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Plastic Product Development

The development of all products is a much wider process than some understand. Plastic product development has additional technical considerations due to the way most plastics are made. We have many who have requested more information than we can generally provide via phone, so this white paper is designed to provide basic understanding of the elements of discovery, design, planning and production. When we communicate we can then get right to the issues of designing and building your products.

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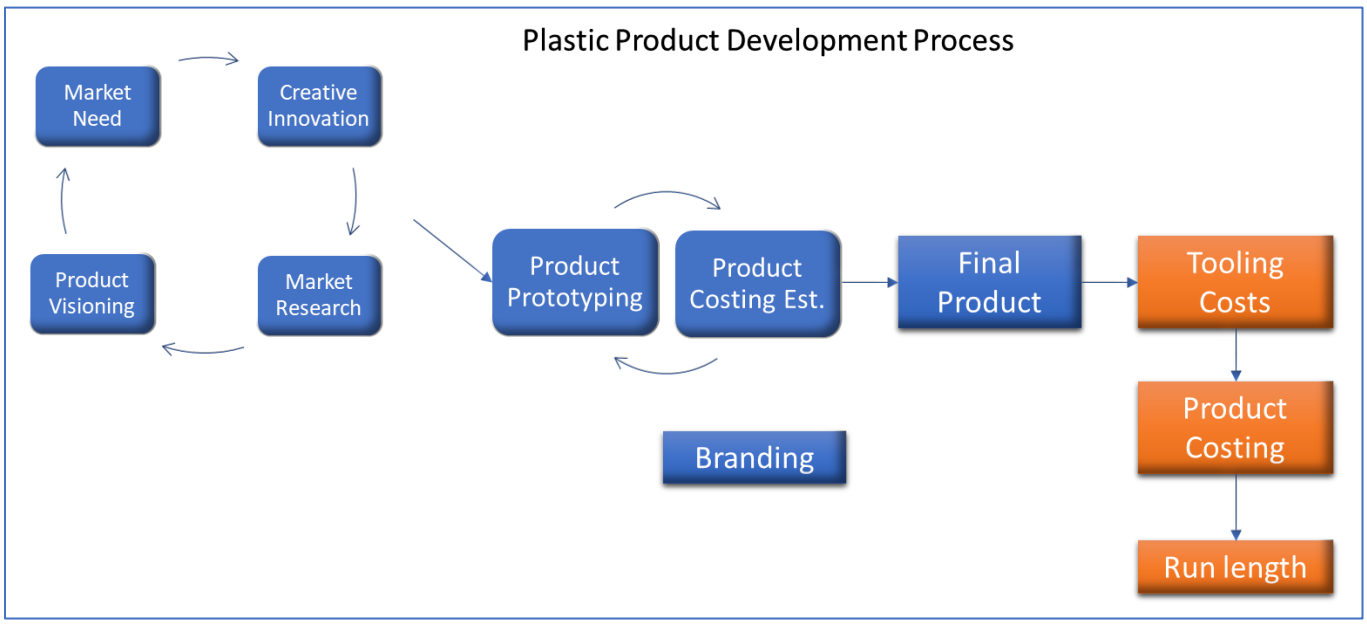
Product Development Innovation Prep

Lots of great new ideas are developed every year by existing companies and fledgling new companies. Microdyne has been proud to have been part of hundreds of new products over the decades with small and large companies.

It can be a formidable task to get that new idea to the market. In fact, the idea and prototype is just the start, the vast majority of products never make it to the factory floor for production because making products that are cost effective is much harder than the novel idea itself.

We get frequent requests for pricing on new custom products. Most entrepreneurs find the investment is much greater than they expected. Existing companies have whole teams that are involved in new products and containers. These companies pay experts to do the marketing research, design concepts and production estimates. The salaries alone represent huge investments in new product development.

Yet the production cost is always an important factor to determine if a product will be competitive in the market. We get lots questions from both new and experienced companies that we hope we can assist with this whitepaper. Here is how product innovation works well.



Market

Ideas flow, inventors tinker and brainstorming sessions produce lots of enthusiasm. But will anyone buy it? If we look at data from the brainstorming phase, some researchers site a 3000 to one success rate. But that is debated. Of the products that do get to market Stephen Markham of North Carolina State University says the failure rate drops to 40% to 50%[i].

