Symposium on Rotational Molding

McCormick Place, Chicago, Illinois, November 19, 1963

U.S.I. Chemicals USI

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SYMPOSIUM ON ROTATIONAL MOLDING

Sponsored by

U. S. INDUSTRIAL CHEMICALS COMPANY

Division of National Distillers and Chemical Corp.

Tuesday, November 19, 1963

Chicago, Illinois

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WELCOME

Tuesday, November 19, 1963

The Symposium on Rotational Molding, Sponsored by the U. S. Industrial Chemicals Co., convened in the Banquet Room of McCormick Place, Chicago, Illinois, at the hour of 2:00 P.M., Mr. W. F. McDonald, Assistant Director, Polymer Service Laboratories, U. S. Industrial Chemicals Company, Tuscola, Illinois, presiding.

William F. McDonald, U. S. I.

William Marsh, U. S. I.

MODERATOR W. F. McDONALD:

Good afternoon, ladies and gentlemen. We are pleased to have with us Mr. W. P. Marsh, Vice President of National Distillers and Chemical Corporation and Assistant General Manager of U. S. Industrial Chemicals Company, a division of National Distillers and Chemical Corporation.

MR. W. P. MARSH:

Good afternoon, ladies and gentlemen. You will see on your program that Dr. Robert Hulse was supposed to do the chores at this point but, unfortunately, Bob has had to stay in New York and won't be back until about three o'clock this afternoon, which was a little too late for us to start; but in any event, on behalf of all of us in U.S.I. and especially on behalf of our Polymer Service Laboratories and other technical groups in the company who helped to arrange this symposium, it is indeed a real pleasure for me to extend a sincere welcome to you.

We are particularly grateful to you for two reasons. First, because of the high caliber of speakers who have so kindly agreed to participate in the program and, second, because so many of you have taken the time out from your busy show schedule to be here with us.

In the program that follows, we will try to give you in a minimum amount of time a maximum amount of information on rotational molding of powdered polyethylene as a plastic processing technique that holds tremendous promise for the future.

I understand we have a very tight schedule, so without further ado I will turn you back to Bill McDonald, who will introduce our first speaker.

Again, many thanks for coming, and I sincerely hope that it will prove to have been worth your while.

MODERATOR McDONALD:

Because of the size of this wonderful audience, we will not be able to accept questions directly from the floor. Instead we have provided you with cards. We ask that you write the questions on the card, giving your name, address, company affiliation, and the person to whom you wish your question directed, and pass them to the aisle at the end of each talk. These will be picked up and I will direct your question to the indicated person during the question and answer period at the end of this program.

In addition, full proceedings of this symposium are being reproduced. If you would like a copy of the proceedings, compliments of U. S. Industrial Chemicals Co., simply leave your badge in the container at the door and copies will be mailed to you. If you should not have a badge, your wallet will do. (Laughter)

INTRODUCTION TO POWDERED POLYETHYLENE
U. S. INDUSTRIAL CHEMICALS CO.

MODERATOR McDONALD:

Our first speaker today is Dr. A. B. Zimmerman, who will give an introduction to powdered polyethylene and its application to rotational molding.

Dr. Zimmerman is Manager of Customer Services at the Polymer Service Laboratories of U. S. Industrial Chemicals Company in Tuscola, Illinois. Much of his work since joining the Polymer Service Laboratories in June of 1958 has been concerned with powdered polyethylene processing.

Dr. Zimmerman received his B.S. degree in Chemistry and Mathematics from Western Kentucky University and his Ph.D. in Chemistry from Indiana University. He is a member of the Society of Plastics Engineers and the author of five published articles, four dealing with powdered polyethylene.

A. B. Zimmerman, U.S.I.

DR. ZIMMERMAN:

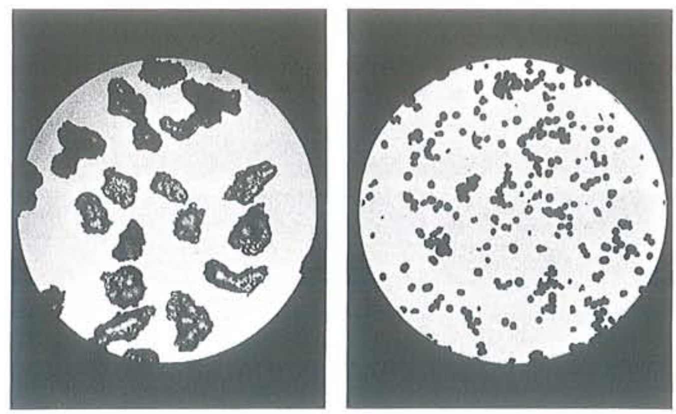
Symposium Guests: It is certainly a pleasure for me to have this opportunity to briefly outline the development of polyethylene powder at U.S.I.

Back in 1958 when U.S.I. first became seriously interested in the prospects of powdered polyethylene most of the technology for this product was in Europe, both for its production and its uses. Therefore, a number of people from U.S.I. traveled extensively throughout Europe studying production methods for polyethylene powder and observing uses for the material. Largely because of the very promising things that were observed in Europe, U.S.I. decided to produce polyethylene powder in large scale commercial operation. Thus in 1958 we became the first commercial producer of large amounts of polyethylene powder.

We have used the trade name MICROTHENE for our product. Since 1958 many rather large applications have developed for polyethylene. However, at U.S.I. we feel that we have only started to touch the surface of the actual potential volume for many of these applications. Today we plan to go rather deeply into one of the applications that we think holds much promise in the future. That is rotational molding. However, before we focus on rotational molding, I would like to describe for you some of the methods that are used to produce polyethylene powder, briefly mention its properties and some of its other uses.

Actually there are two major techniques for making polyethylene powder. One is by precipitation from solution. This is not a new method. It has been used for quite a number of years. However, it is an expensive method and the powder will cost approximately three to four times as much as another technique, which is grinding.

Grinding is not a new technique either, but prior to 1959 when equipment was introduced which allowed grinding of polyethylene at high rates without expensive refrigeration systems, the polyethylene that was produced by grinding was even more expensive than that produced by precipitation method.



Slide I

Slide I shows products from each technique. The material on the right is made by the precipitation technique and the material on the left is the mechanically ground material. As you can see, there is quite a difference in configuration or physical shape of the two products. Actually, there is another difference and that is particle size. In the precipitated product, you get a much finer product, which has an average particle size of around twenty microns and very few particles larger than 53 microns.

In the mechanically ground product most particles are larger than 100 microns.

The mechanically ground powder also comes in various particle sizes. We usually sell it, according to mesh size. For instance, a fifty mesh product means that all of the powder will pass through a fifty mesh screen. We have fifty mesh, seventy mesh, thirty-five mesh and twenty-five mesh, and so on.

I would say that approximately ninety-five per cent or more of the polyethylene powder sold today is made by mechanical grinding. Very little of the precipitative product is used; however, it does have certain areas where its special properties are necessary.

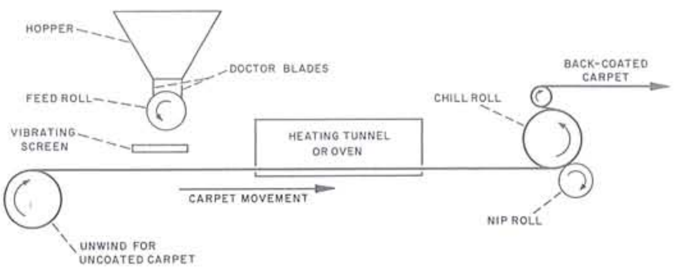
Slide II shows some of the powders that are available from U.S.I. These all happen to be 50 mesh products in a range of melt indexes and densities. We have other mesh sizes available. You can see that almost any combination of melt index and density is available.

TYPICAL MICROTHENE® POWDERS

CODE	M.I.	DENSITY
702	2	.917
710	22	.915
714	70	.915
722	5	.924
734	3	.933
750	1.5	.937

Slide II

As far as the properties of polyethylene powder are concerned, we use the same parameters that we use when discussing the material in pellet or cube form. So generally the only thing you have is polyethylene available in smaller particle size.



Slide III

Slide IV

Slide III shows polyethylene powder in one of the present large scale applications, the backing of automotive carpeting. Approximately seventy-five per cent of the cars that have carpet in them today are backed with polyethylene powder.

I won't go through this slide in detail at the present time, but this shows schematically a piece of equipment that can coat the carpet for automotive uses.

One thing about our future thoughts. We hope to use the same type of equipment to coat domestic carpeting. We can also use this same equipment to coat fabrics for heat sealing application, for stiffening application and so on.

We are demonstrating this technique in our booth upstairs and we would be very happy for you to go by and observe the demonstration.

Slide IV illustrates another application for polyethylene powder, the coating of rigid substrates. We have coated various types of metals and have obtained excellent adhesion. In our plant at Tuscola we completed recently a test on some valves in an acid system. They cost approximately $25.00 a piece, and prior to coating them with powdered polyethylene, the maximum use we were able to get was one week. We have just removed one that was coated with MICROTHENE powdered polyethylene by the fluidized bed technique, and it showed no signs of wear after a month's service. So polyethylene is a very attractive coating material.

These are simply the steps that are used in coating with polyethylene. I am going over the applications other than rotational molding rather rapidly because it is not our main topic today.

DRY POWDER COATING TECHNIQUES

DIP COATING-FLUIDIZED BED

DIP COATING-NON-FLUIDIZED BED

FLAME SPRAYING

VIBRATORY SHAKING

BLOWING

ROTATION COATING

FLOC SPRAYING

GRAVITY OR FLOOD COATING

Slide V

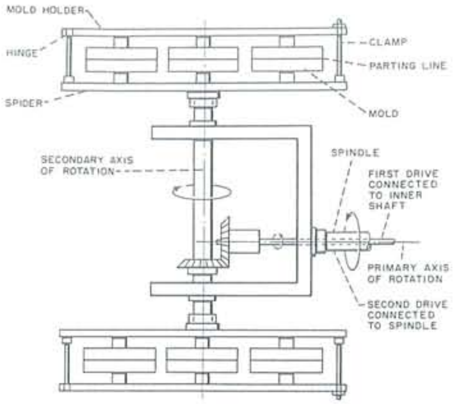
Slide V shows some of the techniques used for coating with mechanically ground powder using it in the dry form. We are also demonstrating some of these techniques in our booth upstairs and again, we would be happy for you to come by and observe these demonstrations.

Slide VI brings us to the main topic of today, rotational molding. This slide shows schematically a piece of equipment that could be used to rotationally mold a part. Essentially what you have here is a device which would turn a mold simultaneously through two planes while the powder on the inside of the mold contacts all the interior surfaces and melts uniformly on the inside to form the product.

The molds are usually split at the largest dimension of the part so that part can be easily removed. You cannot strip polyethylene from molds with a narrow opening as you can strip vinyls.

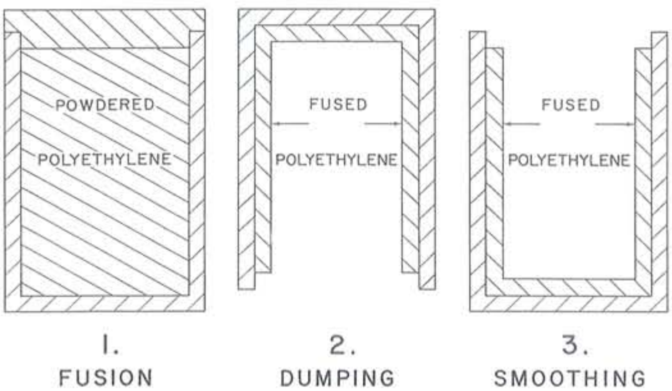
Rotational molding is not a new technique. It has, as you all know, been used for years with vinyls. But U.S.I. made the first public demonstration of rotational molding of polyethylene powder at the 1961 plastics show in New York City.

Various equipment designs and equipment which is available will be covered in later talks.



Slide VI

STATIC-POWDER-MOLDING PROCESS



Slide VII

Slide VII. In addition to rotational molding of powder we use the term called "powder molding." This covers quite a few different techniques for using powdered polyethylene to mold objects. Rotational molding is the one that we feel holds the most promise. However, another technique that is used is the Engle Process or static molding process. Another one is the Heisler Process. We have three others listed in Slide VIII including the "Rock and Roll" which is patented by Chemical Automation Corporation. We have centrifugal casting and a technique which is relatively little used, called mold spraying.

OTHER POWDER MOLDING METHODS

1. "ROCK AND ROLL"

2. CENTRIFUGAL CASTING

3. MOLD SPRAYING

Slide VIII

Slide IX shows some of the advantages of powder molding. This is in respect to blow molding or injection molding. We feel especially that you can get very uniform wall thickness in respect to blow molding. You can definitely get strain free parts with rotational molding. The molds for most powdered molding techniques, especially rotational molding, are cheaper than injection molds or blow molds, and the initial investment for equipment is much lower, especially when you get into large scale parts.

These things that I have listed here will be covered in greater detail in later talks.

ADVANTAGES OF POWDER MOLDING

1. UNIFORM WALL THICKNESS

2. STRAIN-FREE PARTS

3. LESS EXPENSIVE MOLDS

4. LOW INITIAL INVESTMENT

Slide IX

Slide X lists some of the major variables that you should consider if you are going to make a product by rotational molding. Of course, mold geometry is very important. You should be careful not to have any long, narrow fingers that are difficult to fill properly. Particle size of resin is very important especially when it is combined with mold design. It is quite obvious that the time-temperature cycles would be very important, and you should also pick a polymer that has the properties that will best do the job that you want done, and of course, this is where we hope to be able to give you the proper advice.

POWDER MOLDING VARIABLES

1. MOLD GEOMETRY (MOST IMPORTANT)

2. PARTICLE SIZE

3. TIME-TEMPERATURE CYCLES

4. POLYMER PROPERTIES

Slide X

Slide XI shows some of the things that you should consider when you are thinking about "should I rotational mold this object or should I blow mold it or should I injection mold it?" Some of the factors that I have listed here will lead you to the correct answer.

POWDER MOLDING OR...?

1. SIZE OF PRODUCT

2. SHAPE OF PRODUCT

3. LENGTH OF RUN

4. PROPERTIES OF PRODUCT

Slide XI

ROTATIONAL vs OTHER POWDER MOLDING METHODS

1. ROTATIONAL GIVES ESSENTIALLY NO SCRAP
2. MINIMUM EXPOSURE TO OXYGEN IN ROTATIONAL
3. POST-HEATING UNNECESSARY IN ROTATIONAL
4. ROTATIONAL MORE EASILY ADAPTED TO CONTINUOUS OPERATIONS
5. MORE COMPLICATED PARTS CAN BE MADE BY ROTATIONAL

Slide XII

Slide XII shows some of the advantages of rotational molding compared to the other powder molding techniques I have mentioned. Rotational molding gives essentially no scrap and minimum exposure to oxygen. Post heating is not necessary in rotational molding as it is in some of the other powder molding techniques. Rotational molding can be adopted to continuous operations. Also very complicated, completely closed parts can be made by rotational molding. You will be shown many of these parts later on in the symposium.

PRODUCTS NOW BEING MADE BY POWDER MOLDING

1. WASTEBASKETS (ROUND AND SQUARE)
2. FLOOR TRUCKS
3. CHAIR SEATS AND BACKS
4. CASES - BOWLING BALL, INSTRUMENT, ETC.
5. HOBBY HORSES AND TOYS
6. ADVERTISING DISPLAY ITEMS
7. HOUSINGS - MOTOR, HUMIDIFIER, ETC.
8. ATHLETIC EQUIPMENT
9. TANKS AND CONTAINERS

Slide XIII

Slide XIII lists just a few of the products which are being made by rotational molding. This certainly does not begin to cover all of the parts. Many that I have not listed here will be shown to you here today and we also have others in our booth upstairs at the show.

With this brief survey of rotational molding and what can be done with it, we will now proceed to cover each area in more detail. Thank you.

ECONOMIC EVALUATION OF ROTATIONAL MOLDING

A. D. LITTLE, INC.

MODERATOR McDONALD:

Economics, of course, is of prime importance when considering rotational molding in relation to other forms. U.S.I. has asked A. D. Little, Inc. to make a study of the economics and our next speaker is Mr. W. C. Johnson, Case Leader of Arthur D. Little, Inc., who will give us what is probably the first independent broad-based study of the economics of rotational molding with powdered polyethylene compared to injection and blow molding.

