FactoryPhysics

Know the Laws. Use the Tools. Profit.

Factory Physics® Principles for Managers—Third in a Series

A series of articles designed to help managers and executives better control and optimize their operations through a solid understanding of the practical science that governs their environments.

Understanding Your Value Stream in a Hurry

Understanding your value stream (or plant or supply chain) in a hurry means:

- **Understanding how well the value stream is performing versus how well it could be performing.**
- **Understanding where the biggest levers are to drive performance improvement.**

So how do you understand your value stream in a hurry? At Factory Physics, Inc. it's a practical, scientific technique we call Absolute Benchmarking. For executives and managers Absolute Benchmarking is as fundamental to understanding operations performance and profit potential as revenue and expenses are fundamentals for accountants to understand income statements.

A number of insights follow from this understanding. For instance, if your value stream is performing about as well as it can but you are unable to meet demand, a new value stream or an increase in capacity for your current value stream is required. On the other hand, if your value stream is capable of meeting demand but you are not getting the output you need, then improvements to your existing system are required. In either case, assigning "stretch" goals without understanding the limits to which your value stream can stretch is potentially a recipe for a meltdown in performance. Stretch goals should not be used as a proxy for understanding performance drivers.

At the same time, the mantras of "Reduce Waste" (Lean Manufacturing) or "Eliminate Variability" (Six Sigma) are intuitively appealing but provide no focus for determining where to start or how to prioritize efforts to get the biggest benefits as quickly as possible. That being said, it is very important that the reader understand that Factory Physics® principles and applications are not in competition with Lean Thinking or Six Sigma or Theory of Constraints or Supply Chain Management. If your company is using Lean Thinking or Six Sigma or some other productivity initiative, you are heading in the right direction. Factory Physics principles and applications such as Absolute Benchmarking provide comprehensive, practical science and tools to enable you to fill in the gaps between existing efforts, understand best possible performance and improve profitability and performance as quickly as possible.

Absolute Benchmarking

There are two types of Absolute Benchmarking: Flow Benchmarking™ and Stock Benchmarking. Figure 2 illustrates a Flow Benchmark for a value stream, e.g. pharmaceutical tableting, coating and packaging, semiconductor production or bearing manufacturing. In this article we will describe only Flow Benchmarking. Stock Benchmarking will be covered in a later article.

