DESIGN ALTERNATIVES TO IMPROVE CONSUMER APPEAL AND MANUFACTURABILITY OF A WATER-FILLED TEETHER FOR BABIES

by

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(1982)

Submitted to the Sloan School of Management
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Master of Science in Management

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Signature of Author

MIT Sloan School of Management
May 11, 1990

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ABSTRACT

As part of an ongoing effort initiated during Thesis Projects in Design for Manufacturing, a course offered by the MIT Sloan School of Management, product design consulting was conducted for Kiddie Products, Inc., a manufacturer and distributor of products for infants and toddlers located in Avon, Massachusetts. The product was a blue triangular-shaped, water-filled teether made of ethylene vinyl acetate (EVA) with a permanently attached white handle made of polypropylene that is manufactured in two parts. Its intended use is as a therapeutic device for teething babies.

The teether has sold well, but has not undergone a design or marketing review for approximately six years. Therefore, a number of shortcomings have yet to be addressed. The current design is too bulky, does not afford thorough cleaning of the teether/handle interface, and involves a somewhat inefficient assembly process.

This thesis presents and evaluates design alternatives for the handle of the teether with the objectives of improving assembly efficiency and consumer appeal without violating product safety requirements and without adversely affecting production cost. A major component of each evaluation is the effect a design will have on product manufacturability.

This thesis recommends that a one-piece, removable, polypropylene handle be adopted and manufactured using the same injection molding process as used for the current design. It also suggests ways of improving the production process with the added benefit of reducing total cost.

Thesis Supervisor: Dr. Steven D. Eppinger
Title: Assistant Professor of Management Science
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1.0 INTRODUCTION

Kiddie Products, Inc. is headquartered in Avon, Massachusetts and is a manufacturer and distributor of approximately 225 basic, accessory and related products for infants and toddlers. Products are marketed under "The First Years" brand name and are sold nationwide to mass merchandisers, department stores, variety and drug chains, supermarkets and catalog showrooms. The company also distributes its products internationally. In 1989, earnings totalled $1.43 million on sales of $32.97 million.

This thesis is the culmination of an ongoing effort initiated during Thesis Projects in Design for Manufacturing, a course offered by the MIT Sloan School of Management. As members of the fall 1989 session of this course, four other students and I were tasked with developing individual projects related to Kiddie Product's "Cooling Teether" (exhibit 1). Each project formed the basis for a thesis to be completed during the 1990 winter semester.

The Cooling Teether is a translucent blue triangular-shaped, water-filled teether with a permanently attached opaque white handle. It is intended for use as a therapeutic device for teething babies and as such affords minimal play value. The teether skin is formed from ethylene vinyl acetate (EVA) via a blow molding process. The handle is injection molded in two parts from polypropylene. Each process is
performed by a separate manufacturer under contract with Kiddie Products. The two components are then shipped to Kiddie's Avon facility where the filling and sealing of the teether, attachment of the handle, packaging, and shipping operations are performed.

Exhibit 1: THE KIDDIE COOLING TEETHER
Although the teether has sold well, it has not been subjected to a thorough design or marketing review for approximately six years. The challenge of the triangle teether project as determined by the student group, with the concurrence of Kiddie Products, was to improve product safety and consumer appeal without adversely affecting its cost-value ratio or performance. Emphasis was placed on marketing issues, product design, and production methods with all proposed changes being subject to regulatory constraints.

This thesis presents and evaluates design alternatives for the handle of the teether with the objectives of improving assembly efficiency and consumer appeal without violating product safety requirements and without adversely affecting production cost. Methods of data collection included interviews with marketing, operations, and design executives from Kiddie Products and the two manufacturing facilities, multiple tours of all three production facilities, and consumer focus groups.

