



TOCICO is pleased to recognize this paper as part of the TOC Body of Knowledge.

## The Six-Step Process for Standing on the Shoulders of Giants

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The six-step process for Standing on the Shoulders of Giants (SOTSOG) is fundamental to the successful development of the various historical applications of TOC that have resulted in dramatic performance improvements. Even though the process was first presented during Dr. Eli Goldratt's two-day upgrade workshop at the 2011 TOCICO International Conference, it was applied in essence for creating the Theory of Constraints (TOC) Body of Knowledge (BOK) long before it was documented. The same was true for the TOC five focusing steps (also known as the process of ongoing improvement). It wasn't until the second edition of Eli's best-selling novel, The Goal, was written, that the steps were verbalized and explained.

The inspiration for the SOTSOG process came from an Isaac Newton quote: "If I have seen further, it is by standing on the shoulders of giants." The realization is that we can effectively create breakthrough solutions by building on the prior work of giants. That is what has been achieved in TOC concerning developing business applications, first in manufacturing, and later in all other business functions. Eli created TOC to achieve his goal in life of teaching the world to think.

My final writing test as Eli's apprentice in 2008 (that I passed) was the creation of the white paper titled *Standing on the Shoulders of Giants: Production concepts versus production applications: The Hitachi Tool Engineering example* (to learn more and read the paper, use the following link: HYPERLINK "" <https://www.tocico.org/page/StandingontheShouldersofGiants>)

That white paper was designed to combine my expertise and writing style as an academic (former business professor of operations management) with Eli's more dramatic approach, which includes storytelling. It was supposed to be the first in a series of white papers which would become part of a TOC reference book.

This BOK paper describes the SOTSOG process for inclusion in the TOC BOK. Each step of the process is described below, along with the three examples provided in Eli's final workshop prior to his passing in 2011. (The presentation materials for the workshop can be viewed by members at this link: [https://www.tocico.org/page/upgrade\\_workshop](https://www.tocico.org/page/upgrade_workshop).) The first example is about the TOC production application, while the other two address the subject matter of the TOC project management solution.

### First Example:

1. Identify a "giant," not a chupchik.

Intuition will guide you to choose a subject matter that is important enough for you to analyze and improve. An important subject will be one in which you already have a significant level of logic, intuition, and emotion, thus providing a great foundation and motivation for the work.

I recommend using logic, intuition, and emotion for choosing the subject matter because of one of the conclusions reached by Eliyahu M. Goldratt in his co-authored book, *The Choice*. That book transitioned TOC from a management philosophy into a philosophy of life. At the book's end, Eli pointed out that we can each have a more meaningful or full life by moving up the spiral of logic, intuition, and emotion.

We must be able to always use critical thinking skills to determine if our logic is valid. In other words, we need to verify that our assumptions are facts of life, and that our cause-and-effect logic of the reality is sound. Intuition is necessary to develop a hypothesis or predicted effect to test and for validate assumptions. Intuition stems from our emotions since we must care about a subject to develop an intuitive understanding of it.

The giant chosen for Eli's first example in the TOCICO workshop was based on the white paper referenced above, which is focused on the Toyota Production System (TPS, later known as Just-in-time and Lean) invented by Taiichi Ohno (see page 1 of that white paper). Lean production became popular in the world due to Toyota's significant success.

## **2. Identify the enormity of the area not addressed by the giant.**

Reality provides the signals that so much more can be done. By evaluating the current reality of the subject matter, one should realize that a huge gap exists between what is happening and what is possible in terms of potential. We are aiming for a broader, not a more confined area, than was addressed by the giant. For example, what was not addressed in the application or solution of the subject matter you chose?

Despite the profound success of TPS (which is also known as Just-in-time), in addition to the knowledge and skills shared by Toyota in the public domain, less than 20% of the manufacturers in Japan have effectively implemented Lean (see page 1).

## **3. Get on the giant's shoulders.**

Gain the historical perspective by understanding the giant's solution better than the giant did. One way to understand how to do this can be achieved by studying that white paper, which also describes the TOC application for production.

