How To Compare Six Sigma, Lean and the Theory of Constraints

A framework for choosing what's best for your organization

by
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WITHIN THE AMERICAN business community a multitude of process improvement champions are vying for leadership attention.

Each champion advocates the adoption of his or her improvement methodology in your organization. Almost all plead that if you adopt their specific tools or follow a specific way of thinking, all your business problems will be solved.

After listening to multiple champions advocate their special methodology, how do you choose what will be best for your situation? What methodology fits the culture of your organization?

Many process improvement methodologies appear to conflict with each other or at least downplay the contribution of other methodologies. This montage of tools and philosophies creates the illusion of conflicting strategies.

In this article, I will discuss the basics of the three improvement methodologies and present a model to help you understand their concepts and effects and similarities and differences. Table 1 describes the essence of each methodology.

Six Sigma

Six Sigma claims that focusing on reduction of variation will solve process and business problems. By using a set of statistical tools to understand the fluctuation of a process, management can begin to predict the expected outcome of that process. If the outcome is not satisfactory, associated tools can be used to further understand the elements influencing that process.

Through a rigid and structured investigation methodology, the process elements are more completely understood. The assumption is the outcome of the entire process will be improved by reducing the variation of multiple elements.

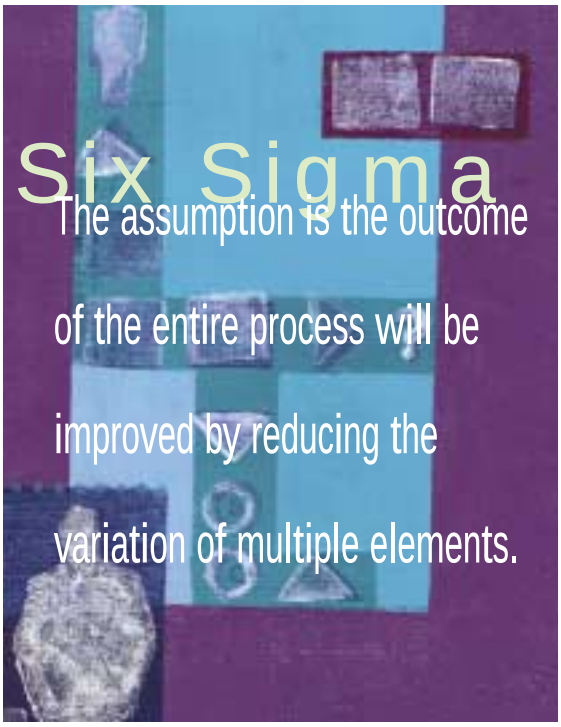
Six Sigma includes five steps: define, measure,

TABLE 1 **Improvement Programs**

Program	Six Sigma	Lean thinking	Theory of constraints
Theory	Reduce variation	Remove waste	Manage constraints
Application guidelines	1. Define. 2. Measure. 3. Analyze. 4. Improve. 5. Control.	1. Identify value. 2. Identify value stream. 3. Flow. 4. Pull. 5. Perfection.	1. Identify constraint. 2. Exploit constraint. 3. Subordinate processes. 4. Elevate constraint. 5. Repeat cycle.
Focus	Problem focused	Flow focused	Systems constraints

analyze, improve and control (commonly known as DMAIC):

- **Define.** Practitioners begin by defining the process. They ask who the customers are and what their problems are. They identify the key characteristics important to the customer along with the processes that support those key characteristics. They then identify existing output conditions along with the process elements.
- **Measure.** Next the focus is on measuring the process. Key characteristics are categorized, measurement systems are verified and data are collected.
- **Analyze.** Once data are collected, it is analyzed. The intent is to convert the raw data into information that provides insights into the process. These insights include identifying the fundamental and most important causes of the defects or problems.
- **Improve.** The fourth step is to improve the process. Solutions to the problem are developed, and changes are made to the process. Results of process changes are seen in the measurements. In this step, the company can judge whether the changes are beneficial, or if another set of changes is necessary.
- **Control.** If the process is performing at a desired and predictable level, it is put under control. This last step is the sustaining portion of the Six Sigma methodology. The process is monitored to assure no unexpected changes occur.



Focusing on the primary area of variation reduction produces other secondary effects, too. Quality is improved. Process investigation produces the re-evaluation of the value added status of many elements. Some elements are modified, while others are discontinued. Elements are refined and improved. Mistakes and opportunities for mistakes are reduced.

Some elements discovered during the Six Sigma investigation constrain the flow of products or services through the system. Flow is defined as the time from the input of raw material to the output of a salable item. Improvement of a process that was restricting flow results in reduced variation, better quality and improvement in the volume of the process output. Thus the organization has less money tied up in in-process inventory. The time from paying for input material to seeing a profit is reduced, and the organization can respond to customer needs more quickly.

