



Key for data sources: Calculated by a function in EM Database value in EM User entered value

Financial Model for Manufacturing Price

1. Manufacturing Price/unit (£ProductionCost)

Costing of any product is profoundly concerned with the amortisation of fixed costs. These fixed costs apply to both the operations and administrative functions in a company. In the case of PCBAs the fixed cost is predominantly the fixed cost involved in setting up machines to produce a given design (labour costs dominate in this case), and the administrative overheads that a company must defray in manufacturing and selling PCBAs. It should be noted that the object of this exercise is to predict prices for a customer to get PCBAs manufactured (profit is included in the independent variables), e.g., **£ComponentPlacement** is the price to a client of having a component placed, not the cost to the manufacturer.

The unit manufacturing price (**£ProductionCost()**) of a PCBA may be expressed as follows:

$$\text{£ProductionCost()} = \text{£VariableCost()} + (\text{£SetUp} + \text{£Admin})/n \dots\dots\dots(i)$$

where **n** – number of units in the batch

- £VariableCost()** is the variable cost of a single PCBA as the batch size **n** tends to infinity
- £SetUp** is the one off cost of setting up all the machines necessary to manufacture the batch
- £Admin** is the fixed cost for all sales and administrative processes

The manufacturing price (£M) tends to £VariableCost as n tends to infinity, and when n = 1 the cost of overheads dominate.

$$\text{Let } \text{£Overheads} = \text{£SetUp} + \text{£Admin} \dots\dots\dots(ii)$$

This is a slightly unorthodox combining of overheads from operative and administrative functions, but it lends itself to this model without introducing errors.

£VariableCost for a PCBA may be structured as follows:

$$\text{£VariableCost()} = \text{£PCB} + \text{£Components} + \text{£Assembly} + \text{£TestCost} + \text{£PackagingCost} \dots\dots(iii)$$

Where each of the independent variables is based on a batch size (**n**) tending to infinity.

$$\text{£PCB} = \text{PCBCostMM2} \times \text{PCBLayers()} \times \text{PCBCSA}^{0.5}$$

The square root in the formula above is empirical. The formula was derived from an analysis of various suppliers/manufacturers.

The £Components cost can be calculated from the fact that the £DevCost is known, i.e., the cost of all the components on the basis that n is low is known from the sum of the Module component costs (£SysModule). A formula may be stated by using the same logic applied in equation (i):

$$\text{SysComponentCost()} = \text{£Components} + (\text{FixedCostMultiplier} \cdot \text{£Components})/n \Big|_{n=1}$$



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Transposing gives

$$\text{£Components} = \text{SysComponentCost()} / (1 + \text{FixedCostMultiplier})$$

But FixedCostMultiplier >> 1, and therefore

$$\text{£Components} = \text{SysComponentCost()} / \text{FixedCostMultiplier}$$

$$\text{£Assembly} = \text{SysNumberComponents()} \times \text{£ComponentPlacement}$$

$$\text{£TestCost} = \text{TestCostMultiplier} \cdot \text{SysCSA()}$$

$$\text{£PackagingCost} = \text{PackagingCostMultiplier} \cdot \text{SysCSA()}$$

The £Overheads (cost of setting up the machines to run batch size of n and associated administrative costs) must be proportional to £VariableCost. It follows from this statement that a job with a higher £VariableCost will be more complex than one with a lower £VariableCost, and therefore it is reasonable to assume the following:

$$\text{£Overheads is directly proportional to } \text{£VariableCost()}$$

Therefore $\text{£Overheads} = \text{FixedCostMultiplier} \cdot \text{£VariableCost()}$ (iv)

FixedCostMultiplier is normally a significant number, say 50. To put this in practical terms, if a mass manufactured PCBA has £VariableCost = £15, it would not be unreasonable if a request to manufacture a single unit were met with a quote of £750.

Substituting (iv) into (i) using (ii), the manufacturing price per unit becomes:

$$\text{£ProductionCost()} = \text{£VariableCost()}(1 + \text{FixedCostMultiplier}/n) \text{(v)}$$

2. £BatchPrice()

The price to the client for the batch must be corrected for the type of delivery selected. There are three types of delivery – sprint, jog and walk.

The price for the batch:

$$\text{£BatchPrice()} = \text{£ProductionCost}(n) \times n$$