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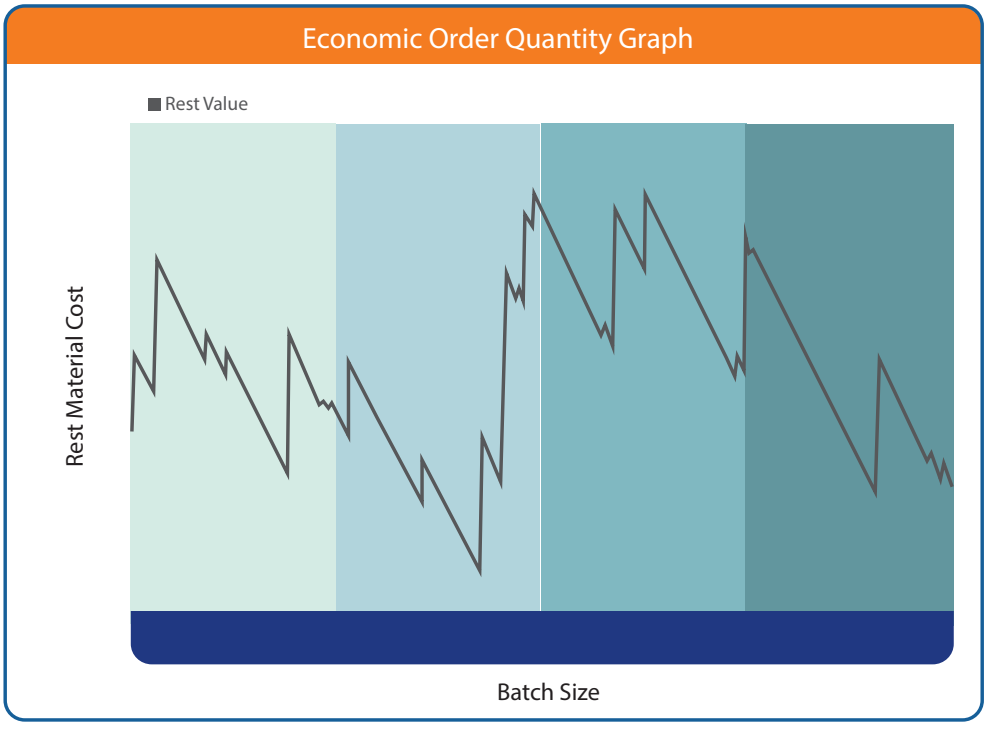
WHITE PAPER

THE ECONOMIC ORDER QUANTITY IN ELECTRONICS CONTRACT MANUFACTURING

This White Paper is about the Economic Order Quantity (EOQ) in Electronics Contract Manufacturing; a very different type of EOQ.

Because its impact is often surprisingly much greater than that of the classic EOQ, much more attention should be paid to the electronics manufacturing EOQ.



The electronics manufacturing EOQ is defined by Electronics Contract Manufacturers when they receive a request for quotation (RFQ) from their customers (OEMs).

This has nothing to do with the classic definition of EOQ. The classic EOQ definition states that the most economical order quantity minimises the total costs of product inventory (holding costs, order costs and shortage costs, etc.). The electronics manufacturing EOQ is about materials minimum order quantities (MOQs), job sizes and residual material costs.

The materials purchase dilemma

Electronics Contract Manufacturers (often referred to as EMS providers – electronics manufacturing service providers) are highly specialised companies. They produce and test the electronics that their customers develop and design. EMS providers are usually also responsible for purchasing/acquiring the required materials, predominantly of electronic components.

There are more than 100 million different, commercially available electronic part codes in the world and more are added daily. Therefore, during the design process, OEMs can in principle choose from millions of different electronic components.
Thousands of component manufacturers around the world use specialised distributors to bring their components to the attention of technicians working in the development and design departments and laboratories in order to have these included in product designs. They hope to be able to supply their components to the specialised EMS providers for prototype and pre-series manufacturing, and finally for inclusion in mass production.

Component "retail services"

Both OEMs and EMS providers need electronic components. In the majority of cases, an OEM development department needs only one or a few units of each component type (part code) for a new product design. Usually only a limited number of components are required for prototype and pre-series productions by an EMS provider.

Unfortunately, the manufacturers of the electronic components supply their products in standard packaging, specially developed to keep them in prime condition for a longer period of time and to ensure they are flawless when used in production. The standard factory packaging quantities can vary from one single component to more than ten thousand components in one package. Sometimes, the same part codes are offered in different standard packaging types, whereby different packaging quantities apply.

You will agree that it would be insane to always purchase factory packaging for each of the different part codes in a product BOM (Bill of Materials), which can sometimes include more than 1,000 different part codes. This would mean huge expense and significant material wastage if these are not used for production. Therefore, for many part codes, most component distributors offer a service where they supply one single or a small number of components at somewhat higher prices. This is a great 'retail service' that is perfect for the electronics industry.