Six Sigma is founded on two main assumptions. First, people in an organization understand and appreciate the fact that numbers can represent features and characteristics of a process. They appreciate that a deeper understanding of data and data analysis can be used to produce improvements, and graphical representations of data can provide new and different perspectives of the process. Analytical types, such as engineers and scientists, generally respect this approach.

Another assumption is that through the reduction of variation of all the processes, the overall performance of the organization will be improved. But while it is hard to argue against improvement, the economic reality of business is we want the most improvement for the least investment. Improving all of an organization's individual processes could actually have a detrimental effect on the company's ability to satisfy the customer's needs and provide product and services at the right time at the lowest cost. The realized savings to the system might be less than the cost of all the improvements.

So, an organization that improves things just because it can may be improving the wrong things for the business.

Lean thinking

Lean thinking is sometimes called lean manufacturing, the Toyota production system or other names. Lean focuses on the removal of waste, which is defined as anything not necessary to produce the product or service.

One common measure is touch time—the amount of time the product is actually being worked on, or touched, by the worker. Frequently, lean's focus is manifested in an emphasis on flow.

There are five essential steps in lean:

1. Identify which features create value.
2. Identify the sequence of activities called the value stream.
3. Make the activities flow.

4. Let the customer pull product or service through the process.
5. Perfect the process.

Identify value. The determination of which features create value in the product is made from the internal and external customer standpoints. Value is expressed in terms of how the specific product meets the customer's needs, at a specific price, at a specific time. Specific products or services are evaluated on which features add value. The value determination can be from the perspective of the ultimate customer or a subsequent process.

Identify the value stream. Once value is identified, activities that contribute value are identified. The entire sequence of activities is called the value stream. Then a determination is made as to whether activities that do not contribute value to the product or service are necessary. Necessary operations are defined as being a prerequisite to other value added activities or being an essential part of the business. An example of a nonvalue added but necessary process is payroll. After all, people need to be paid. Finally the impact necessary, nonvalue added activities have on the process is reduced to a minimum. All other nonvalue added activities are transitioned out of the process.

Improve flow. Once value added activities and necessary nonvalue activities are identified, improvement efforts are directed toward making the activities flow. Flow is the uninterrupted movement of product or service through the system to the customer.

Major inhibitors of flow are work in queue, batch processing and transportation. These buffers slow the time from product or service initiation to delivery. Buffers also tie up money that can be used elsewhere in the organization and cover up the effects of system restraints and other wasted activities.

Allow customer pull. After waste is removed and flow established, efforts turn to letting the customer pull product or service through the process. The company must make the process responsive to providing the product or service only when the customer needs it—not before, not after.

Work toward perfection. This effort is the repeated and constant attempt to remove nonvalue activity, improve flow and satisfy customer delivery needs.

While lean focuses on removing waste and improving flow, it too has some secondary effects. Quality is improved. The product spends less time in process, reducing the chances of damage or obsolescence. Simplification of processes results in reduction of variation. As the company looks at all the activities in the value stream, the system constraint is removed, and performance is improved.

The lean methodology also makes some assumptions:

- People value the visual effect of flow.
- Waste is the main restriction to profitability.
- Many small improvements in rapid succession are more beneficial than analytical study.
- Process interaction effects will be resolved through value stream refinement.

People in operations appreciate this approach.

Lean involves many people in the value stream. Transitioning to flow thinking causes vast changes in how people perceive their roles in the organization and their relationships to the product.

Theory of constraints (TOC)

TOC focuses on system improvement. A system is defined as a series of interdependent processes. An analogy for a system is the chain: a group of interdependent links working together toward the overall goal. The constraint is a weak link.

The performance of the entire chain is limited by the strength of the weakest link. In manufacturing processes, TOC concentrates on the process that slows the speed of product through the system.

TOC consists of five steps:

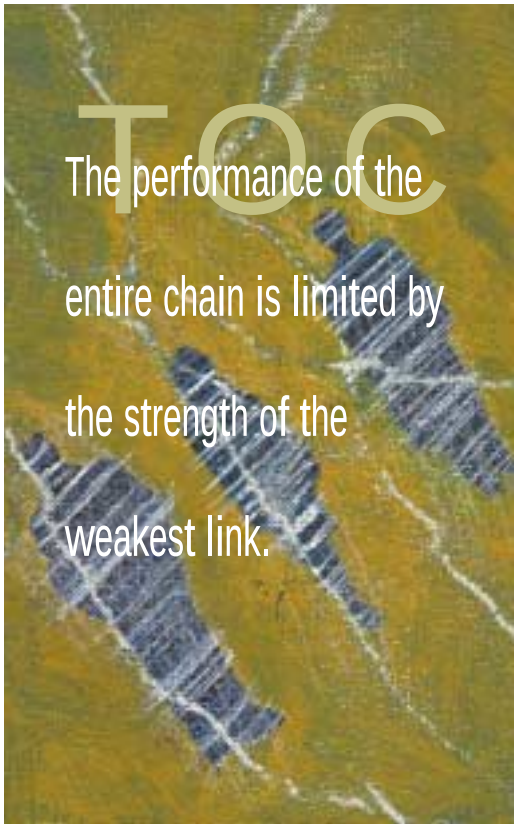
1. Identify the constraint.
2. Exploit the constraint.
3. Subordinate other processes to the constraint.
4. Elevate the constraint.
5. Repeat the cycle.