Microdyne is right in the middle of these two phases, so we see lots of ideas never get to market. This is for several reasons:

- Products cannot be made using normal production techniques
- The initial tooling (mold) is much more expensive than the designer expected
- There is not enough capital to pay for upfront engineering and tool making
- The cost of production (including distribution and selling) is too high to be competitive in the market
- The run length for cost efficiency will take too long to sell profitably
- Design and material mistakes make the product undesirable
- The market is too small to manufacture at an affordable quantity

So the company has lots of work to do before starting the costing phase of the project. We hope to assist you with preliminary work to do before you enter into the cost phase.

The Market

Inventors tend to have an idea that they think will solve a problem or have a cool idea. Entrepreneurs tend to see a problem first and fix the problem with a product. Existing businesses discover issues their customers have, or technology trends that they can capitalize on for existing customers.

Solving existing customer problems or desires is called a market-driven approach. Inventors use a product-driven approach. The first method is much more successful than the latter. We all know of great products that were invented and changed the world; personal computers, the iPhone, electric light bulbs, the air plane and automobiles. However, in each case these products were developed by inventors who had great insight into the problems that would be solved by each invention. In the examples listed, major new markets were tapped due to extraordinary break-throughs in technology. Being an inventor does not inherently mean break-throughs or adequate differentiation from other products is achieved.

Most of the time existing company's products are incrementally improved over and over. It is a process more than a brand-new product. These small changes tend to

retain customers with product improvements, making the products successful. Steve Jobs did this with Apple. The first personal computer was a kit for hobbyists. The Apple II added a case, and assembly to the kit. The Mac was a major improvement on the Apple II. Even the iPhone was a copy of previous cell phones, with lots of computer functionality.

Once the computer market acceptance was realized, Apple built on its existing customer and technology base. They did very little market research in the traditional sense, but Steve Jobs was an unusually enlightened inventor. His wins were so huge that few remember his failures like the Lisa, the first graphical interface computer from Apple, which he adapted from other ideas from Xerox and others.

Most companies make estimates of the market size and how many they might expect to sell of a new product. This is important because with most plastic injection or blow molding processes, the cost of the initial design and tooling will be necessary prior to manufacture or market testing. The new process of 3-D printing allows samples to be made. This can help work the kinks out of more complex products.

Developing a brand-new plastic product can be complex requiring engineering and technical design on computer aided programs. Fortunately, 3-D printing allows many iterations until the product performs as hoped.

The Apple II used simple metal cases to enclose the computer, and the standard components inside. The monitor was also a basic CRT with their name on it. They didn't have a large enough market to build a full plastic container. The Macintosh however was built partially based on a unique plastic enclosure after Apple earned some market share and the personal computer market was well established.

Market Research

But using Apple as a model for innovation is a dangerous place to start. Dozens of other startup companies also jumped into the market, but only a couple were really successful[ii]. Most companies prefer to focus on markets they understand extremely well. Companies that understand how their products solve customer problems have an advantage because they understand their customers already. They also see the direct competition and can envision how to make improvements in existing products compared with the competitive ones. Occasionally, creative thinking identifies new niche markets with current customers.

Having access to customers adds marketing communication power, something that will cost more when acquiring new customers.

Companies can then make some educated calculations about how many products might be sold. This is helpful to understand the total revenue possibilities, which is

highly desirable in understanding how many units will be needed to cover the upfront tooling costs.