The remainder of this thesis focuses on the concept of a one-piece handle and its performance relative to the current two-piece design in the areas of assembly, consumer appeal, production cost, and product safety. The simple design and function of this product made this project extremely attractive as it allowed a greater degree of creative freedom in analyzing production, design, and marketing issues.
2.0 THE CURRENT PRODUCTION PROCESS

As mentioned in the introduction the teether skin and handle are manufactured at separate facilities under contract with Kiddie Products. The company which injection molds the handles is located in Leominster, Massachusetts.

Approximately one third of its total production capacity is dedicated to making various Kiddie products, five percent of which is teether handle production. Therefore, the handle represents roughly 1.7 percent of the company's total output.

The teether skins are blow molded by a company in New Hampshire. Approximately forty percent of its total production capacity is dedicated to Kiddie Products, fifteen percent of which is teether skin production. The New Hampshire facility is much smaller than the Leominster facility. However, it has both blow molding and injection molding capabilities, unlike the Leominster operation which is almost exclusively devoted to injection molding with no plans to expand into blow molding.

A breakdown of production costs is shown in figure 2.

2.1 BLOW MOLDING THE TEETHER SKIN

In spite of the fact that this thesis focuses on issues involving the teether handle, this section is included to
allow the reader to develop at least a basic understanding of each stage in the Cooling Teether's production.

In this operation a premeasured mixture of clear EVA and blue pigment pellets is top loaded into a single blow molding machine. Resistance coils heat the mixture to 300 degrees to afford uniform coloration as it is simultaneously mixed. The resultant "bubble gum like" mixture is then air-cooled to 250 degrees and mechanically fed into a constant pressure injection head. The pressure and temperature are critical in maintaining a constant product weight, wall thickness, and cycle time per molding. From the injection head the mixture is fed in 60 gram increments through an orifice forming a cylindrical tube of material which drops vertically from the opening of the orifice. A mold then automatically closes around the exposed tube, a needle is inserted which injects air into the mold forming the desired shape, the mold separates, and the molded material drops into a tray. The machine produces 150 to 180 moldings per hour, each of which contains two teether skins.

During operation the machine is constantly tended by one worker whose primary duties, other than monitoring the machine's performance, are to trim scrap from the moldings and separate the two skins. The finished skins are packaged in boxes of fifty dozen and shipped daily (as available) to the assembly facility in Avon. The scrap is sent through a
grinder and reused. Of the 60 grams used per molding, 40 grams is scrap and 20 grams goes into the finished product.

2.2 INJECTION MOLDING THE TEEETHER HANDLE

The heating and mixing processes for injection molding the handle are similar to those employed in blow molding. However, the material used and molding process are quite different.

Polypropylene and white pigment pellets are heated and blended at a ratio of 100:1. The mixture is then fed under pressure into a mold which channels the material into four cavities to form two male halves and two female halves, or two complete handles. After a precise cycle time, the machine automatically separates the mold, removes the excess material, and ejects the finished product into a holding bin. Approximately 275 sets (complete handles) are produced per hour during continuous operation.

There are two critical parameters which determine the minimum required pressure for the injection molding process and therefore, the size of the machine needed to perform the operation. These are the projected surface area and wall thickness of the part to be molded. As a rough rule-of-thumb, for every square inch of projected surface area approximately 2.5 tons of pressure will be required to force the material
throughout the entire mold. A 200 ton machine is currently used to make the teether handle.

In contrast to the blow molding operation, the injection molding machine is not constantly attended during operation. Periodically a worker empties the bin containing the finished teether halves and packs male and female parts in separate boxes of 1100 pieces for shipment to the assembly operation in Avon.

2.3 THE FILL AND ASSEMBLY PROCESS

As the components arrive at Kiddie Products' headquarters in Avon, Massachusetts they are stored in an adjacent warehouse. Components are retrieved as necessary to support the fill and assembly operation.

Two manually loaded and activated machines are used in the fill and assembly process, each of which requires a skilled operator. The teether skins are filled by placing the empty skins vertically in a metal slot with the fill opening pointed upwards, and filling them with treated tap water via a hollow needle inserted in the opening. The newly filled teether skins are then rotated counterclockwise to a new position where an ultrasonic welder is manually activated to simultaneously seal the fill opening and cut away any excess material. Finally, the operator removes the filled and sealed teethers from the operating surface and places them in a
plastic container. A portion of the filled teethers are to be sold separately and are therefore taken to be packaged in an adjacent work space. The rest are taken to a second machine which attaches the handles.

