# Case Study 12.1 Estimating the Cost of an Injection-Molded Pocket Knife

          There are many methods for determining the cost of an injection-molded part. Some are based upon rough estimates and rules-of-thumb, whereas others are extremely detailed with costs allocated for numerous plant functions and overheads. The method chosen in this case study is a compromise between these two extremes. The major cost elements are identified explicitly for a particular part, a pocketknife with a plastic handle. The knife analyzed in this case study is made with a nylon handle (Figure 12.29) in a two-cavity mold, some-what like the mold illustrated in Figure 12.5 except that the knife handle requires cores and is there-fore a more complicated mold.

        The cost elements are calculated in such a way that the same procedure can be applied to other parts with relative ease. This method has proven to be effective in determining a cost that will allow the sales price to be set in a way to assure profitability. To permit a systematic examination and calculation of each of the major cost elements, a form is created on which the key information can be gathered and that will serve as a historical document so that pricing estimates can be reviewed from time to time. Such a form is given in Table 12.4. A blank form is given in Appendix 2.

**Figure 12.29 Pocket knife with foldaway blade and injection molded handle**

## 12.9.1. Introduction

        It is assumed the form will be filled out by the company doing the molding of the part (the molder). This company may not be the company who will use the part in some other assembly or otherwise sell it. The molder and the customer can be different entities, although, of course, they could also be the same. Mold making is another function that may be done by the molder or by a different company. The mold could be secured by the customer or through the molder. Both cases are explained in the detailed instructions on the form.

          The name of the part, part number, part print number, and revision are self-explanatory. The customer should be identified and some reference given for the customer's request for a quote so that any specifications or other details can be referred to. The date, name of the estimator, and name of the approver should be noted for historical reference purposes.

## 12.9.2. Resin and Additive Costs

        The type of resin and particular grade should be made very clear. The source is the resin manufacturer or wholesaler from whom the resin is obtained. The cost of the resin should be stated in a typical order quantity. Many resins are sold at quantity discounts. The packaging of the resin might also be important to note since shipments by rail car are often less than bulk shipments by truck. If shipped in **pillar packs** or **gaylords** (palletized boxes), the cost is higher than when the resin is shipped in bulk. The highest-priced packaging of all is bags. In the example of the knife, the resin is to be nylon (6/6), Zytel 101, which is to be obtained from DuPont. The cost is $1.36 per pound and the material is to be bought in pillar packs at order quantities of 40,000 lbs.

         If an additive is included in the resin, the type of additive and its cost are noted. Several additives could, of course, be added, and each of these would be shown on the form. In this case, the only additive is a color concentrate (black), which has a price of $3.00 per pound.

          The concentrations of all the additives would be shown separately in the next column of the form. Since each additive may have a separate price, it is important to reflect the concentration and price of each. In this case, the concentration of colorant is 1.0%.

The total material cost is determined by equation (12.5):

$$ Total \; mantl \; cost = (resin \; coat)(resin \; fraction) + \sum {\_i} [(cost \; of \; add.)(fraction \; of \; add \_i)] (12.6) $$

The summation is over all the different additives. If there is more than one additive, several terms could be included. The only requirement is that the sum of all the fractions be unity. In the knife handle case, the total material cost calculation is given by equation (12.7).

$$ 1.38 = (1.36)(0.99) + (3.00)(0.01) $$

**Table 12.4 Cost Estimating Form for Injection Molding**

## 12.9.3. Part Costs

        The part cost is a function of the actual amount of material in the part (part weight) and the amount of product that is waste. The part weight is determined by simply weighing several parts and averaging their weight. In this case, the weight for each part is 3.8 g. 356

        The waste factor is not determined from the weight of material such as runners and sprues or even bad product, which will be reground and then reused in the process. The waste factor is found by dividing the total weight of resin purchased, less the total weight of resin currently in the plant, by the total weight of the resin (parts) that is shipped. This waste factor will therefore account for all resin losses. Other methods for determining the amount of unrecoverable waste would also be acceptable. In the present case, a waste factor of 1.05 (5% total waste) is used.

        The adjusted weight is the actual weight times the waste factor. The adjusted weight of the knife handle is 4.0 g.

        The part material cost is calculated by multiplying the adjusted weight of the part by the total material cost, which includes resin and additives. Because the total material cost is usually given in $/pound (in the United States), a conversion to similar weight units is required if the weight is in grams. In the case of the knife blade, the part material cost is $0.003 per part.

        The cost contribution per 1,000 parts is determined for each of the major cost components. The cost contribution for part costs is calculated by multiplying the part material cost by 1,000. The quantity of 1,000 parts was chosen because of the small size of many injection-molded parts. The cost contributions are then in convenient price figures. The part cost contribution for the knife is $12.20.

## 12.9.4. Tooling Costs

        Since many parts may be made on similar tooling and the cost of the part is dependent upon the tooling used, a description of the tooling should be given so that the particular tool can be identified exactly. The knife blade is made on a two-cavity steel mold.

          The external cost is a key element in determining the cost of the mold and represents the cost quoted by the mold maker. When the mold is made by the molding company, the external costs are zero unless some special work has been done externally. The internal costs are those costs associated with handling, modifying, and otherwise preparing the mold to run properly and make parts to specification. Even when the mold is made externally, some minor adjustments are usually needed and can most reasonably be made by the molding company. When the mold is made internally, the internal costs represent all costs of the mold. In the knife blade case, the mold is made internally but some special machining is done externally; hence the external costs are $5,000 and the internal costs are $15,000.