Mr. Johnson received a B.S. in Chemical Engineering from Cornell University in 1954. Since joining the staff of Arthur D. Little, Inc., in 1960, he has worked on a number of engineering and process studies including foamed plastic materials, decorative laminates, engineering evaluations of plastics, and breathable vinyl films. He is a member of the American Chemical Society and the Society of Plastic Engineers.

W. C. Johnson, A. D. Little, Inc.

MR. W. C. JOHNSON:

Ladies and Gentlemen: As noted, my talk here today is on the economics of rotational molding or casting as compared with injection molding and blow molding.

By way of introduction, I'd like to say that some papers have been written about the costs of rotational molding with polyethylene powders, but very little has been done to make a direct cost comparison between this process and the injection and blow molding processes. The reason for this is fairly obvious. The processes are designed to do different things.

For example, injection molding produces high precision parts at high production rates, but cannot easily be used to make one-piece, closed vessels. Blow molding is best suited to making bottles and other items which have reentrant curves and which require a high-viscosity resin; it is not well-suited to making heavy-walled parts. Rotational molding is best suited to making closed parts with heavy walls.

Furthermore, each process has wide differences in the operating variables. With rotational molding, for example, a change in resin composition, density, or molecular weight makes a much larger change in the cycle time than it does with injection or blow molding. Resin type is also much more limited in rotational molding due to possible polymer degradation at the high temperature used.

On the other hand, increased wall thickness makes much less difference in the rotational molding cycle than it does in blow molding or injection molding cycles. Also changes in part design are usually much easier and cheaper to make in rotational molding.

Now, although it is difficult to compare these processes fairly, nevertheless by selection of study items suited to all processes, but not to any one in particular, it is possible to compare costs of the three processes.

TABLE I. SELECTED STUDY ITEMS

Items	Wall Thickness (mils)	Weight (Pounds) Injection, Rotational Molding	Weight (Pounds) Blow Molding
1-gallon container with lid	30	0.23	0.25
5-gallon container with lid	60	1.34	1.48
20-gallon waste can with lid	90	5.35	5.89
55-gallon drum with lid	90	9.5	10.5
250-gallon tote bin	200	48.7	53.6

In Table I, we have five study items which were chosen for this evaluation. These are a one gallon container with a lid; a five gallon container with a lid; a twenty gallon waste can with a lid, a 55-gallon drum, and a 250-gallon tote bin. Wall thicknesses and weights are given for each of the items.

In the study we assumed that we are using a low density polyethylene of 5.0 melt index as the material for injection and rotational molding, while a 1.0 melt index resin was used for blow molding. In this study we have made the following assumptions:

1. That we have a good molder with economical equipment; he has a trained work force; and a location with moderate labor and utility costs.

2. The second assumption we have made is that our management requires a five year write-off on its plant, a two-year write-off on molds, and a ten per cent return on investment. This will depend, certainly, on management philosophy, but in this day and age, where we have a great deal of obsolescence in parts and processes, we feel that this is a fairly reasonable aim to have.

Our third assumption is that where production is less than plant capacity, the investment write-off, except for the molds, is pro-rated on an hourly basis. The molds are written off on the length of run.

Now, this is similar to the basis for custom molding operations where the buyer will pay for his mold and then pay a custom molder on a piece rate basis to make the particular item.

Our fourth assumption is that all our parts in the study are compared on the basis of equal strength. Now, this is quite important because when we come to the blow molding process, much of the plastic remains in relatively thick sections of the bottom and top pinch points and not in the wall where it is needed. Thus, in parts of equal minimum wall thickness, the blow molded item may weigh thirty to one hundred per cent more than the injection or rotationally molded items. The weight of a blow molded article may be reduced by programmed parison control but only at some cost in cycle time.

While the prices would be expected to vary with the purchase volume, particularly for injection grades, we have assumed that the molder would be able to purchase resin at the standard price even at low production levels because his purchases for other items he might produce would be larger.

Operating expenses include direct labor, indirect labor, supervision and utilities. Selling expenses, however, are not included in this particular study. The reason why is because there is a wide variance with the type of product, market and volume, which it would be almost impossible to include in a study of this nature. Our utilities and labor costs are based on an average rate for the normal industrial community. These costs, of course, vary considerably with location.

For the purpose of this study we have assumed that the location of facilities are all the same and labor and utility rates on all processes are the same. Therefore, no factor for skill has been taken into consideration between the blow molding, injection molding, and rotational molding processes, even though we realize this may exist in some cases.

Investment related expenses, our third item, include depreciation, taxes, insurance, and return on investment. While the write-off on the plant and equipment is set at 20 per cent per year, the Federal Government usually only allows a ten per cent write-off on equipment and a 3.3 per cent write-off on buildings. Any extra depreciation and the return on investment are taxed at the corporation income tax level of about fifty per cent. Insurance, state taxes, and local levies are assumed to be 3 per cent of the building cost. These costs are assumed to represent the selling price of the item before the sales cost at which the manufacturer could expect to make about ten per cent run on his investment and pay off his plants in five years.

TABLE VI

1-GALLON CONTAINER WITH LID

Production	10,000	100,000	1MM	10MM
Injection Molding				
Investment	$134,000		$177,500	$861,000
Raw Materials	0.0473	0.0473	0.0473	0.0473
Operating Expenses	0.1448	0.1382	0.0450	0.0313
Capital Expenses & Taxes	0.7499	0.2825	0.0751	0.0485
	0.9420	0.4680	0.1674	0.1271
Sealing Costs 14/unit				
Blow Molding				
Investment		$201,000		$701,000
Raw Materials	0.0525	0.0525	0.0525	0.0525
Operating Expenses	0.0586	0.0484	0.0363	0.0182
Capital Expenses & Taxes	0.2778	0.0746	0.0411	0.0375
	0.3889	0.1755	0.1299	0.1082
Rotational Molding				
Investment		$126,000		$390,000
Raw Materials	0.0555	0.0555	0.0555	0.0555
Operating Expenses	0.1225	0.1045	0.0802	0.0177
Capital Expenses & Taxes	0.1840	0.1262	0.0673	0.0196
	0.3620	0.2862	0.2030	0.0928

Table VI shows our one gallon container and the comparative cost on these one gallon containers by the three different processes. On the vertical axis of Figure I we have the unit cost in dollars, our annual production in number of items — ten thousand, one hundred thousand, one million and ten million.

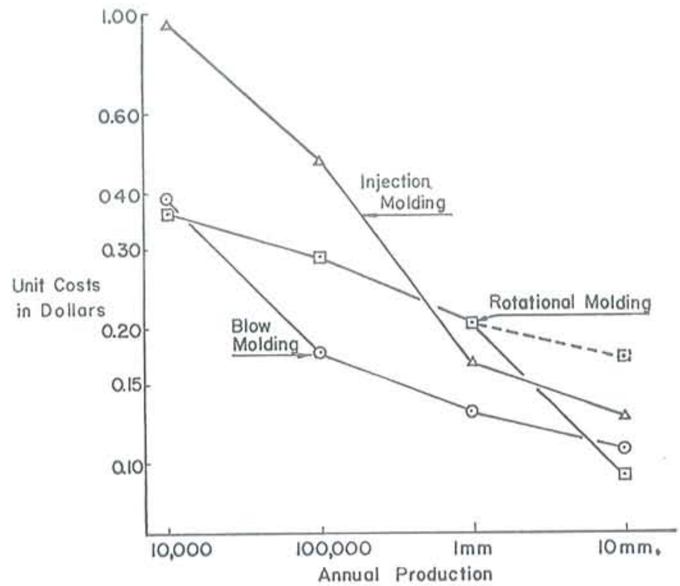


Figure I: Comparative Costs for 1-Gallon Containers

Blow molding, you can see, comes down very, very rapidly and levels out. Rotational molding starts a little lower, not much lower than the blow molding, goes across fairly high, and if we continue to use low production equipment, would still stay high. When we come to high production equipment, of course it drops considerably. Injection mold cost and high investment makes it very costly for low production items. As we come higher in our production, the cost comes down in the same general region as we are talking about for blow molding and rotational molding.

The most surprising result of this study is the cost of the one gallon container by rotational molding is lower than that for blow molding. Obviously high production equipment with many molds is required for this item since the cycle times are on the order of thirty times longer than those for blow molding. In this case, the mold costs for rotational process are higher than those for blow molding. The major factor contributing to the lower cost, other than the lower investment, is that rotational molding has lower labor costs than blow molding and injection molding for this type of item.

With blow molding, trimming and scrap recovery add greatly to the costs of operation, while in rotational molding, these functions are minimized. Even if the weights of the items are assumed to be the same, the rotational molded item still compares favorably in cost with the blow molded item.

Table VII and Figure II show the five gallon container. These prices are virtually the same all the way through the levels except for the injection molding which is about twenty-five per cent higher than for the other two.

Table VIII and Figure III show the twenty gallon container. In this case injection molding is the cheapest means of making this particular item even though it does require higher capital investment and more mold costs, greater mold cost. Of course at low production levels, again we are talking about fairly high costs.

The fifty-five gallon container in Table IX and Figure IV show the rotational molding process as the lowest cost way of making this item. Now, of course fifty-five gallon drums are being made by injection and blow molding in spite of high cost. These are usually made at fairly high production rates where the costs are not as critical and usually they are being made with resins such as high density or high viscosity polyethylene which require long rotational cycles or are not suited to rotational casting.

TABLE VII

5-GALLON CONTAINERS

Production	10,000	100,000	1MM	10MM
Injection Molding				
Investment	164,300	164,300	244,400	1,609,000
Raw Materials	0.270	0.270	0.270	0.270
Operating Expenses	0.204	0.174	0.059	0.041
Capital Expenses & Taxes	0.984	0.392	0.124	0.090
	0.458	0.836	0.453	0.401
Blow Molding				
Investment	216,000	216,000	293,000	1,601,000
Raw Materials	0.297	0.297	0.297	0.297
Operating Expenses	0.243	0.208	0.115	0.038
Capital Expenses & Taxes	0.522	0.259	0.126	0.087
	1.062	0.764	0.538	0.422
Rotational Casting				
Investment	135,700	135,700	226,000	936,00
Raw Materials	0.322	0.322	0.322	0.322
Operating Expenses	0.323	0.242	0.059	0.052
Capital Expenses & Taxes	0.405	0.300	0.079	0.056
	1.050	0.864	0.460	0.430

$\bar{c}$ 2 molds = 0.950

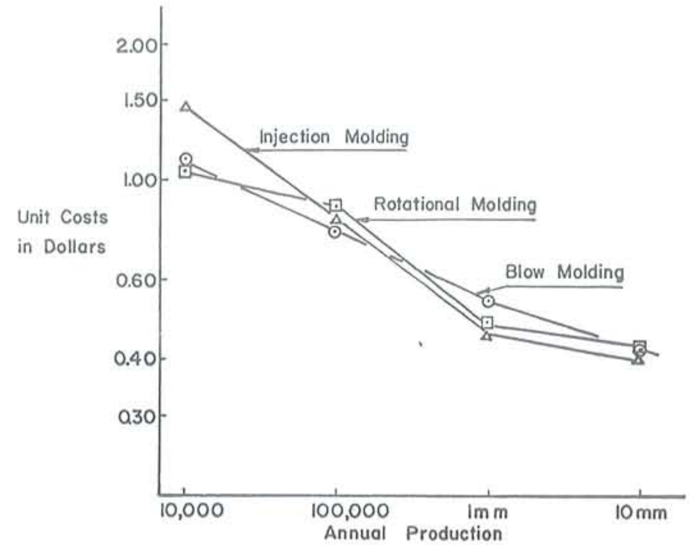


Figure II: Comparative Costs for 5-Gallon Containers

TABLE VIII

20-GALLON CONTAINER WITH LID

Production	10,000	100,000	1MM
Injection Molding			
Investment	235,000	235,000	651,000
Raw Materials	1.110	1.110	1.110
Operating Expenses	0.266	0.193	0.115
Capital Expenses & Taxes	2.574	0.697	0.375
	3.95	2.00	1.60
Blow Molding			
Investment	223,000	223,000	590,000
Raw Materials	1.220	1.220	1.220
Operating Expenses	0.459	0.359	0.173
Capital Expenses & Taxes	1.311	0.661	0.327
	2.990	2.24	1.72
Rotational Molding			
Investment	133,000	133,000	395,000
Raw Materials	1.315	1.315	1.315
Operating Expenses	0.630	0.491	0.157
Capital Expenses & Taxes	0.865	0.584	0.228
	2.81	2.39	1.70

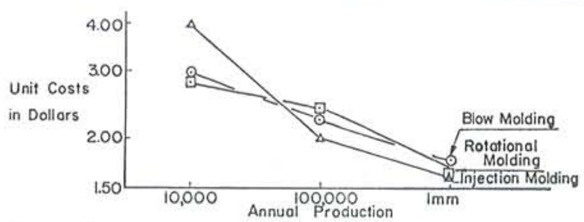


Figure III: Comparative Costs for 20-Gallon Container

TABLE IX

55-GALLON DRUM WITH TOP

Production	10,000	100,000	1MM
Injection Molding			
Investment	421,000	421,000	2,169,000
Raw Materials	1.82	1.82	1.82
Operating Expenses	0.68	0.45	0.27
Capital Expenses & Taxes	5.42	1.73	1.21
	7.92	4.00	3.30
Blow Molding			
Investment	351,000	351,000	1,274,000
Raw Materials	2.01	2.01	2.01
Operating Expenses	1.35	1.20	0.36
Capital Expenses & Taxes	3.65	1.99	0.69
	7.01	5.20	3.06
Rotational Molding			
Investment	136,000	262,000	634,000
Raw Materials	2.18	2.18	2.18
Operating Expenses	0.99	0.30	0.23
Capital Expenses & Taxes	1.68	0.57	0.36
	4.85	3.05	2.77

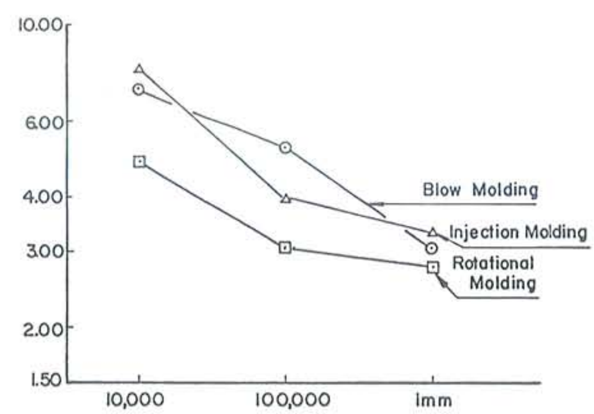


Figure IV: Comparative Costs for 55-Gallon Container

TABLE X

250-GALLON TOTE BIN

Production	1,000	10,000	100,000
Injection Molding			
Investment		635,000	
Raw Materials	9.60	9.60	9.60
Operating Expenses	1.44	1.55	1.49
Capital Expenses & Taxes	43.28	8.81	3.56
	54.32	19.96	14.65
Blow Molding			
Investment	463,000	463,000	800,000
Raw Materials	10.60	10.60	10.60
Operating Expenses	2.72	2.14	1.99
Capital Expenses & Taxes	17.38	5.46	3.82
	30.70	18.20	16.41
Rotational Casting			
Investment	227,000	227,000	388,000
Raw Materials	11.45	11.45	11.45
Operating Expenses	1.95	1.66	1.36
Capital Expenses & Taxes	5.52	3.05	1.39
	18.92	16.16	14.20

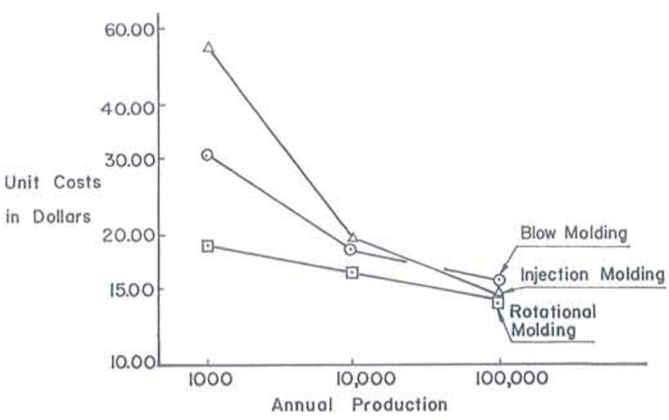


Figure V: Comparative Costs for 250-Gallon Tote Bin

Table X and Figure V show unit cost data for the 250-gallon tote bin. Once again rotational casting has the lowest cost across the board. Injection molding comes down fairly close to it. Even though low production costs are quite high, it drops rapidly. Blow molding costs more. There is some doubt on an item this large — this weighs fifty pounds — whether we could begin to mold something like this by blow molding.