The operator of the machine which attaches the handles places six male halves of the handle in machined grooves on the lower plate of a hydraulic press. He/she then positions filled teethers on top of them. The female halves of the handles are placed in the upper plate and the press is activated. The fully assembled teethers are then removed, placed in a plastic container, and taken to the packaging area when the container is full.

The capacity of the fill and seal machine is approximately 8000 units per day based on a 7.5 hour work day. The hydraulic press operation produces 4300 units per day on average. These numbers vary according to the specific operator assigned to a given machine, availability of components, and any unscheduled down times.
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**NOTE:** Numbers are disguised as requested by Kiddie Products. However, relative magnitudes are accurate.

**Figure 2: PRODUCTION COST BREAKDOWN**
2.4 EVALUATION OF THE PRODUCTION PROCESS

In evaluating the fill and assembly process two problems were identified as having an adverse impact on daily productivity. The teether skins were not always delivered in sufficient quantity (approximately 14 boxes) to support a full day's production and the handle components frequently required cleaning before they could be used due to the presence of grease and dirt.

It is not within the realm of this thesis to perform a detailed analysis of the teether skin manufacturing operation in order to uncover ways of improving productivity. However, it is fair to suggest that the inconsistent supply of skins presents a potential bottleneck to the assembly process which does involve the handles and impacts total Cooling Teether production. Therefore, it will be necessary to investigate ways of increasing the availability of skins to ensure current demand will be met with sufficient excess capacity to support reasonable future sales growth. Some possibilities include:

- Increasing the weekly hours of production at the New Hampshire facility
- Adding a second blow molding machine
- Replacing the two-cavity mold with a four-cavity mold (see figure 3)
- Modifying the injection head assembly such that it can alternately serve two two-cavity molds from one machine by alternating between molds
Because the Cooling Teether is a high volume, low cost product, its demand may not support incurring the added cost that some of the afore mentioned suggestions would entail.

Figure 3: FOUR-CAVITY ALTERNATIVE FOR TEETHER SKIN MOLD
The need to clean the teether handles prior to attaching them to the filled teether is an undesirable added step in the assembly process. It reduces daily throughput by effectively shortening the work day for the hydraulic press operator. However, having investigated this problem at the source (Leominster, MA facility) I have concluded that it would be impractical to try and enforce higher cleanliness standards at the manufacturing facility.

During operation of the 200 ton injection molding machine lubricating oil may occasionally drop on the mold or the catch tray which directs the molded parts into the collecting bin. As the parts are molded and directed into the bin they may pick up some oil which may then collect dirt and dust. To effectively prevent this from occurring an operator would have to be permanently stationed at the machine during operation to keep surfaces that come in contact with the finished parts free of oil and to clean any parts which may have become contaminated. This would require periodic stopping of the machine and more direct labor. Both of these would add to the total production costs chargeable to Kiddie Products.

The cleaning operation also affords an opportunity to inspect the quality of the handle components. Therefore, it is not clear that the assurance of cleanliness during manufacturing would warrant negating the inspection of the parts at the assembly location.
The individual capacities of the injection molding and assembly processes are more than adequate to support the current level of demand for the Cooling Teether with or without the handle. There is also sufficient excess capacity to accommodate future increases in demand.

Projected 1990 sales for the Cooling Teether is 300,000 units with an additional 300,000 unit sales projected for the teether without the handle attached. This is an increase over 1989 sales of approximately 35 percent.

Orders for components for 50,000 handles are placed with the Leominster facility bimonthly. The manufacturer requires a four week lead time to allow for variations in machine availability and production time. Each order requires approximately two weeks of production.