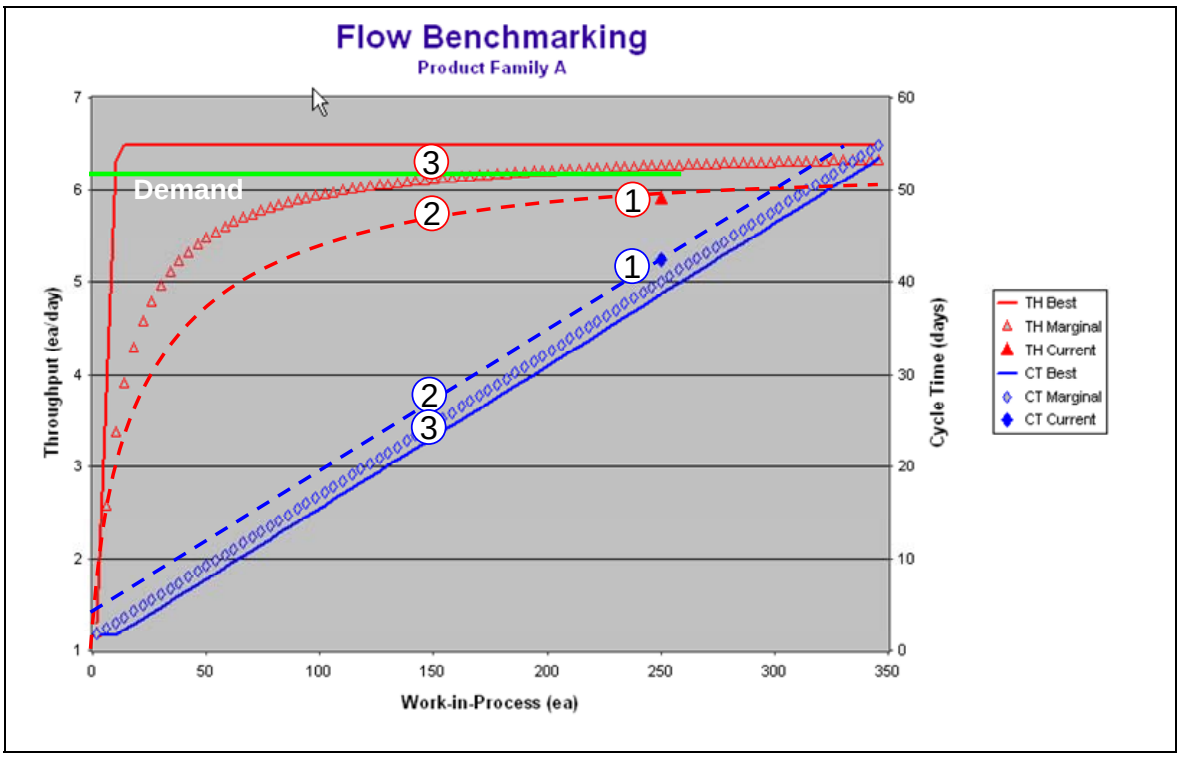

Figure 1: Flow Benchmark Graph

It's a busy chart but stick with us and you'll see it's fundamentally important for understanding your value stream and accompanying opportunities for improvement. First, the axes:

A. The left axis is throughput (or revenue) and is associated with the red lines and icons.

B. The right axis is cycle time (responsiveness) and is associated with the blue lines and icons.

C. The x-axis is Work in Process (a component of working capital). **Note of paramount importance: Both throughput and cycle time are related to WIP.** This is a law of nature, like the law of gravity. It is a fundamental Factory Physics law called Little's Law and is stated as WIP = (Cycle Time) x (Throughput). You can ignore it if you want to but you *will* be affected by it. We have seen blind devotion to WIP and cycle time reduction (increased

responsiveness) lead also to huge decreases in throughput (revenue). Huge decreases in revenue typically lead to changes in management.

To simplify the explanation, let's stick with just the throughput (red) portion of the Flow Benchmark for now.

Throughput

A. The red solid line (—) shows "best case" throughput performance. This is optimal performance under perfect conditions i.e. zero variability. Your value stream cannot *ever* perform any better than this and typically does not perform close to this line.

B. The triangle icon line (Δ Δ Δ) shows "marginal case" throughput performance. This represents a practical lower limit for throughput. In the marginal case, substantial variability has been assumed (i.e. the standard deviation of process time is equal to the average process time) and most managers would agree that as a practical target they should be able to control their process times (e.g. VDF time at a furnace, tableting time at a tablet press, machining time at a mill) to have less variability than in the marginal case.

   The region between the best case line (—) and the marginal case line (Δ Δ Δ) is known as the "Lean Zone." As we discussed in the last article in this series, being in the Lean Zone is a *necessary but not sufficient* condition for achieving outstanding value stream performance.

C. The red dashed line (---) is the actual performance curve for your value stream. Notice that it runs approximately parallel to the marginal performance line.

D. The solid red diamond (▲) shows the current throughput of your value stream.

E. The green line (—) shows customer demand. In the Figure 1 example, you can see that your current throughput is not achieving the throughput needed to meet customer demand, i.e. the solid red diamond at red point 1 is below the green line.

So What?

So now that you understand how to read the Flow Benchmark it tells you a number of things:

- For the example in Figure 1, your value stream is not performing close to best case, as a matter of fact; it's not even in the lean zone.
- Given the current capability of the value stream, you can meet demand with reductions in variability alone—move the red solid diamond up vertically (increase throughput) without changing the amount of WIP or corresponding cycle time—though that is not necessarily the first

approach you might want to take. Pure variability reductions are typically hard to implement. You could chose to improve performance merely by establishing WIP control, such as kanban or CONWIP, and reduce WIP from red point 1 to red point 2. **Note that this will also reduce your cycle time from blue point 1 to blue point 2—*approximately 15 days (35%) with no significant reduction in throughput.***

- Once you are at red point 2, you can increase throughput and go to red point 3 to meet customer demand either by decreasing pure variability effects (e.g. reduce flow variability) or by reducing variability and increasing available capacity (e.g. reducing setups).