As would be expected here the production rate can have a bigger effect on the cost of the item than the method of production. This is primarily because the mold investment costs play such a large role in the costs at lower production levels, but it is also due to lower efficiencies at these levels, particularly with the high capacity and high investment equipment associated with injection and blow molding.

Therefore, it is not surprising that at the lowest production levels, rotational molding has the lowest cost per item no matter which item is chosen, while injection molding has the highest costs. Thus, for short-run, and prototype moldings which are suited to it, the rotational molding process is economically superior to injection or blow molding.

I would like to go, a little bit, into the flexibility of the rotational molding process and as was stated here before, the conditions chosen for these study items were not necessarily the most economic for the rotational molding process.

For example, the melt index of the base resin chosen is lower than the optimum for rotational molding; the walls on the smaller items are relatively thin. Also we haven't at all gone into many of the subjective factors which can also be as important as cost, although they are much more difficult to put a price factor to them.

For example a high melt index resin usually has less impact strength and stress crack resistance than stiffer resins. If it can be used, however, cycle time can be shortened significantly in rotational molding. If we had assumed fifty per cent shorter cycle times in this study, on the basis of high melt index resins and special heating techniques, the cost of the one gallon container would be about twenty per cent less, the five gallon container fifteen per cent less, and the other items ten to twelve per cent less.

Other factors, as wall thickness increases, the cycle time increases much less with rotational molding than with injection or blow molding. If we wanted to increase the wall thickness of an injection molded part, it would require completely modifying the mold. In rotational casting we can dump more resin in the mold and perhaps it takes a little more cycle time to manufacture the item.

One of the clearest advantages of rotational molding is in the manufacture of prototypes. In injection molding or blow molding, the costs of molds are usually too high to permit much experimentation. Machine time is also expensive, since production of other items on a particular machine must stop while the molds are changed and the experimental mold is run.

In rotational molding mold costs are relatively low, and the molder can modify the molds with relative ease if it proves necessary, to do so. Furthermore, individual molds may be mounted and run on a rotational molding spider with other molds similar to it in size, so that little production time on other items is sacrificed. We would also expect to have a shorter lead time on rotational molds as compared with injection molds and blow molds.

Another plus for rotational casting is the ability to mold two colors at one time on a single spindle or single machine. We can also mold with open areas and reentry curves and strain free character of the parts is also a plus in many rotationally molded items.

Now we don't want all of you injection molders and blow molders to go out and scrap all your machines and buy rotational casting machines. The study certainly shows an encouraging picture for rotational casting, but it should be re-emphasized that this process, like any other, cannot do every job well. While high density and high viscosity polyethylene has been run successfully in rotational molding equipment, this has proven generally more difficult to process than low density resin. Therefore, it would probably not be economical at this time to use this process for items such as high density detergent bottles or bleach bottles. The high thermal stability requirements for this process also limit the number of resins which can be successfully processed without degradation by rotational molding.

This process is now undergoing extensive research and development to overcome its limitations. In the future, with better techniques and more automatic equipment we may expect to see a much greater variety of items molded by this simple and economical process.

Thank you.

DESIGNING WITH ROTATIONAL MOLDING

CHECK ENGINEERING COMPANY

MODERATOR McDONALD:

The A. D. Little report was not able to consider part configuration. This, of course, is an important factor in economics, but one which cannot be evaluated except on an individual basis.

The next four speakers will discuss their experiences in designing specific items for rotational molding.

First Mr. R. D. Pappas, Sales Manager of Check Engineering Company, Skokie, Illinois.

Mr. Pappas attended the University of Illinois and for the past three years has handled all sales of the Roto Casting Division of Check Engineering Company. He has been particularly active in relating the rotational molding process to product design and development at the customer level.

R. D. Pappas, Check Engineering Co.

MR. R. D. PAPPAS:

Thank you. The first application that was considered for rotational casting was a bowling ball and shoe carrying case. We examined the existing vacuum form, two piece, machine aluminum extrusion construction and noted also that the handles, feet and ball socket on this particular case were separate. In other words, it involved a secondary operation for assembly.

Keeping that in mind we designed around those short features. We molded in the ball socket, the handle and the feet. We also molded in one piece the door, the door opening, plus the door landing. This eliminated any problems as far as the aligning of the door in the case. The fact that we did mold in the feet, the handle and the ball socket makes the case relatively economical as far as assembly is concerned.

The second application that we converted into rotational casting was a stacking chair. We looked at the original construction of an upholstered unit and tried to simulate the same effect, a cushioned effect, using a plastic material. We developed a cushion effect using a plastic material. We developed an airtight envelope and suspended in it a metal frame around the perimeter only. Having this suspension gave us this simulated cushioned effect when you sat in the chair.

The next problem was assembly. In order to expedite assembly, we molded in four recesses in the bottom of the unit, and we also cored the holes, which maintained the airtight situation that we were after.

In the back of the unit we took advantage of the two posts that stuck up from the metal frame. We cored in two holes in the back of the unit and then also molded in two recesses on the bottom which allows the fastening to be very simple. In other words, this unit is put over the post and then two standard, inexpensive sheet metal screws hold this back in place and, of course, the sheet metal screws are also used in the seat itself and when fastened, hold the seat into the frame.

The third application which we converted was a fresh water tank. Originally this construction was of metal, metal welded seams plus welded fittings, and in most cases it was a square construction. This, of course, made the tank itself very hard to clean. The other problems involved with the metal tank was that the corrosion characteristics continually would cause leading, and also the cleaning problem was of major concern.

We designed into our unit radius corners plus male and female fittings. The radius corners, of course, eliminate any dirt collection which is apparent in the welded tank. The smooth interior virtually allows this unit to be self-cleaning.

The next complement to our line will be our attache case which is a step up in design. This case, we feel, will give us the entry into the luggage business plus a few new outlooks as far as carrying cases are concerned. We have printed literature on this, on all these products up in the front and when you are there, if you would like to pass by and pick them up, they are free.

We would like to extend our thanks to you, to U.S.I. for giving us this time to display our products. Thank you.

MODERATOR McDONALD:

Now, Mr. Jack Keown, Associate Designer, Dave Ellies Industrial Design, Inc., Columbus, Ohio.

Mr. Keown is a graduate of the University of Cincinnati, College of Applied Arts. He majored in industrial design. Mr. Keown has ten years of industrial experience and has worked with both thermosetting and thermoplastic resins.

Jack Keown, Dave Ellies Industrial Design, Inc.

MR. J. A. KEOWN:

Good afternoon. In this particular application of the rotational molding process we have, more than likely, ventured into the virgin territory of the small appliance market. Up to this time the uses of this process have been in market areas far afield to the one mentioned. Namely, the areas of containers, toys, displays, children's furniture, sports equipment and materials handling bins.

After an extensive market research program for the W. B. Marvin Manufacturing Company of Urbana, Ohio, our findings directed our efforts to the design and development of a one room air humidification unit.

Marketing price, quantity, quality, appearance and function were the factors which established the basic design parameters for the success or failure of this product. However, as long as the price is competitive and the unit functions properly, the most important factor which dictates the maximum dollar return is appearance, and in this product, the moldings play this important role.

One of the big questions which may be asked at this point is, "Why rotational molding over injection, blow molding or, even, metal fabrication?" The answer is not simple, for each process has its advantages and disadvantages and all had to be examined one against the other.

In our initial approach in theory of function and design was a tank or hassock type unit. The basic thinking was for the base to be metal, deep drawn with a reverse roll in the upper edge or open end of the tank.

In the base section, other possibilities for the base were either injection molding, blow molding or expanded poly bead. The top was to be injection molded of a high impact material.

Humidification tests were run by use of a metal prototype and cost studies also accumulated. The test proved that the theory of this design did not meet the full requirements established for proper humidity level. Cost studies also put the unit somewhat higher than was competitively practical. These factors thus eliminated this approach.

During these tests, however, an alternate design was developed and put to test. Slides I and II. Here we used the direct air flow in our design approach. Tests proved this unit to function at the maximum established humidification requirements.

For this design three process avenues were examined for the molding of the top and bottom shells. Here again we stress the importance of appearance.

Injection molding was the first process examined. This particular process was rejected because of the cost involved in both die expense and valuable lead time required. Quantity requirements in relationship to the above expense was also a strong determining factor of rejection.

However, all other aspects were more than adequate.

Blow molding was our second process for examination. In examination, this process proved to be competitive in die and part cost. Tool lead time and secondary tooling produced a somewhat less favorable light on blow molding, but not alone the inherent molding limitation of the process itself weighed strongly in the decision for rejection.

Uncontrollable wall thicknesses in parts which are not either cylindrical or spherical in shape.

Unpredictable tolerances from part to part.

Molded internal stress in the material and the product which could lead to possible difficulty once the product is on the market.

Color molding problems when both halves are blown on the same machine.

No guarantee of end results of the parts.

However, there were blow molders who were willing to accept the challenge to advance their own art. But the above limitations presented too great a risk for our liking.

Our third process was rotational molding. As can be seen, this process won out. Tool and piece prices were slightly higher than blow molding, but other factors outstripped these limitations. Here, we had a process that gave us our needed design requirements of:

Slide III

a.) Controllable part thickness and dimensional tolerances, as you can see, in the side wall and across the bottom. Also across the top edge and in the handle area.

b.) A strain free part.

c.) Color flexibility while molding both halves at the same time on the same machine.

Slide IV

d.) Required overall rigidity.

e.) Simple tooling and still we were able to mold undercuts without difficulty, which can be seen in the handle area and also in the return flange of the bottom which forms a partial sixth side.

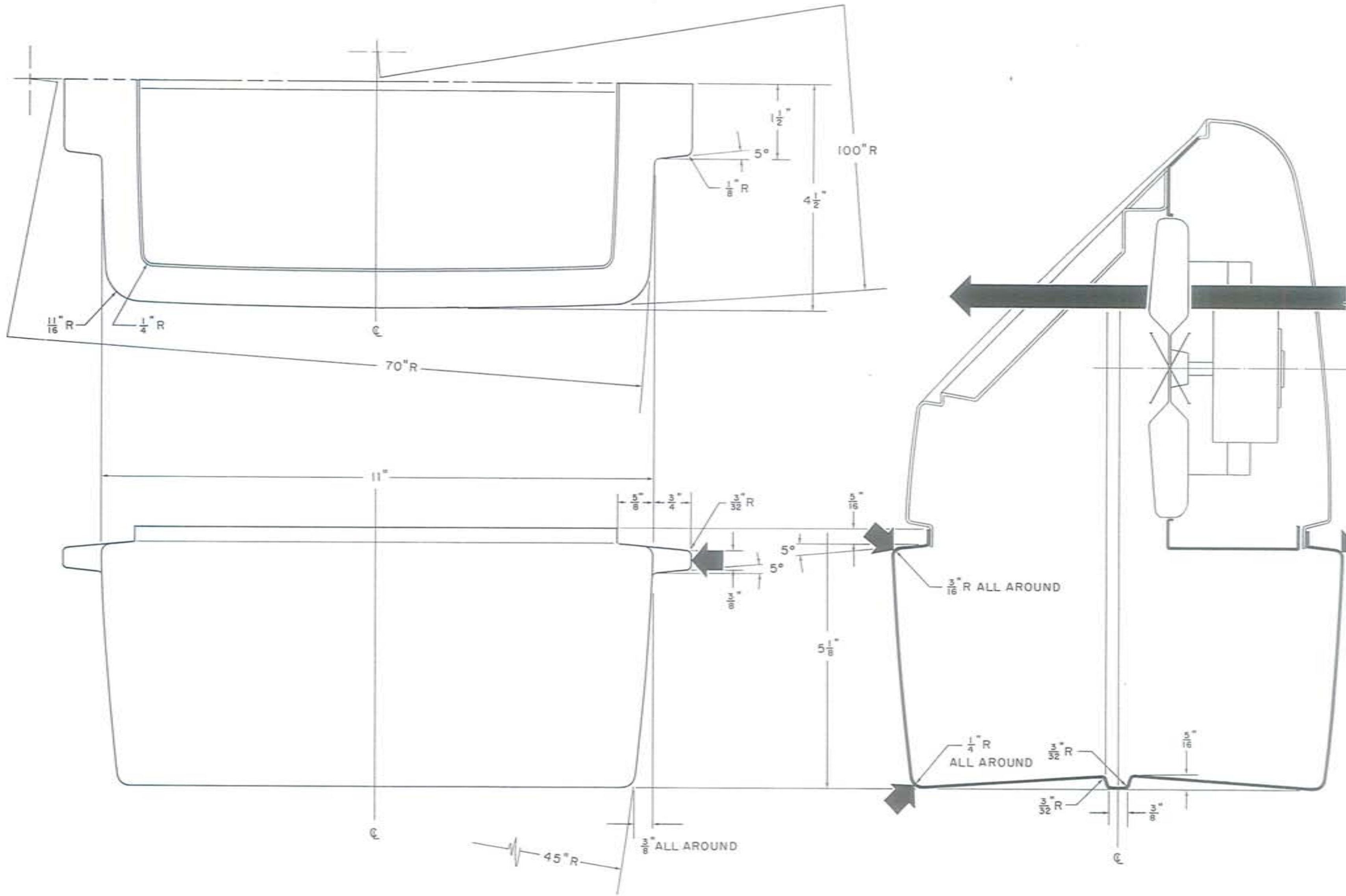
f.) Lead time for tooling was cut by one-third over blow molding and considerably over injection molding.

g.) Cross-sectional deformation is held to a minimum.