No buffer stock is maintained at the injection molding facility. All finished products are delivered to the warehouse in Avon. At the time this thesis was prepared there were sufficient components stored in the warehouse to make 40,000 handles. In contrast there were no teether skins in stock.

As far as the assembly process is concerned, at an average of 8000 units per day the fill and seal machine is capable of satisfying projected demand in 75 full working days. Similarly, the hydraulic press operator would take 69.8 days to meet projected demand assuming an average of 4300 units per day are produced. While it would be unrealistic to
assume that the assembly operation could be run for 75 consecutive days at full capacity, it is safe to conclude that capacity is not an immediate concern with either the manufacturing of the handle or assembly of the teether. Therefore, the remainder of this thesis will concentrate on improving the manufacturability and lowering unit cost through redesign.

3.0 EVALUATION OF THE CURRENT HANDLE DESIGN

The current design (refer back to figure 1) has been on the market for almost ten years and, as previously mentioned, is overdue for both marketing and design reviews. One aspect of the handle design that could be improved upon is the two-part construction. This design unnecessarily complicates the assembly process in that it requires the manipulation of three separate parts in five discrete steps (refer to the discussion about the hydraulic press). It also requires that male and female components be sorted and packaged separately which in turn necessitates segregated storage and handling at the Avon warehouse.

In defense of the current design, it does use a relatively inexpensive material and a manufacturing process capable of producing dimensionally consistent parts at a fairly high rate.
3.1 CONCERNS RAISED BY CONSUMERS

To compile the results discussed in this section three separate focus groups were convened. Each group consisted of four individuals with children between the ages of one and three. Packaged Cooling Teethers (with handle) were given to each individual to examine. Participants were then asked to remove the teethers from the package for a better look. Finally, they were asked to examine the teether with the handle removed. After each step an open discussion was held. The highlights of these discussions, particularly those pertaining to the handle, are presented below.

-The teether as a whole is too bulky for a young child.

-The design does not allow for proper cleaning. The interface between the teether and handle can trap food particles that cannot be rinsed free without prying the handle apart. The internal cavity of the handle may partially fill with water and/or saliva which can remain trapped for quite some time. This promotes the growth of bacteria.

-Once the teether is removed from the package there are no markings which identify the brand. This was pointed out by two individuals who were interested in the product, having seen it at a friends house, but were unable to determine the brand name.

-The handle is difficult for a baby to grasp. It is too thick, the hole is too small, and it is not designed to conform to the shape of the hand.

-Babies do not tend to use the handle. They grasp either the teether itself or an area near the top of the handle.

-After refrigerating or freezing (note that the teether is not meant to be frozen) parents are reluctant to place the cold handle in their baby's hands.
The majority of the comments concerning the packaging of the teether were favorable.

It is important to note that, while most of the concerns raised by these focus groups are of little consequence to a teething baby with regards to safety and functionality, it is after all the perception of the parent that determines whether or not the teether is purchased. If the purchase is not made there is little chance of developing brand loyalty that could lead to purchases of other products possessing the "First Years" label. Therefore, it is important that redesign efforts address these concerns.

4.0 ALTERNATIVE HANDLE DESIGNS

In searching for a design that would both address some of the issues raised by the focus groups and improve manufacturability, numerous concepts were considered. From these, the concept of a one-piece removable handle was chosen as the most promising.

The one-piece design is a change that can be easily implemented with virtually no delays in production. It will also afford a more efficient production process. At the Leominster facility there will no longer be a need to manually sort the parts into separate boxes for shipment. Each finished product will be a complete handle that can automatically be directed from the mold into an open shipping
container. When the container is full it is sealed and moved to a designated area to await shipment to the Avon warehouse. Separate accounting of male and female parts would no longer be required.

As the boxes of complete handles arrive in Avon, they can be stored in a single location. Sight inventory of the handles would be simplified since it would only be necessary to count the number of boxes rather than the number of boxes of each handle component. Individual boxes, rather than pairs, would be transported to the assembly area as necessary to support daily operations. In addition, one box would occupy less space than two in the assembly area.

