*It's hard to design the future
when you're stuck
in the here and now*

LeanFlo SM

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**A Quantitative Approach to
Identifying the Real Velocity of Production
By
Valuing the Value Stream
Through the Development
Of
Quantitative Analysis Models
That Use
PPH Measures,
Queuing
And Other
Mathematical Tools**

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A Quantitative Approach To
Valuing the Value Stream
By J. Ambrose Callaghan

Introduction

Gradually, through the deliberate introduction of production changes, improvements occur on the shop floor. This article will provide formulas and a mechanism for managing, measuring, and evaluating specific changes to the shop environment. The identification of raw data components, step-by step calculations, and evaluation of results will be discussed.

We will also discuss how to measure the flow of production. Then use the measurements to establish optimum levels of standard inventory. In conjunction with optimum inventory levels, production capacities can be adjusted to more precise levels. Overall, this reduces the average amount of time each piece waits on the ground. Finally the process will become visible to all in the Company, thus conditioning the 'corporate culture' to accept lean and flow procedures.

This paper will demonstrate how a Company can marshal a blend of tools that will measure the current value stream, develop 'what if' scenarios, measure production improvements, and compare value streams. This process allows the Production Scheduler to quantify the potential effects of changes before they occur, and to measure productivity without manually collecting and processing large amounts of raw data.

Bill of Resources as Representing Production Flow

This paper begins with the basic principle of Bill of Resources (BOR). APICS defines BOR as the process of converting the master schedule into requirements for key resources, such as machinery, labor, warehouse space, supplier's capabilities, etc. The BOR is a listing of all key resources that are needed to manufacturer one unit of product.[1]

Expanding the BOR, Lean Stream Management (LSM) considers it a representation of the flow of production, or a map of the Value Stream. Included in the Value Stream are non-value added assets such as out sourcing, over production, waiting, transportation, unnecessary processing, storage, motion and defect repair. For each, data can be made available, that reflects demand from the proceeding resource, and capacity at the current one. Accumulating WIP is the result of inequalities between capacity, demand and uneven production flows and batch processes. And depending upon supply, demand and capacity, each resource makes its own unique contribution to value or waste.

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[1] American Production and Inventory Control Society, "Dictionary", Cox, Blackstone, and Spencer, Eighth Edition.

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Measuring PPH by Identifying Value and Waste
The Society of Manufacturing Engineers (SME) has established PPH (parts per hour measurement) as one mechanism for determining productivity.[2] PPH is an index. The measurement can be used on the Lean oriented shop floor to highlight waste, identify over-all efficiency, control line flow and determine if a line is meeting Takt time.
PPH is not Parts per Hour, but a measure based upon a formula. It assumes the shop floor is labor intensive and that production activity can be divided into cells. It therefore measures the most typical Lean environment.[3] PPH takes into consideration all types of resource activity including value added, wait and waste.   Above all, it views the accumulation of WIP inventory as an indication that productivity is inefficient.

PPH = G / (O + or – (K + N)). The PPH measure recognizes the following:

1   **G** – total good parts produced within the standard operation time
2   **O** – standard operation time, less breaks, or the total time in all shifts multiplied by the number of workers within that resource
3   **K** – Wait Kanban time or those activities that can be defined as pure waste and do not add any value
4   **N** – scheduled non-production time or those activities that can add value but at the same rate regardless of the number of pieces

All activity within the resource needs to be categorized as subsets of K or N. Then Parts per Hour is calculated from the G and O variables.

Analysis of G
G is the total good parts (less scrapped parts) produced by a cell during the standard operation time. In the following example G = 100.

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[2] The SME identifies a second productivity measure called PLH. PLH considers the variability of the work force, and considers the line to be machine intensive rather than labor intensive. For example, if there is excess line stoppage the quantity of parts produced would not be as high but the labor content would remain the same. A variable work force is not typical in Lean. This article will therefore focus discussion on PPH. It is important to note however that most manufacturing enterprises are a combination of both machine and labor intensive activities. Waste can be extracted from both and both value streams can be can be incorporated into a BOR.

[3] Lean Manufacturing – A Plant Floor Guide, "Lean Measurements and Their Use", Meier, 2001, p. 50-53

Analysis of O

O is the value of standard operation time. Assuming the standard hours for production within the factory are 8 and the number of persons within a resource are two then O is $(8)(2) = 16$. For the sake of simplicity, I did not consider breaks or lunch as a reduction from the standard production shift. I have also chosen to use hours rather than minutes in my examples.