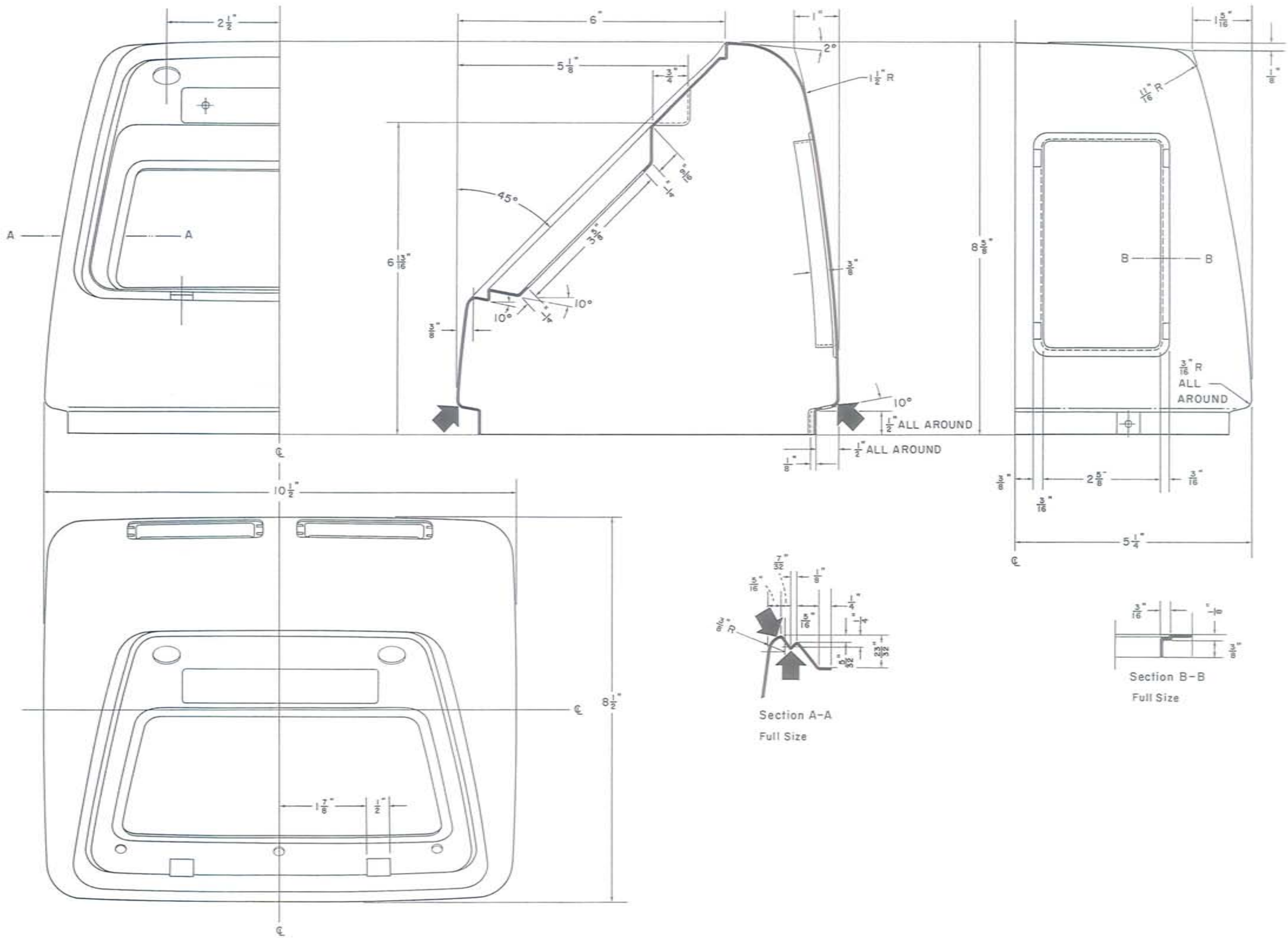
h.) Secondary tooling was practically eliminated by molding in the majority of needed open areas which can be seen at the intake and the exhaust end, of the unit.

This also saved on material and waste.

Through accurately measured charges of the polyethylene powder waste was all but eliminated.


100"R
1 1/2"
5°
1/8"R
4 1/2"
11/16"R
1/4"R
70"R
11"
5/8"
3/4"
3/32"R
5/16"
5°
5°
3/8"
5 1/8"
3/16"R ALL AROUND
1/4"R
ALL AROUND
3/32"R
3/32"R
5/16"
3/8"
45"R
3/8" ALL AROUND

Slide I



2 1/2"
6"
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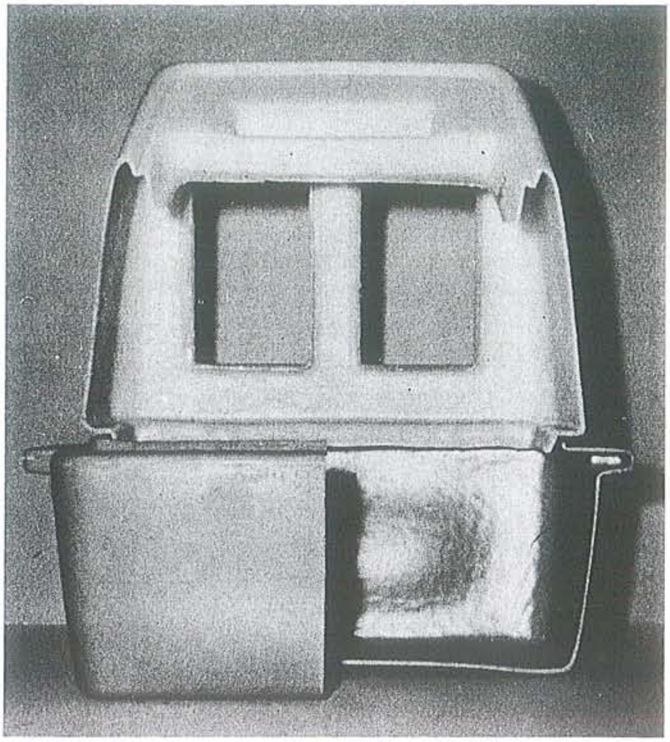
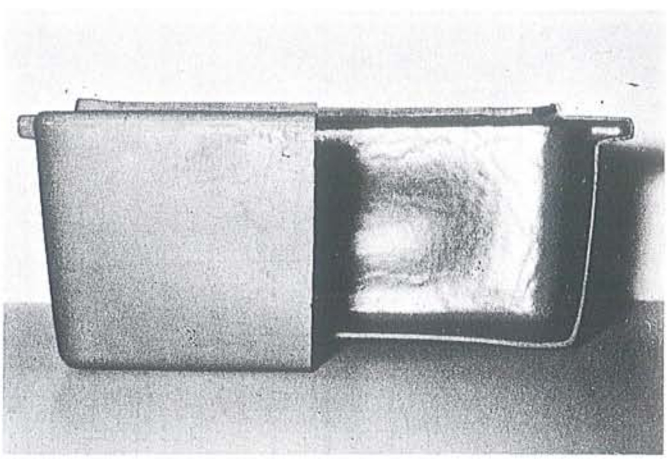
1 1/2" R
11/16" R
1 5/16"
1/8"
3/4"
6 13/16"
45°
3 3/8"
10°
10°
3/8"
8 5/8"
A — A
B — B
10°
1/2" ALL AROUND
1/2" ALL AROUND
3/16" R ALL AROUND
1/8"
3/8"
2 5/8"
3/16"
3/16"
5 1/4"
10 1/2"
8 1/2"
1 7/8"
1/2"
Section A-A
Full Size
Section B-B
Full Size

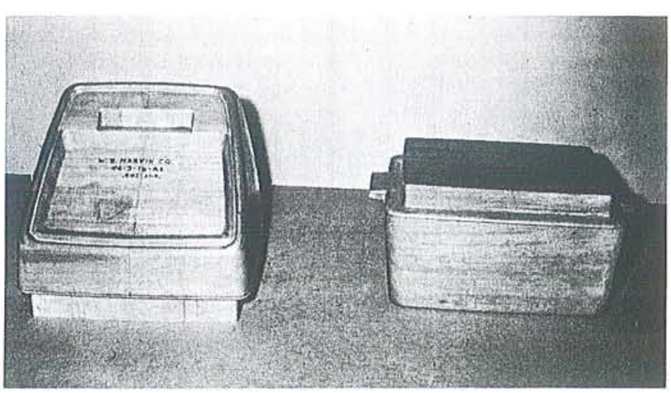
Slide II



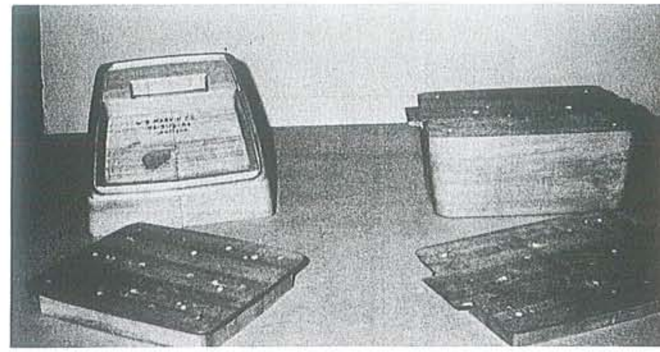
Slide III



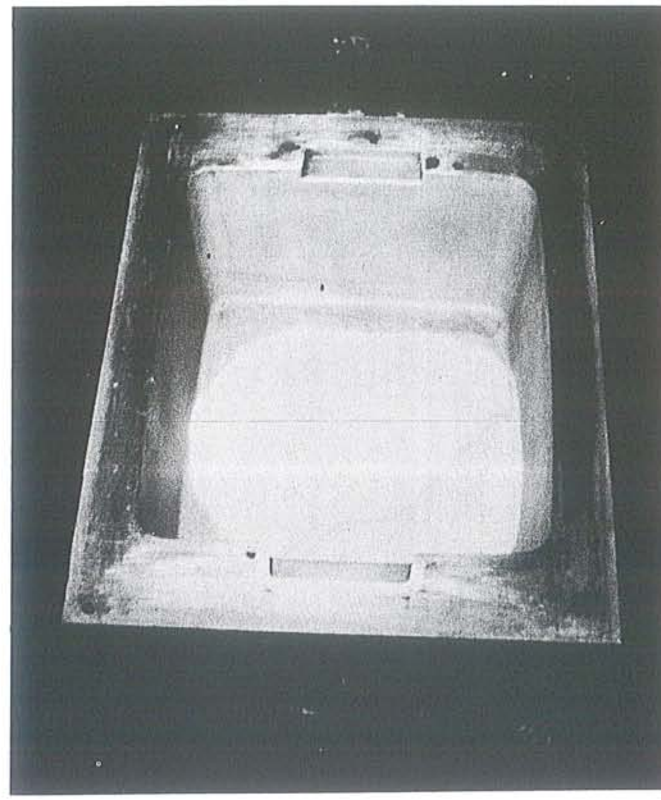
Slide IV



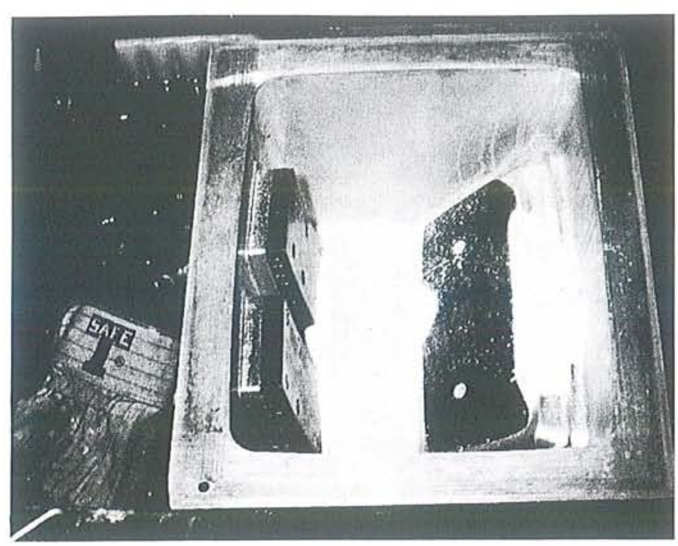
Slide V



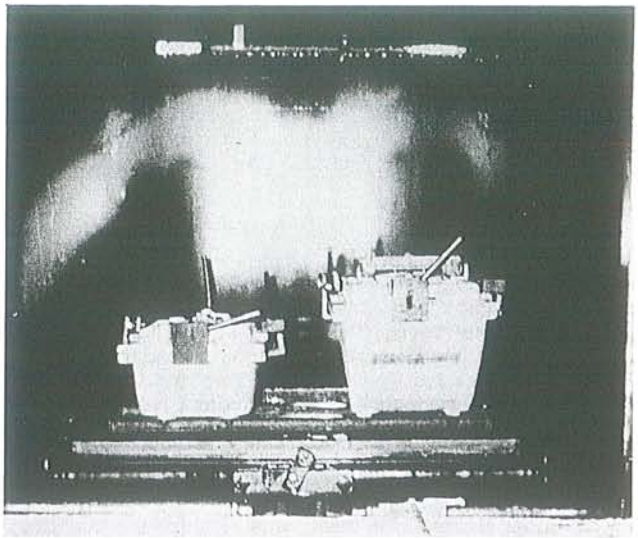
Slide VI



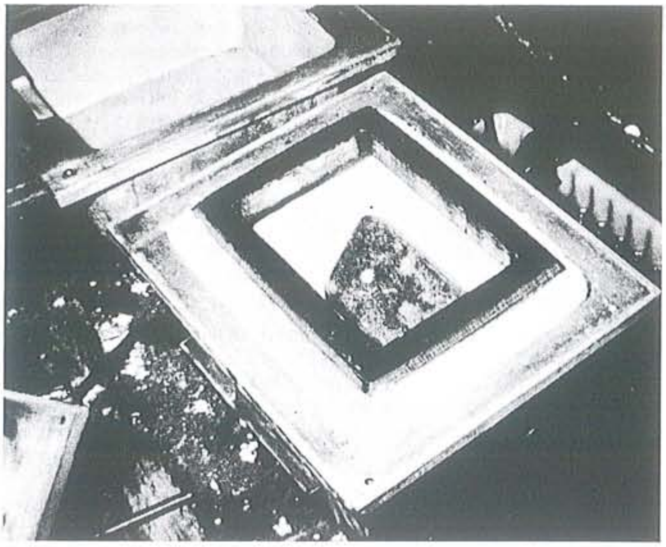
Slide VII



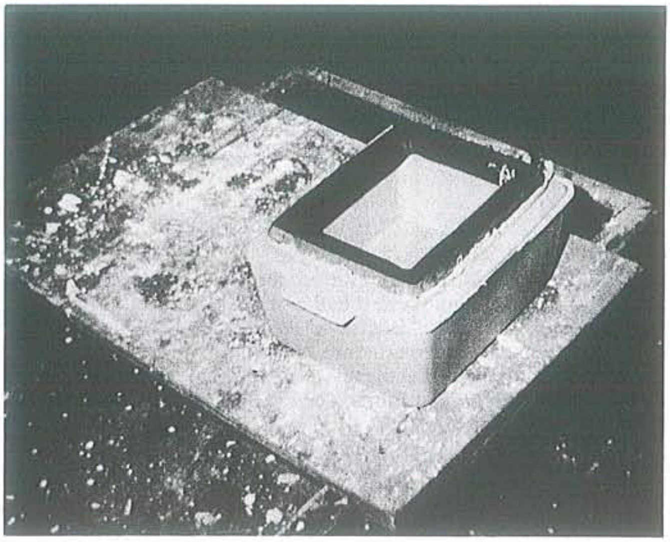
Slide VIII



Slide IX



Slide X



Slide XI

The molds and patterns were designed by Fabri Form of Byesville, Ohio, to produce the parts with a minimum of parting line exposure. As can be seen in Slide V, we have the pattern showing the front of the unit, both the top and bottom.

Slide VI. You will notice in the transition of the two slides that there isa definite split in the area where a shadow line is present, and both molds for the top and bottom halves part on a horizontal line or at a shadow tangent point.

In this particular application, aluminum molds were used and blasted for matte finish, again for appearance sake, to reduce reflective gloss.

In next sequence of slides, we have the bottom half being charged with powdered polyethylene material. Slide VII.

Slide VIII. Top half being charged with the powdered polyethylene material.

Slide IX. These are the two molds in the oven before rotation.

Slide X. This is the molded top half part with shrink fixture still in the mold.

Slide XI. This is the bottom part after it has been pulled out of the mold with the shrink fixture still in it.

In the future we industrial designers will be intensely interested in the progress of this process and the advances of its art, and engineering. With the development of new powdered thermoplastics, which we hope is under study, having improved physical and molding characteristics, greater latitudes in market areas and design will be forthcoming. Thank you very much.

MOULDED PRODUCTS COMPANY

MODERATOR McDONALD:

Mr. C. R. Moore, our third design speaker, attended the University of Minnesota and has a B. S. degree in Mechanical Engineering. As Chief Engineer for Moulded Products, Inc., he is responsible for engineering and technical sales. Mr. Moore has worked extensively on rotational molding techniques, mold design and fabrication.

C. R. Moore, Moulded Products, Inc.

MR. C. R. MOORE:

I am going to discuss our more recent custom rotational molded products, but first I'd like to explain how we got into rotational molding.

Moulded Products, Inc. was organized in the Minneapolis area in 1947 to make fiber products. By fiber I mean a product similar to Masonite except in a molded shape. Our hobby horses for children were the main product line. However, the large amount of fabrication and finishing labor made it difficult to compete as the years went by. Several years ago we made the switch to rotational molding and this certainly has restored our competitive position in the hobby horse market.

Rotational molding is considered the best way to make these horses. Both blow molding and injection molding have been tried. However, the big bonus in the switch to rotational molding has been the addition of new avenues of both proprietary and custom work, in short, diversification.