Identify. The constraint is identified through various methods. The amount of work in queue ahead of a process operation is a classic indicator. Another example is where products are processed in batches.

Exploit. Once the constraint is identified, the process is improved or otherwise supported to achieve its utmost capacity without major expensive upgrades or changes. In other words, the constraint is exploited.

Subordinate. When the constraining process is working at maximum capacity, the speeds of other subordinate processes are paced to the speed or capacity of the constraint. Some processes will sacrifice individual productivity for the benefit of the entire system.

Subordinate processes are usually found ahead of the constraint in the value stream. Processes after the constraint are not a major concern—they are probably already producing under capacity because they have to wait on the constraining process.



Elevate. If the output of the overall system is not satisfactory, further improvement is required. The company may now contemplate major changes to the constraint. Changes can involve capital improvement, reorganization or other major expenditures of time or money. This is called elevating the constraint or taking whatever action is necessary to eliminate it.

Repeat. Once the first constraint is broken, another part of the system or process chain becomes the new constraint. Now is the time to repeat the cycle of improvement. The performance of the entire system is re-evaluated by searching for the new constraint process, exploiting the process, subordinating and elevating.

By focusing on constraints, this methodology produces positive effects on the flow time of the product or service through the system. Reduction of waste in the constraint increases throughput and improves throughput time. When the constraint is improved, variation is reduced, and quality is improved.

Constraint focus does not require intimate knowledge of data analysis or that a large number of people understand the elements of the system. Understanding by a few people with the power to change things is all that is necessary. The effort can be localized with minimum involvement of the workforce.

TOC overcomes one criticism of most process improvement programs: that many programs use a mass, one size fits all approach to improvement. With the mass approach, a company hopes that by refining and improving each process individually and independently to maximum output, the entire system output will improve.

TOC methodology operates on several assumptions:

- As in the case of lean, the organization places a value on the speed at which its product or service travels through the system. Speed and volume are the main determinants of success.
- Current processes are essential to produce the desired output.
- The product or service design is stable.

Value added workers do not need to have an in-depth understanding of this improvement methodology. Suggestions by the workforce are not considered vital for successful implementation of the theory of constraints. Organizations with hierarchical structure and centralized knowledge value this approach.

Comparing the three methods

There are some commonalities and general criticisms of all improvement models. In addition, all process improvement theories and methodologies make a few of the same assumptions. The main points of each methodology are summarized in Table 2.

Improvement methodologies begin by taking the product or service configuration at face value and improving the processes or system. They assume the following:

- The design of product or service is essentially correct.
- The design of the product or service is the most economical.
- Customer needs are satisfied with that design.
- The current product configuration fulfills the functional requirements of the market and customer.
- The management structure supports and nourishes change.

These assumptions may not be valid and require exploration.

After extensive refinement of the existing processes or systems, many improvement methodologies begin to look at the product or service design. However, each views the design through its theory and tools.

Quality function deployment and value management are two techniques used to help connect the product or service design to customer needs. Both bring marketing, finance, operations, design, customer and suppliers together to systematically explore how the product performs the function the customer needs.

An interesting part of this investigation is that cost can be associated with function. When marketing and customers know the cost of specific features, they make informed choices about the configuration of the product or services.

TABLE 2 **Comparison of Improvement Programs**

Program	Six Sigma	Lean thinking	Theory of constraints
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Focus	Problem focused	Flow focused	System constraints
Assumptions	A problem exists. Figures and numbers are valued. System output improves if variation in all processes is reduced.	Waste removal will improve business performance. Many small improvements are better than systems analysis.	Emphasis on speed and volume. Uses existing systems. Process interdependence.
Primary effect	Uniform process output	Reduced flow time	Fast throughput
Secondary effects	Less waste. Fast throughput. Less inventory. Fluctuation—performance measures for managers. Improved quality.	Less variation. Uniform output. Less inventory. New accounting system. Flow—performance measure for managers. Improved quality.	Less inventory/waste. Throughput cost accounting. Throughput—performance measurement system. Improved quality.
Criticisms	System interaction not considered. Processes improved independently.	Statistical or system analysis not valued.	Minimal worker input. Data analysis not valued.

