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TECHNICAL PAPERS

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REGIONAL TECHNICAL CONFERENCE

"PROFICIENCY–OVERLOOKED SAVINGS IN MOLDING and EXTRUSION"

SEPT. 23 & 24, 1963

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SHERATON WORCESTER HOTEL & MOTOR INN
WORCESTER, MASS.

SOCIETY OF PLASTICS ENGINEERS, INC.

PIONEER VALLEY SECTION

"PROFICIENCY–OVERLOOKED SAVINGS IN MOLDING and EXTRUSION"

Regional Technical Conference

Sponsored by

Pioneer Valley Section

Society of Plastics Engineers, Inc.

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Regional Technical Conference of the Society of Plastic Engineers, Inc.

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(nothing pertinent to Plastics)

UPGRADING PERSONNEL

by: **Walter G. Brakey**
Monsanto Chemical Co.
Springfield 2, Mass.

This article concerns industry's need for a practical, workable approach to raise the level of competence and increase the contribution of members of its workforce at all levels, management included.

Why -

First, as companies, we are faced with severe domestic competition, a cost price squeeze and in many cases over-capacity.

Secondly, our manpower resources management offer many improvement areas to cope with the above problems.

Let's look first at the types of people we have. Basically, whether salaried or wage, the personnel will fall into three categories: 1) The "Comer" (the man who will succeed regardless of what we do); 2) The "Growing Boy" (the one with potential that will go quite a ways if handled properly); and, 3) The "Indian" (the one of limited talent who can make a good though limited contribution. All three types will exist and all three types are necessary to industry.

Here are some considerations in the handling of wage people:

In this group, you contemplate making a 1/4 million dollar investment even if he stays in the same job. Naturally, you want to insure the investment as much as possible.

So you use tests - a very limited tool; but a valuable one if used well - the test battery might be based on High School norms - for it's assumed that this would be your minimum requirement. Included would be such tests as Numerical and Verbal Skills, Mechanical Aptitude, Dexterity etc. Personality tests have yet to show any great reliability.

Induction and Orientation - Here is where the attitude conditioning is done so be sure that someone who is qualified is made accountable to perform this operation. Checklists are an extremely helpful device in this area to insure completeness and uniformity.

Job Descriptions - Sure scientific management favors these, but don't get so sticky on them that you limit yourself forever on flexibility.

Performance Standards - Sure develop some practical ones, but remember this too can be a two-edged sword. As soon as you freeze the pattern of expected performance, flexibility goes out the window.

So far we've considered this handling only from the viewpoint of the breaking in of the new employees. This is a nice clinical approach, but we are not operating in a vacuum and our best efforts on him will have little influence compared to the prevailing spirit in the work group he joins. We all have employees with varying years of service conditioned to attitudes that always need improvement. It's the group not just the newcomer that you must influence to promote profitability. This is an area where assignment of accountability can pay dividends.

1. Don't assume that your people really know their jobs or feel particularly responsible for them.

2. Review with supervision your Standard Operating Procedures - Revise and update as necessary.

3. Complete Operations Reviews with the operators to assure full understanding.

4. Outline their responsibility and expected performance.

5. Hold them accountable.

In Foreman Selection and Training

Consideration - Give this area thoughtful treatment for not only the company's welfare, but in most contracts now, the man leaving the wage group abandons his seniority and protection.

Recommendations -

1. Open the nomination up for self-nomination.

2. Administer a thorough testing including Numerical and Verbal, an Intelligence test and Mechanical Comprehension.

3. Conduct a depth interview - by a high level of supervision from an area where he has not worked.

Recommendations (Continued)

4. Conduct a Departmental Evaluation - by a personnel man with his immediate supervisor and another, if possible, who has seen the man's performance. (Check here for leadership qualities, relations with others, attitudes and job knowledge).

5. Give him a thorough physical examination.

6. Summarize the above and make your decision.

So much for the Wage personnel and their line of progression. Now, how can we help our management group perform better? Provide better leadership?

Incentives? - Well most of us try this in one form or another with varying degrees of success. Let's look at it, at man in general - His basic needs food, clothing and shelter. While he lacks these, he cannot be interested in a higher order of things. When these needs are fulfilled, he then needs to "belong" and be "accepted". Then he turns to be the next level "status" - The recognition and respect of his fellowmen. After this a higher set - self-fulfillment, creativeness.

Man is a wanting animal, according to Doug McGregor, he wants more and more, but not necessarily of the same things.

So monetary incentives are important, but more than this is needed.

Human Relations? - This got a lot of attention and effort - But the results were disappointing.

1. Too many assumed there is a positive correlation between employee satisfaction and high productivity. Research somewhat refutes this.

Factors a. The most satisfied workers aren't necessarily the best producers - they tend to work at average rates to protect the status quo.

b. The outstanding producers are often those dissatisfied with their lot and intent on improving it.

2. Emphasis has been on teaching supervisors how to manipulate people.

Factors a. People don't like to be manipulated.

b. Supervisors are uncomfortable and inept in the role of arm-chair psychologist.

Stress Techniques -

Pushing people beyond reasonable limits - threats, fear psychology.

Factors - a. Short term gain in productivity

b. Long term unrest and dissatisfaction

c. Management has grown up too much to use this method - fortunately.

Leadership - Actually what do we expect of our people - Do we expect inspired leaders? A Ghandi, a DeGalle, an Eisenhower? What would they be doing in industry for us? A Henry Ford or Tom Edison or land of Polaroid - How many of this type of leaders can we expect to develop?

If this is what we're lacking for no wonder we are disappointed in our search, disillusioned in our programs.

We do have, however, a type of leader. Most of them up from the ranks who know their jobs and understand their subordinates - once their colleagues. Only a very few will have the rare combination of personality and basic qualities of the inspired leader and they will move on to bigger challenges. The rest will remain to face up to the important day-to-day job of getting things done. How can we help him? These are the basic elements for this leadership:

1. Set goals and standards
2. Evaluate progress.
3. Counsel and Guide
4. Discipline (reward and withhold)
5. Tie his contribution to results.

Our people respond well to a firm sense of direction. If we supply it, we'll get the results we seek.

TRAINING TO SAVE

BY

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SPERRY RAND CORP.

Presented Before
Society Of Plastic Engineers
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In Worcester, Massachusetts
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TRAINING TO SAVE

Once on a trip I developed engine trouble out on the highway. I managed to coax my car into a garage. The attendant said the regular mechanic was on vacation, but he would try to help me. I pulled into the garage and he raised the hood and went to work. He asked me to step on the starter while he poured gas into the top of the carburetor. The result was a backfire shooting flame out the top of the carburetor and igniting the can of gas he held. He threw the can which rolled under the car still burning. Some of the gas splashed on the cases of oil stacked nearby and they began to burn. No fire extinguisher was in sight. We grabbed some coveralls hanging on the wall and managed to beat out the flames before there was serious damage. After that, I decided my engine trouble was not so serious after all and drove on to the next garage where I got competent service.

Untrained help can be costly in operating and servicing a hydraulic system also. Machine breakdowns cause lost production and lost profits. The only way to save money in the operation of a machine is to take care of it so that you get longer life with a minimum of breakdowns and down time for repairs. An idle machine is expensive. So is the cost of repairs and lost production. Our goal, therefore, is to keep the machine running at peak efficiency.

Training To Save

The answer is trained personnel. The type and amount of training depends on the circumstances in each company. Large companies with many machines can justify an elaborate training program. Small companies with only a few machines may have to settle for a simpler training program. Even a company with one machine can justify some training, particularly if it is operated during the second and third shift. Many companies put their best men on the night shifts when outside help is not available. This is one way of providing "first aid" on the night shift. You decide how much training your company personnel needs.

The old saying, "A little knowledge is dangerous" applies only if the knowledge is misused. Even a little knowledge on preventative maintenance can be very valuable when properly used.

Training should begin with Management becoming well enough informed to recognize the need for and importance of preventative maintenance. Then to take the necessary action to train their personnel to provide good preventative maintenance.

I am sure you have heard about this subject of preventative maintenance many times. Doctors have been proclaiming it for years. How often has your doctor told you, "Joe, you've got to cut down on your smoking, get more exercise and lose some weight". Your dentist says, "brush your teeth". Isn't this simply preventative maintenance to avoid serious trouble later?

You are all aware of the need for preventative maintenance on your automobile. You have them lubricated regularly, the oil and filter changed, and the tires checked. It is just as important in a hydraulic system or perhaps more important. A car driven at an average speed of 40 miles an hour travels 80,000 miles in 2,000 hours. This is about the expected life of a car, and look at the service it receives during this time. 2,000 hours on a hydraulic machine operating two shifts a day is only about six months. How much service and attention does it receive during this time? Probably none unless it develops trouble. The hydraulic system operating at 2,000 PSI pressure includes finely finished precision parts fit to very close clearances to provide high efficiency. Adequate maintenance is necessary to keep this system in good working order. Neglect can result in costly breakdowns and expensive repair bills.

Properly trained operators and maintenance men can watch for signs of trouble before the trouble becomes serious. The down time can then be prevented or scheduled at a convenient time.

Training of personnel may take many forms. The operator or maintenance man can be taught to watch for signs of trouble and report them promptly. A hydraulic system usually gives a warning of trouble before a breakdown actually occurs. Some warning signs to watch for are:

1) External leakage may indicate a bad packing or seal, a loose fitting or connection, a damaged or worn hose or pipe, a loose plug, or some other relatively minor problem. The possibility of leakage can be reduced by the use of straight threads, welded flange connections, brazed or drilled manifolds. Frequently the cause

of leakage may be corrected by simply tightening a connection or replacing a seal. A minor repair that could prevent serious trouble. In addition to the machine trouble, leakage may also create a hazard to personnel, resulting in a person slipping and injuring themselves.

2) Low fluid level in the tank could permit air to be drawn into the pump causing erratic machine operation, noise, rapid wear, fluctuating pressure, or perhaps overheating.

3) Unusual noises could be the sign of a dirty suction strainer, an air leak in the suction line, shock in the system, or malfunctioning valves.

4) Slow operation might indicate a worn pump, excessive leakage in the valves or cylinders, or high oil temperature.

5) High oil temperature might be caused by inadequate cooling water or a pump being held under pressure when it should be unloaded.

6) Contaminated fluid could be caused by:

    a) Grit and dust entering the oil reservoir through an unprotected air breather or cylinder rod packing.

    b) Dirt entering the system when oil is added.

    c) High temperature causing a chemical breakdown of oil resulting in oxidation and sludge formation.

    d) Wear particles accumulating in the oil.

e) Scale, paint, or other fragments breaking loose from the tank, pipes, or valves.

f) Condensation resulting in the accumulation of water in the oil.

g) Air in the oil is also a form of contamination.

Most of these signs are clearly apparent to a trained operator who can watch for them without any extra effort or lost time. They can see external leakage or low fluid level on the gage, hear unusual noises, detect excessive oil temperature by feeling the reservoir, and observe machine's speed and performance.

Recognizing these symptoms of trouble you might say comes from experience - true, but only a fool learns by his experience alone. The wise man learns by others' experience. Training is learning by others' experience.

Detecting these warning signs early permits the serviceman to analyze the symptoms while the machine can still be operated. This enables him to localize the trouble and save considerable time and work.

Servicing a machine after it has broken down is somewhat like performing an autopsy on a body. It is much easier for the serviceman or doctor to determine the cause of the trouble while the machine or body is still functioning.

Keeping maintenance records and reviewing them periodically will enable you to anticipate troubles and schedule repairs at a convenient time rather than on a breakdown basis. This is another form of savings because scheduled repairs are less costly than breakdown repairs.

Training To Save

I have explained the need and the importance of trained personnel. Now let us consider how to train personnel. A great deal of material is available to help you.

1) The instruction manual supplied with each machine contains many helpful suggestions on the adjustment, maintenance, and repair of the machine.

2) The hydraulic equipment manufacturers can supply parts drawings, installation drawings, and service bulletins containing helpful information about the individual hydraulic components. (Show examples)

3) Several reference books on hydraulics are available:

   a) Basic Hydraulics - Navpers No. 16193 - available from U. S. Government Printing Office.

   b) Oil Hydraulic Power & Its Industrial Application By Walter Ernst - Published by McGraw Hill, New York City, New York.

   c) Shaums Outlines Of Theory & Problems of Hydraulics & Fluid Mechanics - By Gillis - Published by Shaum Publishing Co.

   d) Design Of Hydraulic Control Systems - By E. E. Lewis & Hansjoerg Stern - Published by McGraw Hill.

   e) Fluid Power Controls - By John J. Pippenger & Rich M. Koff - Published by McGraw Hill.

   f) Industrial Hydraulics - By John J. Pippenger & Tyler G. Hicks - Published by McGraw Hill.

   g) Industrial Hydraulics Manual No. 935100 (School Manual) - Available from Vickers Incorporated, 1400 Oakman Blvd., Detroit, Michigan. (Show Examples)

4) Many oil companies publish pamphlets on hydraulics. (Show Examples)

   a) Operation & Care Of Hydraulic Machinery - Available from the Texaco Company.

   b) Hydraulic Systems For Industrial Machines - Available from Socony Mobile Oil Company.

   c) Hydraulic Fundamentals & Industrial Hydraulic Oils - Available from the Sun Oil Co. - Industrial Products Division.