Thus far I have mentioned some of the more subtle benefits of the one-piece design. The major benefit of this design from a production standpoint is that it will lower total production cost per unit. Since the handle is designed to be attached and removed by the parent, the same advantage can be used to simplify the assembly process. It would only require a single operator to manually attach the handles to the teethers as they exit the fill and seal operation. The hydraulic press, along with its associated operating and maintenance expenses, would no longer be required. In addition, an unskilled worker with little or no training could be assigned the task of attaching the handles. The risk of personal injury inherent in the operation of a hydraulic press would also be removed.
The removable feature allows the parent to take the handle off prior to refrigerating the teether. Before giving the refrigerated teether to the baby, the room temperature handle would be reattached. The one-piece design allows for improved cleaning with no internal accumulation of water and saliva.

4.1 THE ONE-PIECE REMOVABLE HANDLE

The following four designs were selected from twelve candidates. The selection was made after considering comments and recommendations made by persons involved in the design, manufacturing, and testing of the current design as well as individual consumers.

4.1.1 THE PUSH-ON DESIGN

Figure 4 shows the proposed push-on design. It is a solid, lightweight design with a greatly reduced wall thickness. The compressed shape is a feature recommended by the focus groups intended to focus the baby's attention on the teether and reduce the temptation to chew on the handle itself. However, should a baby decide to put the handle in its mouth, the shape could improve the ability to reach the back teeth. The hole in the middle of the handle conforms to
the shape of the hand allowing the baby to get a better grip. It also addresses the issue of the teether being too bulky.

Injection molding using a double-pull, slide action mold is the preferred method of production. The double-pull slide action is necessary to form the clamp without leaving any sharp edges. Blow molding was considered, but rejected due to the difficulties and expense of designing and building a mold that could produce the clamped end to which the teether would be attached. Blow molding also allows greater variability in dimensions from part to part.

Polypropylene and poly vinyl chloride (PVC) are two possible materials from which to form this handle. Polypropylene has the benefit of an established supply network at the Leominster facility. It also costs less than PVC and is rigid enough to ensure a firm grip on the teether. However, the solid construction of this design would dramatically increase the cycle time per molding due to the added thickness of the material. Even though the thicker walls and reduced projected surface area would require less injection pressure, the change in cycle time would result in a higher production cost per handle.

PVC would require a shorter cycle time than polypropylene and would make a less rigid product that is easier on the gums of a baby. However, because it is less rigid it will probably be less effective in holding the teether. It is also more expensive ($0.75/pound versus $0.50/pound for polypropylene).
One other shortcoming of this design is that, should the baby manage to pull the handle from the teether, the slot which normally holds the teether could present a problem in that a small finger, lip, or a baby's tongue could become stuck in it. In addition, even though slide action molds have been constructed and used at the Leominster facility for quite some time, it would cost Kiddie Products between $30,000 and $35,000 to have this mold made. Due to the added complexity, longer setup times would be required to install this mold in the machine resulting in more costs chargeable to Kiddie.
Figure 4: THE PUSH-ON REMOVABLE HANDLE
4.1.2 THE CLIP-ON DESIGN

Figure 5 shows the clip-on design. The obvious differences between this and the push-on design are the overall shape and the method of attachment. However, the arguments concerning manufacturing method and material selection are the same.

The clip would provide a more secure grip on the teether regardless of the material chosen. It would also be more difficult for a baby to remove. However, it requires more material, a longer cycle time, and a more complex mold that would exceed the cost quoted for the push-on design. It may also be possible for a baby to get a finger caught in the area between the teether and the clip opening.
Figure 5: THE CLIP-ON HANDLE
4.1.3 THE WRAPAROUND DESIGN

The wraparound design is shown in figure 6. It features a flexible extension that is wrapped around the teether. A hole in the end of this extension snaps onto a small post protruding from the base of the handle. This design is easier to manufacture in that it does not require a slide action mold. However, the need for flexibility in the flap may rule out polypropylene as an alternative. PVC would be suitable in this case. It is sufficiently flexible and would require a shorter cycle time than polypropylene, but at a higher material cost.