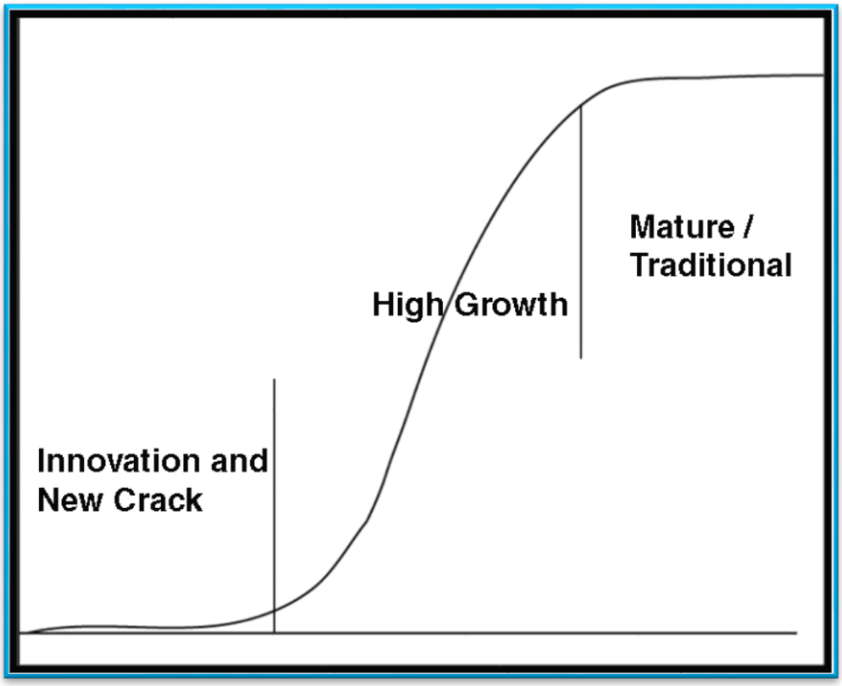
Without market research, expecting a product to be successful is a long shot. Yet many great products exist because someone did see a solution to a problem. Notorious consultant Jack Trout, says that most people buy the same 150 items which make up 85% of all household needs[iii]. About 75% of consumer-packaged goods and retail products fail to generate over seven million dollars the first year. But smaller companies don't really expect this kind of success.

Failure Rates

Another opinion from two professors, say failure rates aren't that bad. George Castellion and Stephen Markham PhD. suggested in "Myths About New Product Failures," that this is an "urban legend.[iv]" They argue that many other studies of first hand empirical work leads to more like 30% to 49% failure rate[v]. These failure rates differ across industries.

One can still argue that the difference between 80% and 40% is not significant enough to really change decisions, but it may play into the decision to launch more or less products. More new products mean the chances of one success is higher. It is widely thought that no changes to products will result in a stagnant market so pushing for upgrades, trend following, and general innovation has few detractors other than the cost savers.

Building failure rates into new product development costs however does create more realistic expectations and better forecasts.



Product Life -Cycles*- From "Finding Your Crack in the Market," Ron Burgess*

Innovation

Many great products are the brainchild of someone who discovered a need and couldn't find a product to solve the issue. Our customers have had lots great successes in our decades of business. One made the famous Shark Tank cut and got start up money to start production.

But most products are developed by existing companies that have intimate knowledge of their niche market and follow customer preferences in some way. Innovation and incremental change of products can be different, yet the type of thinking about solving problems or creating demand is much the same.

Product have a natural life cycle, some last decades or even centuries (screws, frying pans), while others are one season wonders. But in all cases they follow the stages outlined below. They slowly start out, catch on and grow rapidly, ten the market becomes saturated and slows down. New products replace the old, or are updated, or entire industries change. When was the last time you used that typewriter in the closet?

Many experts in innovation have various steps.

Certain principles may be helpful when considering plastic product development. Here are the basic broad categories of innovation.

Inspiration

- Incremental
- Product extensions
- New products for new existing niche
- Creating a new market
- Disruptive innovation

Incremental innovation is when existing products are updated, improved or changed (color or material). These factors can keep an old product relevant over time. Certain industries must match trends in packaging, coloration, or design to stay relevant in the market, others must stay the same to avoid being missed on a shelf full of other alternatives.

In plastic bottle the wall thickness has become thinner based on new technology, as many bottlers want to save material, lower the cost and leave less plastic in the land fill or recycling center. The lighter weight also saves shipping costs, small but significant over time and volumes.

Product extensions are new sizes, flavors, colors, uses or market positions. The old product is unchanged, but new variations are meant to increase the purchasing or add new customers to the product category, through variety. Marketers are always wary of market extensions because the new versions can cannibalize the revenue of the old one, while increasing costs to develop and sell the new extended variations.

New Products are generally what we think of when discussing innovation and product development. New products will either compete with existing ones or create a completely new market niche. When competing with an existing product, the new one must have obvious advantages and appropriate market positioning.

New market niches require educational advertising to help prospects understand what the product does and the problems it addresses.