5) Films on hydraulics are also available.

   a) Harnessing Liquids - Shell Oil Company

   b) Hydraulic Oils - Texas Company

   c) Basic Hydraulics - Government Film - Cat. No. MN-5027A Norwood Films, 926 New Jersey Ave., N. W., Washington 1, D. C.

   d) Fluid Flow In Hydraulic Systems - Government Film - Cat. No. MN-5027-B Norwood Films, 926 New Jersey Ave., N. W., Washington 1, D. C.

   e) Derivation Of Pascal's Law - Government Film - Part I - Cat. No. MN-1730-A - Norwood Films, 926 New Jersey Ave., N. W., Washington 1, D. C.

   f) Derivation Of Pascal's Law - Government Film - Part II - Cat. No. MN-1730B - Norwood Films, 926 New Jersey Ave., N. W., Washington 1, D. C.

   g) Application Of Pascal's Law - Government Film - Part I - Cat. No. MN-1730C - Norwood Films, 926 New Jersey Ave., N. W., Washington 1, D. C.

h) Application Of Pascal's Law - Government Film - Part II - Cat. No. MN-1730D - Norwood Films, 926 New Jersey Ave., N. W., Washington 1, D. C.

i) Vickers Hydraulics - A Universal Tool - Available from Vickers Incorporated, Advertising Dept., P. O. Box 302, Troy, Michigan 48084.

j) Controlled Power - Available From Vickers Incorporated, Advertising Dept., P. O. Box 302, Troy, Michigan 48084.

6) At least one hydraulic equipment manufacturer, Vickers Incorporated, conducts a school for training customers' personnel as well as their own employees. The classes have been held regularly for 18 years during which over 5,000 men, representing over 1,250 companies, have been trained. This two weeks course consists of both classroom and laboratory work. It is intended to give service and maintenance men a thorough and practical training in the application, operation, and maintenance of hydraulic equipment.

7) Some companies send one man to school to train him as a hydraulic specialist. He, then, teaches a class in his own company to train additional men, perhaps for 2nd or 3rd shift maintenance.

8) If a company has a large group of men they want to train, arrangements can be made for one of Vickers school instructors to present a special training course at the company's plant.

9) Another source of assistance in training your personnel is the machinery manufacturer's sales and service representatives or the hydraulic equipment manufacturer's application engineers and service representatives. These men are trained specialists, well qualified to advise and assist you.

After recognizing the warning signs of trouble, it is important that the actual repair work be done by a specialist who has been trained in the know-how of hydraulics. These high pressure hydraulic components contain finely finished precision parts. They must be carefully handled and assembled to function properly. This requires trained personnel.

You wouldn't want an amateur mechanic to repair your car. If you have an electrical problem, you call in an electrician---a specialist. Repairing hydraulic equipment also requires a specialist. This is not a job for an untrained pipe fitter or machine repair man. If you do not have personnel trained to repair hydraulic equipment, call upon your machine manufacturer or hydraulic equipment manufacturer for a service representative.

When calling an outside serviceman for assistance, be prepared to accurately describe the symptoms of the trouble and to identify the units involved by model number. This will save time, and the serviceman can then come prepared with the necessary repair parts.

If you have a trained repair man, it is advisable to stock critical parts to avoid the delay required to have parts shipped to you. A small investment in inventory can save you a lot of down time.

Training To Save

The selection and care of the oil in your hydraulic system is probably the most important preventative maintenance function. Hydraulic equipment manufacturers provide hydraulic oil specification sheets covering a range of physical properties of oils which, in general, are suitable for their equipment. Most major oil companies can supply an oil which will meet these specifications. Not all of these oils are equally good for your particular application. Some oils are better than others. The oil company representatives are specialists who can assist you in selecting the most suitable oil for your particular operating conditions. The important thing, then, is to keep the oil clean, change filters regularly and control the oil temperature.

To prolong the life of pumps, Vickers Incorporated have recently been recommending the use of "MS" automotive crank case type oils for industrial hydraulic pump applications. These "MS" oils contain a large amount of "anti-wear" compounds which are very effective in reducing pump wear. Few industrial hydraulic oils available contain these "anti-wear" compounds, and none provide as much wear protection as the "MS" oils.

Not all "MS" oils are equally suitable for industrial hydraulic use. "MS", meaning maximum severity, is an American Petroleum Institute (API) classification for oils to provide good wear protection in gasoline engines. This does not necessarily mean that the oil will also be suitable for industrial hydraulic use. Some are, some are not. Vickers Incorporated has investigated many "MS" oils supplied by the major oil companies, and can recommend several that are suitable for industrial hydraulic use.

Training To Save

New industrial hydraulic oils containing "anti-wear" compounds are now under development by some oil companies, and should be available within about one year. As a temporary measure until these new industrial oils are available, the "MS" automotive type crank case oils will give you longer pump life. For a recommendation on the type of "MS" oil to use, contact your oil supplier, machine manufacturer or Vickers representative.

To illustrate how training can save you money, I will review a few reports of service calls made in this area recently.

1) Blow molding machine overheating.
   Improper valve adjustments and cover turned wrong on unloading valve. Correcting cover position and adjusting valves eliminated trouble. A trained maintenance man could have saved a 380 mile trip, and $154.00 service charge.
2) Die casting machine lost pressure.
   Pumps wearing out in 6 months. Changing from an off brand water base fluid to a recommended fluid eliminated trouble.
3) Injection molding machine wore out 3 sets of pumps in 6 months. Changing to a recommended hydraulic oil corrected trouble.
4) Deep hole drill pump noisy because the drive belt was slipping.
5) Injection molding machine pump worn out because the return oil was discharged over the suction strainers, causing aeriation of oil.

6) Injection molding machine pump failed because relief valve had been adjusted too high. 2500 PSI on 1500 PSI pump broke bushing.

7) Saw carriage in lumber mill overheated and lost speed. Worn pump, cylinder and valves resulted in excessive leakage and heat. The wear was due to contaminated fluid because filters had not been cleaned.

   An identical machine which received good maintenance in another plant had been operating without trouble for 5 years.

All of these troubles and service calls could have been avoided by proper training.

In summary, let me emphasize three points. It is important to:

1) Select a good oil and keep it clean.
2) Train your personnel to recognize warning signs of trouble.
3) Let only a trained hydraulic repair man service your machine.

Training will save you money.

August 29, 1963

"Handling Material & Reclamation of Scrap"

James E. Raus, Western Electric

Due to the continued growth and development of molded piece parts in telephone apparatus, the Indianapolis Works of Western Electric developed and constructed a building entirely for the molding and finishing of thermoplastic parts. This building contains 152,000 square feet of manufacturing area, and 73,000 square feet of basement area for material storage. There are presently 118 molding presses and, by the end of the year, this total is expected to be 130. It is expected that the building will be filled to capacity in 1965, having approximately 155 presses.

This building was constructed around our specific molding job and it is felt that we have both an efficient and functional operation.

Raw Material Handling

For the handling of raw material in the new building, it was found necessary to use the 50 pound bag and advantageous to use 1,000 pound containers.

The 50 pound bag is used for handling materials which are, in isolated cases, moved to the molding room floor for hand loading, or for materials which run in such low volumes that 1,000 pound containers would be impractical. Generally, we would prefer not to use this type container because they are difficult to stack, they puncture easily and must be transferred to some other type container for press feeding.

The 1,000 pound container was chosen in that it was the largest container available considering our multi-plexity of colors and molding material types. Also, each container has its own pallet and may be handled and stacked easily with a fork lift truck. In addition, the 1,000 pound may be placed under a press for direct feeding without transfer to some other container for loading. To completely empty a container of this size it was necessary to provide a method of moving the material into one corner. This was accomplished by tilting the containers on special tilt tables.

The various materials are stored together by type and, when required for use, a material handler on a fork lift truck picks up a container, trucks it to the press where required, and loads it on the tilt table.

<u>Drying</u>

Unfortunately, many molding materials must be dried to eliminate moisture which shows up in the molded product as mico specks, bubbles, internal voids, or surface blisters.

Many drying methods are used for removing moisture. Some of the more popular methods are: hot air circulating ovens, hopper dryers, desiccant dryers, and hot air rotating auger dryers. While some of our drying is accomplished in ovens, and hot air rotating augers, the bulk of the material molded at the Indianapolis Plant is ABS and not dried at all. It is purchased dry and kept dry until used.

It was found that ABS material manufacturers were capable of controlling moisture content to an acceptable range for molding and that if the material were shipped in polyethylene lined containers it would arrive at our plant dry. It was further found that the material could be kept dry even after opening if stored in a dry atmosphere such as we have provided in our material storage basement. (85°F dry bulb with a 15% maximum relative humidity)

To keep the material from picking up moisture at the molding press hopper, it became necessary to provide special hoppers which hold about a 15 minute material supply.

In case material should arrive at our plant containing moisture above the safe moldable range, hot air rotating auger dryers have been provided. These auger dryers have found application primarily for heating and drying the cellulosic plastics.

Press Loading

There are five basic loading methods available: hand, gravity, low pressure venturi, screw, and pneumatic. The volume of material used makes hand loading impractical, feeding from the basement prohibits gravity loading, desire to load from the original material container prohibits low pressure venturi loading, and the possibility of contamination between materials makes screw loading risky. This left the pneumatic loader as the best suited for our use. The pneumatic loader has been found to meet our requirements, presenting only the problem of "blow back." Normally, when a press hopper is full, the air must be shut off before it blows down into the pickup tube causing the material to cavitate and pack. We have eliminated cavitating by placing a small vibrator on the pick up tube which allows instant start up when the press hopper requires more material.

When a press requires a change of material, or if a feeding problem arises, a press operator steps to one of a number of telephones on the molding room floor and dials a number for the area in the basement from which his press is serviced. A material handler, in the basement, accepts the call starting the steps necessary to either change the material or correct the feeding problem.

Scrap Reclamation

In our new molding building, scrap generated at the presses--sprues, runners, defective parts, etc.--are returned to the basement via scrap chutes located at each press. Each type of material falls into its own sub-class. Some minor sorting may be done to take out metal inserted parts. The scrap material is then gathered and granulated in one of 14 grinders located in soundproof booths in a special granulating room. Central grinding was chosen over beside-the-press grinding for the following reasons:

1. It reduces noise level in the molding room
2. It means less pieces of equipment in the molding room
3. Less capital expenditure is required
4. It ties responsibility for quality of reground material

No reground material as such is used in our operation. All material for reuse is reprocessed by extrusion after grinding. This extrusion operation offers us a number of advantages as follows:

1. Blends into the reusable material slightly color contaminated material which would not, by itself, meet our color specifications for virgin material
2. Removal of "fines" from the material. These dustlike particles contaminate the air, settling on everything from the floor to open tools. Their elimination helps reduce dropouts as well as contributing to a reduction in housecleaning.
3. Control of bulk density. When scrap is granulated, the ground particles are of all sizes from "fines" up to the size of the grinder screen openings (usually 5/16" diameter) which produces a varying bulk density. This

problem shows up primarily in high speed automatic operations where controlled injection ram cushion is required. Our reprocessed material has a bulk density similar to that of virgin material.

4. Loading. With the method of loading the presses pneumatically from the basement, it is essential that the loading be performed with a minimum of difficulty. The "longs" found in reground will bridge across the pneumatic pickup tube opening, thus resulting in a stoppage. This problem does not occur when the reprocessed material is used.

5. Tramp metal. Many parts contain inserts which are molded into them. There are specific operations for the removal of these inserts; however, one missed insert, when granulated, will become 20 to 30 small pieces which contaminate the product and in the case of "hot runner molding," the tooling. The reclamation by extrusion process eliminates tramp metal by screening it out on a breaker plate.

The development of our reclamation by extrusion process started several years ago when colored telephone set requirements started increasing. We had previously molded the bulk of our product from black material which we were able to regrind and reuse. As color requirements grew, we were confronted with an increase in non-reusable scrap due to color contamination. At that time, it was felt that an appreciable amount of this scrap could be used by blending and mixing with virgin material.

Our first attempt to blend and mix was by a Banbury roll-mill process. This method proved uneconomical due to the large investment in equipment and the small amount of material which we felt we could salvage.

Later experimentation with an extruder indicated that this mixing could be performed economically.

We first started our extrusion operation to produce a uniform color from a mixture of contaminated material which we had developed from a tumbled blend of the various telephone set colors based on scrap generation rates. This mixture was molded into variegated color and was used for an internal terminal plate. As scrap generation grew with the greater demands for colored telephones, more scrap was being generated than we had use for, and when we attempted to extend usages of this mixed material, (commonly called "rainbow") we found the color variegation masked characters. We then ran the material through an extruder, blending the "rainbow" into a uniform color and today we use this blend for over 20 various internal parts.

In the developing of our extrusion operation, consideration was given to the use of a sheeting die instead of the pellet die we use. The pellet die was found to offer two very important advantages--it reduced fines and reduced angle of repose of the material in hoppers and containers.

If a sheeting die is employed, each pellet is cut on four sides, thus having 67% of the surface sheared. When a pellet die is used, only 14% of the surface area has been sheared. This results in a considerable reduction of "fines." Anyone who has ever lifted material pneumatically from a container has been confronted with the problem of material stacking on the sides and in the corners of the containers. The pelletized material, having less angle of repose, has a lesser tendency to do this and thus reduces loading problems.

In the course of developing our scrap reclamation program, it became important in the preliminary work to review the entire molding operation to see if each scrap loss was absolutely necessary. From our review, we became fully aware of the large amount of material being scrapped from color changes. To reduce loss in this area, we developed a method whereby a color change could be made with an average loss of 13 pounds of virgin material. This procedure is basically as follows: When a press is changed from one color to another in compatible materials, the first material is removed from the press loader, the press is allowed to run almost dry and then color contaminated material of the color to which the press is being changed is fed into the hopper. The press is not stopped until a color defective part is produced. Once this happens, the press and feeding mechanism is cleaned, the color contaminated materials are continued to be fed into the press, and the press is then purged until void of the first color. After the first color is removed virgin color material is used to remove the color contaminated material. The virgin loss is about 13 pounds compared to a previous loss of 65 pounds, and material which is already color contaminated may be reused by grinding and mixing into the blend color used for terminal plates.

