods for companies outside the USA.

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