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The Seven Secrets of Pressure Forming as a Prototyping Alternative

Pressure forming is an excellent alternative to injection molding or engineered blow molding. The lead times are shorter, the process flexibility is high, production parts in small quantities are comparable in price—but available much sooner. From a timing standpoint, pressure forming makes sense; however, pressure forming's greatest benefits will accrue to those projects that start and stay with pressure forming throughout the development cycle and into production.

Pressure forming combines many risk avoidance features and, therefore, has many lower cost advantages. The design risk can be hedged because the tooling development time is short. Therefore, more time can be left for design alternatives, completing of internal parts affecting the outside design, or worst case, short turnaround to do it all over again. The desired part thickness to give the right customer feel can be hedged. Pressure forming is a one-sided process. Sheet gauge can be changed adding stiffness or lowering material content without changing tooling. Best of all, the overall project costs can be hedged because the hard prototype pressure forming tooling is ready for production. It is capable of cost effective piece part production without the need for additional hard tooling expenditures.

What are the Secrets of Pressure Forming?

- Design for the Process
- Proper Tool Design
- Production Forming Equipment
- Consistent Trimming Techniques
- Knowledgeable People
- Cost Effective Material
- Tooling and Piece Part Cost

Secret #1: Design for the Process

There is a processing window for every job - the bigger the window, the more easily controlled the process will be and the lower the costs of production will be. Lower costs should mean lower prices. The converse is also true. The tighter the processing envelope, the higher the uncertainty and the higher the production costs and prices will be.

With this in mind, it should be your goal to design a part for pressure forming that has as wide of a processing window as possible. There are a few rules or guidelines which cannot be violated, for instance, you cannot start with 0.125" gauge sheet, draw it down 5:1, and have anything but tissue paper left, even if the process were 100% repeatable.

The key design elements that must be understood and considered for any pressure formed part are:

- Draw Ratio
- Radii
- Undercuts
- Draft
- Texture
- Ribs and Louvers
- Fastening
- Tolerances
- Dimensioning

The process must accommodate your design needs in each of these areas or you need not go any further with your evaluation.

Secret #2: Proper Tool Design

QUALITY TOOLS = QUALITY PARTS

Tool design and part design go hand in hand. The quality level and appearance you want to achieve with your parts will largely dictate the tooling costs. You can work the formula backwards and ask what is the best I can expect from a casting or an epoxy tool, but we recommend you start with as loose a requirement as possible and have it quoted.

Highlight what you have to have. Here is where you must decide what quantity of parts you will need and what future use you will have for the tooling.

There are several tooling alternatives to choose from:

- Part or Model
- Wooden Pattern
- Epoxy Casting
- Aluminum Casting
- Spray Metal
- Machined or Fabicated Aluminum

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Each one of these has a place and strengths and weaknesses. Your particular application will generally dictate which one to use.

Since most applications include models or patterns, this can be very cost effectively used for prototypes or even a very complex pattern can be eventually used for the final production tooling. Decisions made at this state of the project can significantly affect total project costs.

Secret #3: Adequate Forming Equipment

Many pressure formed jobs require uncommon production equipment to cost effectively produce quality parts. Unlike injection molding where the pre tonnage, platen size, shot size and process control tell most of the story of production capabilities, pressure forming equipment is less standardized. By comparison to injection molding, the obvious part capacity concerns can be specified by maximum sheet size and depth of draw. The more artful variables of process capabilities and control of not only the forming cycle, but, also, of the heating oven are very difficult to put down on a process capabilities sheet. We believe the key to the forming in pressure forming is control. You must have a machine, set-up procedure and production operation that will result in uniform parts throughout a production run and from run to run.

Equipment-wise, we believe in pressure. Our equipment has 80 to 100 psi capabilities over 5' x 10' platens. This is very uncommon. Most new pressure forming machines are designed for 50 psi maximum over the entire platen. Some forming companies try to pressure assist their vacuum forming machines, which is even more limiting as to the pressure and the resulting detail that can be achieved.

Secret #4: Consistent Trimming Techniques

Over half of the art of producing pressure formed parts can be attributed to the process of freeing the part from the sheet. This must be done in a controlled production-like way to produce usable parts at reasonable prices. There are many techniques that can and have been used to do this. The trade off is usually one of speed vs. dimensional tolerances. As an industry, until recently, the process was very labor intensive and quality generally had to be "inspected in". Profile Plastics purchased the second 5 axis CNC router that Thermwood built in 1979. Today we have many CNC trimming machines in production. Over the years we have learned that 99% of all pressure formed jobs require CNC trimming because it is the most cost effective way of accomplishing the sophisticated part designs the market demands. Because of this we highly recommend it. Without the control of CNC trimming, the dimensional control required for your purchased production parts would be nearly impossible to cost effectively supply.

