



A MIE Solutions White Paper

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Introduction To Job Shop Estimating

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Introduction

Accurate job shop estimating is a critical task in order to win more work which is profitable. The process being when a request for quote (RFQ) or request for proposal (RFP) is received from a potential buyer.

The process of replying to an RFQ is what we define as quoting or estimating. A reply needs to be accurate and take into account many factors to be competitive. You can estimate and quote jobs using paper and pencil, a spreadsheet or software specifically designed for estimating made-to-order or engineer-to-order products.

In this very competitive market I suggest using an estimating software package in order to be most competitive. In this paper we will outline some of the definitions used during the estimating process and explain how they are potentially used to derive your quote.

What is Setup Time?

In order to begin a detailed look into quoting and estimating we will start by giving some definitions.

Setup Time

Setup time is the time it takes to make the first accepted piece which includes bringing all the tools, jigs and fixtures, setup those jigs and fixtures for a particular batch quantity. Operation run time or cycle time is the time spent to complete each unit through the machine.

Setup time can be simple or complex and it really depends on the process being performed. Setup time is usually



independent of the actual run time because once a machine is setup it can be continually run without setting the machine up a second time. Setup time can actually be broken down into a few categories.

Staging Time

The time required to gather materials, dies or any other equipment required to get the machine running. Staging can potentially be performed during the running of another job through the machine because it may not actually require the machine to be available. A simple definition is time spent on a machine or process prior to a manufacturing run.

Setup Time

The time required to bring this production batch quantity to an actionable state.

Transit Time

Transit time is the time to move a particular batch quantity to another step in the process.

Tear Down Time

The time required to remove all the equipment that was required to be setup on the machine making it ready for the next process. A job may continue to the next operation during the tear down time because this time does not affect the actual job, only the machine. A simple definition is the time to take down a machine or process after a manufacturing run.

Quoting and ERP packages should provide the capability for these setup time variations in order to allow your estimating, costing and even scheduling to be as accurate as possible.

What is Lag Time?

The four areas that were spoken about where staging time, setup time, transit time and tear down time. Each one of these 4 processes actually would add costs to an estimate. Lag time does not add costs to an actual estimate under most circumstances. When there are dependencies between operations, delays in handling, transportation, transmission or thinking time, etc. between operation steps we refer to this as lag time.

Lag time does not usually add costs to a operation step because there is no activity actually being performed except for taking up space on the manufacturing shop floor. If there were large lag times you may consider putting a dollar value on the floor space but this may be overkill during the quoting and estimating process.

On the other hand lag time is a critical factor during scheduling of a job shop. This lag time is critical in ERP/MRP systems in order to properly handle dependencies between operation steps. The objective is to minimize the time a job is sitting idle with no work being performed. Reducing cycle time by decreasing the queue time between manufacturing steps is a basic principle of lean manufacturing to reduce work in process inventory.

Quoting and Estimating is not an area where lag time is usually considered because there are direct costs that could be attributed.



As you prepare your estimate keep in mind lag time because it will be used in scheduling the job shop.

What is Cycle Time?

One of the most difficult aspects of estimating is figuring out what the cycle time may be for a process. There are many factors which affect the cycle time which are not fixed including skill level of the person running the machine, reliability of the machine, maintenance of the machine, inspection of the parts being run, the quality of the material and others.

Cycle time is defined as the handling time + run time.

Handling time is the time spent as the operator loads and unloads the part being manufactured from the machine.

Run time is the time the operator spends at the machine running the part or the time the machine is running by itself, i.e. a cnc machine.

Some operations require the operator to be present during the running of the part and others do not.

The basic formula for estimating an operations cost is

Cycle Time Per Piece

(Handling Time + Run Time)

Total Estimating Operation Time

Setup Time + Cycle Time

or

(Staging Time + Setup Time + Transit Time + Tear Down Time) + (Handling Time * Run Time) * Quantity To Be Produced

Estimating your cycle times is a critical area for any manufacturer to be profitable.

What is Handling Time?

Handling time is defined as the time it takes during the cycle time phase of production to move the material in place to begin a step and the time to remove the material at the end of the step.

The basic formula for estimating cost is

Cycle Time Per Piece

(Handling Time + Run Time)

Under many situations there is a one-to-one relationship between the run time and the handling time.