However, these electronic component distributors are not charities. They take a considerable risk with this 'retail service'. After all, they have to stock factory packaging and open this packaging to be able to sell small quantities of the components. After a certain period of time, the remaining stock of (unpopular) part codes can no longer be sold because solderability diminishes and production problems could arise. Or a part code may become obsolete. In any case, the remaining stock must be written off.

Quite clearly, this 'retail service' is not a good idea for very sensitive components (e.g. ultra-fine pitch or moisture-sensitive components) or highly specialised components that are only sold infrequently. These can therefore only be kept in stock in unopened factory packaging and some are not even stocked and only delivered directly from the factory after being ordered. Additional considerations that play a role in the performance of this service lead to differences in pricing and MOQ policy between the distributors.

Minimum Order Quantity (MOQ) and Multis (Multiple Order Quantities)

To provide the aforementioned retail service in an efficient manner, Minimum Order Quantities (MOQ) are frequently used and, for larger quantities, Multiple Order Quantities (Multis). For an identical part code, the MOQ can differ per distributor. An MOQ for the same part code can be '1' at one distributor and '5' or '100' at another.

The corresponding prices and the scale can also vary per distributor.
Popular component brands are often available at every distributor, sometimes with large differences in MOQ and Multis for the individual part codes. In short, there is a wide range of options, which is a real nightmare for engineers at EMS providers that wish to issue quotes.

Residual material and its costs

In general, for OEM development departments, component availability as opposed to price tends to play a significant, if not dominant, role for the prototypes they develop. Large MOQs can result in a lot of surplus material, which in the worst case scenario must be written off. These costs are relatively insignificant when considering the total development costs of a product. But with expensive components, things can become quite expensive in absolute terms.

Residual expensive components could be offered to the EMS provider for production, but they generally prefer not to accept components on this basis; apart from the additional inspection costs that have to be incurred, if components have been stored in poor conditions at an earlier stage this, plus other adverse influences, can entail a production risk. With certain exceptions, all consequences and related costs will then have to be borne by the EMS provider.

Once mass production is underway at an EMS provider and is planned to continue over a longer period of time, the problem of small component quantities does not seem to arise. The EMS provider only orders factory packaging for all part codes at the best prices and conditions. I deliberately say "seem", because there is a catch here too, which I will return to later.

In terms of small series production and certainly in terms of the assembly of prototypes and test series, there is a significant problem with small numbers of components.

When an EMS provider receives a Request for Quotation (RFQ) the required material is analysed based on a Bill of Materials (BOM) and the requested number of products.
The material can be divided into four categories:
– (Standard) materials in stock
– Known* materials not in stock
– Unknown* materials
– Materials to be specially ordered (e.g. PCBs but also cable harnesses, brackets, etc)

**The terms 'known' and 'unknown' refer to whether the part codes requested in the BOM are already recorded in the business systems of a EMS provider (e.g. ERP) and are already possibly in stock.*

Given the 100+ million different, commercially available electronic part codes, it will be no surprise that with newly developed products, the percentage of unknown part codes can rise to well over 80% of BOM content. The percentage of unknown part codes has a significant influence on the additional costs in relation to materials.

Residual material: the core problem

After aforementioned analysis the EMS provider should, in principle, request quotes from various distributors for the material that is not in stock or of which there are only low stocks. But the high pressure involved with providing quotes and the large variation in availability, prices, volume discounts and MOQ, make it very difficult, if not impossible, to select the best options. Besides, to be able to define an accurate and optimal material cost scenario, not only should the different distributor quotations be compared, but the internal costs for purchase and goods receipt/storage must also be considered. The more suppliers, the greater the internal costs.

Although availability is a major driver for prototypes, it still may be useful to perform price analyses for more expensive part codes. For some part codes in the BOM, the exact quantities that are required can be ordered at a higher price. Other part codes have an MOQ and others require that full factory packaging is ordered. The last two scenarios of MOQ and full factory packaging are responsible for the 'residual material' cost issue.

In addition to that, component price differences between exact quantities and factory packaging can be so significant that, in particular for more expensive components, consideration could be given to selecting the factory packaging to drastically reduce the price of the product. But especially if subsequent orders are not guaranteed, this approach dramatically increases the residual material risk.

What can be done about this?

Every EMS provider will be faced with residual material. Every EMS provider discards residual material every year. It is a problem from both an environmental and business economics point of view.

The environmental aspect requires, of course, no further explanation.