Creating New Markets is another risky but popular approach. An existing product ca be re-positioned into a completely different market, or a new product can fill a niche market that has not been filled. Brand new markets are usually discovered by one who has seen a need for a new solution or realizes that a new demographic group or process needs to be addressed. The iPhone was a new product in an existing market, but as use increased a new market for portable battery chargers was revealed. Inventions create many new markets such as the ones created due to new advances in computer/human speech recognition.

Disruptive innovation is when a market is substantially changed by a new product. The introduction of the iPhone may be the most famous example. Lots of cell phones were on the market when it was introduced, but despite early smart phone examples in the market, the iPhone was perfectly positioned and so superior in obvious performance and panache that it took the market by storm putting many talk only cell phones out of business.

Disruptive product development and new market development both tend to have much higher margins, as first adopters will pay more. So, much development cost is covered by increased prices during the adoption phase of the product. The other types of incremental, and extension development tend to have prices similar to the existing market. Prices come down as sales volume increases and initial investment is paid back.

"What is the right final price to the end user?"

Plastic Product design: Considering the cost and lead times etc.

When building new products in plastic, a custom molder is needed. They will use one of the several plastic molding methods to build your product based on the different features and requirements of the product.

Control over the plastic molding process allows more creativity. Understanding the specifics of resin and molding issues helps in the end design.

According to some manufacturing authorities, the design can determine 80% of the product cost! It is very hard to remove costs after the design is completed, so **thinking about cost upfront makes sense.** That is when the material is

selected, and the weight of plastic is considered against strength and aesthetic design.

Other environmental considerations are important in the products final use, such as temperature range, contents, need for rigid vs. flexible material, use of toxic contents. Uses for food or drinkable fluid requires food grade resin, and BPA free resins. Molding other objects into the plastic requires different techniques. These considerations should be considered early in the development process so as not to waste time on designs that will not functionally work or not pass regulations for a particular industry, such as medicine, food or electronics.

A slightly different but relevant discussion may be "what is the right final price to the end user?" Most manufacturing is based on what is believed to be the lowest cost, however many examples exist where quality was over engineered, aesthetic design was under considered, and the market knowledge was cursory. Spending too much time saving a penny, may not really help sales or profits, consider what the really important characteristics actually are.

An aesthetic design can be critical for many products. In a quest to find that design, production considerations can be overlooked, this can increase final cost. The higher cost reduces the selling volume. When the selling price and other associated costs are considered, along with cost, this mistake can be avoided, while adding to the creative process. This is especially true in packaging. If selling in a retail environment, the product must jump off the shelf to get noticed. The packaging is a huge influence of the final decision.

"In a retail environment, the product packaging must jump off the shelf."

When the concept is complete, simplifying the design by reducing the parts intersects with cost. When an elegant product is developed it tends to be higher quality inherently. When it is done right the first time, later issues melt away.

Allowing a longer lead time for planning, development and production can smooth out the whole process. Change orders are expensive for you and your custom plastics manufacturing partner. Plan your product inventory requirements carefully and consider the costs of warehousing and cashflow as part of your pricing.

Many buyers of plastic products have little flexibility with finance and warehousing policy. The directive is to lower the inventory and increase turn over, (this is a basic principle of finance today,) but your lack of flexibility here is just one reason why product costs may be higher. Good planning, and adequate

time as well as flexibility on finance and inventory costs can be your friend regarding product costs.

The overall summary is that squeezing cost out of your products needs a strong partner who will legitimately work with you to find cost savings, and fit them into a schedule that you and your company can deal with. Here are additional considerations that will help:

Your Loyalty- Manufacturers have costs associated with finding new customers. When they know you are a long term recurring customer they can lower margins because they know they will have long term production. This can have very big cost saving consequences. Knowing customers are loyal, helps manufacturers manage machine purchase and maintenance more efficiently. This itself changes the financing risk and associated costs. Good partners will split these benefits with you lowering your costs. Jumping from manufacturer to manufacturer will increase your cost eventually. Don't be afraid to ask for lower prices with longer runs, and more production stability.

Managing people is a major cost. Having the optimum number of full paid employees to do your job, instead of various schemes to get part time and contract employees saves administration and downtimes due to scheduling issues. Be upfront about how much business you will really be able to send their way, they will be able to use this information for their costing considerations.