As a manager looking at a local value stream (a production line) or an executive looking at a global value stream (a number of assembly and test operations in a supply chain feeding a distribution center), you can with one glance see how your resources are performing versus how they could be performing and in the same glance determine the type of improvement opportunities that are going to provide you with significant performance impact. For instance, if your value stream is already at red point 2, it's potentially a career-limiting move to spend a lot of effort on reducing WIP and cycle time. You can certainly get reductions in cycle time but you are going to lose a lot of throughput (revenue) in the process.

Though we didn't go into the data details, Absolute Benchmarking is a data-driven process that can be performed very quickly—typically in a day or two—with a minimal amount of data. Additional data means additional resolution but additional data typically just confirms your initial understanding in greater detail. In other words, additional data typically does not give you a different interpretation of your value stream's Absolute Benchmark performance and performance improvement opportunities. That being said, there can be a significant effort required once the Absolute Benchmark is performed to determine how to best unlock value from your value stream.

Factory Physics principles and applications provide the tools to do the additional work quickly but the appropriate tools should be used appropriately. As one executive stated, "If there's gold lying on the ground, I don't need a model to tell me to pick up the gold and put it in my pocket. If the gold is in a stream bed, I might need to get some panning equipment or build a sluice box. If the gold is deep underground, I'll need more sophisticated equipment." Absolute Benchmarking quantitatively helps you determine which value streams contain the most gold—and gives you an idea of the appropriate tools you will need to unearth the gold. Our experience has shown this to be a tremendous saver of

time and energy for manufacturing executives and managers…and this is just one of the applications of Factory Physics principles and tools!

As stated in the introduction, understanding the concept of Absolute Benchmarking is a fundamental expertise that any manufacturing or supply chain executive or manager should master. It leads you to **comprehensive and predictive control** over your value stream's performance and profitability.

Defining a Value Stream

In the discussion of Absolute Benchmarking and understanding a value stream, we mentioned Flow Benchmarking and Stock Benchmarking. Stock Benchmarking will be described in the forthcoming article on inventory. Here, we described only Flow Benchmarking but we haven't yet discussed the fundamental value stream components of stocks and flows. We need to define some basic concepts about value streams.

Every value stream is made up of two *essential* components: **demand** and **transformation.** Demand is the *reason* for the existence of the value stream. Transformation provides the *ability* to satisfy the demand. We're getting into differences in semantics when we say transformation instead of supply but there is a distinction between the two. One person's supply is used to satisfy another person's demand, so that "supply" ends up being simply transformation on the part of the supplier.

The Value Stream also involves only two basic components: **stocks** and **flows.** See Figure 2 for a conceptual illustration. Both demand and transformation are types of flows. Flows involve **capacity** and **time**. The capacity of a flow represents the maximum amount of flow (what we will call the "throughput" that is measured as parts per year, parts per day, patients treated per month, etc.) the flow can produce. The time element describes how long it takes for a part to traverse the flow. We call this the "cycle time."

Stocks are what separate flows. If two or more parts need to come together in an assembly, for instance, there will be a stock for the parts to match up. Raw materials and finished goods are also examples of stock. Note that only parts can be stocked and services cannot. If you break your arm, you cannot go to the emergency room and get your x-rays, a diagnosis and a cast for your arm off the shelf.

Interestingly, work in process in a flow (the parts that are being made) is not a stock. WIP is a characteristic of the flow and is the product of the throughput and the cycle time (Little's Law).

However, parts that are stored between flows are in a stock. The difference is determined by whether the parts are waiting for a resource (e.g., a machine) or waiting for another "logistical event" such as matching with other parts at an assembly or waiting to be shipped. WIP is waiting for a resource. Stock is waiting for a logistical event. The drivers of resource performance are quantitatively different than the drivers of logistical events.