From a business economics point of view, the issue is problematic for several reasons.
Below are just a few:

- the customer may not wish to compensate for the costs of residual material
- the residual material occupies warehouse space without a storage fee being received for this
- for commercial reasons, the EMS provider may have to bear the residual material costs
- it is not always clear whether the EMS provider will receive subsequent orders for which the residual material can be used in whole or in part
- it is uncertain whether expensive part codes in a future BOM revision will not be replaced by others.
- after 3 years, stored components can start to cause production problems (e.g. moisture issues or soldering problems)
- for newly released components, prices can fall drastically within a short period of time

All in all, these are significant risk-increasing aspects, which may significantly erode your annual bottom line.

Order quantities

Unfortunately there is an additional aspect that reinforces the residual material problem. When ordering the required quantities of components for the assembly of a product, several variables must be taken into account. For example:

- varying numbers of components per part code ("RefDesses") in the BOM
- the claim surcharges (attrition*) as compensation for transport/handling damage, machine rejections, unusable components (e.g. in the run-in of tape feeders), repair of defective components and service repairs.
- various MOQ/Multis per potential supplier
- various factory packaging options per part code

The aforementioned variables mean that the decision where to buy which components can be quite complex. An additional complexity is that MOQ and factory packaging of the different part codes are "consumed" at irregular intervals over the course of batch production. All these different aspects mean that the materials to be ordered must be accurately calculated to avoid significant residual material costs mounting up.

*) Attritions or claim surcharges differ per part code, dependent on shape codes, the required assembly processes and the production machines used. But these are also influenced by design aspects, component quality and repair processes. By accurately defining loss percentages per shape code, if possible fine-tuned by Manufacturing Execution System (MES) feedback, an EMS provider can significantly reduce its annual residual material and inventory costs.

Economic Order Quantity

Imagine that an OEM requests a quotation for the assembly of a series of 100 products. The assembly of those 100 products requires 1,000 components with a particular part code + 2% claim surcharge (= 1,020) and the MOQ/Multi is 500. Inevitably you will have to order 1,500 components to be able to produce all 100 assembled products.

You will consequently have 1,480 components as residual material with the associated cost.
However, should your customer agree to an order of 98 products instead of 100, you could avoid the cost of the residual material as the purchase of 2 x 500 = 1,000 units of the part code would suffice.
The EOQ is therefore 98.

In principle, this calculation would have to be made for each part code in the BOM, which could mean hundreds of calculations for large BOMs.

In terms of costs, the residual material costs barely play a role for many part codes. Most part codes are inexpensive and the costs will generally have little influence on the total costs of the materials to be ordered. The rule of thumb is that, on average, 80% of the components of a product cause only 20% of the material costs.

But considering that a factory reel with 10,000 components @ 0.075 costs €7,500 and a factory reel with 2,500 ICs @ €8.25 costs €20,625, it is definitely worth giving the foregoing a little more thought!

EOQ graph

The fact is that one component more or less defines the tipping point at which an additional MOQ or factory packaging from a part code must be purchased. For every part code in the BOM, this is at different production quantities. An expensive part code then suddenly significantly increases the residual materials cost. On the other hand, one (cheap or expensive!) component too little can cause downtime of an entire production line or otherwise disrupt processes, then all the incidental costs have to be taken into account.

It is therefore definitely worth analysing whether such a tipping point is close to the number of products to be ordered and if so, where that point is. Is that below or above the ordered product quantity? And how is that analysed?