Major obstacles to improvement

There are major obstacles to the improvement methodologies:

- They address management theory as a secondary or tertiary issue.
- They don't address policies, either formal or informal.
- They don't address how managers are measured and rewarded for process improvements.
- They don't address the general theory of management used by the organization.
- They don't address the organization's values.

In any organization many activities are driven by policies whose purpose has been lost in time. All change programs challenge the existing ways of doing things. This necessitates asking what purpose a specific policy serves and whether that purpose is still valid in today's environment.

One technique for assessing an organization's management theory is to search for the underlying assumptions supporting each policy. A challenge of assumptions provides a starting point for determining whether the current policy is still supporting something of value today.

The management theories of W. Edwards Deming may help organizations challenge current management practices and assumptions—not by suggesting incremental improvements but by pointing to a new way of managing. Through this line of study, leaders achieve a greater understanding of the way they can influence the social and economic well-being of their organization.

Beneath a theory of management is a system of organizational values. Is the purpose of the organization solely to increase the wealth of the stockholders? Or is the existence of the organization to benefit society, the nation or some other group? Do not get caught in the trap of thinking an organization's only purpose is to make money. Money, or profit, is the result of good management toward satisfying a societal need. Also, consider that some organizations are created not to make a profit.

The issues of theory of management and organizational ethics and values are beyond the scope of this article but have been raised to point to other areas needing consideration when looking at process or system improvement programs.

Champions of each of these methods say they can overcome these drawbacks because implementation of their particular methodology and focus on their tools, methods and theories will allow an improved theory of management and business strategy to emerge.

How to choose

To help work through the apparent conflicts of different improvement programs, use a model that identifies a hierarchy of cause and effect relationships.

First, identify the primary theory. What is the core emphasis of the program or methodology? This core emphasis is usually a few words or a short phrase: Six Sigma's is variation reduction, lean's is waste reduction and TOC's is constraint reduction.

Then identify the relationship between the primary theory and the primary focus of the tools and methodology. This relationship indicates how the primary theory manifests itself in tangible results—what I call the primary effect. This is an if/then type of relationship:

- **For Six Sigma:** "If we focus on reducing variation, then we will have more uniform process output."
- **For lean:** "If we focus on waste removal, then flow time will improve."
- **For TOC:** "If we focus on constraints, then throughput volume will improve."

The next to last level of the model in Table 2 (p. 77) identifies secondary effects. Secondary effects can be described by using an if/theory and primary effect/results type statement. While the primary theory to primary effect relationship is usually one-to-one, the secondary effects are several-to-many, including:

- **For Six Sigma,** focus on reducing variation and achieving uniform process results in less waste, less throughput time and less inventory.
- **For lean thinking,** focus on waste and flow time results in less variation, uniform output and less inventory.
- **For TOC,** focus on constraints and increased throughput results in less inventory and a different accounting system.

Each improvement methodology appears to be driving toward common tools and concepts. However, different methodologies begin the journey from different perspectives. At the secondary effects level of the model, the results from each methodology start to look similar. Many of the secondary effects of one methodology look similar to the primary effect or focus of another methodology.

Extending the fundamental philosophy through each methodology's primary, secondary and tertiary effects, you might conclude each method strives to achieve similar results. Even along the journey, each methodology incorporates the primary effects of other improvement programs. Can we infer that after extensive time and effort implementing a single methodology, the end result will be similar no matter which path we take?

Where does that leave us? As a manager, how do you select an improvement methodology or program to overcome your obstacles?

Selection of a process improvement methodology is dependent on the culture of your organization. If many popular programs appear to end up in the same place addressing the same issues after a number of years of use, the main issue left to explore is the speed at which a method will be accepted into an organization:

- If your organization values analytical studies and the relationships of data, charts and analysis, Six Sigma is a perfect program for you to start with.
- If your organization values visual change and right now time, then lean thinking might be the way to go.
- If your organization values a systems approach where total participation is not desired and if it values the separation between worker and management, then TOC might be a good way to start.

More and more organizations are trying to determine what improvement method will work best and fit best with their culture. When you are working through the apparent conflicting claims of performance improvement programs, my advice is to concentrate on the primary and secondary effects of their philosophies. Once the values of a specific improvement program are identified, the comparison of those values with the values of the organization can make the method of selection easier, if not obvious.

Never stop learning. Each improvement methodology contributes valuable concepts, ideas and techniques to your organization. Your challenge is to use whatever strengths the methodology possesses to help your organization improve.

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