Our scrap reclamation job is big business and its development has been a long slow process. During its development, particularly right after we started molding ABS, and prior to our present reclamation by extrusion process, we found ourselves generating large amounts of scrap which when reused caused streaks in the molded product or would not flow through the tool gates. This resulted in accumulating a scrap inventory which grew to over 300,000 pounds before methods were set up whereby this inventory could be depleted.

While we had methods of utilizing our normal scrap generation, we were at that time confronted with an abnormal amount of scrap being generated and this led to the development of one of our virgin material colors from white scrap. White was chosen for this because it was our most serious problem. White, when molded a second time, degrades in color to the point where it does not meet our requirements. This problem is amplified by the fact that white is the second largest color used--(black is first).

This very elaborate scrap reclamation process has been developed to allow us to operate the most economical method and if procedures and methods followed today with our 118 presses molding 995 piece parts from 12,500,000 pounds of plastic annually from 50 different types of materials on 460 tools were the same as methods employed in 1955 with 56 presses molding 5,000,000 pounds annually of which 80% was black, our current cost for additional material would be over $1,000,000.

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"HOW LONG SHOULD AN INJECTION MOLD LAST?"

by: Ernest J. Csaszar
Newark Die Company
24 Scott Street
Newark 2, New Jersey

Reference: Pioneer Valley Section
Regional Technical Conference
Worcester, Massachusetts
Sept. 23 & 24, 1963

"HOW LONG SHOULD AN INJECTION MOLD LAST?"

by: Ernest J. Csaszar
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24 Scott Street
Newark, N.J.

Those who are moldmakers have been asked thousands of times, "how long should an injection mold last?" No doubt there have been as many different answers. Because of the many factors that affect mold life, it has been difficult to give a satisfactory answer.

Actually, in the past, the answer to the question was, perhaps not vehemently sought, since molds were not too often taxed to the ultimate of their life. Short runs were much more frequent than the longer ones. In present day molding, however, ther are more and more applications where extremely long runs are required. The question of mold life has assumed a greater importance. Further, more molders are beginning to analyze their costs. For them, if for nothing more, an estimate of mold life is needed to complete the computations on operational costs.

As we give this subject more serious thought, we find that mold life is a quantity that cannot be separated out to stand alone. Many controlling factors are involved. First of all, what is mold life? When do we decide an injection mold has reached the end of its useful activity. Lets list some topics that might apply.

1. Obsolescence
2. Accidental Damage
3. Loss of Dimensional Control
4. Uncontrollable Flash
5. Excessive wear of moving parts
6. Use of new materials

These items, in themselves play a large part in the question we are discussing. However, it would seem a waste if, while we are discussing mold life, we do not include thoughts that would increase the useful running time of a mold. Let us, then, direct our remarks toward the elements that most strongly affect mold life and, as we list them, we can discuss factors that would tend to decrease the negative aspects.

Before we make our list, however, it might be well to determine a starting point. We have mentioned some items that would indicate the end of mold life. When does mold life begin? Does it start when a mold is put into the press?

The answer here could be yes. Most certainly, when an injection mold is exposed to its productive requirements, it is deeply in its function of active life. However, before the mold could be built, it had to be designed.

Does mold design then play a part in mold life? It would be safe to assume that factors of strength, mechanical function, selection of materials, features of runners and gating all would have their effect on mold life. Mold design must be considered a factor. Yet we can go a step further and say that mold design itself is dictated by the part to be molded. If this is so, we start the story of mold life with the details of the part design. Elements such as the material to be molded, configuration of parting lines, symetry of wall sections, and points of gating are factors to be considered. The point to be made is that mold life cannot be thought of as an entity by itself. It is made up of many factors, each contributing its own negative or positive effects. Further, mold life is not dependent solely on the moldmaker. Many of the factors involved are beyond the sphere of influence of the man constructing the mold.

We can now list these factors and explain their role. As was pointed out before, in our discussion of things that would tend to lessen mold life, we shall endeavor to include thoughts toward increasing life.

ITEM #1

Part Design & Mold Design - Often a simple thing such as a radius on the part can greatly weaken a mold component. Let us take as an example a stripper bushing used for ejecting purposes. If the part were to call for a radius at the point where the stripper bushing meets the force, then that point of the stripper bushing would require a knife edge of steel. It is easy to see that this knife edge would not long withstand the repetitive motions of cycle, and would soon chip off and thus break down. Component life on a part such as this would indeed be short.

Another bad application that is often committed in part design is to specify wall sections that are greatly uneven. The resulting pressure required to prevent sink marks cause undue stresses upon the mold components. It is understood that often, design functions require uneven sections of wall thickness. It would be wise, however, to make every effort to either core out the heavy section or redesign. Otherwise, lesser mold life is to be expected, and should be pointed out to those concerned.

ITEM #2

Tolerances & Workmanship - We should all realize that workmanship in mold construction plays a very important part in its life. Slide fits must be carefully engineered as to the clearances that should be allowed. Too loose a fit will cause cocking and subsequent binding. Too tight a fit will cause more immediate seizure. Selections of steel are most important where mold components move one surface against the other. Differential hardnesses are also a factor to be considered for some of the mechanical functions that may be involved.

Sometime ago a mold requirement came about involving the need of interchangeability between all like component positions. This requirement made it necessary to put extremely close tolerances on the fit dimension involved. The feature of interchangeability was thus readily achieved. However, a bonus came along with the close tolerance activity. It was found that the components and the frames made under these conditions yielded a relatively long life. As a matter of fact frames made to these tolerances have run over 5 years in satisfactory high-productive operation. Although we cannot say that close tolerance is the only ingredient required for long mold life, we certainly can say that it can be considered a good step in that direction.

ITEM #3

Initial Mold Set-Up - After a mold is completed and its first insertion into the press is about to take place, we reach a moment of great importance. It is an operation that deserves careful planning. Many hours of design and construction have taken place. These hours usually represent a rather sizeable expenditure. The first shot taken from the mold tells the story of just how well spent these hours were. A definite plan of action should exist in each plant for mold try-out procedures. This is especially true where cam actions or other complex mold movements are involved. In all cases where a component is in a dangerous position somewhere during the molding cycle it would be very wise to provide a micro-switch, and connect it in such a manner that closing of the press would be prevented unless the component were in its proper molding position. This is especially important where cam splits are involved.

One should make sure that one of the first things to do in mold set-up is to activate the low pressure close safety features, if they are part of the press.

One should, as routine, check the press platten parallelity. Initial flashing on a mold can occur with even the slightest condition of non-parallel plattens. As a matter of fact, as little as 1/8 of a turn on the setting of the clamping nut can lose half the clamping pressure.

A careful analysis of the material load as well as pressure and temperatur should be made. If a mold is flashed due to a hot shot with either too high pressure or material temperature, there can be permanent damage done that could require many hours of mold repair with the frame and components so stretched that mold life would be materially reduced.

Perhaps the most important point to make of initial mold setup would be that some definitely prescribed procedure be followed to the letter. To enforce this some check sheet should be provided so that a record of first shots can be kept and made part of the mold's case history.

ITEM #4

Abuse & Neglect - This category of mold life is most certainly a touchy one. No one wants to be accused of either abuse or neglect of a high cost item such as a mold. However, anyone visiting the average molding plant will observe many instances of just this type of activity. Often screwdrivers are used to remove stuck pieces from a mold where a piece of soft brass could be better used. In the opening of a gate, one might see a hand grinder being used. This not only yields an uneven gate as compared with the others, but it deposits considerable grinding dust throughout the mold components making for more rapid mold wear. Runner systems that have become flashed due to improper temperature, or pressure settings are sometimes left to run allowing the mold to pound itself into a permanently distorted condition. Sometimes in order to fill out a reluctant cavity position, excessive pressures are used rather than rework either the gates or mold temperature balance. The high pressures cause packing in the easier filled cavity positions putting unbalanced and unnecessary loads on the ejection mechanism. Here again we shorten mold life by increasing component wear.

The point to be made under this category of conditions is to set-up a procedure of good molding practices. It is true that stopping a press to take corrective steps is an expensive procedure. However this expense can often be a lot less than the cost of repairing mold distortion that would occur by allowing the poor molding conditions to persist.

ITEM #5

Distortion - Under continued use, the initial mold frame sizes can change materially due to the continued cycles of clamping pressure and injection pressure. Excessive movement to the frame can cause uneven wall sections and other lose of dimensional control. One might say that to overcome this weakness, the frames should be built heavier. It is true that in mold construction, material cost is not a great one, and it is certainly easy to add steel for greater strength. However, in our highly competitive industry and with ample plastenizing capacity of our presses, we endeavor to put as many cavity positions on a press platten area as possible. In doing this we put the cavity positions closer and closer together. This leaves less and less steel between each cavity. The less the steel, the weaker the construction. It becomes necessary for us to analyze one consideration against the other. More cavities mean less piece cost, but also shorter mold life. Each separate application presents its own conditions and must be handled separately.

ITEM #6

Abrasions & Wear - Mold frames are often made of conventional low carbon steel.

plates. In recent years higher alloy steels are being more prevalently used. High productive quantities, coupled with higher speed molding have further increased the need for stronger mold frames. This has taken us into frames of prehardened steel, and on some occasions fully hardened mold plates. Needless to say, a mold frame involving fully hardened plates can cost considerably more because, after heat treating, all close tolerance dimensions must be ground to size. Where we have 60 or 70 cavity positions, a fully hardened frame would cost $4000 or $5000 more than one involving plates of machinable hardness. Here again the advisability of going to fully hardened units is a problem in accounting. One must decide if the length of run is long enough to justify the costs of fully hardened plates.

Certain design features can also help in reducing wear. Let us take the specific example of a stripper bushing around a force plug. Its fit is usually that of one component sliding around the other. An alternate design could be used where the stripper bushing sits on a tapered seat. The taper eliminates the sliding motion that occurs with the conventional design. Without sliding there is practically no wear yielding a much longer mold. life. However, the cost of the tapered seat is almost twice as much as the straight slip fit.

ITEM #7

Rust, Corrosion, House Keeping - Molds can become damaged, shortening their life, even without being used. Just in shipping from the moldmaker to the molder, unless properly protected, the important surface can become rusted. Packing a mold for shipping or storage must be a carefully attended to procedure. Just plain smearing the surface with grease is usually not sufficient. There are many rust preventitives produced in spray dispensers on the market that, when properly used in accordance with the directions of the manufacturer, will safely protect against rust. The cleaning of rust from mold surfaces is not only costly, but it involves some steel removal, which could take close dimensions out of tolerance.

Chromeplating of molding surfaces can be an additional protection. However, it must be made clear that chromeplating is a pouros surface, and cannot be considered as an obsolute protection.

When injection molds are being run, many materials, after continued use, leave a film or dirt-like deposit on the parting line surfaces, as well as around ejector pins. This effects the performance of the mold in that the venting positions become partially blocked. Then, in order to fill, higher pressures or temperatures are used than would otherwise be necessary. Some periodic mold cleaning program should be a part of every molding plant's schedule. Where long runs are involved, it may be necessary to remove the mold from the press a few times a month to perform the necessary cleaning and maintenance functions. This point is being made because it is an often neglected function since pressing delivery schedules make it easy to avoid the procedure.

ITEM #8

The Pressure & Temperature - Perhaps the greatest enemies to the injection molder are those of pressure and temperature. This is true because whatever other problems that might occur during a molding operation, usually elevated pressures or temperature enhance the severity of the condition.

Here again, being able to use lower pressures and temperatures, carry us back to original part design. Even wall sections yield easy fill conditions and allow us to use lower pressures and temperatures. Proper mold temperature control lines also tend to help us in this direction.

Further, the design of runner systems and gates play an important part. So much so, that if any single item of mold design would be picked as to which were the most important, many opinions would point to gate and runner design. Fully balanced conditions of cavity fill are necessary for any sustained economical molding operation. In many cases, this is so critical that gate positions are applied via the electro-erosion practice to assure uniformity.

ITEM #9

Obsolescence - Many a mold, although in good working order, will come to the end of its useful life simply because its gone out of date. The part it makes may have been changed to a newer design. Perhaps a new material has come on the market with a different shrinkage necessitating the building of a new mold.

Perhaps we do not answer in terms of hours, days, weeks, or years as to how long an injection mold should last, but we have considered some of the things that shorten mold life, and we have added thoughts on how to lengthen life. It would be fine if we could develope a mathematical formula to help us calculate as to how long a mold might last. Let us try.

$$L_{\text{Mold Life}} = \frac{(\text{PART \& MOLD DES.})(\text{WORKMANSHIP})(\text{MAINTENANCE})(\text{ENVIRONMENT})}{(\text{USE})(\text{ABUSE})(\text{DISTORTION})(\text{PRESSURE})(\text{TEMPERATURE})}$$

We have listed above the elements in our favor that would increase mold life against the elements that would decrease it. Although we cannot substitute numbers into the above equasion, we can take the particular job we are considering and substitute thoughts. As we consider such items as length of run, dimensional tolerances, material to be molded, budgets to be adhered to, and other related items, we can at least make some decisions.

S A F E T Y   S A V E S

(Through Modern Inspection Techniques)

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For

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It is always challenging to develop something new and modern about a subject as old as the hills. The subject "Safety Saves (Through Modern Inspection Techniques)" is definitely in this category.

While the word "inspection" is very familiar to all of us as members of a professional engineering society, its dictionary definitions leave something to be desired.

Any standard dictionary provides three definitions:

1. To look upon
2. To view closely and critically
3. To scrutinize

So, when we make inspections WE LOOK, WE VIEW CLOSELY AND CRITICALLY, AND WE SCRUTINIZE. What do we do with all of this?

Every "Quality Control Plan" and "Every Accident Prevention Plan" with which I am familiar requires some form of "inspection". Altogether too many "inspections" could be classified as sight-seeing, hand-shaking, back-slapping expeditions, or as our current crop of teen-agers term it, "Eyeballing". I think we should ask ourselves the question "how many of our inspections are dry as dust, disorganized, and unproductive?"