In order to better understand Ohno's TPS, I read all three books written by him. As a result, I learned that TPS was based on Ohno's reading of Henry Ford's book ([My Life and Work: Autobiography of Henry Ford](#)) and knowledge of how U.S. supermarkets handled inventory. The history of Ford's and Ohno's implementations is presented in that white paper, in addition to an explanation of the four concepts of flow they utilized, which are NOT focused

on increasing local efficiencies nor on reducing cost (see pages 2-5). Instead, they both understood that the way to improve performance dramatically was to increase the flow or throughput by reducing the lead time.

**4. Identify the conceptual difference between the reality that was improved so dramatically by the giant and the area untouched.**

The relative stability of the environment at Toyota is explained starting on page 4. That stability was a necessary condition for TPS to work. In fact, Lean was developed specifically for that environment over a time frame of several decades at Toyota. The white paper provides an explanation of the types of instabilities that can exist in manufacturing environments. The conceptual difference between the reality that was improved by TPS or Lean at Toyota and the area untouched was how to apply the fundamental concepts utilized by Ford and Ohno to create a breakthrough solution that can be more effectively utilized in a variety of manufacturing environments.

**5. Identify the wrong assumption.**

How manufacturers are (or can rapidly become) stable is presented in the white paper. An explanation is provided about how TOC time buffers and buffer management can be effectively utilized to apply the four concepts of supply chains that Ford and Ohno implemented. Those concepts are:

1. Improving flow (or equivalently lead time) is a primary objective of operations.
2. This primary objective should be translated into a practical mechanism that guides the operation when not to produce (prevents overproduction). Ford used space; Ohno used inventory.
3. Local efficiencies must be abolished.
4. A focusing process to balance flow must be in place. Ford used direct observation. Ohno used the gradual reduction of the number of containers and then gradual reduction of parts per container.

A better way to prevent over-production is to use time as a mechanism, rather than space or inventory. Using a time-based mechanism is more robust for unstable environments. That means we need to release material into production a short time, just-in-time, before the due date of the order.

One way to identify the wrong assumption is explained in the book, The Choice. The true story of a retailer anonymously identified as BigBrand demonstrated how to conduct the analysis. First, Eli identified the two most significant undesirable effects (UDEs) suffered by retailers: shortages and surpluses. Then, the erroneous assumption that caused these UDEs was explained as forecasts being unreliable. Decisions about how much to order are

commonly made far in advance based on unreliable forecasts, thus resulting in lost sales due to shortages and excess inventory of other items.

## **6. Conduct the full analysis to determine the core problem, solution, etc.**

The rest of the white paper addresses how to achieve exponential performance improvements, even in production environments that experience high instability. The key concepts and logic of the TOC production application known as Drum-Buffer-Rope (DBR) are explained.

The way to conduct the full analysis is by applying the TOC Thinking Processes (TP). First, we begin by identifying the core conflict. A good way to do so is by choosing three different significant UDEs in the reality being evaluated and writing a conflict cloud for each. Then, those three UDE clouds are combined to become the core conflict cloud, which we then verify is the core problem by checking to see if it also causes the other UDEs as well. We need to invalidate at least one assumption underlying the core conflict cloud in order to identify a breakthrough solution that achieves the common goal or objective and both needs or necessary conditions. (To learn more, check out the free TOC basics videos on the Thinking Processes at [https://www.tocico.org/page/toc\\_basics\\_portal](https://www.tocico.org/page/toc_basics_portal).)

### **Second Example:**

#### **1. Identify a “giant,” not a chupchik.**

Intuition will guide you to choose a subject matter that is important enough for you to analyze and improve. The giant chosen for Eli’s second example in the TOCICO workshop was Critical Path, a methodology developed in the 1950s for project management.

#### **2. Identify the enormity of the area not addressed by the giant.**

The enormity of the unaffected area of Critical Path is the performance of all projects. Critical Path and Program Evaluation and Review Technique (PERT), which were separately developed in the 1950s, both resulted in improvements in planning and executing projects. Both focus on the critical and longest sequence of tasks. However, those solutions were insufficient for achieving good project performance in terms of time, budget, and meeting specification/quality targets.