Rotational molding has multiplied our potential business many times while placing us in a very desirable field, that of plastics. Rotational molding certainly greatly bolstered our custom business as well, while more than adequately taking care of our proprietary needs.

We value the custom business because our proprietary business tends to be seasonal, and of course, the custom business fills the gaps very nicely.

Don't get me wrong, the fiber business has and still will be very good to us. However, the growth rate in plastics is probably one hundred times greater than that in fiber. In short, rotational molding has projected us from a relatively stagnant field into the fast moving, growing field of plastics.

So much for our background on rotational molding.

The first items I want to discuss are these two juvenile chairs you see here. John Gale, a well-known industrial designer in the Minneapolis area, was examining some small polyethylene toys about a year ago. He noticed that considerable rigidity could be obtained using a low density essentially non-rigid polyethylene, if the shape were right.

A modern styled chair seemed like a good start; so a half sized model was made. However, on examining the half size model, it became apparent that even a better start would be a juvenile chair.

As a juvenile chair the product had to be inexpensive and preferably one piece construction. Injection molding was ruled out because of need to fabricate parts in injection work. Blow molding was considered and the mold designed for this process. However, the expected thinning at the extremities of the parts, coupled with actual tooling quotes of $15,000 for the rocking chair and $25,000 for the two molds needed for the swivel chair, eventually ruled out the blow molding process also.

It was at this point that John Gale became familiar with us and rotational molding through the local U.S.I. office, and chose this process for the chair, because rotational molding certainly offers more flexibility of design than blow molding.

In this particular case, the chairs were redesigned with more esthetic features, and the first sample mold was then procured. Since that time the rocking chair has been redesigned once. The swivel chair features a pop together design for the swivel action and also for knock down cartoning. In short, the seat and base come apart, but they pop together for use.

The rocking chair features a storage cut out in the rear for books and toys.

Now, what are some of the major features of rotational molding and how do they relate to the chairs?

First of all, the model costs are low, allowing inexpensive samples and design changes. The original rocking chair cost $400 for the model pattern work and samples, and each additional change we made in the two chairs cost from one hundred to three hundred dollars.

Final production tooling costs run from two thousand to seven thousand dollars, depending, of course, on the number of molds you use. Production tooling for the rocking chair, for example, was $4500. This compares quite favorably to the blow mold quote of $15,000 mentioned earlier.

Undercuts can be designed when necessary. The pop together feature of the swivel chair is a good example of the undercut adding a unique feature to the item. Color changes are easy. No purging of equipment is necessary. In the case of the rocking chair we have seven molds, so essentially we could run seven different colors if need be.

One piece construction eliminates joints, sharp edges and dirt catching crevices. This is certainly important on juvenile items because of the safety feature and the ease of cleaning involved.

The second item is a bird house by Creative Incorporated. Creative, Incorporated is another local design house in our area. They had done considerable work with blow molding products and with this experience as a stimulus, they looked around for items which would be different that nobody had tried in blow molding. This is where the bird house that you see here got its first start. Strictly as a blow molded item.

The house was designed around a Mother Goose theme, and a mold was procured. The molder assured the people that it could be easily done. Unfortunately, it didn't turn out to be as easy a blow molding job as previously thought.

It was at this point, of course, that a local manufacturer suggested Moulded Products, Inc. The Creative, Incorporated people came out to see us. Creative brought along the blow mold. I used the blow mold actually to run a rotationally molded part to give them a sample essentially the same way. At this point I want to pass around a couple of these samples. Both of them are marked on the bottom so you can t make a mistake.

One is the blow molded bird house before they had come to us. The other is the bird house we actually ran that first day via the rotational molding process.

You will notice in the eaves there is a considerable weak ness in these areas on the blow molded part. The house had to be blended into the roof line in order to make it blow moldable.

With the acceptance of rotational molding as a process for making this house, a new mold was made with changes incorporated to add additional detail Creative, Incorporated wanted.

Keep in mind that the rotationally molded bird house was run from a blow mold and is not the final design that was used for the rotational molding process.

Generally, the advantage enjoyed by rotational molding the bird house are the same I mentioned on the chair — low mold cost and one piece construction. But the big advantage for the bird house is an even material thickness throughout with exact duplication of detail. And incidentally, the material used on these items is U.S.I.'s MICROTHENE powdered polyethylene. Polyethylene is an economical material available to rotational molding. This is why we use it.

In closing, I'd like to mention two things I hope you will take back with you. First of all, design the product to fit the process. This means, of course, you have to be familiar with the processes that are available; but this isn't too difficult with a little time spent. So often a customer will come to us and ask to duplicate an item which was designed originally for injection molding, and, of course, I have to give the answer that I can't duplicate it. The parts, of course, must be redesigned, which may necessitate further redesign of the assembly of the part that it goes into. So pick the right process and the right design to fit it.

Second, rotocasting certainly can offer the cheapest initial samples and this was mentioned before, but I think it bears mentioning again. Even though you chose a process other than rotational molding for production of the article, rotocasting should also be considered for making samples.

The reason, of course, is cost. Savings of about ninety per cent is quite common when rotational molding is used for its initial samples. We have a new brochure out on rotational molding. You may pick up a copy on the Carousel in the U.S.I. booth upstairs. We certainly encourage your interest in our custom rotocasting operation at Minneapolis and thank you for the time.

MODERATOR McDONALD:

And now Mr. Harold Morse will discuss in addition to design, decoration.

Mr. Harold Morse is a chemical engineer who has worked for National Distillers and Chemical Corporation since 1956. For the past several years he has been active in rotational molding equipment development and design of molds at the Cincinnati Research Laboratories of National Distillers. At present, Mr. Morse is Manager of Engineering for U.S.I. at Bridgeport, Connecticut. He is a licensed professional engineer in the State of New York.

Harold Morse, U.S.I.

MR. HAROLD MORSE:

Thank you. Ladies and Gentlemen: You have seen all these colored items here today and the various things we have around here. So now, no doubt, in some of your minds, the question may have come up, how do you put this color in?

There are roughly three ways in which we have experimented with coloring of rotational molded items. One way, which many of you are familiar with, is to use colored powdered polyethylene to begin with. This is a fine way to start if you have the colored polyethylene, and you like to keep large stocks of this material and that material in the various colors.

The second method is to dry blend the white powder with powdered pigment. The third method of getting color into a rotationally molded item is to paint the color on the item after it is finished.

I notice on the little bird house you have yellow windows and a yellow chimney painted on it, which is a very nice job.

There are a few drawbacks particularly in the dry blending operation; if you use the wrong pigment, you can dry blend your materials, put it in, and mold it, and you will take out an item and somebody will grab a hold of it and the color will come off on their hands. Of course, you don't want that to happen.

So we have experimented with over 100 different pigments from various suppliers and have come up with a list of fifteen to twenty pigments that are suitable for rotational molding. One of the problems we have run across was that some pigments, when molded, give you an item that becomes extremely brittle after you had molded it. Of course, you don't want that to happen either. So that's why I say you have to be fairly careful in selecting your pigments. Nevertheless, you can find some that will do a very good job. The rub-off that you get with dry blending is invariably greater on the inside of the product than on the outside. So if you are not too concerned about the inside of the item that you are making, you don't have to be quite as careful, then, about that type of pigment selected.

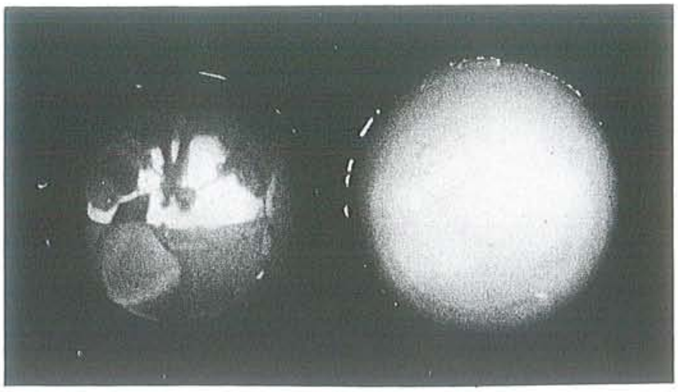
In coating an item, as in spray painting or lacquering, you have to first prepare the surface so that the coating will stick. This can be very easily done by using a torch with a big, bushy flame and going over the molded item very quickly and giving it a nicely oxidized coating. Then your paint enamel or lacquer will stick.

There is another means of coating besides painting. You can also add a flock to the outside of the item. You will notice in the U.S.I. booth upstairs, the pig and the hobby horse has this flock on the outside.

That is done this way. You first have to treat the item with a flame to make it susceptible to a coating. Then apply a cement adhesive which is a solvent type that gets tacky as it drys. When it gets into the tacky phase, you spray the flock. Various people that design spray equipment have these particular guns available.

Slide I

I have some slides which illustrate coloring effects. Slide I shows a large tray in which we dry blended the yellow pigment in the mold. We first put in MICROTHENE powdered polyethylene, then dumped in a little bit of pigment. Approximately half of one per cent is usually sufficient and some of these colors are very strong. As the mold was tumbling while it was heating up, the color dispersed itself. Then as it went through the cycle, why the color blended right in with the MICROTHENE so you ended up with a product with fairly good color distribution. This can be done with some colors, and with others it won't work at all. With some pigments you have to mix and mix for extended periods to get the color dispersed properly.

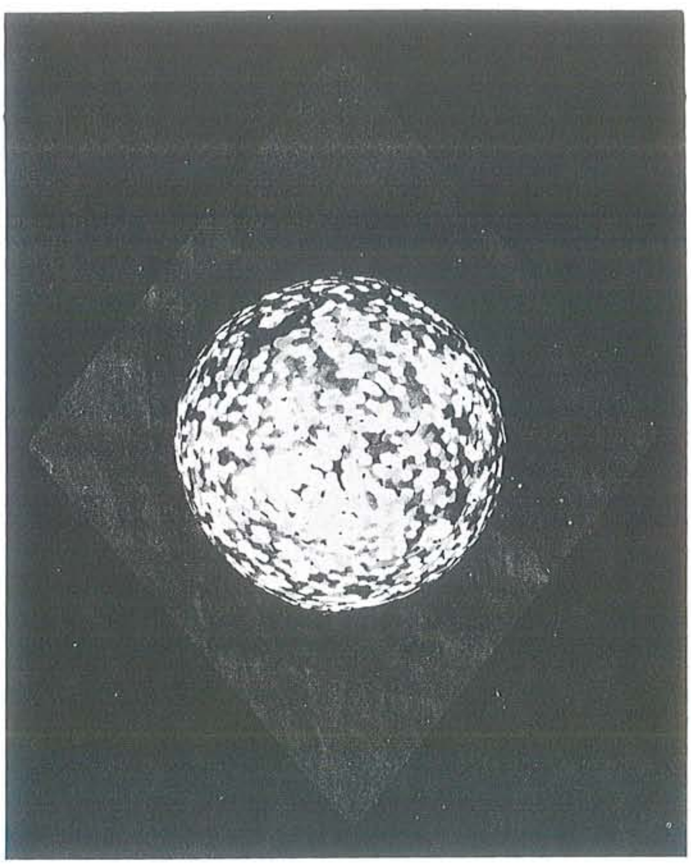


Slide II

Slide II shows you what can be done with a metallic type of addition. On the left we have a copper ball. This contains about a half of one per cent powdered copper. A glossy surfaced mold was used, thus the surface of the molded ball has considerable depth and brilliance to it.

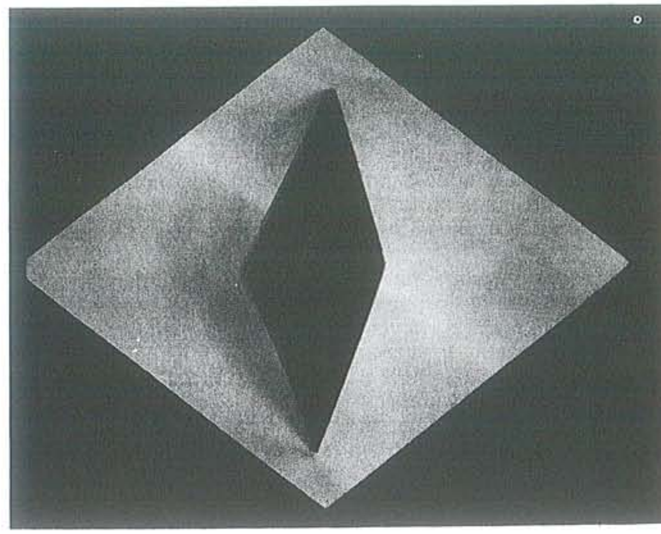
The one on the right is aluminum powder. A tenth of one per cent of aluminum powder was more than ample. This powder disperses beautifully. The little black marks are the remains of identification numbers we tried to get off before we took the picture.

You see that the addition of these metallics will add considerably to the versatility of what you can accomplish.



Slide III

In Slide III you see what you can do if you take some regular, standard colored pellets and put in your mold. These are not going to melt and stick to the edge surface of the mold as readily as the MICROTHENE powder does, but if you have got a little extra time, and it is worth it, you can get this effect. If you wish, you can add a little bit of powdered polyethylene along with the pellets of polyethylene and you will get a glassy effect on the outside with the pellet showing through, and you get a considerable effect of depth.



Slide IV

Slide V

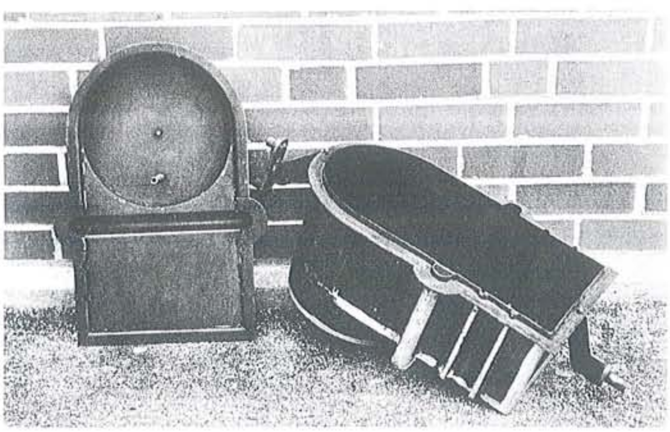
Now, for another variation in color we will see in Slide IV in which we first molded a red pigment into the MICROTHENE. After that had gone through the heating cycle and it formed on the sides of the mold, we opened up the mold and put in the yellow color MICROTHENE, put on the lid and went ahead and molded again to deposit the yellow. So you see on the backside of this particular sample it is yellow and the front side is red.

So your imagination can run away with you on these things. There are all kinds of ramifications to this process, and I hope that some of these things we have done may stimulate you.

Slide V shows a rotationally molded bottle. Incidentally, another division of National Distillers is in the liquor business. Old Crow, of course, is one of our best bourbons, and I get a little dry just looking at that bottle.

Interesting thing about this bottle is that the basic color is made by using a metallic copper powder, and it has no relation, of course, to the contents it is supposed to represent. The top part, you will notice, is a very nice glossy white. That is just put on with ordinary spraying techniques as I described to you previously. There is a black little cap up there, too, which was also sprayed on, and then there is cemented over the top a little simulated pink tax band. The large paper label on the front is also pasted on.

Now, the next consideration we will get into is the mold itself and we have designed a number of fabricated molds. Later on in the symposium Mr. LaMont is going to talk to you about cast aluminum molds, which is the type generally used by most people. But we didn't have casting facilities available so we cut sheet metal and welded it to make various types of molds. We found out they worked very satisfactorily.



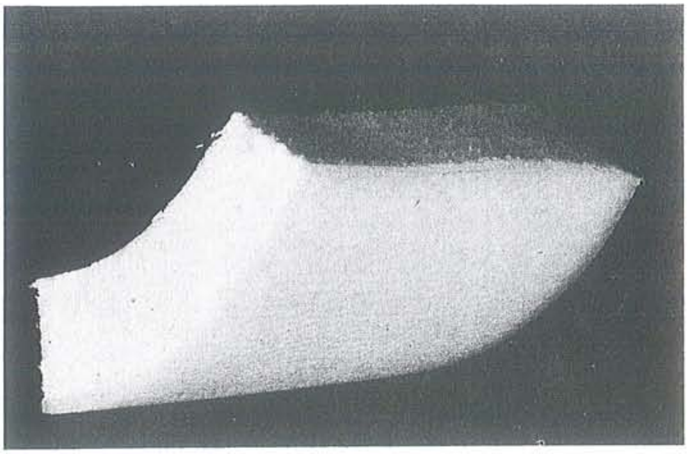
Slide VI

Slide VI. This particular one was quite a challenge. One of our potential customers came to us with the idea of developing something like this. We went ahead because of what this has to offer in the way of a complex mold design. You will note in the lid cover, on the left, the top has a little pin in the middle of it, and as you mold against that, you have a little hole. That little hole is a pilot hole so you use a fly cutter to cut that top part out.