Our inspection plan or program should have clearly defined objectives. I will try in this discussion to outline a few ideas which may be of value to you, as well as outline the benefits derived from an effective inspection plan or program.

The basic duties of an engineer may be jelled into five or six words.

1. Inspect (survey)
2. Record

3. Analyze

4. Evaluate

5. Design

It is difficult to apply the last four items unless we have an honest understanding of the first item "inspect". Therefore, for the purposes of this discussion we will concentrate on the first item "inspect" as well as discuss the benefits developed.

We must realize that experience is still the best teacher. Analyses, accident and quality investigations, and inspections are closely related. One without the other does not provide complete guidance and direction. As further background material we should have a broad knowledge of the successes and failures of other organizations. We should have a knowledge of data published by the Society of Plastics Industry, Inc. American Society of Safety Engineers, Bureau of Standards, American Standards Assoc., National Safety Council, State and local laws, and Insurance Companies.

In directing our own efforts and the efforts of those persons working under our guidance we should have a clear-cut understanding of the greatest human weaknesses with which we are all susceptible, and that is, not being able to understand and record that which we have seen.

The first slide which will be projected shortly will contain a portion of an old adage with which we are all familiar. I will leave it on the screen for three seconds and then it will be blacked out. This is a difficult experiment to carry out with such a large audience. I am going to ask each of you to record on the back of a piece of scrap paper exactly what you think you have seen on the screen.

Project Slide #1 - timed for 3 seconds.

Black out the slide.

Project Slide #1 - timed for 3 seconds.

Black out the slide.

Now I would like to have a show of hands to the following questions:

A. How many noted a triangle?

B. How many noted an equilateral triangle?

C. How many noted the adage "____ ____ ____ ____ ____"?

D. How many noted the adage "____ ______ ___ ____ ____"?

Quote percentages to the group on the answers to each question.

And now let's look at the slide again.

Project Slide #1 again.

Normally, this kind of exposure and explanation to persons making inspections should assist them in digging out the facts surrounding a hazardous condition, observations made during the study of an accident, or checking out the reason for a poor quality product. I believe that this slide proves the point that altogether too often we see or observe that which we expect to see. We expected to see an old adage but a percentage of us failed to notice a slight alteration or addition.

At this time I want to assure you that when I first participated in this experiment I failed miserably.

If time permits it is my intention to cover the following items:

Why do we make inspections?

Who should make inspections?

How should inspections be made?

When should inspections be made?

What should we inspect?

First, however, I believe we should consider some of the results of modern inspection techniques with regard to safety.

Project Slide #2

Countrywide Occupational Accidents

Compared with Employment 1941-1961

Accident prevention efforts of employers and insurance companies have effected a material reduction in work injuries during the last two decades. While the number of workers has increased by 16,400,000 (an increase of 33%) fatal work injuries have been reduced 30% and disabling injuries have been reduced 11%.

Black out slide #2

On the other hand we must consider the other side of the coin. The benefit levels available to injured workers across the board in the United States has increased materially between 1948 and 1962.

To give you some idea of how this works out let me quote some average costs;

In 1951 the average compensable accident (including medical) cost $752. In 1960 this average cost had risen to $1257. On a nation-wide basis, compensation and medical costs have risen 67%. And costs will continue to rise.

Here in Massachusetts compensable accident costs have risen from $908 to $1500 (an increase of 64%).

Personally, I dislike to use statistics, but the message I am trying to convey is; that while workers have increased, number of accidents have decreased, but the costs of those cases that do occur have materially increased.

To provide further cost controls it is necessary to increase inspection and other loss control activities.

In addition to Workmen's Compensation and Medical Costs we must not overlook the Hidden Cost of an Accident. Let me cite an example verbatim from the Plastics Safety Handbook.

"Here is an example of how the unconsidered or hidden costs of accidents can penalize a company. In a manufacturing plant, the base pay for power press operators is $1.85 an hour. If an employee is injured, he continues to get his base pay while he goes to a first-aid room or to a physician. During this time, generally, the worker's press or operation is shut down and produces nothing. However, the overhead in the plant goes on just the same. It includes the cost of power, light, heat, truckers, clerks, depreciation, fringe benefits, and other items.

"In the case just cited, if the shop overhead of the plant is 250% (and in some industries this loading may vary from 150 to 400 per cent), the actual cost to the company is not $1.85 per hour, but $6.48 per hour. It is not unusual for a worker whose injury requires a physician's attention to be absent from his job for three hours.

"The same plant ran a study on ten "doctor" cases, which resulted in 23 additional trips to the physician for redressings and treatments or a total of 33 visits to a physician. When medical expenses, cost of dressings, and overhead costs were totaled, the average cost per case, in which there was no "lost time" as such, was $23.06. The total cost for the ten minor cases was $760.98."

There are many other examples of this nature appearing in the handbook which should be required reading for all management people.

Generally, we figure a ratio of 4 to 1.

To express it another way, for every $100 of <u>direct</u> or "insured" <u>compensation</u> <u>and</u> <u>medical</u> cost you also have, on the average, an additional indirect or "uninsured" cost of $400.

I have here a pamphlet which gives a complete explanation of this subject which even provides a table whereby you can figure your own "indirect" or uninsured cost. Some of the uninsured items considered are;

A. Value of material spoiled, damaged and cost of reprocessing.

B. Cost of repairs to machinery and equipment.

C. Production time lost by other employees.

D. Extra labor employed for clean-ups.

E. Cost of transfer, hiring or training new personnel.

F. Cost of production loss - idle machines.

G. Substandard output of substitute employees, delays and interruptions in normal operation.

1. WHY DO WE MAKE INSPECTIONS

In general, to detect and identify physical conditions and unsafe acts which have caused or may cause personal or property damage accidents.

The inspector should be expected to suggest corrective measures for the hazard observed. If he has difficulty in suggesting corrective action he should be encouraged to review the "problem" with his superiors. Two heads are always better than one.

We make inspections -

a. To reveal specific hazards (clues provided by accident experience).

b. To analyze new, seasonal or infrequent operations - before they occur - for the purpose of eliminating hazards in advance.

Illustrations

Ice, snow and freezing rain on stairs, walks, parking lots and access road; tank cleaning; modification of process; receiving and storing of supplies; painting, overhauling, excavation, construction or demolition.

c. To detect unsafe and personal acts of employees which may result in personal injury to the operator himself, his fellow-worker, or property damage.

d. To further the accident prevention education of management, supervisors, and employees.

2. WHO SHOULD MAKE INSPECTIONS

Inspections may be made by anyone. We will assume that the person will be completely indoctrinated with regard to his status, authority, and responsibility.

An inspector may serve permanently or rotate with others at regular intervals. Permanent inspectors may go stale whereas rotation spreads experience and education.

There is no one in our profession able to recognize and measure all possible hazards. There is no one person in any of our establishments who can perform a 100% complete inspection. The person qualified to inspect one piece of equipment or operation may be unqualified to inspect another.

Illustration

Inspection of a new device to test for "stray radiation" placed a scientist within inches of several high speed in-running rolls. He wore a long, unclipped necktie and had to straddle a "Broke hole" 48 inches square. A mis-step would have dropped him 30 feet to the floor below. In attempting to measure a new suspected hazard, two basic hazards were overlooked.

We must know the qualifications of our inspector, and we must define the objectives and scope of his inspections clearly.

Illustration

Hazards requiring special skills: -

Boilers, pressure vessels.

Elevators, escalators, cranes, hoists and slings.

Toxic vapors - dusts.

Explosive substances.

Radiation hazards.

Let us make sure the man with the proper background is assigned to each inspection job. Time and effectiveness will be lost if we assign a person with restricted qualifications to make an indefinite and undirected "general inspection".

Accidents occurring on injection molders are one of the major hazards confronting the plastics industry. The frequency of the accidents could be termed as low but the severity is extremely high. I have here a long list of accidents that have resulted in major amputations. They average many thousands of dollars.

At the time the Plastics Safety Handbook was published (1959) not too much accident cost data on this subject was available. But with the extended use of the injection molders, data on severe accidents is beginning to pile up.

The chapter in the Plastics Safety Handbook does not emphasize the severity of the injuries that do occur, nor does it discuss in detail, straight mechanical protection against accidental die closure. Yet in the Fitchburg-Leominster area you would have difficulty in locating injection molders without this protection. I believe this represents a challenge to your Chapter in sharing this knowledge and developing guarding standards elsewhere.

With or without mechanical protection the development and use of rigidly enforced safe practices on injection molder safety would minimize accidents.

Suggested lists of safe practices are available for this purpose. It would be extremely difficult to enumerate all the safe practices that should be developed for all models available. However, we urge the consideration and adoption of such safe practices by all users.

On the other hand, if we must use men with limited backgrounds we should regard this as an unsurpassed teaching opportunity. The next slide that I will project illustrates this matter quite clearly. In recent years we have had an increase in the use of plastic injection molders. As a result, a few of our people knew a lot about the subject and others had not even heard of the hazard. Gradually the use of this piece of equipment spread to other areas. It is uneconomical to send one man through the whole area to try to evaluate the complete problem. It therefore seemed sensible to instruct our people on a method of evaluating the problem.

Project Slide #3.

Project Slide #4.

These slides indicate a version of an inspection guide on a highly specialized piece of equipment.

(Discuss major points)

Several users of this equipment have produced their own version of an inspection guide sheet - which includes daily inspection of;

1. Block-out bars - lengths, movement and seating.
2. Front Gates - including all switches, rails, stop adjustments, and transparent screens.
3. Rear Doors and Gates
4. Emergency Stops and Auxiliary Enclosures.

Dates and signatures are required.

To check on the accuracy of the inspection, members of top management make their own personal spot check inspections.

3. WHEN SHOULD INSPECTIONS BE MADE

There are many variations in the time element that should be considered.

a. Periodic

Inspections should be made at regular intervals daily, weekly or monthly of the entire establishment. Certain equipment or processes where the controls are especially sensitive or delicately balanced (case in point - injection molders) should be made daily (or at change of shift).

b. Continuous

Usually conducted by persons employed on a full-time basis who are responsible for the operations assigned to them. If a product quality control unit exists in the organization their able advice and observations should be solicited.

c. Special

Area inspections involving high hazards, new, infrequent, or seasonal operations should be scheduled intermittently. Certainly we should "follow-up" on areas where previous suggestions have been made to determine progress or lack of progress.

d. General Items

Dates set for inspections may or may not be announced in advance. Something good may be said about both methods. All multiple shifts should be covered. It is truly amazing what may be observed on the "grave yard" shift.

4. WHAT SHOULD WE INSPECT FOR

There are many ready-made check lists available. Let us think twice before we adopt them as they are. We should never hesitate to destroy a check list we have been using for years. A change of format is always healthy.

As being much more effective than any ready-made list I heartily recommend a custom-built (tailor-made) guide for every establishment.

I have already presented one illustration which is highly individualistic on a special hazard. This is the type of thinking that should result from such a discussion.

There is no limit to the special hazards that may be surveyed in this manner. We must never forget that each establishment and each operation is as different as the persons involved.

Project Slide #5 - Grading of Basic Hazards

This slide illustrates in a generaly way a method that would allow the hazards within a department to be surveyed. It is as much a check on the powers of observation of the inspector as of the actual conditions within a department. This guide sheet simply asks for the grading of specific hazard and the grading of the controls exerted over these hazards.

The lower half of the sheet asks for details on how the heavy and severe hazards are controlled. I wish it was possible to state that this particular guide is the complete answer to inspections, but alas, it is not.

This sheet simply guides the inspector throughout his inspection. I heartily recommend this technique in the building of your own surveys.

Project Slide #6 "Grading of General Hazards"

This inspection guide covers the general safety aspects and as illustrated allows room to explain all "poor" and "fair" ratings.

I realize that it is estremely difficult for me to project problem evaluation and inspection sheets and discuss it from a standpoint of training you all in the points that should be checked out in your plants. Rather, I believe there guide sheets should open up the doors to literally thousands of applications. This could be developed for any machine manufactured today, in any industry.

It could be and has been adapted as a "ladder" survey. If such a guide sheet was developed for this purpose you would be surprised at the number, type and condition you would find throughout your organization. The same would apply to stairways, floor surfaces, loading docks and even chairs.

It was my privilege during 1961 to work on a joint national committee of American Society of Safety Engineers and Junior Achievement Chapters in the United States. Here we have a situation where it is necessary to develop maximum safety with boys and girls of high school age. The safety inspection guide sheet was geared to enlisting the aid of Junior Achievers of high school age in controlling accidents. I heartily recommend this as required reading for those who are about to embark on a program of developing their own inspection guides.

While on this same subject I would also like to refer you to the "Plastics Safety Handbook" published in 1959 by the Society of the Plastics Industry Inc., in cooperation with the National Safety Council. (In fact, I believe a few of the contributors to the handbook are here with us today.) The handbook contains many references to the subject reviewed today. I heartily recommend continuous study of the handbook.