Give more work to a single vendor; let them know ahead and expect price consideration. Help your manufacturer lock in materials prices by guaranteeing volume and consider pre-paying a portion of the materials costs. While the cost of money is very small right now, larger materials contracts can lower the manufacturing cost without the risk that they will be over inventoried or have the wrong materials in stock. Manufacturers with extra space for storage can be beneficial to volume materials purchases, weight materials costs against any extra charges for storage.

Resist switching to another lower cost vendor when the product development is complete and successful. The new low-bidder may not realize the nuances of production that your initial vendor has worked out. Adding or changing vendors adds to the statistical variation of the overall product, increasing the potential for errors and customer returns. Manufacturers get comfortable with tool building (internal or external vendors) and understand how they will interact with the machinery. This eliminates glitches that can delay your production and increases quality across the run.

Consider your pricing strategy against your competitors. A difference of pennies may yield more margin, but if your overall marketing strategy is on target, very small unit cost should not be the cause of lost sales.

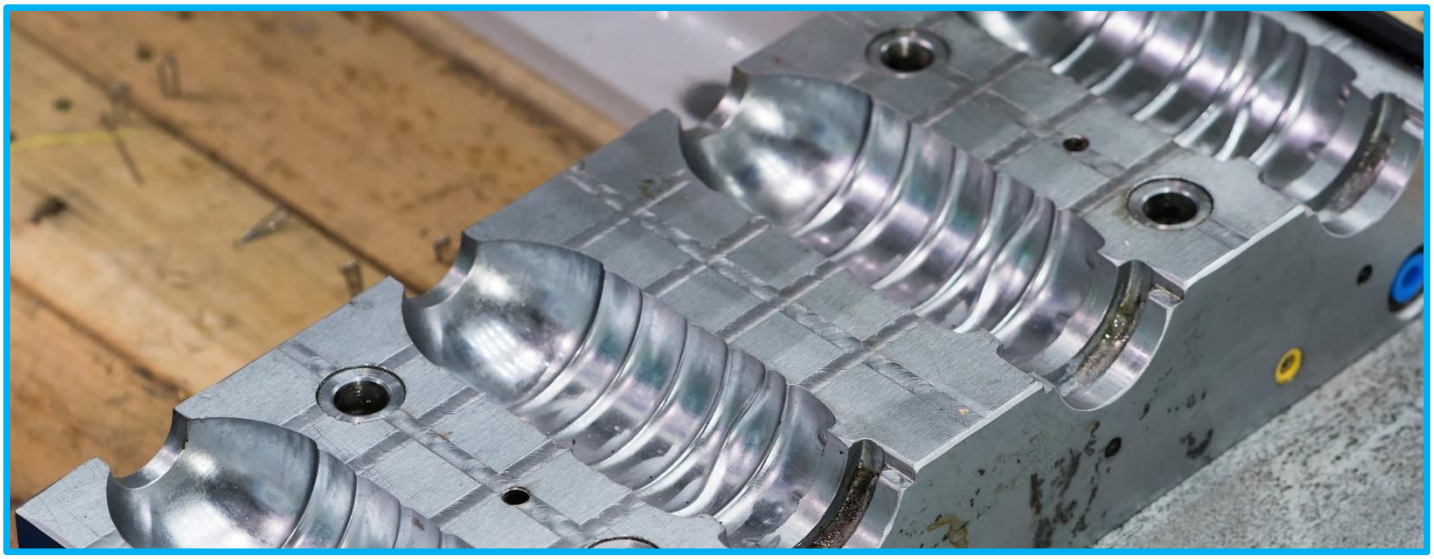
While each product/industry has a low-cost leader, for most companies competing with a low-cost leader is a very poor pricing strategy. Market leaders have developed differentiators in packaging, design, specialization service or quality that more than makes up for small cost differences. Learn to build products that have real value. If value is quality, service, image and cost, then better quality and design can increase the perceived value to the consumer. Good partners can help you do this. Developing value through innovation is not a commodity, finding companies that can do this are difficult to find.

The Tool (Mold)

While some products can be cut to a specific length or painted a certain color to make them custom, in the case of plastic injection or blow molding if the shape is different in any way, a new mold may need to be built for the specific product. It could be just a centimeter different, but it still requires a full set of molds or inserts for the shape. Naturally this means lots of design attention.