We also have another one in the bottom here. The lower hole in the left view is a vent. Most of these molds have to be vented, because as you heat the mold, pressure is built up on the inside. The ribs on the side here are made as narrow as possible, because this part of the item is to be cast in concrete, and the inside of the mold was to be smooth. So by making that small enough, we were able to get the ribs on the outside and make the inside relatively smooth. The large rib around approximately in the middle of the unit is designed to be an expansion bend so that the unit could give back and forth a little bit.

Slide VII shows the item that is made out of that mold. You can see the top has been cut out with a fly cutter. The item was actually black and we over-exposed the film a little bit. You can also see the inside. Notice how nice and glossy it is. The outside is dull because it was in a sandblasted mold.

Slide VII

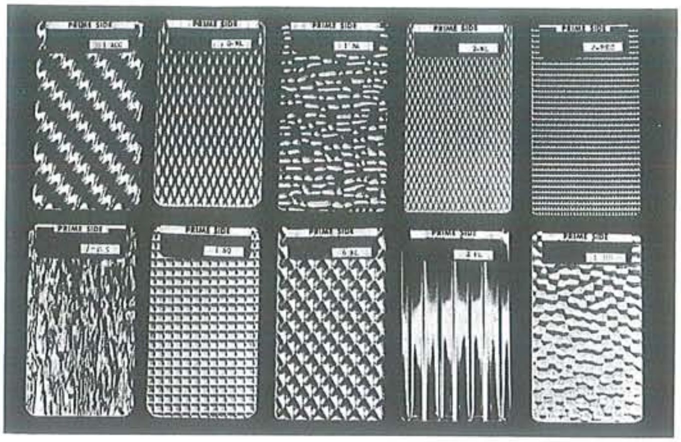


Slide VIII

Slide VIII shows a sample of a molded piece in which the outside is solid polyethylene and is backed up by a layer of foam. The outside is a quarter of an inch thick, and the foam is two inches thick.

This is one of our development projects, and it hs here for what it might be worth to you as a matter of interest. The purpose of that picture originally was to show the model effects on the outside from the mold pattern, but it didn't show up very well.

Slide IX shows what you can do with decorative metal. Here is a series of eight different types of metal that are made by Rigidized Metal Company. There are different people, of course, that make these. These are some samples that I happen to have from the Design Engineering Show, and you can see that you can mold right up against those surfaces and put patterns inside your mold to get that surface on the molded item wherever you want it.



Slide IX

Slide X shows what you can do with combinations of fabricating techniques. Looking at the right hand portion, it looks like a cast aluminum mold, but from the left hand side, you can see it is all fabricated. We didn't have a model for this. This mold produces the Old Crow bottle which we showed you earlier. The bottom part was spun out of a piece of aluminum, just spun and the edge turned up. The cylindrical portion of the bottle was rolled. The shoulder and neck were also spun. And the very top part of it was machined. All these parts were put together, welded and smoothed off on the inside and a flange put around the outside, and that makes the bottle mold.

This is a fairly sizable mold, but we had a machine which we designed which would take sizable items. We made several of these bottles. You will see one of these bottles in the U.S.I. display. You might take a look up there and see some of the things we have been talking about.

Any problems you have in design for rotational molding, the U.S.I. salesman that covers your area will be glad to get the answers for you. He has at his disposal the laboratories in Cincinnati and Tuscola, Illinois, and he is the one you want to look to for answers to your problems.

Slide X

MODERATOR McDONALD:

Speaking of the U.S.I. salesmen, just reminds me here, if you have any questions concerning the commercial availability or other supplier aspects of powdered polyethylene, I'd like to introduce Mr. Vincent McCarthy, Director of Plastic Sales, Mr. Jack Moffet, Assistant Director of Sales, and Mr. Chuck Whitman, Manager of Powdered Polyethylene Sales for U.S.I. These three gentlemen will be glad to answer any questions about the availability of powdered polyethylene, either here or in our booth.

This brings us to our intermission, and we are calling for a fifteen minute intermission here. Immediately following this intermission we will cover the factors involved in mold design and discussions on actual available commercial equipment.

. . . There was a short recess . . .

FACTORS IN MOLD DESIGN

PLASTI-CAST MOLD AND PRODUCTS CO.

MODERATOR McDONALD:

We are going to ask the girls to pick up the questions that have been written during the first half of the symposium immediately, so if you have any questions now, pass them to the aisles and the girls will pick them up.

Welcome back, ladies and gentlemen, to the second half of our Rotational Molding Symposium.

Proper design of molds is a separate technology of vital importance to utilization of rotational molding, and here to talk to us about mold design is Mr. Bud LaMont, President of Plasti-Cast Mold and Products Company, of Akron, Ohio.

Mr. LaMont was employed by Sun Rubber Company during its original work on rotational molding techniques. Recognizing the need for specially designed molds which would meet the needs of this new process, he organized Plasti-Cast Mold and Products Company ten years ago. He has been active in mold design for powdered polyethylene since its commercial introduction in this country.

Bud LaMont, Plasti-Cast Mold and Products Co.

MR. LaMONT:

Good afternoon: The design of a mold greatly depends upon the size and shape of the item to be produced. Therefore, let's choose a relatively simple shape, start small, then increase the size, noting the change in design and also compare the convection oven with the hot liquid machine.

Assuming that we are going to make plastic spheres of four, twelve and twenty-four inches in diameter, the cavities should be produced from cast aluminum since they are low priced, with good heat conductivity, do not rust and are compatible with polyethylene powder. They would all be mounted on steel spiders. The four inch diameter cavity from a single boss approximately one and a half inches in diameter, located in the center of each half sphere. The parting line being short in length, and in a plane, could use any of the three basic types of parting lines. They are the offset or step, the flat with dowel pins and bushings to register the two halves, and the tongue and groove. The flat parting line can be used with either kind of heat; its advantage is easy mold maintenance, but the initial cost is higher than the other two. The step or offset register is best for the convection oven on this size and shape mold. To describe this register, visualize the cross section of the parting line and start from the cavity in a horizontal direction five thirty-seconds of an inch, then downward at an angle of 75 degrees from the horizontal for one-quarter of an inch. Then horizontal for one-eighth of an inch. These dimensions are typical for this kind of register parting line. The advantage is the small amount of metal touching, therefore, needing less closing pressure and having less distortion or longer mold life. In describing the tongue and groove register parting line, start from the cavity in a horizontal plane for one-quarter of an inch, then an elliptical shape protruding upward one-eighth, having a base of five thirty-seconds of an inch. The parting line continues in the same horizontal plane we started with for three-eighths of an inch more, making the width of the parting line twenty-five thirty-seconds. This parting line is recommended for use with the hot liquid machine, since it is more difficult for the liquid to penetrate that distance to the cavity.

The metal thickness of the cavities would be determined by the type of machine used. A hot liquid machine should have cavities with metal thickness of five-sixteenths to three-eighths. Due to the rapid heat transfer by the liquid, the thick metal allows the temperature to diffuse and uniformly heat the plastic without hot spots. Greater closing pressure can be exerted also. With a convection oven the metal thickness of the cavity should be three-sixteenths to the one-quarter of an inch; the thinner metal helps produce a faster cycle.

In considering the twelve inch diameter sphere, we would change the design of the cavity on the outside from a single one and a half inch mounting boss to six one inch mounting bosses located around the periphery of the parting line, perpendicular to its plane, rising approximately two inches above the top of the cavity. For the convection oven we could thin the metal to one-eighth of an inch and use the step or offset parting line, the six sets of opposing mounting bosses exerting closing pressure on the parting line of the cavity.

The flat parting line could be used with six sets of opposed mounting bosses, although you might incur slight mismatch at the parting line after a short while in production.

The cavity using the tongue and groove parting line would also have six sets of one inch opposed mounting bosses located the same as on the other two types of parting lines.

The metal thickness for the hot liquid machine remains the same as for the four inch diameter sphere, five-sixteenths to three-eighths of an inch.

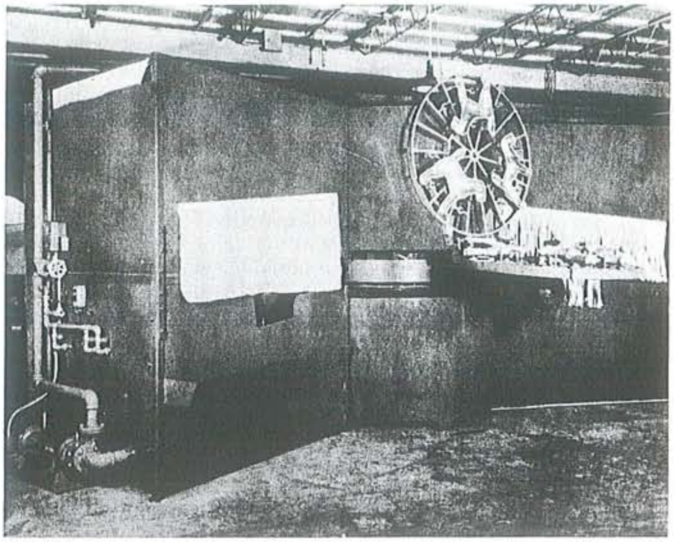
To produce a twenty-four inch diameter sphere the only parting line I would recommend is a tongue and groove, since the other two types of registration for the cavities would allow too much mismatch.

The cavity should have twelve sets of one inch diameter opposed mounting bosses. These bosses should be from three to four inches long and steel rods should be fitted into them.

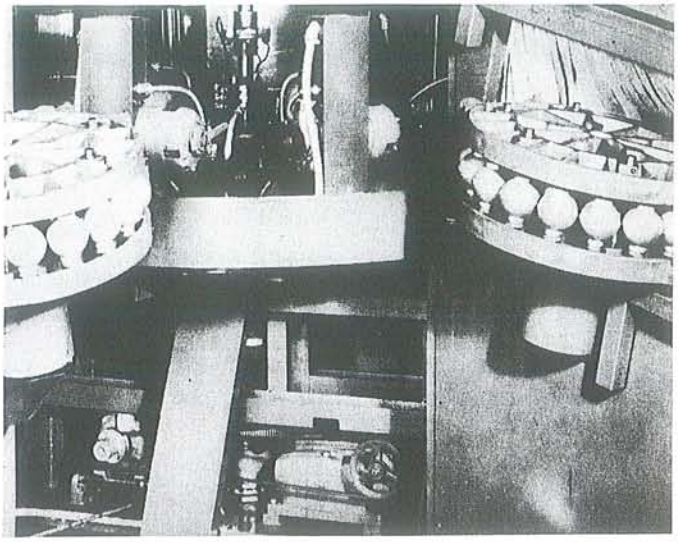
If long mounted bosses of aluminum would be used, two things happen — they rob heat and the metal compresses and in a short time the cavity is not closing properly.

The metal thickness for the convection oven would be one-quarter of an inch; for the hot liquid machine, three-eighths of an inch.

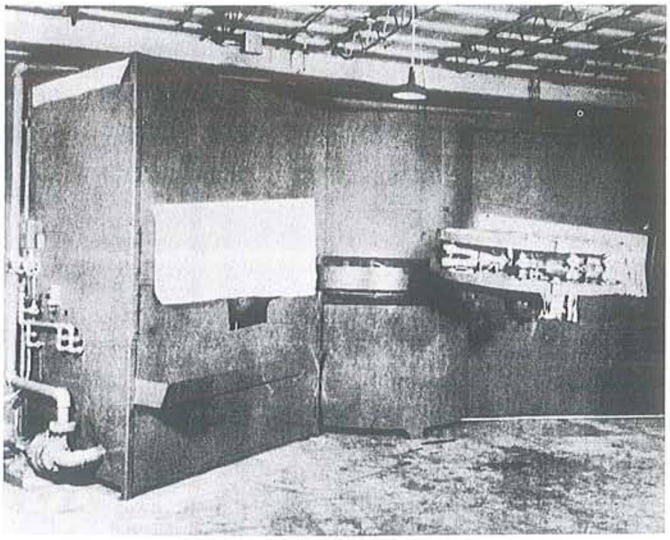
Let's assume we are going to produce cavities for hobby horses. This is a three-piece cavity. The medium sized horse will have sixteen to eighteen sets of opposed one inch diameter mounting bosses. The metal thickness is three-sixteenths to one-quarter inch, for the convection heat, and five-sixteenths to seven-eighths for the hot liquid machine.



Slide II



Slide IV



Slide III

Slide III. An enclosed oven and cooling unit through which each multiple cavity mold passes, taking up 140 degrees of the circle. The remaining space is for the operator to remove the finished article from the mold and dispense the exact amount of polyethylene for the next cycle.

The cycle time can be adjusted from twelve to twenty minutes. On the twelve minute cycle you have a multiple cavity mold appearing in front of the operator every two minutes. The cavities are mounted on a patented spider which is put on to an angular spindle.

Slide IV. These radial spindles are equipped with individual drive shaft and independent motors which cause them to rotate as they are transported through the oven and cooling units and stop at the exact position for the operator to remove the finished product.

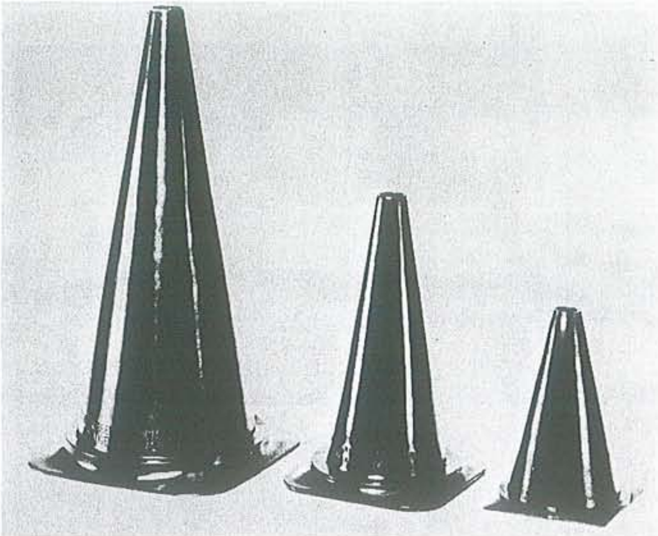
The cycle of production begins with the dispensing of the polyethylene into the cavity. The top section of the hinged mold is then closed and tightened in place with the exact inch pounds. The table motion carries the mold from this station into the oven entrance where a microswitch starts the spindle and the mold rotating on a plural axis with an angular shaft which knows no north and south pole.

The oven is automatically maintained at a temperature just which brings the mold and the polyethylene therein to the required temperature, just prior to the mold entering the cooling unit.

The oven is generally heated with gas through two eclipse burners, capable of producing a million BTU's. On a 75-inch machine it is 2,400,000 BTU's. The oven can be fired by natural, artificial or propane gas, electric or vapor fire.

The cooling unit is a water cabinet which is self-contained with a circulating system with temperature automatically controlled through a G. E. thermostat.

Slide V



Slide VI

The six-spindle, twenty-five inch machine, we have over 200 of them in many places in the world. The seventy-five inch machine, we have fifteen of them. The fifteen inch machine, we have over a thousand. I am not saying this in order to embarrass anybody. I am just stating a fact, that we have now been offered a new material that makes rotational molding really stand out, the material that U.S.I. furnishes to the supplier or the manufacturer of products, as outlined at the beginning by Dr. Zimmerman.

It can be had any way you want it. You can make or use a low density material, a medium or high density, any melt index you wish. The combination makes it easy for you to select a material to do your job right or make your article good.