5. HOW SHOULD INSPECTIONS BE MADE

We have discussed the person who is to make the inspection, when he is to make it, why he is to make it, and what he is going to check. But he is not ready to turn loose yet. I would like to mention a few of the more personal methods and attitudes which will assist any inspector to do a more effective job.

a. He must have the physical ability to get into every nook and corner of the area to be inspected. This may involve walking, climbing, the ability to take noise, confusion, chaos and quiet.

b. He should follow the process from beginning to end. His route should be orderly, but we should remember that on occasion it would be well to reverse the procedure. Altogether too many times the inspector may be tired out at the end of his inspection. In larger establishments we may lay out a route floor by floor or departments.

c. He should have the good taste to contact the person responsible for the segment of the operation he is looking over. Basically he should avoid discussing managerial problems directly with employees unless in the company of supervisors (or at their request).

d. He should have an "inquiring" mind. He should be curious about everything he observes. If an inspector intends to observe any operation from a standpoint of unsafe acts it is worth while to make up your mind to sit quietly in some corner and observe what goes on. You may sit in one spot and look at an operation for an hour and then things may begin to happen that you had never observed before. One word of caution, however, about this particular procedure, and that is, you should have the whole-hearted cooperation and understanding of the supervision of the area under observation.

e. An inspector should never acquire the reputation of being a pessimist or an habitual fault finder. Supervisors should not dislike to have him in their departments. To combat this, the inspector should always try to demonstrate his sincerity and desire to be helpful to the supervisor regarding the health, safety, and well being of his employees. The one single thing that will do the most in this connection is to be willing to recognize those things which are "good" as well as those things which are "poor". It is interesting to note how many things are being done to avoid accidents. If you haven't used this technique - try it the next time you make an inspection. This particular subject could produce a discussion of many hours.

f. We should not hesitate to use a camera to photograph conditions needing correction. This important "tool" may, upon occasion, produce startling results. We should be as eager to take photos indicating good conditions. As stated previously you should have the whole-hearted cooperation of supervisory personnel on such a venture.

g. Whatever the inspector puts in writing he should be willing and eager for anyone to review. Whenever writing up results of an inspection with recommendations the inspector should: -

(1) Clearly identify the location, operations and equipment involved.

(2) Explain clearly and fully the action suggested.

(3) Back up each recommendation with authoritative statements on the potential hazard.

h. He should be dressed properly (and I don't mean as a fashion model). He should be provided with the proper personal protective equipment (such as goggles, hard hats, safety-toed shoes) that workers are obliged to wear in carrying out their daily tasks.

i. Last but not least, his own individual habits should be above reproach - on and off the premises. He should lift properly, walk down stairs properly, and drive properly. In short, he should exemplify all that is good in man.

Now let us examine the results of both adequate and inadequate safety and inspection programs.

Project Slide #7

"Results of Inadequate Safety and Inspection Program"

This slide indicates the experience charges applied to a plastics outfit that has not maintained an adequate safety and inspection program. This chart covers a period of 14 years from 1950 through 1963 - experience charges imposed on the average rate vary from 7% to 154%. There has never been a year when an experience credit has been produced. During this period of 14 years it is estimated premiums have averaged 61% higher than the expected normal.

Project Slide #8

"Results of Adequate Program"

This slide shows the results of 18 years of an adequate program (and this includes the use of gate actuated block-out devices). Credits on experience rating have averaged 22% during this period. Bearing in mind the size of the plant and the payroll developed, a "direct" savings of $30,000 in insurance cost resulted during the last period alone. If you wish to apply the 4 to 1 ratio of "hidden" costs, an additional "indirect" savings of $120,000 has been made.

Project Slide #9

"Comparison of Average and Actual

Workmen's Compensation and Insurance Rates"

(Where an adequate program has been applied)

This chart further indicates how insurance costs are reduced when a continuous and adequate program has been applied.

(Point out highlights)

Any concern in Massachusetts paying a premium of $750 per year at base rates (or averaging $1500 for two years) is subject to experience rating.

You are entitled to know exactly how you stand with regard to such costs. If you do not know how you stack up I believe you should make it your business to do so. Any reputable insurance carrier is equipped to handle this explanation for you.

We have defined the word "inspection" itself, the duties of an inspector, and the background needed. We have covered _why_ we make inspections, _who_, _when_, _what_ and _how._

We have pointed out the "DIRECT AND INDIRECT" savings resulting from an adequate and well maintained top management backed inspection and safety program.

But more important than all of these things we should never forget that through some observation and action of ours while making inspections, we have controlled a situation which saves another fellow human being from personal injury.

DESCRIPTION OF SLIDES

***Slide #1 - "Adage"

*Slide #2 - Countrywide Occupational Accidents Compared with Employment 1941 through 1961

**Slide #3 - Injection Molder Hazard Evaluation (Page 1)

**Slide #4 - Injection Molder Hazard Evaluation (Page 2)

*Slide #5 - Grading of Basic Hazards

*Slide #6 - Grading of General Hazards

***Slide #7 - Results of Inadequate Program

***Slide #8 - Results of Adequate Program

***Slide #9 - Comparison of Average and Final Workmen's Compensation Insurance Rates (Where adequate program is applied)

*Permission granted for general publication

**Data to be released by speaker only

***Data not to be published

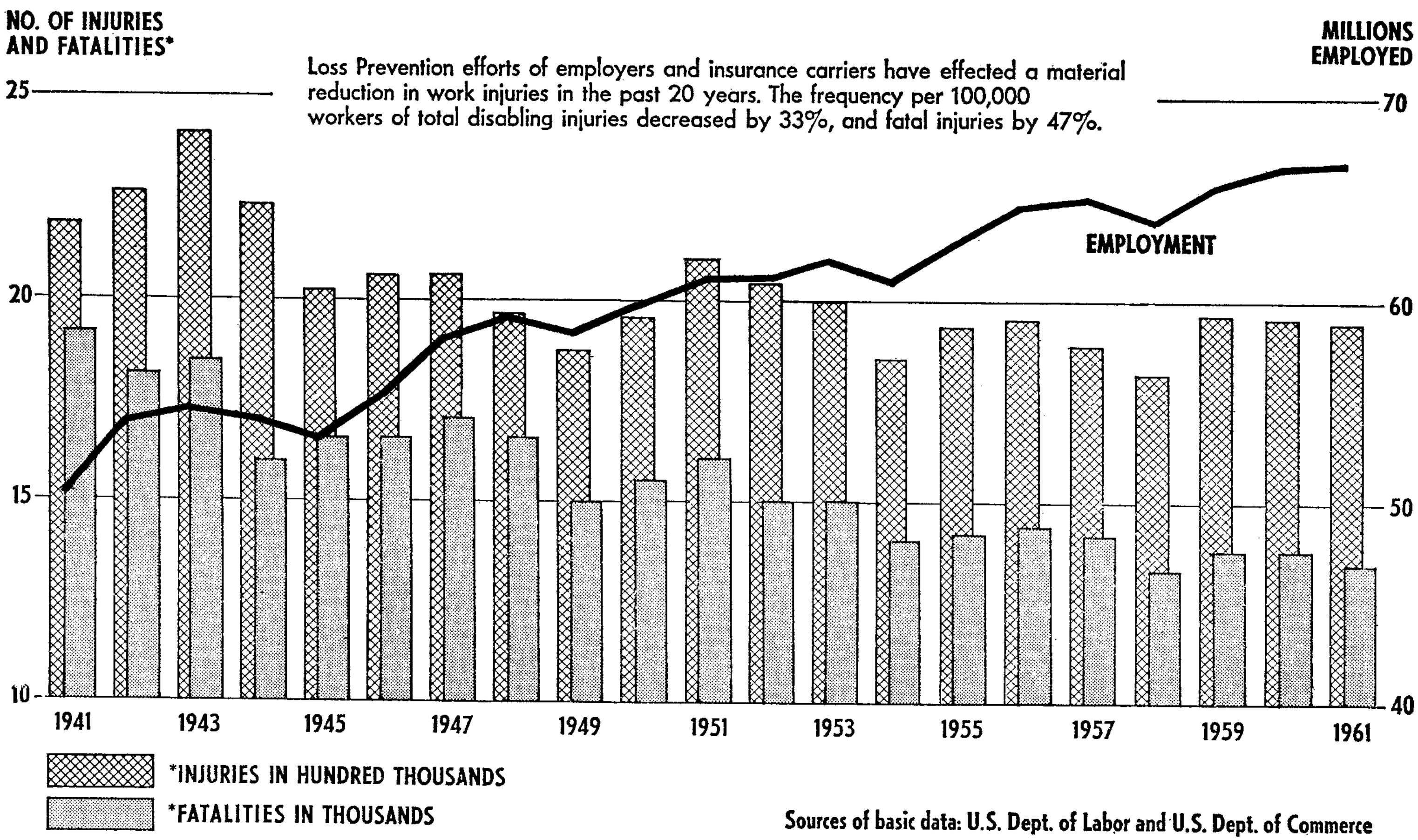
Handout Material - "ACCIDENT COSTS AND WHO PAYS THEM"

" " - "ARE YOU PAYING TOO MUCH?"

COUNTRYWIDE OCCUPATIONAL ACCIDENTS COMPARED WITH EMPLOYMENT

1941-1961

Loss Prevention efforts of employers and insurance carriers have effected a material reduction in work injuries in the past 20 years. The frequency per 100,000 workers of total disabling injuries decreased by 33%, and fatal injuries by 47%.



Sources of basic data: U.S. Dept. of Labor and U.S. Dept. of Commerce

BASIC HAZARDS	SEVERITY OF INHERENT HAZARD				CONTROLS*			
WORKMEN'S COMPENSATION:	REMOTE	LIGHT	HEAVY	SEVERE	POOR	FAIR	GOOD	EXCELLENT
1. **Machines & Equipment** — p't. of operation								
2. Machines & equipment — all other — belts, gears, shafts, etc.								
3. Material handling hazards — manual, mechanical								
4. Electrical hazards								
5. O. D. hazards — incl. dermatitis, dust, gas, radiation, noise, fumes, etc.								
6. Fire and explosion hazards								
7. Slips, falls, collision, etc.								
8. Flying materials — eye injuries, etc.								
9. Burns — heat, chemicals, etc.								
10. Miscellaneous — cuts, punctures, bumps, bruises, abrasions, etc.								
GENERAL LIABILITY:								
11. Non-employees on premises								
12. Hazards to neighborhood — (incl. waste disposal)								
13. Away-from-plant operations								
14. Product liability								

*CONTROLS OVER HEAVY AND SEVERE HAZARDS

ITEM #	DESCRIBE HEAVY AND SEVERE HAZARDS	ITEM #	DESCRIBE CONTROLS

GENERAL CONDITIONS

Cross out items that do not apply	POOR	FAIR	GOOD	EXC.	If item is rated **POOR** or **FAIR**, explain
Housekeeping — General					
Housekeeping — Floors & stairways					
Housekeeping — Aisles & storage					
Maintenance — Machinery					
Maintenance — Hand tools					
Maintenance — Lighting					
Space provision — Layout					
Building construction					
Floor loading					
Exit facilities					
Fire protection					
Neighboring hazards					
Boilers & pressure vessels					
Elevators & hoists					
Storage — Raw material					
Storage — In process					
Storage — Finished					
Traffic control					
Management interest					
Safety program					
Protective equipment					
Training program					
Medical facilities					

8/19/63

Cost Reduction in Blow Molding

By: W.R. Miller, Hercules Powder Company

New developments in blow molding equipment technique, and resins make it possible to effect substantial cost reduction in this field. Of course the degree to which such reduction in blow molding fabrication costs can be accomplished depends upon the design, size, and number of articles being produced. A careful study of the entire operation may reveal several areas where improvements can be made.

Let's begin this discussion by taking a look at basic blow-molding technique. The two generally recognized types of operation are extrusion blow-molding and injection blow-molding. There are of course combinations of the two. One of the advantages of the injection-blow process is the fact that it produces a finished piece with no scrap either in the neck finish, in the case of a container, or bottom pinch off areas. This means that the costs of trimming and reaming, and scrap reprocessing are practically nil. Another advantage of the injection-blow process is the ability to distribute the plastic melt in such fashion that upon being blown the parison produces an article of uniform wall thickness regardless of variation in diameter or shape. The better distribution of plastic permits an overall weight reduction for equivalent impact, stress crack, and permeation resistance and consequently lower material cost per piece. Because the injection-blow molding process has definite limitations, product size and design, the method is not as popular as extrusion blow-molding nevertheless the principles of finished parts and uniform wall distribution should be the target of all blow molders.

Well then, how can the average blow molder with extrusion type equipment obtain the advantages of the injection technique? In containers or similar articles he can approach the finished neck concept by using a captive neck wherever possible. Captive neck meaning that the parison is smaller in diameter than the neck section of the mold and therefore no pinch-off or trim occurs along the sides of the neck. This technique cannot be applied where the neck diameter is small compared to the major diameter of the part as this would result in too high a blow-up ratio. Another technique which the molder might use is to compression mold the neck on a mandrel which is sized to produce the correct inside diameter. Although this method eliminates neck reaming it will produce some degree of pinch-off along the sides which will require trimming. Neck finish trimming is made easier however because the parison is compressed to a very thin web.

There are blow-molding machines available which practically form a finished neck. This is accomplished by using a combination of the captive neck principle together with compression molding. The parison is dropped over a blow pin which moves toward the mold after the mold closes to compression mold the edge of the finish and cut off the excess plastic beyond the finish. The process does not eliminate scrap but it does help to reduce the degree of trimming required.

The problem of bottom pinch-off or tail removal has been approached in two different ways. Equipment is available which is designed to seize the tail and rip it free while the mold is closed.

In addition, at least two machine manufacturers have devised means for trimming and sealing the bottom of the parison before mold closing takes place. This means that the part is blown from a closed plastic tube or true parison. In neither method is there any saving in the amount of scrap generated; however, a trimming operation is eliminated.

Now, lets consider the second advantage of the injection blow-molding process, the ability to distribute the plastic melt so as to end up with uniform wall thickness in the blown part. There are several reasons why uniform walls are advantageous. First, uniformity eliminates the need for excessively heavy walls in some areas to get the minimum required thickness in others. This means that overall part weight can be reduced thus resulting in a material saving or if you wish a saving in utilities per part because of less resin processed. Second, there is a saving in amount of scrap generated and subsequent scrap processing, reject bottles are lighter weight. Third, better quality parts are produced since stresses due to uneven shrinkage because of poor wall uniformity are eliminated.