#### **3. Get on the giant’s shoulders.**

Gain the historical perspective by understanding the giant’s solution better than the giant did. Standing on the shoulders of Critical Path results in the understanding that defining the project duration based on the longest path provides us with the ability to focus on the few elements that make a real difference in the project’s lead time. The Critical Path is the longest path of tasks in the project network or plan. Therefore, only a small subset of all the project’s tasks is important for determining the project lead time.

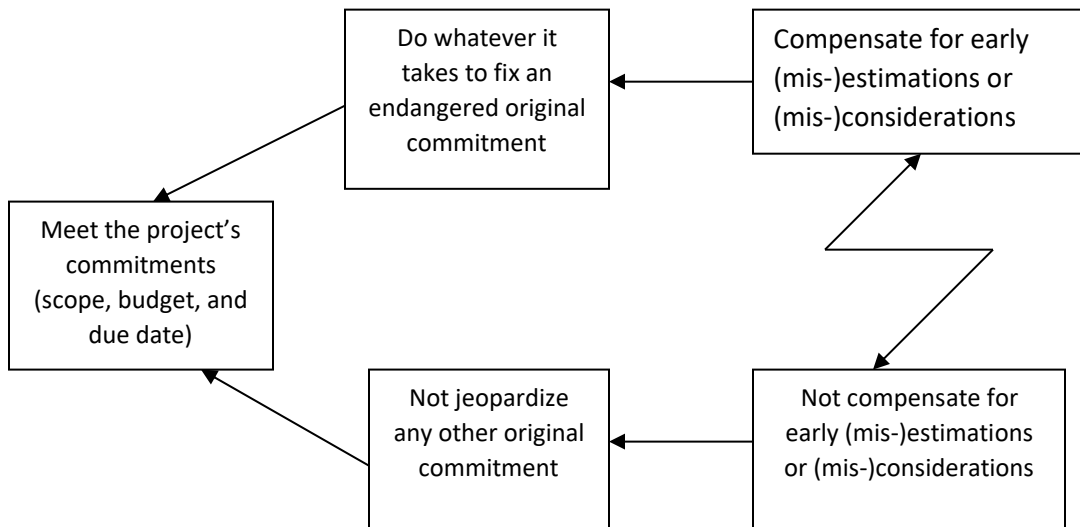
In operations, TOC is focused on the bottleneck that is commonly (though not always) only one resource out of many (i.e., 100). On the other hand, in project environments, we are focused on the Critical Path, which may be 40 tasks out of 40,000 in the plan. Therefore, the constraint in operations is capacity-based, while in projects is time-based.

**4. Identify the conceptual difference between the reality that was improved so dramatically by the giant and the area untouched.**

When creating the project plan, the time estimate for each task is taken as a commitment. The variability of task time estimates is known to be high in project environments. As a result, a huge amount of safety time is included in the estimate since it becomes a commitment because resources and managers providing the estimates do not want to miss deadlines for task completion. This commitment also leads to a disincentive to finish early or report early finishes because it could lead to estimates being cut in the future. Even if an early finish is reported, it is unlikely that the next resource will be able to start its task early.

**5. Identify the wrong assumption.**

The project planning conflict cloud is presented below:



The assumption challenged for this conflict was: “The safety we are allowed is not enough to absorb all the glitches.” Shorter estimated task times result in a faster project completion. We can dramatically improve project performance by cutting estimated task times in half (for the majority of the tasks, if not all) and placing half of the safety time removed in buffers, such as the project and feeding buffers.

**6. Conduct the full analysis to determine the core problem, solution, etc.**

The full analysis resulted in developing the Critical Chain Project Management (CCPM) solution in terms of how to plan and execute projects effectively. To begin to learn more about CCPM or other basics of TOC, go to this link for free videos anyone can view: [https://www.tocico.org/general/custom.asp?page=toc\\_basics\\_portal](https://www.tocico.org/general/custom.asp?page=toc_basics_portal)).