Most of the cavities that we make for multiple production, especially those for the automotive industry, are pressure cast, and some are electroformed copper. Some are electroformed nickel and copper, and this material has been proven to be suited for multiple cavity molds because of its rapid heat transference or absorption of heat. The pressure cast cavities are the best because of the absence of any surface or interior porosity.

Their accuracy is maintained because they are pressure cast on the tool steel die. Plaster cast cavities are used on articles with undercuts. Electroform cavities are used to make articles with undercuts and fine details. Metalized cavities are used on articles where a limited number of parts are required or quick sample needed.

Any hollow article can be molded without a seam. Slide V. Any partially hollow article can be made by opposing two parts of the cavity with a self-trimming edge between them. Slide VI.

Powdered polyethylene will give you a seamless article on rotational molding equipment manufactured by the Akron Presform Mold Company. This equipment is covered by fifteen patents, and five patents pending, on which there is no license or fee charges.

I thank you for your attention, ladies and gentlemen. If you want reprints on our equipment, they will be available at the U.S.I. booth.

E. B. BLUE COMPANY

MODERATOR McDONALD:

Next, Mr. E. B. Blue, President of E. B. Blue Company, South Norwalk, Connecticut. Mr. Blue is an engineering graduate of Cornell University. He formed E. B. Blue Company in 1945 to manufacture industrial ovens, and for the past fifteen years has been active in design and manufacture of equipment for rotational molding.

E. B. Blue, E. B. Blue Co.

MR. E. B. BLUE:

Mr. Chairman, Ladies and Gentlemen: There are a large number of production areas in which rotation molding has a preferred position, often due to better quality of product and frequently to an overall economy of operation. Then there are also certain shapes or forms that can only be made by rotation molding.

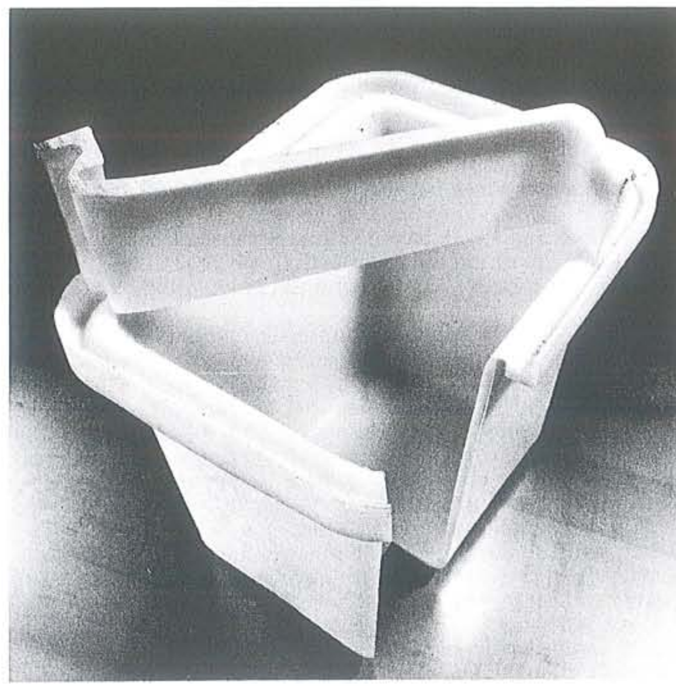
Sometimes in the past a limited production role has been assigned to the rotation molding method. This role indicates that rotation molding is suitable only for short production runs, or very special shapes, or where a limited investment in equipment and molds is a deciding factor. These considerations certainly are very desirable, but we do not agree that our double rotation molding is limited to these somewhat restricted areas.

We have made hot air rotation ovens as well as slush molding equipment, in a wide range of sizes for a dozen years or more. And in these years tens of millions of very acceptable pieces in both short and long runs have been made, serving various industries very well, and, we think, adding to the concept of quality in plastic molding.

There have been several developments within the last two or three years that have added materially to the potential value of rotational molding in its service to the plastic industry.

One major reason is the introduction and now widespread use of the powdered polyethylene. These have been followed by other powdered and dry blend resins of various kinds, together with some new liquid formulations. Accordingly, the plastics industry now has an increasing number of available resins from which to choose and also an ever increasing number of new applications for them.

With these new plastic materials and our new rotation methods, many different as well as difficult products can now be molded. It is both entirely possible and practical to mold very large pieces, either hollow as a barrel or drum, or with open tops or with other open areas, such as large hampers. Very heavy pieces can be made so far up to seventy-eight pounds, with shapes that may be simple or complex, having protruding or recessed sections. Pieces having very thin or very heavy wall thicknesses can be easily molded. These pieces have not only excellent wall thickness uniformity, but also generally have heavier and stronger edges and corners.

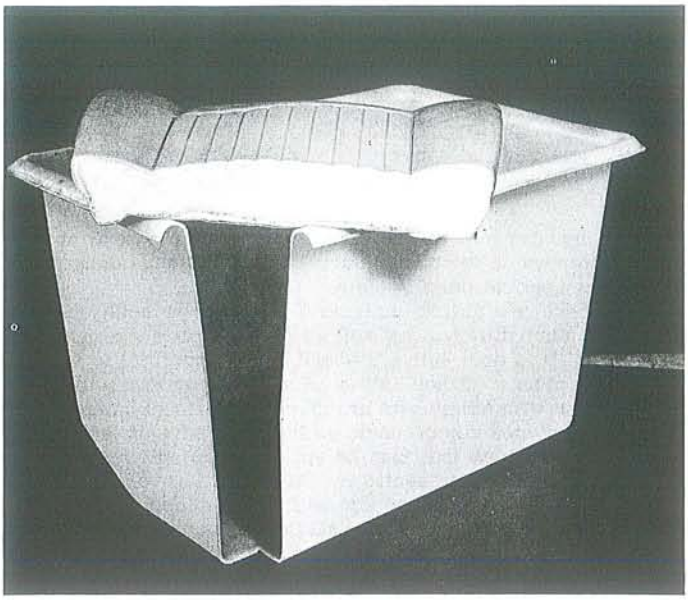


Slide I

Slide I shows a hamper where the material was just piled in, to see about how much we could get. As you can see, it is well over a half inch thick and it is quite uniform and has a cast-in stud here in the bottom for casters in this case, or in the various other types of inserts that can be turned on, too.

Slide II shows a polyethylene dry run powder, bucket seat idea. Worked on by a number of people. The uniformity here is really almost remarkable. This, of course, is urethane foam in here, but this was made in a blueplate aluminum mold. The detail on this is extremely good and molds in a very, very short time, and this is the hot liquid molding process. Such molding has become practical very largely, and in many cases exclusively, because of our development of the hot thermal liquid method where a heavy shower of molten salts pours down over the rotating molds at predetermined temperatures, speeds, ratios and time periods. Many complicated pieces simply cannot be made by any other molding method. It has also become evident in molding some medium size pieces, the equipment and mold costs for other molding methods could well be prohibitive.

In the event of very high production requirements for large and/or heavy pieces, as well as those with exacting uniformity



Slide II

specifications, we have design plans for semi-automatic rotation equipment using our thermal liquid method.

At the present time, while we are always building hot air ovens, too, I want to emphasize our hot liquid type of equipment, and offer these several examples of where it has been used.

Example No. 1: We have made some special heavy wall barrel containers molded from U.S.I. MICROTHENE, weighing about ten pounds, and having walls from 7/16" to 1/2" thick. The cycle molding time was about ten minutes with the hot salts at around 500 degrees Fahrenheit, the finished pieces being fully fused with good wall uniformity. We have been advised that a suitable "B" machine would cost about $100,000 with another $10,000 for a single cavity mold.

The cycle molding and dwell cooling for the blow molding, dwell cooling time, was estimated at about three minutes, or around twenty barrels per hour, with, however, reservations as to whether they actually could be properly molded.

In this example we estimated that nine or ten of our molds in two piece aluminum, could be mounted on each of our two spiders, giving at least 18 pieces every fifteen minutes, or an estimated hourly production of seventy-two pieces. We would then expect to get from our machine over three times the hourly production of the "B" machine, and our equipment investment would be one-third to one-fourth of the other's cost. The total mold costs for either method would add up to about the same (as we would use a number of molds), our production labor costs would be greater, but we also feel that operating and maintenance costs would be in our favor.

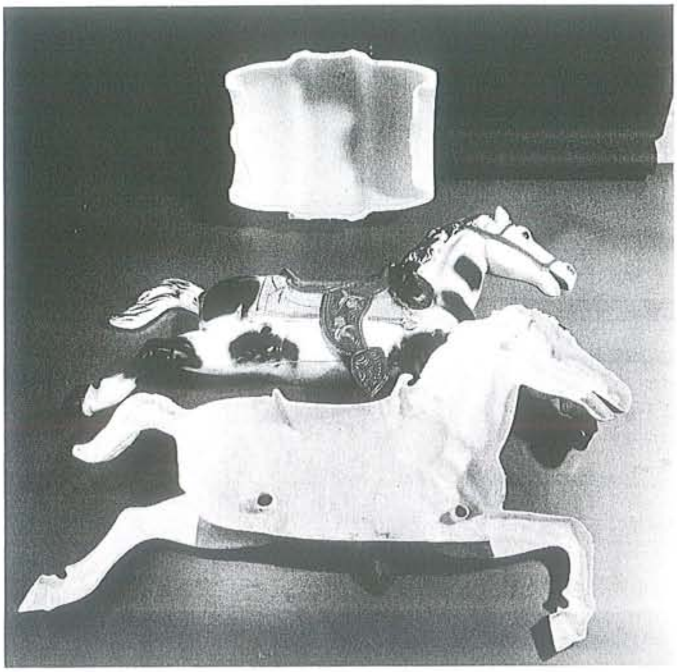
Example No. 2: A 300-gallon closed drum was recently made out of U.S.I. MICROTHENE. It weighed 78 pounds, was a good one-fourth inch thick, stood over five feet high by about thirty-six inches in diameter, and took approximately thirteen minutes to mold, total time in and out of the oven.

With our two spider design, this would give about eight pieces per hour. These pieces were also fully and uniformly fused, and as is almost invariably the case in our rotation molding, the corners and edges are well filled out with a little heavier thickness at these points of abuse and wear.

In this particular oven we had incorporated a combination recirculating hot air system at our customer's request. Following this first lot of the 300-gallon containers using the thermal liquid, they also made a test run, using their recirculating hot air system for a comparison with the hot salts. The pieces made with the hot air heating, due to the considerably higher temperature required in hot air, and the prolonged time necessary for the heat to penetrate the mold and the material itself, was discolored and cracked, being definitely degraded. This may well be the result where hot air heating is used on large and heavy wall pieces in production.

Example No. 3: Under Example Number 3, I would like to mention several items, the first one having been molded in a steel hamper mold using polyethylene, with forty pounds of material piled in to see how thick we could go. (See Slide I).

The side wall thickness which is fairly uniform, is 9/16 of an inch, with the upper rim being both thinner and thicker at different parts of the top section. Four steel inserts with threaded studs were cast in the bottom corners, and inserts of various kinds may also be cast into other kinds of molded pieces.



Slide III

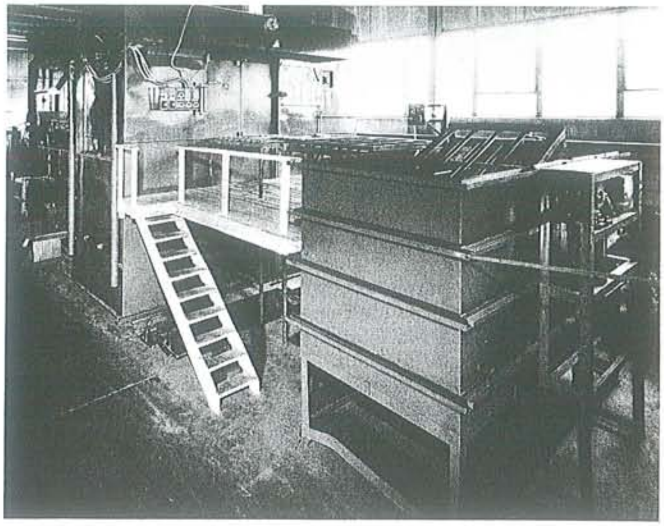
We would consider hobby horses, which are relatively thin-walled, Slide III, as examples of complex pieces, and these have been and are now made by the thousands in both recirculating hot air and the hot salts ovens. However, we are advised by one of the major manufacturers of these horses, that because of the speed and almost perfect uniformity of the liquid heating obtaining in his two spider cube 54", (up to 78" in diameter), hot liquid oven, they cannot only reduce their oven cycle time to about forty per cent of hot air cycle, but also can reduce the weight of the finished pieces by about ten per cent, due to improved wall uniformity. In other cases, weight savings up to twenty per cent have been made. We usually have a complete cycle time of about one-third that of hot air molding.

Polyethylene granular powders, of which I believe U.S.I. are the originators, with their several low density MICROTHENE grades, are by far the most generally used material in rotational powder molding.

Various higher density and linear types are also becoming more available and are now in production. Some of these types require relatively slow and controlled cooling in thick wall pieces, but thin sections are handled the same as the lower density materials.

In our hot salts ovens, the immersion gas heating (which may also be oil fired, or electrically heated) is very efficient. The make-up or replacement costs of the molten "salts" varies from one installation to another, with one operator calling them "of no significance" and another plant referring to them as so "minor" they are not entered in their cost keeping.

We have developed an effective combination "reclaiming" system, in which the hot molds are partially cooled and washed down for a few seconds, ten to thirty, inside the molding oven just before they are taken out. These molds are then further cooled and washed down as necessary, outside the oven



Slide IV

in a special stand (see Slide IV). This wash down water is now a salts solution and is later returned periodically back into the oven. The water of this solution goes off into steam at this point and is automatically exhausted, leaving the salts again inside the oven.

The heat transfer salts are referred to as a "low melting point" mixture, melting at about 280 degrees Fahrenheit. We have used them as low as 340 degrees for certain plastics, and up to about 600 degrees for others, with from 450 degrees to 525 degrees being the usual range for various polyethylenes.

The use of these salts presents a fire hazard under certain conditions, but assuming the recommended precautions are properly followed, there should be no such problem. During the three or four years in which these ovens have been in development and production operation, there have been no fires reported, except one in our own plant (Laughter). Two or three years ago we tried out an unvented 55-gallon steel drum as a mold, using vinyl plastisol to in effect clean it out before making some polyethylene pieces. We started the rotation, the hot salts came down, the drum cover buckled from the air inside, and the five or six pounds of plastisol dumped out into the steel screens. Before long it started to burn, making a very black smoke. It caused no other trouble, except being very embarrassing, as our visitors that day were a group from the U. S. Industrial Chemicals Company, who, however, bought an oven from us after all.

I want to thank U.S.I. for this very unusual and certainly most welcome opportunity of being a part of this program. We appreciate it very much, and we value it very highly.

Thank you.

MODERATOR McDONALD:

Mr. Paul Thuoit of Brooklyn Blower and Pipe Corporation was one of our scheduled speakers, but due to a recent injury, we are sorry to announce that he was not able to be present. He has asked that we express his regrets, and will be happy to arrange production demonstrations in New York for any of those here who are interested in learning more about equipment by Brooklyn Blower.

Our third speaker, Mr. Mark Page, President of Chemical Automation, Woodside, New York, graduated from New York University with a degree in Mechanical Engineering. He has had wide experience in plastic fabricating techniques and has been concerned with rotational molding equipment since 1948. Mr. Page is a member of the American Society of Tool and Manufacturing Engineers.

Mark Page, Chemical Automation Corp.

MR. MARK PAGE:

Gentlemen, I am happy to be here this afternoon, and I see some of my friends that I have known throughout the years. I think that before I even start, I'd like to pay tribute to Al Miller, if he is still here, who taught me the first things I ever knew about rotational molding. Where are you, Al? He is hiding.

At any rate, the specific reason for the importance of Chemical Automation Corporation's automated molding lathe for the manufacture of items such as those you will see at the U.S.I. Carousel, is due to the patented apparatus used.