Sure, with digital design, an old set of plans can be tweaked a little and saved as a new set. There can be lots of time saved in the design, but an engineer usually is making the changes. Once the design is completed, the mold or tool must be mostly hand built.

What is called a mold or a tool in the plastics industry is really a machine in its own right. It contains a cavity (or multiple cavities) which is how the shape and form of the part is determined. But the tool must also have a way to get the molten plastic into the cavity and a vent where gasses (air) can escape from the voids in the tool. The mold is generally in two halves, so it can be pulled apart to get the molded pieces from the tool. These two halves must fit together precisely so the molten plastic does not leak from the tool. To get the cooled molded



plastic out of the tool, ejector pins or other methods are needed to move through a cavity pushing the part from the cavity.

Finally, the tool itself must fit onto the machinery that handles the plastic. We have left several other components from this illustration, but the point here is that the tool is a machine itself, usually one of a kind. Each of these parts must be designed to fit with the other parts, and has a high degree of hand work.

The tool-making process requires precision machining of steel or aluminum. CNC machining or electrical discharge machining processes are used to remove solid metal material from a larger block. While some of these processes are automated today, skilled operators are required. Many other smaller operations and other metal machining operations must generally be crafted by hand. And, in many cases, since only one of each tool is made, robots can't easily be programmed to do this custom work.

As a result, while the per-piece cost of plastic is low, these little "machines" are expensive to build. While they can last for years and be made to make well over a million parts, the initial capital investment can start in the tens of thousands of dollars and go up. Tools can have a wide life span, depending on the mold type and material used.

In considering the cost of the tool, remember to spread out the initial investment cost over the tool's lifetime. If a tool's cost is $20,000, then its investment cost per piece for 500,000 pieces is just 4 cents each. Add the cost of the material, machine time, human setup time, and some profit, and you have the overall cost of your plastic product.

When you have short product runs, there are more set-up and run time costs so the unit price rises a slight amount per piece over a large run.

If you need a small quantity only, then your tool cost is spread over a smaller number of total units which effectively increases the cost. If you only need 20,000 pieces in the example above, then the investment cost is $1.00 each.

If your product is a standard plastic bottle or jar, and you can use a standard shape, the manufacturer of this standard shape has already incurred the cost of the tool, so your cost can be less. This same approach can work for other standard or purchased parts if you can find them. These may include plastic bottle tops, clips, connectors or other products.

Understanding how plastic products are made will help your design team understand more about how to keep cost in control.

Check list of to-dos for preparing estimates

- ☐ Three dimensional proto-type or CAD (Computer Aided Design) drawings in 3-D. These provide critical information of the dimensions, complexity and size (volume) of the product.

- ☐ What will the product physical characteristics be? What conditions will the product be in as a finished product? This includes considerations like heat, corrosive environments, or contact with chemicals, as well and malleability, flexibility or rigidity, and other mechanical characteristics.

- ☐ What will the function be? Medical and food grade resins must be used for some purposes.

- ☐ What polymers or resins are to be used?

- ☐ Initial quantity to manufacture with an estimate of the long-term quantity over the life of the product or part[vi].

- ☐ What level of reliability of usage is required?

- ☐ Will the part be used as an electrical conductor or insulator?

- ☐ Will the part have inserts, connectors or other non-plastics molded into the part?

- ☐ Will the part surfaces need special treatments, colorations or finishing?

- ☐ Will labeling or other post molding be required?

Conclusion

Plastics are the most versatile of materials for product development and generally cost less than using other materials while providing a high level of serviceability. In many ways, however, the process of manufacture can be highly complex and technical. Designing plastics products for optimal use can add a level of technical requirements.

For these reasons plastic product development requires the benefits of experienced professionals to bring a successful product to market. The upfront costs of developing plastic parts and products can be substantial, therefore an understanding in the market is also essential prior to the design phase.

Microdyne Plastics can assist you in understanding the many facets of product development. To start a conversation, fill out the QUOTE form found on our website.

Additional Resources

For more on types of plastic molding, go to the Blog Section of our website, http://microdyneplastics.com/category/molded-concepts/

Research and Sources

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