This design has a number of shortcomings. When not attached, the small post could possibly be chewed or broken off and swallowed. While there is no real danger of choking on such a small object, the very possibility of this occurring may discourage some potential buyers. Another problem is that the design, as shown in figure 6, would probably fail the impaction gauge test as presented in section 4.4. To pass the test the flap would have to be wider which would require a redesign of the teether to accommodate it. The end result would be a teether that is even bulkier than the current design.
Figure 6: THE WRAPAROUND HANDLE
4.1.3 THE SNAP-ON DESIGN

The snap-on design is shown in figure 7. It consists of two parts connected by a flexible hinge which snap together around a specific side of the Cooling Teether (the side without raised ridges). Like the current design, the thin walls of the snap-on handle would allow the use of the cheaper polypropylene with a fast cycle time.

Because this so closely resembles the current design, the same 200 ton injection molding machine could be used. A new mold for this design would cost between $15,000 and $20,000. However, the individual at the Leominster plant who supervises the design and manufacture of molds revealed that if the dimensions of the handle are specified such that they can be modeled mathematically for his CAD/CAM system, as much as $3000 could be trimmed from the cost of the mold. He was fairly certain that the design in figure 7 would meet this criteria.

This one-piece, removable alternative is the most attractive of those presented in this thesis. It provides all the benefits to production discussed previously and it addresses most of the key issues raised by the focus groups.

Although still somewhat bulky, the snap-on handle is thinner and lighter than the current design. It also has the "seal of approval" of the management of the Leominster facility as a design that would be easy and cost effective to
make with virtually no production gap when the proposed change is implemented.

The manufacturing cost per part would remain the same. Therefore, the only cost to be recovered by the assembly cost savings and an almost certain boost in sales, would be the fixed cost associated with the purchase of the mold (see figure 9).
Figure 7: THE SNAP-ON HANDLE
4.2 THE ISSUE OF PLAY VALUE

Although it is not clear whether play value is an appropriate concern for a water-filled teether, it was mentioned by a number of individuals during the focus groups as something that might influence them at the point of purchase. Therefore, I will quickly mention a couple of the ideas that were discussed.

One idea involved developing a hollow handle that could be partially filled with plastic beads to form a rattle that could also be removed from the teether and used as a stand alone toy. Another idea was to make the hollow handle out of clear plastic, fill it with water, and add either glitter or small plastic shapes that would move around when shaken.

Once again, these ideas are presented here to avoid inadvertently editing consumer comments which may prove useful in future design efforts. No attempt was made to incorporate these ideas in the design alternatives presented in this thesis.

4.3 IMPROVING BRAND RECOGNITION

Whenever possible a company's brand name or logo should be clearly visible on each of its products in addition to the packaging. Doing so ensures that the origin of a product is easily identified long after the item is removed from the
package. Satisfied customers may develop a loyalty for a certain brand which results in repeat purchases of the item as well as purchases of other products under the same brand name. In the case of teethers, there is such a wide variety of shapes, sizes, and brands available that word of mouth from parent to parent could have a significant impact on the choice made by first time purchasers. However, if a parent inquires about the brand of a certain teether and it is not included on the product, the sales opportunity may be lost.

To address this issue I propose the addition of "the first years" logo on the face of the handle as illustrated in figure 8.

![Figure 8: THE SNAP-ON HANDLE (WITH LOGO)](image)
4.4 APPLICABLE SAFETY REQUIREMENTS

The Consumer Product Safety Commission (CPSC) has imposed specific testing requirements for toys and other articles intended for use by children under three years of age. Because the handle designs proposed here are part of a product meeting this description, they are subject to these requirements.

The critical first test is the impaction gauge test in which the handle is placed in a device similar to that shown in figure one. If it fits entirely within the cylinder in any orientation it fails the test. This must also be repeated with the handle open. The purpose of this test is to identify articles which may present choking, aspiration, or ingestion hazards because of small parts.

