# Manufacturing Critical-path Time (MCT): The QRM Metric for Lead Time

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**Motivation for a New Definition**

Manufacturing today abounds with acronyms and definitions. So why is there need for another one? The reason is integral to the theme of Quick Response Manufacturing (QRM)*: in order to reduce lead time, you first must measure and benchmark its current value. In this document the focus will be supplier lead time. However, since every company is a supplier to its customers, this definition should help the operations side of any manufacturing enterprise.

Amazing as it may seem, prior to the formulation of MCT, no precise, unambiguous, practical, and universal definition for supplier lead time had been put forth. Such a definition is essential to the success of QRM: if you were interested in reducing lead time, you would need a precise definition of lead time. You can't reduce something if you can't even agree how to measure it!

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*For details on QRM see the book *Quick Response Manufacturing: A Companywide Approach to Reducing Lead Times,* by R. Suri, Productivity Press, 1998.

Indeed, most prior definitions of supplier lead time are too general, and are along the lines of:

*(Traditional definition of lead time): The time from when an order is transmitted by a customer until the order is received by that customer.*

However, this traditional definition has two significant disadvantages*:

1. It does not help to understand and eliminate system-wide waste, and
2. It does not give any indication of how order fulfillment is achieved.

In other words, the traditional definition of supplier lead time focuses strictly on a result. Consequently, stockpiling finished goods or partially completed components may result in a short lead time. However, this inventory is obviously a waste of working capital. Worse yet, it can result in even greater waste if a quality issue is discovered by the customer, an engineering change requires material to be scrapped or reworked, or demand falls significantly below what was forecasted and the inventory cannot be used for an extended period. Conversely, if demand greatly exceeds the forecast and the stockpiled components are depleted, supplier lead time can extend significantly beyond the value in the traditional definition, resulting in customer dissatisfaction or even lost sales. None of these issues is captured in the traditional definition.

What is needed instead is a supplier lead time indicator that focuses on both the outcome and how the outcome is achieved. Such a metric is described next.


**Definition of Manufacturing Critical-path Time (MCT)**

*Manufacturing Critical-path Time is the typical amount of calendar time from when a customer creates an order, through the critical-path, until the first piece of that order is delivered to the customer.*

Note that MCT is related to the concept of Value Stream Mapping. Although MCT can be derived from a Value Stream Map, MCT is not the same as the time value defined on a Value Stream Map. Additional details on this point will be given in forthcoming publications from the Center for Quick Response Manufacturing.


**Detailed Explanation of Key Phrases in MCT Definition**

Each of the key phrases in the above definition is now explained in more detail.

*"The typical amount…"*

MCT is a representative value of typical "real-world" interactions that are common in all manufacturing organizations. Each instance that the "amount of calendar time" described

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*For details on these points, see "Managing the Extended Enterprise," by P.D. Ericksen and R. Suri, *Purchasing Today*, Vol.12, No.2, February 2001, pages 58-63.

in the MCT definition is measured, its value will likely vary. Potential users of MCT therefore might think that detailed data-gathering and statistical techniques are required to determine MCT, and might be put off using MCT because of the effort required to do this. However, the idea behind MCT is to keep data gathering efforts at a much simpler level for two reasons:

1. The purpose of MCT (in keeping with QRM philosophy) is to provide a reasonable ("ballpark") estimate to identify the biggest opportunities for improvement – to get insights into the main causes of long lead times and consequently the major drivers of system-wide waste.

2. A key management insight after getting the value of MCT is to compare the amount of non-value-added time to the value-added time within the MCT. The amount of non-value-added time is usually very high in most cases, typically surprising management and employees and motivating them to take corrective action (using QRM methods). Thus it is not necessary that this value be extremely accurate, as long as it demonstrates clearly the magnitude involved.

In summary, the strength of the MCT metric is that a reasonably representative value will suffice. More on how to derive MCT, as well as the insights it provides, will be seen in the detailed examples provided in other documents.

### *"…of calendar time…"*

MCT must be measured in "real time" because that is how delivery is viewed by customers. Consequently, breaks in continuous operation, such as work weeks less than seven days and work days less than 24 hours, do extend MCTs, but must be accounted for. Calendar time is generally measured in days.

### *"…from when a customer creates an order…"*

MCT starts with the creation of the order by the customer, since this is "when the clock starts" as far as the customer is concerned. An order is measured from the perspective that it was previously unplanned. An unplanned order could be a "surge" in demand for make-to-forecast or make-to-stock manufacturing or a "custom" order in make-to-order or engineer-to-order manufacturing. This perspective ensures that a supplier's true responsiveness is measured and total system waste is captured.

### *"…through the critical-path…"*

MCT quantifies the longest critical-path duration of product-specific order fulfillment activities including: order processing, materials planning, scheduling, manufacturing operations, and logistics. The assumption is that all activities are completed from "scratch" so that, for example, pre-built components cannot be used to reduce the MCT value. On the contrary, in order to capture and quantify the total system waste, time spent by material in any stage actually <u>adds</u> to the MCT value. Specifically, this includes, raw material, work-in-process, and finished goods materials.

*"…until the first piece of that order…"*

MCT takes the perspective of the first piece of an order to ensure consistent measurement of the value of time regardless of order size. This view is particularly important in terms of providing insights into improvement opportunities.

*"…is delivered…"*

MCT includes logistics time, which is of particular interest for three reasons*:

1. With the growing emphasis on global sourcing, it is important to quantify the impact this has on a supplier's ability to respond to changes in customer orders.

2. Costs associated with expediting orders can rapidly spiral out of control, becoming prohibitive.

3. Once an order has been shipped from a supplier, it becomes very difficult, and sometimes impossible, to influence shipment time.

*"…to the customer."*

MCT ends when an order is delivered to a customer's first point of receipt.


**MCT Calculation and Application**

Detailed examples demonstrating the calculation of MCT for actual situations, along with case studies of application of MCT, will be provided in forthcoming publications from the Center for Quick Response Manufacturing.

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*For details on these points, see "Filling the Gap: Rethinking Supply Management in the Age of Global Sourcing and Lean," by P. D. Ericksen, R. Suri, B. El-Jawhari and A. J. Armstrong, *APICS – The Performance Advantage*, February 2005.