How then can the extrusion blow-molder obtain better plastic distribution in his product? He can reduce the thinning out effect of drawdown or parison stretch by extruding the tube rapidly with a plastic accumulator or ram screw extruder. By extruding rapidly just prior to mold closing the tube has less time to stretch under its own weight. Drawdown can be reduced by using a resin with good hot strength properties. Resin viscosity, temperature, and molecular weight distribution effect hot strength.

The blow molder can obtain better plastic distribution in his product by a system of parison programming, that is by varying the parison wall thickness at various points along its length. In this manner he can put a greater amount of resin at points where the blow ratio is greatest. There are at least two programming methods available in commercial blow-molding equipment. Probably the most common method is referred to as pressure programming. In this method the melt pressure is raised and lowered to increase and decrease the plastic swell thereby increasing and decreasing the parison wall thickness. Plastic pressure is increased or decreased by varying the hydraulic pressure on the accumulator or ram screw if this device is used. With a well designed pressure programming system it is possible to obtain gradual as well as very abrupt changes in wall thickness.

Parison programming may also be accomplished mechanically by changing the size of the diehead orifice during the extrusion portion of the cycle. The above is usually done by moving a tapered flow pin tip with respect to a stationary tapered die. As the cone shaped tip approaches the die the opening becomes smaller and a thin walled section is produced in the parison, the reverse occurs when the tip moves away from the die. This programming method is particularly effective on continuous extrusion type machines where there is sufficient time to actuate the moving parts of the diehead. The use of mechanical programming in this type machine eliminates the need for an accumulator except for very heavy parts where parison sag becomes a problem.

Better plastic distribution with more uniform circumferential wall thickness can be achieved through improved diehead design. Many designs are sensitive to changes in melt viscosity brought about by variations in the resin, temperature fluctuation, or pressure fluctuation. Since the diehead design is fixed, changes in melt viscosity result in different flow and velocity patterns in the diehead. If wide variations in melt velocity are not reduced to uniform flow rates at the die opening excessive parison curl and rippling will result. In attempting to eliminate parison curl die and flow pin tip excentricity may become so great as to result in a nonuniform parison and consequent nonuniformity in part wall thickness. The conventional solution to this problem has been to incorporate a choke or weir in the diehead to create uniform annular velocity in the spill-over. However, the use of a choke is not a good solution to the problem because it creates a pressure drop and lowers extrusion speed. A much better solution is the so-called "high-volume" section in the diehead. The high volume section is a zone well above the die orifice in which the annular area between the diehead housing and the flow pin is suddenly increased several fold then gradually decreased to the die entry area. The flow of hot melt into the high volume section results in a velocity decrease and elastic recovery which promotes uniform flow to the die. The high volume section goes a long way toward eliminating parison curl, diehead weld lines, and high velocity ripples in the parison without reducing melt output rate. It must be realized that the end effect of good wall distribution is not only a material saving but also a saving in trimming and scrap reprocessing costs because the scrap has been light weighted as well as the part.

Obviously, any increase in the efficiency of machine operation represents a cost reduction. Equipment modifications or changes in procedure which shorten the molding cycle are most beneficial for the result is better use of equipment and manpower. Since the cooling or curing portion of the total cycle represents about 75% of total cycle time it is here that our efforts will pay the biggest dividends. As far as the polyolefins are concerned, the value of well distributed mold coolant at as low temperatures as possible is well known. The limiting factor here is the dew point of the air surrounding the mold. As the mold temperature falls below the dew point water condenses on the mold and disfigures the blown parts. Air conditioning or dehumidification of the molding area helps but is expensive. Some advantage is to be had by keeping mold open time to a minimum thereby reducing exposure to the air and at the same time preventing the skin temperature of the mold from dropping to its lowest possible temperature. High blow air pressure and good mold venting help to shorten the cooling portion of the cycle by promotion better contact between the plastic and the mold wall. Of course, operation at the lowest possible melt temperature, consistent with processing requirements, is desirable.

Internal cooling of the blown part helps to shorten the cooling cycle. Ventilating the blown part during cooling by allowing the hot blow air to escape while maintaining blow pressure helps to cool the part faster and reduces stress buildup by making internal and external wall shrinkage more nearly the same. Blow air pressure should be maintained until just before the mold opens. Internal water vapor spray helps to cool faster but sometimes creates water removal problems. Blowing with expanded liquid carbon dioxide certainly helps to shorten the cooling cycle, the economics of such a system are reported to be good.

Post forming operations are responsible for a large portion of the total part cost in extrusion blow-molding plants. Due to the many variations in blow-molding technique, designs, and part sizes involved there is no standard equipment available to finish blown parts The following check list is offered as a means to review the post finishing operation and perhaps stimulate ideas which will result in cost reduction in this area.

1. Is the finishing line completely conveyorized with rollers, belts, chains, or pneumatic tubes to save time and labor in transporting parts?

2. Are all possible finishing operations being done in the mold or blowing press?

3. Have machine components been supplied to do the cut off, trimming, reaming, etc. which cannot be done in the press? Are these components tied in to the conveyor system?

4. Has hand trimming been reduced to a minimum?

In the post finishing area we have found that the method of material removal will depend on part design, size, and plastic type. Generally speaking, saws of various kinds, fly cutters, knives (sometimes heated), reamers, and routers will do the job. It is important in all trimming operations to hold the part securely, in a clamp or nest. Sharp tools of hard steel are necessary. Saws should have sufficient set to minimize binding and clogging. In all rotating tools sufficient inertia should be provided to prevent changes in angular velocity and subsequent chattering, this is very important when cutting thick walled parts. Cutting tools should be fed into the plastic at constant, controlled rates for best results.

In the above discussion I have tried to cover the technical and mechanical aspects of blow-molding which have a bearing on production costs; however, there is room for one more thought. Significant economies can be had through the use of a resin which is consistent from lot to lot in the vital properties of viscosity and pressure sensitivity. The above properties being the ones which give highest output at lowest temperature consistent with good processing and desirable properties in the finished part. Because there are so many differences in blow-molding machines and operating conditions it is essential that the molder work closely with his resin supplier to determine the optimum resin properties for each application. I hope that you have found this discussion interesting and that it has stimulated ideas which can be applied to your operation to make it more profitable.

WRMiller/bb

8/19/63

COSTS AND BUSINESS DECISIONS*

by: Arthur S. Wells, Jr.
Tennessee Eastman Co.

My assignment on your program today is to discuss how simple economic analysis can be used in the management of a plastics processing business. I shall draw upon my experience with Tennessee Eastman, which has been largely in the area of making staff economic studies to aid management in reaching decisions in business problems of all kinds. I shall, however, try to adapt my comments to the plastics processing industry and particularly to some of the problems likely to be encountered by a molder or extruder in that industry.

First, I shall outline briefly what might be called "the anatomy of a business decision", as background. Second, I want to discuss the kinds of cost and profitability information which are useful in making business decisions. Finally, I will suggest some ways of developing this information cheaply and effectively in a small business.

The Anatomy of a Business Decision

The steps in the decision making process are quite obvious - perhaps so obvious as to be often overlooked in the pressure of day to day operations. In our staff group, we have found a step-wise pattern to be quite useful in preparing studies for management. This procedure, which is by no means original with us, is the following:

1. Define the problem.
2. Define all the possible alternatives for solving the problem.

3. Analyze each alternative to determine the effect on:

    a. Profitability in dollar terms

    b. Other objectives in non-dollar terms

4. Reach a decision or recommendation. In my case, of course, that of a staff man, I don't decide but merely recommend.

Now, you may wonder: what is the purpose of this rather formal statement of the obvious? Of the items listed, only the third calls for the generation of economic - i.e. cost and profitability-data. The reason for thinking about economic analysis as an integral part of the decision making process will, I hope, become apparent as we proceed. For the time being, I would like to discuss each of the above items briefly.

1. Define the Problem. This simply means stating the question before the house as precisely as possible. For example, such questions as: What price should we bid on a job; What should the run size be on a molded part; What should our inventory levels be on purchase materials; Should we buy resin in bags or in bulk; Should we acquire a new extruder; How can we obtain additional capital to support projected sales? All these questions are really problem definitions.

2. Set Down the Alternatives. Problem-solving is really a matter of comparing alternatives; hence, it is important to consider more or less explicitly all the reasonable alternatives which are open to us. Someone has said that there is a fine line between the alternative that is a hare-brained scheme and one that is a stroke of genius, but the distinction is a crucial one. Also important is the fact that you are always looking at at least two alternatives. Obviously, there is no problem if that "problem"

has only one possible solution. It is already "solved"; all that remains is to execute the one solution. Often the choice may be between a more or less hidden alternative - "do nothing about the situation", "continue with the present system" - and the alternative of making a change. It is important to bring the "do-nothing" alternative out into the open; to make an explicit forecast of what will happen to sales, costs, profits, etc. if we do nothing. This then serves as a base against which all the competing alternatives can be compared.

3. Analyze the Alternatives to (a) determine the probable cost and profit consequences of each, and (b) evaluate the non-quantitative, intangible factors which operate on each problem. An economic analysis provides a forecast of the effect of each alternative upon the net profit of the Company. Once this analysis is complete, and it is surprising how far just a little arithmetic based on the proper concepts will go in completing it, it becomes a simple matter to select the alternative which is most profitable. Then, if there are no "intangible" factors which are not or cannot be reflected in the cost estimates, the decision is clear. Let me hasten to add, however, that usually there are intangibles, and frequently they are at least as important as the cost and profit estimates.

4. Weigh and Decide. The decision becomes a matter of weighing the intangible factors into the balance along with the profitability figures. This is one of the key points at which the manager's judgment enters the picture; another is when the underlying assumptions on which the economic calculations are based are set up.

Cost and Profit Data

I should now like to turn to the second portion of my discussion - the question of the kind of cost and profit information which is useful in making sound, profitable, business decisions.

The costs which are relevant to a business decision are:

1. Future costs.
2. Incremental costs, i.e. costs related to the alternatives under consideration.

First, future costs. We need estimates of the future to guide our decisions as to future courses of action. What is past is history and cannot now be changed by any decision. Now, clearly historical cost records may be helpful in forming an estimate of the future, but this is quite different from taking historical, i.e. "actual", costs as the best estimate of what the future may bring. Only if we believe that our best estimate of the future is that it will be just like the past, should we use unadjusted historical costs. When we pause and think about the problem, however, we generally reach the conclusion that we can modify our experience somewhat to obtain a more probable estimate of the future. To cite only one example, we can be fairly sure that wage rates will be higher in the future than they are today.

The fact that the costs pertinent to a decision are estimated future costs also means that we must consider margins of error. These costs are simply not known for certain. There is no point in carrying out calculations to four or five decimal places when the underlying assumptions are accurate only to one or two decimal places. In fact, there may be considerable danger of being misled by the illusion of precision which such figures can create.

Frequently a rough guess is the best we can do. Let me emphasize, however, that a rough guess based on the proper cost concept will always be more useful than an extremely precise figure based on a completely irrelevant cost concept.

Second, the concept of incremental cost. This notion refers to the fact that basically we are comparing alternatives; we are interested in the change, or increment, of cost associated with choosing one alternative rather than another. This concept is so basic that I would like to illustrate it in some detail.

Consider the costs of operating an automobile. These costs could be set out in some systematic fashion as follows:

Table 1
Estimated Operating Cost of an Automobile

	10,000 miles/yr.		20,000 miles/yr.	
	Cost per Year	Cost per Mile	Cost per Year	Cost per Mile
Gas and oil	\$ 200	2.0¢	\$ 400	2.0¢
Maintenance	100	1.0	200	1.0
Tires	50	0.5	100	0.5
Subtotal (variable cost)	350	3.5	700	3.5
Depreciation	500	5.0	500	2.5
Insurance	100	1.0	100	0.5
License, fees	20	0.2	20	0.1
Subtotal (fixed cost)	620	6.2	620	3.1
Total Cost	\$ 970	9.7¢	\$ 1,320	6.6¢

The cost items involved in operating a car are set out in straight-forward fashion. Note, however, that I have listed together the elements of cost which vary <u>in total</u> in proportion to the number of miles driven. These costs are frequently labelled "variable costs", because they tend to vary in total proportionally to output. Note, too, that the variable cost per miles, or variable cost per unit, is the same at either level of "output"; that is, of miles per year driven.

The other group of cost elements is termed "fixed costs", because their total dollar amount is independent of the number of miles driven at least within wide limits. Notice that the fixed cost per unit is reduced as the output increases; this is the result of dividing more units of output into the same number of dollars. This spreading of fixed costs over a larger number of units of product is the reason why statements are so frequently made to the effect that - "if we could only get our volume up, our unit cost would drop to a reasonable level".

How can we draw from a statement such as Table 1 the incremental costs relevant to various decisions we might have to make concerning the operation of the car? First, let us assume that we as owners of the car are planning to make a trip and are considering whether or not to take along a passenger. Conventional cost accounting procedure would be to compute the cost of the trip on the basis of, say, 200 miles times 9.7¢ per mile, or $ 19.40 for the trip. Then, the $ 19.40 would be allocated in some fashion, presumably equally, to you and to your passenger. Following this reasoning, the cost of taking the passenger on this trip would be $ 9.70. Is the figure of $ 9.70 in any way relevant to a decision whether or not to take the passenger on the trip? The answer is, No. Taking the passenger will have no effect whatever - unless wear and tear on the seat is considered-upon the total cost of operating the car. Accordingly, in this case, the relevant incremental cost is zero.