In the June 1962 issue of Plastics Technology on Page 86, the statement is made, "The Chemical Automation design is unusual in at least two aspects – the curing is not conducted within an oven, and the mold is not caused to rotate in two directions. Heating is provided by small units located close to the surface of the mold. Motion of the mold is rotary in one direction, rocking or oscillatory in the other. The heaters rock with the mold, thus maintaining a fixed distance from its surface. Cooling is by means of a water spray", and other methods not divulged in the article.

Now, ladies and gentlemen, we have a problem. Chemical Automation Corporation has a number of licenses. We are unable to release to you details which concern this licensing arrangement.

However, within the scope of the information generally available, we shall try to answer each and every question. I urge you to look at the board which is upstairs at the U.S.I. booth, which details some vital facts that have been proven about Chemical Automation Corporation equipment.

Within the last week we have been very, very happy to learn that this approach that we have used for so many years and which has been exemplified, one, in the coating of a large steel shipping container held to fantastically rigid tolerances, has proven completely successful after months of testing with concentrated sulfuric acid and concentrated phosphoric acid, and being shipped all over the country, and being beat about as only truckers can.

Secondly, we are informed by two other large companies that items that we had molded showed no evidence of degradation whatsoever. That wall thicknesses were held within two to three thousandths of an inch.

At this point I'd like to quote from Mr. Blue's very interesting article on Page 390 of Modern Plastics, October 1963 issue.

Mr. Blue states, "Molding large complex and thick wall pieces are impractical with standard recirculating hot air type of rotation ovens, due to their prolonged heating cycle, high air temperatures, possibly overheating, and degradation of material."

Of course, we concur completely. The action of all oven and liquid salt type systems may be likened to that in a tumbling barrel, in which is enclosed a cylindrical bar of steel which is tumbled along with the charge of shot, the shot being analogous to the hot air or salts. Eventually the bar will decrease in diameter slightly. But practical production usually makes use of a lathe for turning the diameter down to some required smaller size. Similarly the precision glass industry has used glass lathes with heat as a tool, and the familiar incandescent bulbs are, of course, sealed to their stems on an automatic version of a vertical glass lathe.

Chemical Automation Corporation has produced and licensed a patented automated lathe with no oven, no extruder, no salts. Chemical Automation's molding lathe is faster than any other equipment. It handles all varieties of U.S.I. polyethylene. It handles the cheaper and more expensive grades of polyethylene, and we are proud to announce that we can mold linear polyethylene which is not degraded. We are molding today carpet backing grades of polyethylene which are two to three cents a pound cheaper than other varieties, in addition to innumerable other materials which are not to be named on this channel.

Our equipment can readily be field erected and operated outside our plant to build sturdy motel units and cabanas, as well as even larger structures. The automated molding lathe knows no size limitation, either microscopic or enormous. We have been investigating this field for many, many years. We have spent in this research and development perhaps fifty to sixty thousand dollars, just in the research and development aspects of this alone.

Today we feel that since complete control of material flow is inherent in the automated molding lathe that wall thickness uniformity – again I wish to emphasize this – can be held within two or three thousandths of an inch. Reinforced and varying wall thickness can be programmed and produced.

Now, I think you gentlemen have been subjected to so many facts, so many things and so many temperatures and so many BTU's, that perhaps you share with me a distaste for a further examination of such detail.

I do think that all of you may have noticed that the approach that we have used is that common to all American engineers and all American industry, the approach of bringing to problems the concept of the automation, the concept of science in action.

Our machine has now proven itself for both molding and coating of the most intricate items all over the world. Important details of design, as we said before, must be, must remain secret to protect our licensees. However, we do extend a cordial invitation to visit our plant at Woodside and see some of the unbelievably intricate and complex items we have successfully produced thus far.

Please call or write for an appointment. We shall be happy to accommodate you all at the first mutually available date that can be arranged. Thank you for being such a wonderful audience.

MODERATOR McDONALD:

The final speaker today is Mr. H. E. Wolford, Consultant, McNeil Manufacturing Company, Akron, Ohio. Mr. Wolford has been active in development of rotational molding techniques for several years and has also worked on plastic tooling, jigs, fixtures, and sheet metal fabrication. He is currently technical consultant of the process machinery section, McNeil Machine and Engineering Company.

H. E. Wolford, McNeil Machine & Engineering Co.

MR. H. E. WOLFORD:

Mr. Chairman, Fellow Members of the Symposium, Ladies and Gentlemen:

I deem it a privilege to be given this opportunity to describe and relate to you the many superior and economical advantages of the McNeil Machine & Engineering Company Roto-Cast equipment.

I assume you have heard of the McNeil organization. We are world famous for our rubber machinery. In fact, approximately ninety-five per cent of all the rubber tires manufactured in the world today are processed on our famous Bag-O-Matic presses, and we are naturally striving to attain this same degree of success and acceptance in the plastic rotational molding field.

I am, therefore, proud to announce the establishment of the McNeil Research Laboratory for rotational molding and other plastic processes. This Research Laboratory will be located at our main plant in Akron, Ohio. We have set a tentative date for completion on January 1, 1964.

In this laboratory, we will have a standard McNeil Roto-Cast #800-64 Machine, and our new single spindle research machine with allied necessary equipment. This Machine has been designed solely for research use and is the only one of its type available today. This equipment will be for our development use and the use of our customers and potential customers of McNeil equipment.

Presently available McNeil Roto-Cast equipment consists of four major production pieces, plus the Research Machine and auxiliary equipment consisting of a liquid and powder dispenser.

The four production Roto-Cast Machines are namely, the #500-56, which is commonly used for the manufacture of plastisol products only; the #800-64 which has a larger capacity and higher temperature capabilities, and is used for powder or plastisol molding; the #1500-88 Machine, which is our largest present machine, and is used for powder molding; and last, but not least, is a fully automated chain machine now under development. This is a continuous, non-indexing type of machine for high production requirements, and is designed to meet your individual production requirements. All operations will be automatic.

We have one such machine in the planning stage, which is designed to produce four articles per second — I did not say four articles per minute — I did say four articles per second. At present, I am not at liberty to discuss this project further.

Engineering-wise, all the machines are similar with the exception of the Lab Model and chain machine, size being the primary difference.

Each of the first three machines are of the three spindle indexing type of design, with provision for two molds containing as many cavities as can be placed on these molds, mounted on each spindle. Each spindle has its own separate set of timing and index controls. Each spindle also has its own individual speed of rotation controls.

It is, therefore, entirely possible with McNeil equipment, to rotationally mold three different powdered polymers or plastisols and six different products simultaneously. Actually, each of our indexing type of machines is the equivalent of three machines in one.

The three indexing type machines are equipped with what we think is a rather unique method of spindle drive on each axis of rotation. There are no belts or adjustable sheaves to change when speed of rotation must be varied, but a very simple drive train, consisting of a gear head motor through a roller chain to a pneumatic tire, utilizing a friction contact with drums attached to spindles.

When spindle with molds attached index to the heat source or oven, rotation of both axes is driven by two electronically controlled direct current motors. The speed of these two direct current motors can be varied at the operator's wish by merely setting a dial. This gives us an infinitely variable speed range control, naturally within the limits of the pre-set machine limit of the drive.

High speed spin is also available as an optional feature. This high speed spin is normally used only with cavities having extreme restricted projection areas. To fully utilize this feature, cavities with projections must be placed on spiders with projections mounted away from center of the mold. Speeds to 80 r.p.m. can be obtained automatically, with separate lock-in, lock-out controls for each spindle.

After the machine indexes to the cooling station drive is accomplished with an alternating current motor with the pneumatic tire transmission. This drive is normally set at a suitable point for all molds being run on the machine. Speed of rotation while cooling may be varied by changing simple chain sprockets. The machines are indexed by means of an alternating current motor with pneumatic tire transmission of power to the table, and are provided with a positive air-powered locking device. An alternating current motor is also provided at the load and unload station to give power controlled positioning and turnover to the molds while loading or unloading. This is controlled by the operator at the operator's podium. An air powered locking device is provided to lock molds into a level position when molds are being indexed from cooling station to the load or unloading station. There is also a spindle hold-down provided to hold molds firmly while items are being removed from the molds.

There are no motors mounted on the center table spider. All motors are mounted close to the floor where they are not directly exposed to high oven temperature and are, therefore, capable of longer life. Elimination of motors on the center table spider and by use of pneumatic transmission eliminates the necessity of slip rings in our electrical circuits. All of the electronic controls are mounted in a locked cabinet. The oven controls are mounted in a cabinet, and controls include a visual and recording temperature controller. This gives a complete record of production heats during an eight-hour period, and will eliminate any guesswork as to temperature or time. This recording device can also be used for repeat performances when re-runs are made on any particular product.

Each spindle of the #500-56 Machine will support two multiple cavity molds on each spindle, 45" in diameter and 12" high, with a maximum total weight of 500 pounds. The #800-64 Machine will support two multiple cavity molds on each spindle, 56" in diameter and 12" high, with a maximum total weight of 800 pounds. The #1500-88 will support two multiple cavity molds on each spindle, 78" in diameter and 15" high, with a maximum total weight of 1500 pounds.

Heating of molds is accomplished by the means of hot air convection heaters. The burners of these heaters are two-stage and gas-fired, or pressure type, depending on the model. You may also use oil or electric heat source. The cooling of the molds on the McNeil Machine is accomplished by means of air, and/or water. This cycle is automatically timed. All air cooling, or water cooling, or combination of the two, is easily obtainable. The operator may, at his election, stop the water cooling at any point by merely pressing a button on the operator's podium.

The three production indexing machines are also provided with a neutral position which is a point halfway between either fusing or cooling, cooling or unloading, or loading or fusing. This is a safety feature. If any problem is experienced by the operator, he may, at his option, move the molds to this neutral position and thus all molds will be out of all operation stations. This is also extremely valuable during start-up and shut-down, as no molds are in the oven or heat source while it is attaining its pre-set peak temperature. All operations of the machine, with the exception of timing and speed control, are controlled by means of devices mounted on the podium placed at the operator's station.

Last — but by no means least — is our new and unique research or laboratory model. This was designed by McNeil expressly to take the art out of rotational molding and establish rotational molding as a science. This machine has at your fingertips all available sources of heating — radiation, convection, combination radiation and convection, plus liquid heating. It has all presently available methods of cooling — air or liquid. It has speed adjustment about either axis, and it has a newly developed method of recording temperature of the polymer or plastisol inside the mold during the entire fusing and cooling cycle. This feature is a McNeil first, and patents are pending. Temperatures are recorded on instruments, as are the speeds of rotation of the machine.

Along with this unique research machine, and our four major production units, we feel that the McNeil Machine & Engineering Company will fill a tremendous need in rotational molding and the special machinery field of the plastics industry. Thank you.

QUESTION AND ANSWER PERIOD

Over 1000 engineers, processors and management personnel attended U.S.I.'s Symposium on Rotational Molding.

MODERATOR McDONALD:

This brings us to the question and answer period of our program. We don't have much time left, so I am going to go through a few questions here, that I think are pertinent and of interest.

The first question is to Mr. Keown, and it is from T. D. Miller, Plastic Products, Limited. The question, Mr. Keown, is:

"How does the finish of a rotational molded part compare with blow molded or injection molded parts? That is, what degree of gloss can be obtained?"

MR. KEOWN:

Well, the degree of gloss that can be obtained depends on the type of mold that you would use and how well it is polished. On this particular product, we purposely went to a mat finish to bring out more of the esthetic look, of the grill area, and compared to injection, well, then, you could more than likely get a better surface, a higher gloss surface with injection than you could with rotational molding or blow molding. I think blow molding and rotational molding are comparable in appearance.

MODERATOR McDONALD:

The second part to that question.

"How do physical properties, that is, tensile strength and stiffness, compare with parts molded by blow or injection molding?"

MR. KEOWN:

I — all I can say to that is that we are industrial designers, not engineers. I think that particular question could be answered better by an engineer or a U.S.I. sales representative.

MODERATOR McDONALD:

Thank you, Mr. Keown.

I have a question here for Mr. Pappas. From Frank DeWitt, DeWitt Plastics, Auburn, New York.

"To what degree is the shrink gauge needed?"

MR. PAPPAS:

Well, we haven't incorporated any shrink gauges in any of our parts at the present time. I think the fellow that was just speaking here could give you a little better pitch on shrink gauges. We don't incorporate any shrink gauges in any of our parts.

MODERATOR McDONALD:

Another question from DeWitt Plastics in Auburn, to Dr. Zimmerman.

"Does the adding of the additional material increase the cycle? If so, how much for say ten one-thousandths?"

DR. ZIMMERMAN:

Would you repeat that, the last part again?

MODERATOR McDONALD:

Does the adding of additional material increase the cycle? If so, how much for say ten one-thousandths?

DR. ZIMMERMAN:

Well, I can't give you an exact time for ten one-thousandths. I would say that as you build up your wall thickness, it increases cycle time. So the answer is, yes, but I can't give you an exact number for ten one-thousandths.

I would like to add a couple of comments to the previous question. We have used pyrex glass molds and you can reproduce the surface of the glass and get excellent gloss on the outside surface.

MODERATOR McDONALD:

Al, could you answer that question on impact strength?

DR. ZIMMERMAN:

Yes. If properly molded, you can get comparable products with rotational molding.

MODERATOR McDONALD:
One more here for Mr. Harold Morse, from N. Lonnsberry, Plasti Company, Toronto. He says,

"On pump housing was — how was mold parting line sealed against cooling water leakage? If gasket was used, what was maximum mold temperature?"

MR. MORSE:
Well, we did use a gasket. The mold was made so that it overlapped and the metals were made to fit as closely as possible and then the flanges were set back a little bit so when the mold came together you had about a sixteenth of an inch spacing in there. We put in an eighth of an inch sponge gasket. Let's see. This was a silicone sponge gasket and that went down to a sixteenth of an inch and gave us a perfect seal.
The temperature of the mold was up around five hundred degrees, something like that.

MODERATOR McDONALD:
While you are still there, Harold, here is another question for you. From Mr. White, Western Foam Packaging.

"What are the best cutting tools for cutting out parts of rotationally molded products?"

MR. MORSE:
What do you mean cutting out parts? I don't follow what he is driving at there.

MODERATOR McDONALD:
I imagine it is the cutting after the molding.

MR. MORSE:
To trim it up, something like that?

MODERATOR McDONALD:
That's what I would assume it is.

MR. MORSE:
We have used ordinary linoleum type knives to cut pieces off from time to time. We have also used a saber saw, and one case we used a portable rotary saw.

MODERATOR McDONALD:
I have one more question here for Mr. Keown from Mr. Barnett of Loma Plastics.

"Please clarify the use of shrink fixtures in molding."

MR. KEOWN:
What was that again?

MODERATOR McDONALD:
It says, "Clarify the use of shrink fixtures in molding."

MR. KEOWN:
These particular parts were molded over-sized. The dies are made oversized. In these particular areas — just a moment — in these particular areas, bottom and the top, we have a fit problem, and through the expert molding of Fabriform and their controls, we have been able to maintain a tolerance between the top and the bottom so that we have a clearance with the top fit inside of the bottom of a thirty-second of an inch over all, both in this dimension and in this dimension, which gives us a good, tight and consistent edge.
The shrink fixtures were mainly put into this product to maintain this configuration and also to maintain this reverse in here, so that there wouldn't be any draw back or shrinkage during the cooling process.

MODERATOR McDONALD:
Thank you. We have one more quickie here for Dr. Zimmerman from Mr. Stout, of Sun Oil Company.

"Is there a practical limit as to how high the melt index can be for rotational molds?"

DR. ZIMMERMAN:
We have molded 250 melt index. We have not gone higher than this only because it hasn't been available in powdered form. We had no trouble molding the 250 melt index material in which you would get the properties of a material with that high melt index.

ADJOURNMENT

MODERATOR McDONALD:
Thank you, Al. I'm sorry, but that's all we have time for.
And that, ladies and gentlemen, brings us to the close of our symposium. We sincerely want to thank all of you for being here today. Remember, if you would like copies of the proceedings, just drop your badge in the container at the door. If you have any questions or cards not turned in, leave them at the door and they will be answered by mail.
On behalf of U.S.I., the speakers and myself, thanks again, and good night, everybody.

. . . The symposium adjourned at 5:00 p.m. . .

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