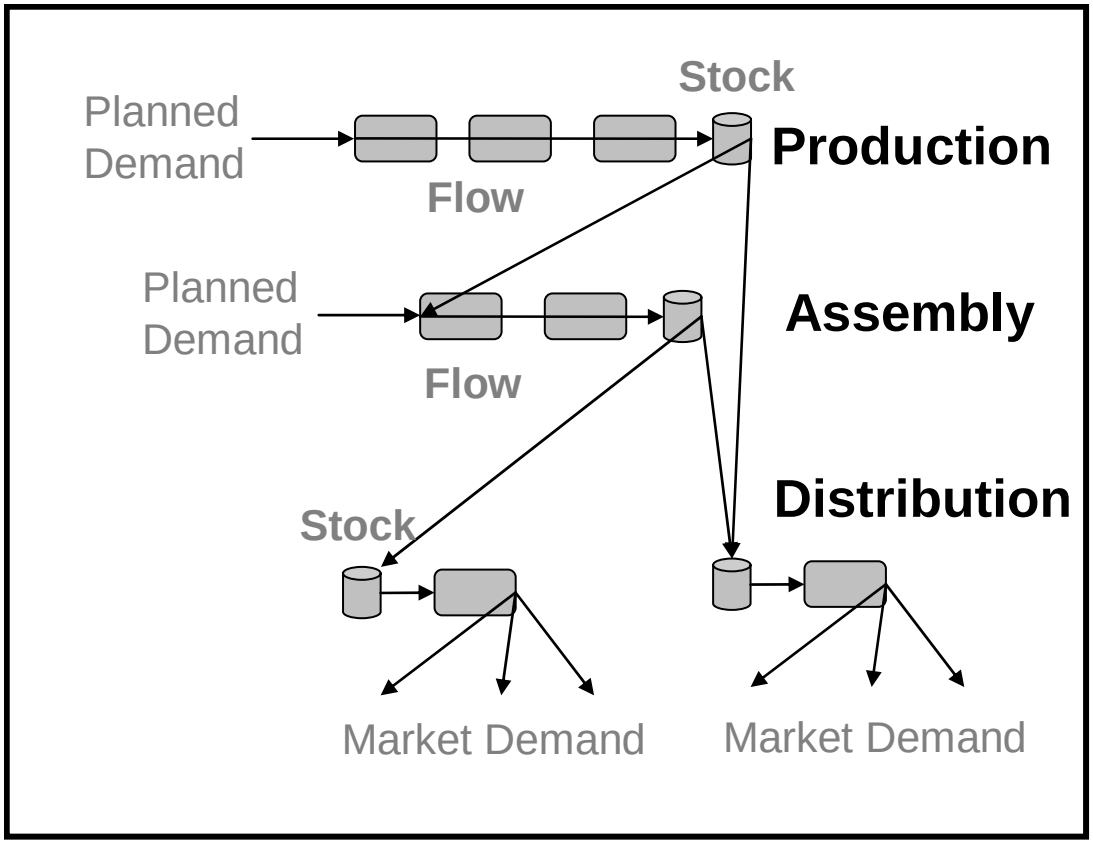

Figure 2: Elements of the Value Stream

So now we have laid the groundwork to enable definition of a value stream. A value stream is *a structure of flows and stocks providing transformation to meet demand*. Note that this definition is completely scalable and can apply to a production line, a plant or an entire supply chain.

In the previous article, we described the issues with trying to improve performance through management by initiative. We also introduced 5 quantitative measures that enable practical determination of best possible profitability and thereby provide an antidote to management by initiative. Here, we have described in more detail one of those measures: Operation between the Best Case and Marginal Case on the Throughput versus WIP curve and Cycle Time versus WIP curve—

also known as operating in the Lean Zone. We have also provided some basic definitions for understanding value streams. In next month's article, we will describe how variability affects performance of your value stream.

For copies of the previous articles in the "Factory Physics Principles for Managers" series, go to www.factoryphysics.com and select the Press Room link. Viewing and downloading the articles requires registration on the website if you have not already registered.

If you would like to speak to someone directly, contact:

In the US and outside Europe:	**In Europe:**
Ed Pound	Marc Colpaert
Factory Physics, Inc.	Factory Physics Europe
+1 (630) 870-1163	+32 (0)479-784634
Email: pound@factoryphysics.com	Email: colpaert@factoryphysics.com

Web site: http://www.factoryphysics.com