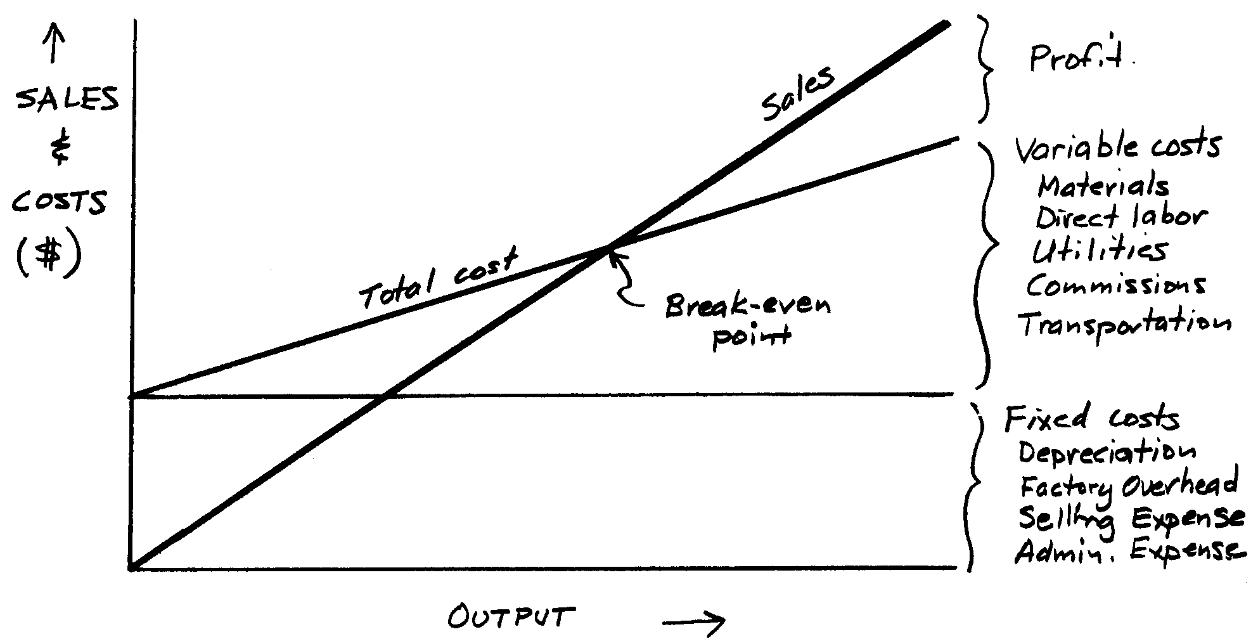
Now let us assume we as owners of the car are considering whether or not to take a trip. Here, again, the relevant incremental costs are only those costs that will be affected by the decision. On the basis of Table 1, then, we would conclude that the cost relevant to the decision whether or not to take the trip would be 3.5¢ per mile times 200 miles, or $ 7.00. Only the items of gas and oil, maintenance, and tires will be affected by the decision; none of the fixed cost items will be affected.

In this case, too, conventional accounting procedure would allocate some portion of the fixed costs to the miles involved in this particular trip. Nevertheless, this allocation is totally irrelevant to your decision and in fact may be worse than irrelevant; it could lead to an unprofitable decision.

Finally, assume we do not own a car but are considering acquiring one. The incremental costs which we should consider in reaching a decision in this case will include not only the variable costs, but the fixed costs as well. All these costs will be affected, indeed, they will be brought into being, by the decision. In addition, we might even want to consider a cost which frequently does not appear on a conventional cost accounting statement: interest, the cost of using capital.We might want to include in the cost figures an amount for the interest which we would forego by not having the money with which we purchase the car invested in the bank, or elsewhere. Or, if we plan to borrow money to buy the car, the interest cost is no longer imputed, but becomes an actual cash outlay.

What is the point of these rather simple examples? Simply that costs are relative, not absolute; they are relative to the specific alternatives being analyzed. What is an incremental cost in one problem may not be in another, and vice versa. This is why it is important to define the problem and the alternatives as carefully as possible before developing cost and profitability information. The specific cost figures which are relevant to a particular problem depend upon the alternatives being considered. Relating this reasoning to the plastics processing industry, the relevant cost of a molded article could be one figure if the equipment is set up and running; another figure if the mold is on hand but the machine is not set up; another figure if the mold must be purchased or manufactured; and still another figure if we must acquire both the mold and the machine to do this particular job. It might be even still another figure if we had to pass up the opportunity for some profitable business in order to undertake a particular job.

I would like now to illustrate these points further with the aid of a simple analytical tool - the breakeven chart:



This chart shows dollars of cost and sales on the vertical scale and some measure of physical output (lbs., pieces, machine-hours, % capacity, etc.) on the horizontal scale. Just about any manufactured product of manufacturing business will have a cost pattern similar to that shown. There will be a group of fixed elements of cost which will be more or less independent of short run changes in volume over a fairly wide range. Most overhead, selling, administrative, and some manufacturing costs such as depreciation, rent, and maintenance will fall into this category. There will be another group of costs which increase or decrease more or less in proportion to volume. These will generally include materials, direct labor, utilities, commissions if these are based on a percent of sales, transportation if paid by the manufacturer, etc.

The vertical difference between the sales and cost lines represents profit or loss. Thus, by plotting a breakeven chart for your company or for a product, you can tell what your profit will be at any level of production, at different sales prices, and at different levels of fixed and variable cost. The point at which sales equal cost is of course the breakeven point, which is how the chart gets its name.

The breakeven chart leads to an extremely useful concept; that of incremental profit, or "profit contribution" as it is often called. If we describe the chart in equation form, we have the following relationships:

Operating Profit = Sales - Costs

Operating Profit = Price/unit x Volume - Variable cost/unit x volume - fixed cost

Operating Profit = (Price/unit - var. cost/unit) x volume - fixed cost

Profit contribution/unit
or
Incremental profit rate = Price/unit - var. cost/unit

Operating Profit = Profit Contribution - fixed cost

Profit contribution is a means of estimating quickly and easily the profit effect of a short-run change in sales volume. Profit contribution tells us the rate of change of total profit with respect to volume. Since the dollar amount of fixed costs is independent of short-run volume changes, the equation says that, in the short-run, profits will go up or down in proportion to the difference between sales price and variable cost per unit. This is why it can be profitable to continue to manufacture and sell a product that appears to be losing money, i.e. showing a loss after some proportion of fixed overhead has been distributed to it. While it is absolutely true that in the long run the total sales revenue from all products must exceed total costs, it does not necessarily follow that the sales price of each product must cover its total distributed cost, including some proportion of all overhead items.

The concepts of profit contribution and variable, or incremental, cost are also helpful in pricing problems. It is possible to calculate quickly and easily how much volume is needed at any number of possible sales prices to cover the applicable fixed costs and provide any desired level of profit. Incremental cost per unit tells you how low you can go to meet a competitive price when you have unused capacity. If you are operating at capacity, the relative profit contribution per machine-hour for your products will tell you on which products to concentrate in order to maximize your total profit.

In considering expansion programs, the expected profit contribution from the added volume, less the additional fixed costs such as depreciation, maintenance, selling expense, etc., expected to be incurred as a result of the expansion, can be related to the added capital investment required. This comparison will show the expected return on the new investment and the decision can be made on the basis of whether or not the prospective return is attractive in terms of your cost of capital and your other opportunities.

Some Suggestions for Developing Cost Information

I would now like to turn to the question of how the type of cost and profit data I have described can be developed in a small business.

I believe the data can best be derived completely aside from your books of account. Let your accountant continue to develop your balance sheet and profit and loss statement by whatever means he now uses to do so. At the beginning of each year sit down with your key people and estimate the following:

1. Variable operating costs per hour (exclusive of materials) for each piece of production equipment. These costs will be primarily made up of labor and utilities.
2. Fixed operating costs for the entire year for each piece of equipment. This will include depreciation on equipment, maintenance, superivision, etc.
3. General overhead costs for the entire year for the entire business. This will include building depreciation or rent, general factory overhead, selling and administrative costs, interest on bank loans, etc. These general costs can be estimated in much the same manner one would use in planning a houshold budget.
4. The variable costs per machine hour from (1) can be combined with material costs, mold or die costs, and production rates to develop variable unit costs for each product. These can be kept current

simply by maintaining a card file by products and keeping it up to date with respect to material costs, wage rates, extrusion rates, molding cycle times, etc. Information as to sales prices can be combined with variable product costs and production rates to develop profit contribution figures for each product, both on a per unit and a per machine-hour basis.

5. The fixed operating costs for equipment, combined with general overhead, can be divided by the total machine hours which represent normal or expected operating levels to obtain an average fixed cost per hour for each piece of equipment.
6. The sum of variable cost per hour and fixed cost per hour, plus an allowance for a desired profit, together with production rates, can be used to set target selling prices. Then, these can be adjusted up or down, depending upon the particular competitive conditions involved.

Finally, an overall profit plan for a business can be developed by estimating:

1. The dollar profit contribution expected from each product. This is simply a matter of multiplying the forecast sales volume for each product by the expected profit contribution per unit for each product.
2. The fixed costs for the year can be broken down on the basis of estimates of machine time, management time, etc., devoted to the manufacture and sale of each product.
3. The relative profitability of each product or product line can be ascertained by comparing profit contribtuion figures by products. Net profit figures by product can be developed by subtracting the fixed costs which are estimated to be devoted to each product

from the profit contribution figures.

In conclusion, I would like to emphasize a point which I mentioned earlier: it is not necessary to set up an elaborate cost accounting system of the type used by large companies in order to implement the suggestions I have made. In my experience, the big elaborate cost systems are designed for purposes other than the generation of cost figures which are directly useful as a basis for a business decision. When cost information is desired for a decision problem, generally estimates are called for. In making estimates, simple arithmetic goes a long way, when based on the correct cost concept for the problem at hand.

HOW TO JUSTIFY PURCHASE OF NEW EQUIPMENT TO MANAGEMENT

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The purchase of new equipment whether it is to replace or supplement existing equipment must be justified to management. You as a representative of the company must show management that the investment they are making will return to them an amount which will cover their investment plus a reasonable profit over the useful life of the equipment.

Once the need for new equipment has been established the presentation to convince management to invest their capital must be approached on a dollars and cents basis.

The purpose of this paper is to furnish you with a suggested format to present to management. It should be presented from the viewpoint of management.

The initial cost of a machine which will be entered in the books as an asset can be recovered through tax deductions allowed for depreciation. The rate of depreciation is most important as it determines how fast you can recover the invested dollar and use it for some other profit making investment. Naturally, since the recovery of this investment capital is accomplished through tax deductions, the Government has the final word on how fast a piece of equipment can be depreciated. To fully understand the methods and advantages of depreciating a piece of equipment let us first define depreciation. Depreciation is basically an accounting procedure although people will interpret it as deterioration and obsolescence. It is a way of allocating over time the loss and value of an asset as it gets older. It is the result of deterioration and obsolescence.

As a machine is used it wears so that eventually it is incapable of doing the job for which it was purchased. Since its wear is proportionate to its use, the deterioration of a machine can be predicted. Obsolescence is a result of the introduction of new machines on the market which will do the existing work more efficiently. Its factor related to depreciation is not a gradual predictable one, but one that occurs in steps.

Depreciation is important to management as it reflects the declining value of the physical assets of the company and influences the amount of the income tax bill. The method you take depreciation on equipment affects this as in most cases the tax laws say that you cannot deduct the entire cost of equipment from your taxable income during the year that you buy it. You must spread the deduction over the equipment's useful or tax life as defined by the tax laws. The amount you deduct each year is termed "depreciation expense".

Depreciation can be computed if the following three things are known about the equipment:

(1) Its depreciable cost basis;

(2) Its useful life;

(3) At what rate to depreciate it.

The depreciable cost basis is the original cost of the equipment usually adjusted for salvage value, for example:

Original cost (may include installation and delivery)	$20,000.00
Estimated salvage value at end of life	2,000.00
Depreciable cost basis for tax purposes	$18,000.00

The useful life of a piece of equipment is set forth in the tax regulations. The regulations set "guide line" lives that apply to all production equipment within a given industry. The useful life on injection molding machines is eleven years. Publication Number 456 (7-62) titled "Depreciation: Guide Lines and Rules" of The U. S. Treasury Department are available from The U. S. Government Printing Office, Washington 25, D. C. for 25¢.

In the event that you are now using shorter tax lives on your equipment than set forth in this publication, you may continue to use them if you have justified using the shorter lives or if you have used them for at least one-half of a replacement cycle and your reserve ratio is proper for the tax life and depreciation method used.

If you are using tax lives that are longer than the specified guide line, you can increase the annual "depreciation expense" accordingly for the next two years without question. After two years, the reserve ratio test will be applied.

The reserve ratio test will be applied by the Internal Revenue Service in the 1965 tax year to substantiate that you are replacing equipment as fast as you are depreciating it. This test will show that you are setting aside a "reserve fund" (non taxable) for replacing your equipment as fast as you are depreciating it. If the test shows that this is not true, they will ask you to lengthen the tax life of equipment to bring the ratio back to a normal range. No penalties are made if this adjustment is required.

If a "guide line" life is assigned to a piece of equipment it is possible to shorten it by showing the Internal Revenue Service that the equipment is obsolete. For example, a piece of equipment worth $20,000.00 is being written off at a rate of $2,000.00 a year. If after five years you can show that the equipment will be obsolete in another two years, you may write off the remaining $10,000.00 in two years at the rate of $5,000.00 a year.

There are three basic methods to select from to determine how fast you can deteriorate your equipment. The examples shown for each will be based on a five year tax life.

(1) Straight line method.

The annual depreciation expense is the same for each year of the useful life period.

Depreciable cost basis (net after salvage value)	$10,000.00
Tax life	Five years
Annual depreciation expense	$ 2,000.00

(2) Double declining balance method:

The annual depreciation is double the percentage of the straight line method. This percentage is applied against the unrecovered balance each year.