Examples

Let's say you are fabricating 1000 widgets. Each widget must go through the step of forming, which is basically bending the material. If it takes an employee 30 seconds to form each widget, the estimated run time would be 30 seconds per piece. The handling time is in direct correlation to the run time because you are forming a single widget at a time. In this situation you include the handling time into the run time or keep it separate for more accurate reporting.



Now let's assume that widget A is very large and it takes a forklift to move each piece into the forming machine. In this situation the run time may be 30 seconds because that is the time it takes to form widget A once it's in the machine. The difference is the handling time is much larger because it may take 5 minutes to setup and remove widget A from the machine. Separating the handling time and run time out in this situation becomes a bit more valuable because the handling time takes such a large portion of the actual cycle time.

Last example is you have a widget A that needs to be cut on a laser. A laser machine in my example is a machine where you put a sheet of raw material onto it which then the laser can cut out 1 or more widget A's on a single sheet. Let's say to cut widget A the run time is 3 minutes per part. Each widget A takes the same amount of time to cut but in this situation the handling time is not one to one with each widget A.

The reason for this is the laser cuts multiple pieces of parts out of a single sheet. The handling time is actually the time it takes to load the sheet into the machine and then the time to remove the widgets from the sheet and machine when the widgets have been cut. Handling time is actually the time it takes to load the sheet divided by the number of parts a sheet makes.

The new cycle time formula is

Cycle Time Per Piece

$((\text{Handling Time} / \text{Quantity Manufactured Per Handling Time}) + \text{Run Time})$

Handling Inspection Time?

Inspection is a category of the cycle time which is not normally considered during the quoting process. I mentioned earlier that the following formula which is normally used for machine time quoting which is for sheet metal, machine manufacturing, assembly and pretty much any other process.

Cycle Time Per Piece

$(\text{Handling Time} / \text{Quantity Manufactured Per Handling Time}) + \text{Run Time}$

One piece of information that is missing from this formula is how to handle inspection time. Inspection time can be included on the estimate in a variety of ways.

1. Inspection time could be included in the run time because the employee may be able to actually inspect the parts being manufactured as the machine is running. In the machining and sheet metal type of machinery this would work for lasers, turning machines, mills and lathes. These machines usually do not require 100% dedication of the employee as they watch the part being processed by the machine.
2. Inspection time could be included as part of G&A overhead. There could be a basic markup that is added to the quote to handle inspection time.
3. Inspection time can be a separate operation. In this situation while the inspection operation is being performed it



does not allow more parts to be produced until the inspection operation is complete. An example in the sheet metal and machining organization would be first articles.

First article inspections are required before the production run could be started. This ensures that the parts are made accurately.

4. Inspection can also be done during the actual production run for SPC.

Estimating software for industries such as metal quoting, machine shop quoting, sheet metal quoting, stamping need to be able to handle these different situations. If these different situations. If these scenarios are handled by your estimating software you will be able to manage any time of quote that requires inspection.

Final Result

Calculating the entire operation costs depends on both setup and cycle time. In order accurately estimate your costs to complete a job you must be as accurate as possible during the estimating process. If you spend too much time estimating you will be burning a lot of cycles which costs money. If you do not accurately estimate you are potentially losing jobs and or losing the job you one because it costs more to produce then you have estimated.

It is now time for the final formula to be realized which includes setup

time and cycle time with all its details.

The setup formula again is

$(\text{Staging Time} + \text{Setup Time} + \text{Transit Time} + \text{Tear Down Time})$

The cycle time formula is

$(\text{Handling Time} * \text{Run Time}) * (\text{Quantity To Be Produced}) + (\text{Inspection Time} * \text{Quantity Of Parts Inspected})$

The operation formula becomes

$(\text{Staging Time} + \text{Setup Time} + \text{Transit Time} + \text{Tear Down Time}) + (\text{Handling Time} * \text{Run Time}) * (\text{Quantity To Be Produced}) + (\text{Inspection Time} * \text{Quantity Of Parts Inspected})$

Cost estimating using good estimating software tools makes producing accurate quotes much simpler. The formula given is only the first step in learning how to estimate.

Summary

MIE Solutions provides software for the manufacturing industry including quoting and estimating, ERP, asset management and B2B supply chain software. You can download a trial version of the quoting software MIE QuoteIt at the following web address

<http://www.mie-solutions.com/mie/index.php/MIE-QuoteIt/>

Please visit my blog at the following address where we talk about everything dealing with quoting and estimating.

<http://jobshopestimating.wordpressolutions.com>