        The total cost of the mold is the sum of the external and internal costs. If the tooling is to be sold to an outside customer, the molder places a markup on the total price and sells it to the customer. The markup is justified because the molder accepted some responsibility when the molder agreed to obtain the mold. The customer price is the sum of total cost and markup.

        Another circumstance could be that the customer owns the mold but has requested that the molder amortize the mold by adding the cost of the mold to the cost of the part. This is the normal practice when the customer and the molder are the same entity and is the case used in the knife handle example. When the cost of the mold is to be amortized by adding to the cost of the parts, the number of parts to be made on the mold must be estimated. In the knife handle case, the number of parts is 4,000,000. The cost contribution from tooling costs is the total cost of the mold divided by the number of parts to be made multiplied by 1,000 to get the cost per 1,000 parts. For the knife handle, the tooling cost contribution is $5.00.

        One of the major drawbacks to the use of injection molding is the relatively high cost of the tooling. Hence, systems that allow tooling costs to be spread over the parts to be made are very inviting to new companies that are trying to get started with a new product. Someone, however, must take the risk that the projected number of parts will actually be produced. This risk is rarely borne by the custom molder. Hence, even when the molder agrees to amortize the cost of the mold over the cost of the parts, some payoff clause is usually inserted in the contract to ensure that the required number of parts are made within the agreed-upon time.

        Another circumstance is possible for determining the tooling cost. Since the mold is normally owned by the customer, the customer may supply the mold to a custom molder with no cost to the molder. In this case, no mold cost is included in the price of the part.

## 12.9.5. Machine Costs

        The cost of the machine depends on the time the machine is in use to make the parts and whether the machine is attended by an operator or not. Normally, each machine will have two rates (operator or automatic). These rates are determined by the original cost of the machine, the ongoing costs to operate that particular machine (maintenance, lubricants, and so on), and any special equipment that might be added to the machine (such as special control equipment) that might allow a premium to be charged for the machine. The rate charged for a particular machine may also depend on the demand for the machine.

          In the case of the knife handle, the mold has two cavities and the mold cycle is 30 seconds. This results in 240 parts per hour. The cost of the machine is S25.00 with an operator and $18.00 without an operator. In this case, the operator is needed to cut the parts off the sprue and runner system.

          The machine cost contribution is determined by dividing the machine rate per hour by the number of parts made per hour and then multiplying by 1,000 to get the contribution per 1,000 parts. The machine cost contribution for the knife blade is $104.17.

## 16.9.6. Secondary Operation Costs

        Many injection-molded parts are subjected to other operations after molding. For instance, the part might be put into an assembly (as is the case with the knife handle), or it might be drilled, machined, or bonded to another part. The costs of these operations are normally figured at some rate that depends upon the nature of the equipment involved and whether an operator is required. Therefore, the secondary costs are identified with a cycle time and a rate. The secondary cost contribution from secondary tasks is the sum of all the costs of all secondary operations required. In the case of the knife blade, the only secondary operation is securing the blade into the handle.

        This is done by screwing together the blade and the handle. The rate for this operation is $7.00 per hour and each operation takes 10 seconds.

        Most plastic parts must also have the runner and sprue system removed. Normally, the machine operator does this task and it is not considered a secondary operation. The machine operator's time has already been included in the cost as part of the machine cost. If, however, the operator does not remove the runners, then the cost should be added as a secondary operation.

## 12.9.7. Purchased Item Costs

        These costs are usually just the cost of the item that is included in the assembly of the product. In the case of the knife, the blade and the screw to attach the blade to the handle are purchased items. The purchased cost contribution is the sum of these purchased items. For the knife the costs are $1,250 per 1,000 for the blades and $2.00 per 1,000 for the screws.

## 12.9.8. Packaging and Shipping Costs

        The costs of boxes, bags, blister packs, and any other packaging material are important costs of the product. The pocket knives are packaged in a blister pack ($50.00 per 1,000) and then in a cardboard box ($0.70 for a box that holds 1,000 parts). The cost of transportation can be added if that is included in the quoted price. However, goods are usually quoted with the price at the factory. This is called f.o.b. factory. (The abbreviation f.o.b. stands for "freight on board" and indicates that the costs are for goods loaded on a truck or train but not moved from the location stated, in this case the factory.)

## 12.9.9. Total Factory Cost per 1,000 Parts

        This amount is simply the sum of the various components of factory cost. For the knife this cost is $1,443.51.

## 12.9.10. General and Administrative Costs per 1,000 Parts

        This cost is associated with the general running of the company. It includes all costs that cannot be directly allocated to a product or service. It includes such items as general management, accounting, legal services, rent, utilities, insurance, and other overheads, which can include services such as quality control, warehousing, and maintenance. The G and A costs are normally a percentage of the total factory cost. This percentage is determined by experience, although some allocation methods can be used for it. In the case of the knife, a 10% G and A cost is used. This value is typical of the plastics industry.

## 12.9.11. Marketing Costs

        The marketing costs are usually an estimate of the costs associated with marketing, which include the salaries of inside sales staff, commissions to sales people and agents, and advertising costs. The 20% value used here is typical. In some companies, the G and A costs are figured after marketing costs. The reverse has been done here because sales of this type of product are often done by outside commissioned sales representatives and their commissions would be added after G and A.

## 12.9.12. Total Cost Per 1,000 Parts

        The total cost is the sum of the total factory cost plus the G and A and the marketing costs. The knife cost is $1,876.16 per 1,000 parts, or $1.88 per knife. The sales price of the knife would only partially be based on cost. Other factors that affect the sales price are demand and reputation. Hence, the sales price is quite variable and dependent upon specific market conditions. However, the cost should be somewhat stable and can serve as one of the key components in determining sales price.

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