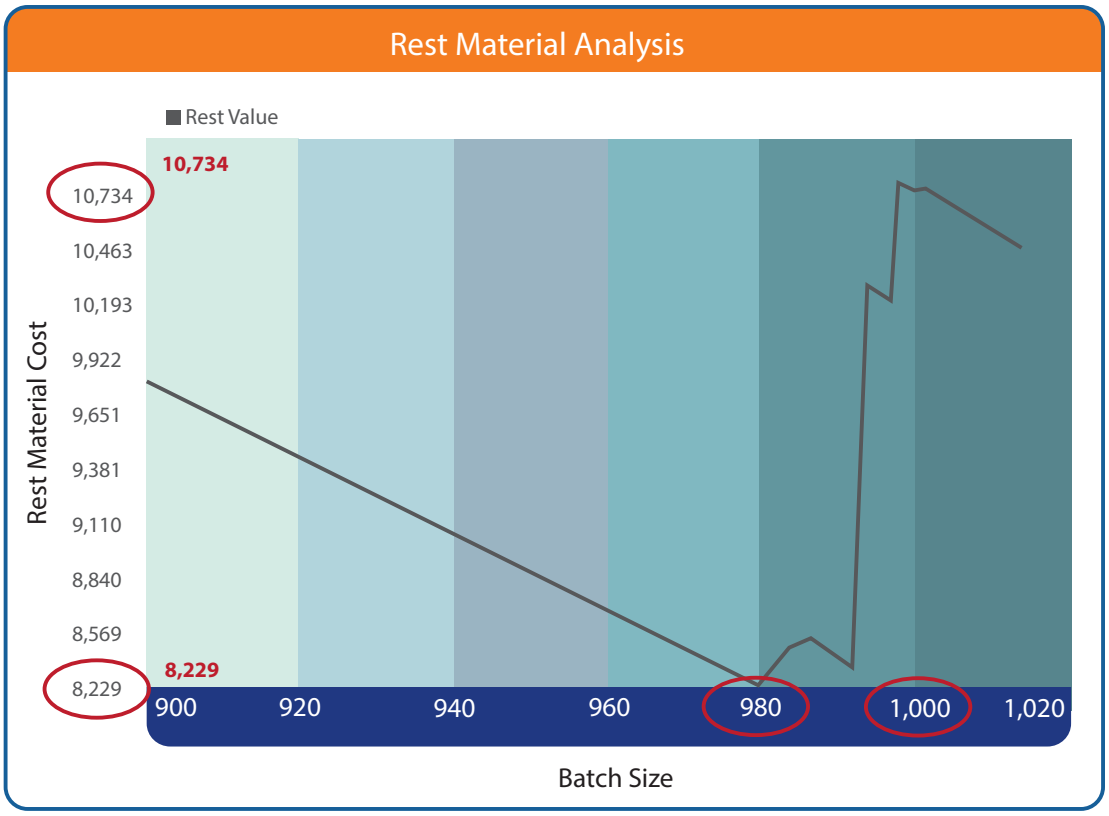
The best way to analyse this is by using an EOQ chart. But we can safely conclude that, due to the large number of variables that influence the calculation of the EOQ and, due to the high time pressure on quotation delivery, it is virtually impossible to do this manually. For large series, where the pressure of providing a fast quote is somewhat lower and the component range and consumption are more clearly arranged, this could be done but is then often less relevant.

Good quotation software offers the right analysis options

Modern quotation software enables an EOQ graph to be generated automatically for each quotation calculation. This shows 'order size' versus 'residual material costs' and indicates, considering all variables, what the ideal batch size will be and why.
Packaging and price scenarios of different distributor combinations can be varied and their influence on the EOQ can be analysed.

The EOQ chart below (the grey line is the residual material cost line) shows, for example, that between 980 and 1,000 components the cost of the residual material jumps from € 8,229 to € 10,734.

By narrowing the window and zooming in on the specific location, it is possible to determine exactly which part code(s) is/are responsible for this sudden cost increase. Adjustments can then be considered, either by the customer (e.g. smaller order size) and/or by the EMS provider (e.g. adjustment of a claim surcharge or an additional purchase of a small amount at a higher price instead of factory packaging).



The EOQ does not necessarily mean a lower order quantity. To achieve a better product price, it can also mean a larger order quantity. A declining residual material cost line may not yet have reached the minimum at the requested quantity. With a somewhat larger order quantity, the residual material cost can be reduced further still. Although this would mean more products, the additional manufacturing costs of those few extra products would be relatively small. The residual material cost saving can be much greater and will easily compensate for the additional manufacturing cost of more products.

An order quantity from an OEM is often rounded off, so adjustments are usually possible. All this can be discussed and determined with the customer based on the facts in the EOQ chart.

What about the previously mentioned catch...

At the beginning of this article the following was stated:
"Once mass production is underway at an EMS provider and is planned to continue over a longer period of time, the problem of small component quantities does not seem to arise."

But what if long-term mass production phases out or ceases? What is the EOQ of the last production order for that product? If the order quantity choice is poor, the EMS provider may be left with tens of thousands of Euros/Dollars in residual material. So it is certainly worth analysing this last RFQ (or order!) accurately and ordering the correct quantities for some critical part codes at a higher price to minimise the residual material cost.

This may or may not be in consultation with the customer.

Conclusions

1. The use of EOQ calculations and graphs allow an EMS provider to enter into a fact-based discussion with customers about the difficult cost issue of residual material.

2. For the OEM, this ultimately means an optimum product price at the lowest possible residual material costs. Even in the event of a design change, little consideration is given to extreme depreciation costs for the component codes that have been designed out.

3. Conversations about the EOQ and the residual material cost between OEMs and EMS providers are often very enlightening and fruitful. Thousands, sometimes tens of thousands of euros/dollars, can be saved per individual assignment. Both the OEM and EMS provider would benefit.

4. It is virtually impossible to manually calculate the EOQ for a particular product and batch size. Modern quoting software is required to generate useful EOQ information.

5. Using professional quoting software, the EMS provider avoids confusing conversations with the customer about poorly quantified residual material costs. To the contrary, the residual material costs are specified precisely and up to the individual component part code.

6. In general, using the EOQ approach also means (for the EMS provider) an annual reduction in stock and a significant reduction in unusable residual and obsolete materials being written off; something that every EMS provider strives for.

For more information about automating the quoting process of EMS providers, please visit our website **www.quotearchitect.com**

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