Once the handle passes the impaction gauge test it is subjected to a number of use and abuse tests. The first of these is a drop test during which the handle is repeatedly dropped from a specified height. Any components or pieces which become detached during this procedure must pass the impaction gauge test. As an added precaution Kiddie Products' Quality Assurance personnel subject the handles to a bank of tests specified for articles intended for use by children between the ages of five and eight years. Without going into detail these tests include a bite test, torque test, tension test, and compression test.
The design drawings in this thesis are drawn to show the actual size of the handles. Dimensions were chosen to ensure that the impaction gauge test would be passed. Without a prototype of the handles it was not possible to subject the new designs to the remaining tests. However, they are similar enough to the current design that the additional tests should not pose a problem.

5.0 SUMMARY OF BENEFITS

There are many benefits to all the one-piece removable designs, but the snap-on handle would prove particularly beneficial and can be easily modified to attach to a variety of teether shapes. From a manufacturing standpoint it is a fairly simple change that can be quickly implemented without causing any production delays during the changeover process. It simplifies the packaging and shipping process at the Leominster facility by eliminating the need to sort and provide separate accounting for both male and female components. At Kiddie's headquarters in Avon it simplifies the inventory accounting applicable to this component, requires no changing to the packaging process for the finished product, and above all it greatly enhances the assembly operation. It eliminates the need for the hydraulic press as well as the need for a skilled operator. The elimination of this piece of equipment cuts production costs by 9.8% through
the reduction of handle attachment overhead (see figure 10) and provides floor space that could be used for new production equipment to increase the capacity of existing products or produce new products. With the aforementioned assembly cost savings, the price of the new mold would be recovered in approximately one year.

As far as handle assembly is concerned, all that would be required to expand the capacity is the additional workers to snap on handles. No additional equipment would be required.
### Production Cost Advantage of the New Design

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<td>Misc. Costs (Shipping, Mold Amort., etc)</td>
<td>1.0466</td>
</tr>
<tr>
<td>Labor + Overhead for Misc. &amp; Packaging</td>
<td>.9884</td>
</tr>
<tr>
<td><strong>Total Cost of Cooling Teether</strong></td>
<td><strong>8.1523</strong></td>
</tr>
</tbody>
</table>

**The one-piece design eliminates the handle attachment overhead, thereby reducing total cost by 9.8%.

**NOTE:** Numbers are disguised as requested by Kiddie Products. However, relative magnitudes are accurate.
This design also improves the marketability of the Cooling Teether by incorporating design changes that are a direct response to consumer comments and concerns. Some of the concerns raised during the focus groups were probably not significant enough to have had a serious impact on sales. However, a creative change to the copy on the packaging (blister card) exposing the benefits of the removable feature of the handle would probably enhance the teethers comparative advantage in the teether market resulting in a boost to its already impressive sales. The addition of the logo on the handle would have a similar effect, but would also have a significant impact on the number of repeat purchases as well as the number of purchases due to referrals.
6.0 RECOMMENDATIONS AND CONCLUSIONS

Throughout this project the support of the management and personnel at Kiddie Products as well as the two independent manufacturing facilities was outstanding. With their assistance I was able to gain a thorough knowledge and understanding of the design, material selection, manufacturing, and testing procedures involved in producing this deceptively simple product. This has enabled me to develop design alternatives and recommendations that are well thought out and which hold tangible benefits over the current design.

I make the following recommendations.

1. Increase the capacity of the blow molding operation and investigate new teether skin designs.

2. Adopt the snap-on handle design with the "First Years" logo.

3. Continue injection molding the handle with polypropylene.

4. Remove the hydraulic press and assign the task of cleaning and attaching the handles to an unskilled worker.

5. Modify the blister card to inform consumers of the benefits of the new design.

If adopted, these changes would have a significant impact on production efficiency and trim total cost by 9.8% while providing a safe and more appealing Cooling Teether for what is sure to be a growing number of customers.