Depreciable cost basis (before salvage)	$10,000.00
Tax life	Five years

Year	Unrecovered Balance	Rate	Depreciation
1	$10,000.00	40%	$ 4,000.00
2	6,000.00	40%	2,400.00
3	3,600.00	40%	1,400.00
4	2,200.00	40%	880.00
5	1,320.00	40%	528.00

The balance of $792.00 represents the salvage value.

(3) Sum of the year's digit method:

This method gives a fractional annual rate of the equipment's depreciable cost basis.

Depreciable cost basis (net after salvage value)	$10, 000. 00
Tax life	Five years

Fraction: Denominator equal to 5 plus 4 plus 3 plus 2 plus 1 equalling 15

Numerator first year equal to 5, second year equal to 4, etc.

Year	Depreciable Basis	Rate	Depreciation Expense
1	$10, 000. 00	5/15	$ 3, 333. 00
2	10, 000. 00	4/15	2, 667. 00
3	10, 000. 00	3/15	2, 000. 00
4	10, 000. 00	2/15	1, 333. 00
5	10, 000. 00	1/15	667. 00

The law will allow you to use any consistent method for new equipment purchased after 1953. However, you cannot use any method that will depreciate your equipment more during the first two-thirds of the equipment's useful life than you could get with the double declining balance method.

Of the foregoing methods, the declining balance and sum of the year's digit methods allow you to take most of the depreciation by the time the equipment is half way through its tax life. This allows you to recover your investment faster so that the money can be reinvested to earn more money.

The following graph will show you how the three most common depreciation methods affect your tax bill. The example is figured for a $14, 000. 00 machine having a tax life of twelve years, $2, 000. 00 salvage value. The corporate income tax is figured at 50 percent.

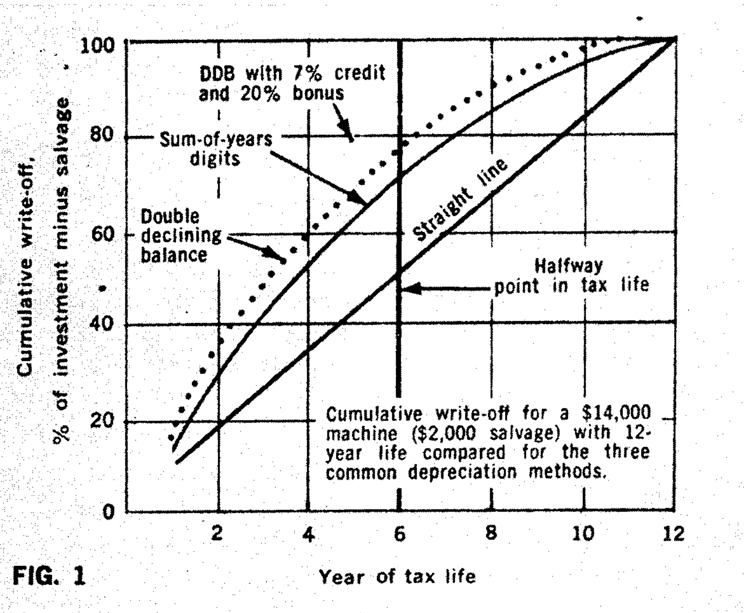

FIG. 1

As the graph depicts, the double declining balance and sum of the year digits methods enable you to take more of your deductions sooner than the straight line does. In order of preference the ranking is double declining balance, sum of the year digits, and straight line.

You have a further advantage with the double declining balance method in that you may figure the depreciable cost basis without substracting the salvage value. Naturally the higher the salvage value the greater the advantage of the double declining balance method. With the sum of the year digit and straight line methods you must net out the estimated salvaged value to compute the cost basis.

The top line on the graph depicts the double declining balance method of depreciating equipment including a 7 percent credit and 20 percent bonus.

The 7 percent investment credit has been initiated by the Internal Revenue Service Department to stimulate new capital investments. This investment credit gives a tax benefit to companies that buy new equipment in tax years after 1961. It allows you to deduct directly from your tax bill 7 percent of the cost of the new equipment (not reduced by salvage value). Please note that this credit must be taken during the same tax year that the equipment is put into service.

One qualification that must be met to allow you to take a full 7 percent is that the machine or equipment being installed has a service life of eight years or more. The percentage is reduced for estimated lives less than eight but more than three.

The disadvantage of this credit is that you must deduct it from the cost basis of the equipment for depreciation purposes. For example, if you take a $700.00 credit against a new $10,000.00 machine its depreciable cost basis then becomes $9,300.00.

In addition to this 7 percent credit you may also take a 20 percent depreciation bonus when buying new equipment. The limitations on this are that the equipment must have a life of at least six years. You must also take this credit in the same tax year that the equipment goes into service.

The bonus can be applied to a maximum of $10,000.00 worth of assets in any one year. It is applied to the original cost of the equipment without regard to its salvage value. As with the 7 percent credit, if you take the 20 percent bonus, you must reduce the depreciable cost basis of equipment by the same amount. The only advantage is that you may take an extra $2,000.00 write-off for the first year. This is most beneficial for small companies who need their money back fast so that they can reinvest and progress accordingly.

To sum up the foregoing, the method of depreciating a piece of equipment is best when a level can be reached that will allow a maximum tax advantage per dollar invested in fixed assets.

ESTIMATED OPERATING COSTS OF PLASTICS INJECTION MOLDING MACHINES

Perhaps the most heard objection to replacing existing equipment with new equipment is, Why should I buy a new machine? This machine is making a profit for me now." Undoubtedly what has been said is true, however if you can prove a new machine will make a larger profit there is less argument.

In many cases, mold tests made with customer's existing molds on new equipment have shown production increases of 200 percent. These increases can be easily understood when specifications of the new equipment are compared to the older machine. For example, assuming that the part cure time is the same, increased speeds of both the clamp and injection end in the new machine show a substantial savings in time as compared to the overall cycle.

Supplementing a new machine's ability to out-produce an older machine, cost of operating the machines should be analyzed. The following table lists estimated costs to operate some of the new in-line screw machines:

TABLE I

PLASTIC INJECTION MOLDING MACHINE

ESTIMATED OPERATING COSTS

ITEM	COST PER HOUR 200-IX-14	350-IX-20	450-IX-20	650-IX-60
Amortization of Machine Based on 10 yrs. at 6000/hrs. year.	.49	.66	.98	1.02
Machine Oper. Cost incl. elec. power & cooling water.	.65	.95	1.15	1.45
Direct Labor.	1.65	1.65	1.65	1.65
Overhead (170% Direct Labor).	2.80	2.80	2.80	2.80
Maintenance Cost (Average over 5 yrs.)	.15	.20	.20	.45
TOTAL COST PER HOUR	5.74	6.26	6.78	7.37

The amortization cost per hour is prorated over ten years which would equal the initial investment (cost of the machine including freight and installation). Cost of auxiliary equipment such as hopper loaders and dryers, and temperature controllers should be included in this amortization cost. Undoubtedly this auxiliary equipment will be depreciated faster than the machine. However, the appropriate amount should be included under this heading. Please note that this amortization rate is based on 6000 hours per year which is arrived at by using fifty weeks of production with three shifts a day. This cost would increase to twice the amount for a two shift basis and three times the amount for one shift. It is to the molder's benefit to get as much production out of his machine as possible to keep the amortization cost per hour low. The machine depreciates regardless of use.

The machine operating cost should include the electrical power and cooling water required to run the machine.

The direct labor operating cost covers the machine operator's wages and will vary depending upon the labor demand in the area. As a general rule, this cost per hour is the largest single expense.

The overhead or "burden" includes housing, light, heat, supervising personnel, general maintenance, material handling, setup, property taxes, insurance, fringe benefits, etc. It can best be estimated as a percentage of the direct labor costs and will usually range from 150 to 200 percent of the direct labor costs. The larger the company the higher the percentage factor.

The maintenance cost should include repair parts and their installation. The figure shown is an average over five years. This figure should range from nothing (assuming a new machine should require no maintenance after installation) to an increasing figure as a machine ages and wears.

When the above items are figured for a new and old machine for comparison, it will undoubtedly show a small amortization figure for the old machine as compared to a large one for the new machine. However, the reverse should be evident under the maintenance cost.

The total cost per hour for the machine should then be used in conjunction with the established production rates for the machines. This will establish a cost per part produced and give the true picture of increased profits available.

One of the main reasons for purchase of new equipment is to be more competitive. It would be well to analyze the competitive advantages of new equipment in relation to the equipment which you now have.

For example, new machines dry cycle faster. This is due to better designed hydraulic systems and, in many cases, the use of additional horsepower. Take a new machine which has a four second dry cycle time, compared with a ten-year old machine which has a ten second dry cycle time. With the same cooling time on a fast running job, the new machine would show considerable savings. Assume that the cooling time for a part is 15 seconds and you are figuring a machine cost of $10.00 per hour. The cost price per piece on the two machines would be as follows: 10-Year Old Machine: Total cycle - 25 seconds, or 144 pieces per hour. Cost of molding per piece - $10.00 divided by 144 equals 6.9¢ per piece. New Machine: Cycle time - 19 seconds, or 189 pieces per hour. Cost of molding per piece - $10.00 divided by 189 pieces equals 5.3¢ per piece.

In addition to the new machine's ability to cycle faster, most machines inject into the mold at a much faster rate. In comparing conventional machines it is necessary to have additional horsepower in order to secure a faster rate of fill. However, with screw machines you are working with plasticized material and the same horsepower will give approximately twice the injection rate as a conventional machine. In a conventional machine it is necessary to compress the granular material while injecting into the mold and this results in a loss of approximately 50 percent of the injection speed.

A 10 cubic inch displacement of the injection plunger in a conventional machine will result in approximately a 5 cubic inch "shot" into the mold. With a screw machine, a 10 cubic inch displacement of the screw will result in the 10 cubic inch shot into the mold.

A further advantage of new equipment is that most designs permit the installation of additional horsepower and pumps for faster injection than is normally furnished. Serious consideration should be given to purchasing additional injection speed on a machine when the type of jobs you normally run can make use of this speed. The added cost of higher injection speed is very minor in comparison to the advantages which can be obtained.

Fast injection speed fills a mold quickly. When this is done, stock temperature can be lowered with a corresponding reduction in cooling time. If the stock temperature is lower, it is natural that the part will set up more quickly and you can open the clamp sooner to remove the part.

To see what will happen to the cost of molding a part, let's take a new machine where it is possible to cut the cooling time in half due to increased injection speed. The new machine has a 4 second dry cycle plus a 7-1/2 second cooling period or a 11-1/2 second overall cycle. It will produce 320 parts per hour at a cost of 3-1/2¢ each. The ten year old machine has a 25 second cycle, will mold 144 parts per hour and the cost per part will be 6.9¢.

Another factor to consider in evaluating equipment is its ability to change colors and materials. Screw machines have proven very effective in this area thus increasing productive time. We have seen, as you probably have, where it took three to four hours to change colors in a conventional machine running ABS. Even though the material in these cases could possibly be reused, the cost of machine time could be as high as $40.00 to $50.00 for a color change. A change from an ABS material to another material can even be more difficult than color change. The modern screw machine can change colors in ABS in as little as ten minutes, and if a severe material cannot be purged out, it is possible to pull the head and clean the screw in approximately forty-five minutes to an hour. Let us assume you are running a color change every twelve hours on a job and on the screw machine takes 15 minutes to change colors and on the conventional machine one-half hour. This means that you must add 2 percent to the cost of the job with the screw machine and 4 percent on a conventional machine for the time spent handling color changes. Granted a 2 percent increase is not very much, but it can mean the difference between a profit or a loss on a job. We are probably being very optimistic in assuming that we can change colors on a conventional machine in half an hour. I think that you can judge for yourselves on the basis of your experience as to what this actually can mean to you in dollars and cents.

Another factor which must be considered in the purchase of new equipment is its ability to handle PVC, polycarbonate, acetal, and some of the new exotic materials which are extremely difficult, if not impossible, to process on conventional equipment. A very convincing argument can be made to your customers about your company's versatility when screw machines are installed.

We have tried to show that, assuming your cost per hour for a new machine and an old machine are the same, it is very easy to justify a replacement program. Many times these advantages can be proven by actual production. Most machinery manufacturers have facilities to run a mold test for you and to demonstrate their equipment. We feel that this is the best way to sell management on a replacement program.

Normally, in figuring a replacement program, it is necessary to charge more per hour for new equipment but this additional charge is offset by added productivity. Let us assume that we wish to purchase a 200-IX-14 screw machine, shown earlier, and that we are using the double declining balance on a ten-year depreciation. The amortization per hour on a 6000 hour basis for the first year would be approximately \$1.00 per hour, based on a \$30,000.00 machine, including installation. Let us further assume that we are going to replace a ten year old machine, which is fully depreciated, with a maintenance cost of 50¢ per hour rather than 15¢ per hour. The total cost per hour of the machine is now as follows:

	200-IX-14	10 Year Old Machine
Amortization of machine for first year	\$1.00	\$ .00
Machine Operating Cost Including Electric Power and Cooling Water	.75	.65
Direct Labor	1.65	1.65
Overhead (150% of Direct Labor)	2.80	2.80
Maintenance Cost	.15	.50
TOTAL COST PER HOUR	\$6.35	\$5.50

These figures are very realistic and for another 75¢ per hour you can replace this old machine with one that could run up to twice as many parts per hour.

The ability to increase your production rate with a new machine will save money from the standpoint of mold requirements. This savings can be a major one. For example, the production of a specific part may be large enough to require three molds when operating three old machines. Two new machines could give you the same production and eliminate the need of a third mold.

It is hoped that this information will help you analyze your specific problems and assist you in presenting a justifiable replacement program to your management - one that will be beneficial to the company's growth.

Literature References:

The ABC's Of Depreciation - Metalworking Magazine