This is a major dilema in the manufacture of prototype parts. The fixturing and programming cost of CNC trimming for only a few parts is very high. Instead, we recommend hand trimming by machinists for the few that are required. This is still generally very cost effective. It must be emphasized, however, that many trimming problems can be solved in the tool design stage. Part design for minimum trimming and open tolerance will pay big dividends.

Secret #5: Knowledgable People to Control the Process

Thermoforming is a people process.

Good people control their process and are not controlled by it. However, as with most other production processes, the greater the machine control, the narrower the process variation and the more uniform the quality will be. The industry is moving toward greater and greater process control but, compared to most other plastic processes, pressure forming is still an art. You will want to visit your prospective vendor and get to know their people.

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Secret #6: Cost Effective Material Selection

The most important factor in specifying a material is part performance. However, please do not use a computerized database to optimize that selection! Thermoforming is tied to the sheet extrusion industry. Fortunately, this is a very large industry and there are many resins available to be manufactured into sheet. There are several that enjoy very high volumes and are excellent starting points for your review. If your application can use HOPE, HIPS, GP ABS or FR ABS, one of these four should be your first choice.

The material component of pressure formed parts is directly related to the quantity of parts to be produced. Unlike other plastic processes, the smaller the production requirements, the smaller the material components. The larger the requirements, the higher will be the material component. This is because of the high labor component and the high set-up costs involved with pressure forming.

Thermoforming, in general, and pressure forming, in particular, requires custom extruded sheet to be cost effective. If "warehouse" sheet is less costly than custom sheet, it will be preferred. We rarely find this to be the case, however, except for very small quantities (ie., for prototypes). Custom sheet adds a lot of value to the pressure formed part. Part weight and forming time can be optimized, painting can be eliminated, and oftentimes excessive trimming or cleaning can also be reduced.

Initially, the key material decision that needs to be made relates to the design shrink factor to be used for the tooling. Materials with similar shrink rates, ie., HIPS, GP ABS, FR ABS, can be substituted even after the tool is finished. Final gauge decisions are best put off until first formed parts are reviewed. If the production material can wait until a molding trial is conducted, the gauge can easily be optimized without tooling modification. This generally saves you money. For gauge optimization, however, a heavier gauge with all of its higher cost disadvantages is much less risky than a lowest possible gauge, which more often than not is based upon wishful thinking.

For the lowest cost prototypes, use what is available and plan to paint the parts. For production parts, the long term best buy is custom colored sheet in a high volume resin that meets the products requirements.

Secret #7: Tooling and Piece Part Costs

To properly compare two or more prototype or production alternatives, costs must be compared. We know the following relationships to be true for pressure forming.

Tooling Cost = f
(Part Design, Forming Tooling, Trimming Fixtures)

Part Cost = f
(Quantity, Material, Forming, Trimming, Tolerances, Yield)

But what do we compare? If we try to look at these two relationships separately, we find that we first have to make certain assumptions about one to draw any conclusions from the other. This complex relationship has plagued design engineers, buyers, sales engineers and even company presidents for many years. One solution is to look at competing alternatives on a total cost basis and then divide by the projected number of parts over the life of the product. Then, choose the one with the lowest cost.

This "total cost" approach still does not satisfactorily incorporate the cost effects of development time, the learning curve process yield and the risk that the product life forecasts will be wrong. What is the answer? That often depends upon the risks of being wrong.

We recommend for comparative purposes you use a piece part quote based upon the quantity of parts you will require for a three to four month period in year two after production start up. Use a five year project life and use your business plan sales volume numbers. Use tooling costs equal to the level of quality you feel fits the application. Plot the cumulative total costs per year of the competing alternatives. Where the curves cross each other will put time into perspective.

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For instance, if pressure forming has a lower total cost until year four, consider the factors that might result in product changes prior to that. If they never cross, the answer should be obvious, and, if they cross in the first year, time is probably so important to your new product, you may want to develop parallel parts - one in injection molding and the other in pressure forming, just to get to the market faster.

Before making your final decision, look again at the lower level of risk associated with pressure forming because of the smaller up front tooling money and the opportunity for change being greater. Your total outlay for the parts will be less.

Pressure forming is a production process that bridges the gap between the need for a few parts and many thousands of parts. Because of this, it is exceptionally well suited for prototyping requirements as well as production requirements. Pressure forming is a new product manager's dream come true! By taking full advantage of the process early in the product development cycle, high quality, functional prototypes can be available for customer trials and trade shows at costs not too different than "models", and when production quantities are required, the tooling and trimming fixtures will be complete. If changes are required, they can generally be done quickly and at relatively low cost. This will allow the new product to get to market faster and at a lower total cost. Then, in a few years when an innovation is required to extend the product lifecycle, newly designed pressure formed parts can be retrofitted to highlight the product change to the marketplace.

Contact Profile Plastics today to learn more and see if pressure forming is a good option for your next project.

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