Plastics Topics – Costing of injection moulded and extruded products

TANGRAM TECHNOLOGY Consulting Engineers

Tangram Technology Ltd.

33 Gaping Lane, Hitchin, Herts., SG5 2DF

Phone: 01462 437 686

E-mail: sales@tangram.co.uk

Web Pages: www.tangram.co.uk

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1. Introduction

The costing and estimating of plastics products is often presented as a difficult and complex procedure. This is undoubtedly true if an exact ‘cost is required. In reality it is often impossible to assign an exact cost even if this is done in retrospect so the seeking of exactness at an early stage is often unwise. In many cases there are exact numbers quoted (i.e., lots of numbers after the decimal point but this almost always confuses precision with accuracy – they are very different!).

This document considers two methods of costing:

- The ‘exact cost’ method which is very dependent on the company’s method of cost allocation.
- The ‘budget cost’ method which gives a quick snapshot of the expected price.

The two methods are not incompatible and can be used to complement one another. When used with care, the budget cost method is rarely more than + /- 5% different from the exact cost method. This doesn’t matter because the true cost is almost always both unknown and unknowable.

2. The ‘exact cost’ method

The costs

Fundamentally there is no real difference between good financial management of injection moulding and that of extrusion so the same basic principles of handling a ‘conversion process’ apply. Three of the pre-requisites are in fact common for most capital intensive and continuous process industries, these are:

- Good forward planning
- Good understanding of costs and their allocation.
- Good control procedures.

As a good rule fixed costs (including labour) account for over 45% of the product cost and the material used accounts for the bulk of the remaining costs. The first necessity in the use or establishment of any costing system is thus to establish the fixed cost data. The traditional methods establish the fixed costs (the overheads) and then allocate these in some manner to each product. This method can be based on machine hours, labour hours or any other method chosen by the cost accountant.

A sales forecast for each given profit centre is necessary to allow the allocation of these fixed costs in a rational manner. This allocation of fixed costs can have a dramatic effect on profitability and sales price.

Control procedures need to be built into the costing system to regularly check the allocation of fixed costs.

The background data for costing

An annual sales forecast for each product group is drawn up to include prices, sales value, material costs and net added value.

A materials cost estimate is made from the sales forecast to give an estimate of the added value for each product group.

NOTE: A high added value product may need to bear a larger fixed cost for sales, technical and quality control areas.

A machine requirements estimate is prepared on the basis of machine usage (in machine hours). The machine time is generally used as a basis for allocation of fixed costs. A table of fixed costs and their allocation needs to be drawn up at this stage to ensure correct allocation. This allocated ‘machine hour rate’ is then used in all estimating situations.

The actual estimation

The actual estimate is generally carried out using a checklist as below:

1. Identify the material to be used.
2. Identify amount of material required from:
    - Quantity as first quality sales (**A**)
    - Standard scrap rate for product (**B**)
    - Storage and other losses (**C**)
    - Total cost of material = **A + B + C** = **D**
3. Identify the equipment to be used.
4. Calculate machine hours required from:
    - Output rate for profile or product
    - Downtime/Set up factor
5. Use machine hour rate (see above) to calculate overhead cost.
    - Total overhead cost of running machine = **E**
6. Calculate total tooling cost and allocate as a percentage of tool life expectancy. Remember tool maintenance and storage.
    - Total cost of tooling = **F**
7. Using the utilities factor for machine calculate utilities cost.
    - Total cost of utilities = **G**
8. Using the packaging and transport costs calculate distribution cost.
    - Total distribution cost = **H**

Total product cost = T = D + E + F + G + H

9. Additional factors may need to be added to cover:
    - Additional quality controls
    - Finishing operations
    - Additional packaging

A standard profit factor is then added to the cost to give the selling price.

Commentary

This approach is rigorous and provides a highly precise estimate of costs but it may not be accurate. In modern plastics processing the allocation of overheads is an extremely subjective issue. The end result is a precise product cost based on some dubious assumptions. If you doubt this then find out what percentage of the product cost is accounted for by ‘overheads’ and then go back into the system to try to find out how these were allocated. As a rule a great deal of detailed historical data is necessary to get at the costs and even then the method only gives an extrapolation of the past costs. The actual costs should be reviewed regularly to assess the real profitability and validity of the calculation.

3. The ‘budget cost’ method

This method is the ‘quick and dirty’ method for estimating costs but can give remarkably accurate results if used with care. It not only gives a cost but allows an assessment of the operational efficiency of the factory.

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The model factory

For extrusions or injection mouldings a rough allocation of the manufacturing costs can be made as follows:

Manufacturing Costs		
	Mass-produced product	**Technical product**
Materials	80%	45%
Machine (see below)	10%	25%
Tool	5%	20%
Labour	2%	5%
General (packing and transport)	3%	5%
Total	**100%**	**100%**

The machine element can be further sub-divided into:

Machine Costs		
	Mass-produced product	**Technical product**
Electrical	35%	15%
Water	20%	4.5%
Auxiliary and factory	1%	0.5%
Fixed plant	44%	80%
Total	**100%**	**100%**

These charts are important because they show that for a mass-produced part 80% of the cost is locked up in material at the design stage. Machine costs are less because of higher speeds, lower specification machinery and tooling and generally lower investment. For technical parts i.e., tighter tolerances, you have higher machinery costs because of slower speeds, higher specification machinery and tooling and generally higher investment.

The critical number here is what is called the ‘conversion ratio’, plastics processing is a conversion process so why treat it with any special mystique. The ‘conversion ratio’ says:

Total Product Cost = Material Cost x Conversion Ratio

i.e., T = D x C.R.

For a mass-produced part, the Conversion Ratio can be as low as 1.25 (this is rare) and for a technical part the C.R. can be as high as 2.6 (this is again rare).

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The Conversion Ratio can be regarded as a measure of 'the added value for the particular product' and thus has a definite business meaning.

Mass Produced/Technical

To decide whether a part is 'mass produced' or 'technical' it is necessary to look at the critical tolerances. For any plastic part, the majority of the dimensions will be non-critical and will be open or 'general' toleranced. There will also be critical tolerances which directly relate to the function of the part. As a general rule any product with more than 6-8 critical tolerances is difficult to produce i.e., you get one tolerance okay and the others drift out.

The number of critical tolerances (which should be between 0 and 8) is assessed and the following table is used.

Number of critical tolerances	Conversion Ratio
0	1.25
1	1.40
2	1.60
3	1.75
4	1.95
5	2.10
6	2.25
7	2.45
8	2.60

Material cost

For extrusions the cross-sectional area (in mm^2) of the product is calculated from the drawing. The weight/metre (kg/m) of profile is calculated from the density of the proposed material. The material cost is then estimated using the cost/kg (£/kg) for the proposed material to give a material cost per metre length (£/m).

For injection mouldings the part weight is estimated either from drawings or from weighing a similar product. The material cost is then estimated using the cost/kg (£/kg) for the proposed material to give a material cost per component (£/component).

Product cost

The product cost can then be calculated using:

Total Product Cost = Material Cost x Conversion Ratio

i.e., T = D x C.R.

In reality there are several provisos that must be understood in using this method, these are:

There needs to be a minimum yearly demand or a call-off schedule

The C.R. is dependent on the cross sectional area and weight of the product as well as the number of tolerances i.e., a small part has a higher C.R. than a large part with the same number of tolerances, e.g., a product with a cross sectional area of $10mm^2$ will generally have a higher C.R. than a product with a cross sectional area of $100mm^2$ and a product with a component weight of 10 gm will generally have a higher C.R. than a product with a component weight of 100gm.

This actually requires the development of a matrix for the C.R. which can be presented for each process:

For extrusion:

	Number of tolerances							
Product cross-sectional area (mm^2)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
10	1.25	1.95	2.1	2.25	2.45	2.60	2.60	2.60
20	1.25	1.75	1.95	2.1	2.25	2.45	2.6	1.40
30	1.25	1.60	1.75	1.95	2.1	2.25	2.45	1.60
50	1.25	1.40	1.6	1.75	1.95	2.1	2.25	1.75
100	1.25	1.40	1.4	1.6	1.75	1.95	2.1	1.95
250	1.25	1.25	1.25	1.4	1.6	1.75	1.95	2.10
350	1.25	1.25	1.25	1.25	1.4	1.6	1.75	2.25
500	1.25	1.25	1.25	1.25	1.25	1.4	1.60	2.45

NOTE: Example Only!

The matrix needs to be used with care and updated at regular intervals using factory costs as reported. In practice this simply means running cross checks. Alternatively, a best guess using industry norms can give quicker results.

4. The effect of production speed

The above method does not take into account production speed except by inference i.e., small profiles produced faster than large profiles. In fact, the influence of production speed is often over-estimated (in my view).

Assuming all other conditions remain the same then a 10% increase in production speed will reduce the component price by approximately 2.7%. A 40% increase in speed gives a price reduction of 8.5%. This calculation ignores any effect of increased scrap or increased tooling cost which can often negate these price reductions. There are gains to be made by increasing production speed but they are often not as significant as those to be made from material reduction.

The real gains are to be made in set-up time reduction to reduce the dead time during tool changeover.