#### **CCPM Successes:**

- CCPM was successfully implemented in the Israeli maintenance depot for F-16 fighter jets. Only allowing three open projects per super engineer reduced the average project duration from **14 months to 7 weeks**, while nearly eliminating overtime, without increasing the engineering staffing levels.
- Typical CCPM results are faster projects (**20-30% shorter project duration**), more reliable projects (**increasing from less than 20% on time to greater than 80% on time**), and additional projects completed (**20-50% more with the same resources**)!

#### **Third Example:**

##### **1. Identify a “giant,” not a chupchik.**

The subject matter chosen next was CCPM, which was created by standing on the shoulders of the giant of Critical Path.

##### **2. Identify the enormity of the area not addressed by the giant.**

To stand on the giant of CCPM to further improve project performance, we need to realize that the enormity of the unaffected area is ALL projects. Dr. Goldratt presented an explanation of the solution for single project environments in his novel, *Critical Chain*, which was published in 1997. CCPM implementations resulted in dramatic improvements in performance over the years. Realization Technologies is one organization that developed the software and expertise to implement CCPM in multi-project environments.

Still, bad multitasking was prevalent in TOC-managed project environments. Bad multitasking (BMT) entails working on one task/project, stopping before finishing it even though it could still be worked on and is the task/project with the highest priority, then starting work on another task. BMT can result in a significant amount of time in setups between tasks and extremely elongated task/project lead times. The reduction of the F-16 fighter jet maintenance time from 14 months to 7 weeks could only be explained by the understanding that allowing super engineers only three open projects dramatically reduced their BMT. Even though CCPM significantly reduced the level of BMT, the potential for improvements based on eliminating BMT was still huge.

##### **3. Get on the giant’s shoulders.**

We can achieve this by deeply understanding the causes and impact of BMT to figure out how to eliminate BMT from happening in project environments. The best way to learn

about the full logic of CCPM is to study the Projects Transformational Strategy and Tactic Tree (link for the S&T tree: [https://www.tocico.org/page/s\\_and\\_t](https://www.tocico.org/page/s_and_t)). Also, the latest version of the Projects S&T tree is available in the Harmony software (<https://www.qa.harmonytoc.com/>). (Note: To learn more about Strategy and Tactic trees, view webinars and conference presentations that I (and others) have offered through TOCICO. In addition, it would behoove those wanting to learn more to read the chapter on S&T trees that I wrote for *The Theory of Constraints Handbook*.)

#### **4. Identify the conceptual difference between the reality that was improved so dramatically by the giant and the area untouched.**

It was not until later in the process of implementing CCPM that we realized that the impact of BMT is much more damaging than we realized. According to Eli, 80% of the impact of BMT was missed. The full impact of BMT on the capacity and lead time was not fully understood until the incredible results achieved in the F-16 maintenance depot were analyzed.

#### **5. Identify the wrong assumption.**

BMT lengthens the lead time significantly, but has little impact on the touch time for completing the actual work on a task. In production environments, typically 10% of the actual lead time is touch time, while the rest of the time is spent queuing. That is why the DBR solution can commonly begin by cutting the lead times in half when the four concepts of supply chain are implemented. In project environments, the task times typically have high variability with a long tail, which means that it is possible that the task time will take much longer than the average. It is therefore necessary to institute more changes to improve project performance.

#### **6. Conduct the full analysis to determine the core problem, solution, etc.**

In order to better plan and execute the projects, we needed to include additional steps in the Projects Transformational Strategy and Tactic Tree (TSTT). Specifically, the added steps addressed having freeze mechanisms for projects, tasks, legs, and full kit to eliminate BMT.

We needed to freeze enough of the lowest priority projects to reduce at least 25% of the load on the resources. We already understood in TOC that releasing projects sooner does not yield a faster completion time.

This is not enough though because most organizations have far too many projects being planned and implemented. Therefore, it is necessary in most cases to kill the majority of the projects and only plan to work on those having the greatest predicted impact on improving the performance of the organization.

Since the safety time is reduced and effectively aggregated in the project and feeding buffers, the legs of the project should not begin earlier than planned. The legs are

scheduled to start when necessary to be on time, while reducing BMT. Those leg durations are protected by the feeding buffers, while the entire project has safety in the project buffer that can also handle the time of the feeding buffer being exceeded by completion of the task(s) in the leg.

In addition, we need to create the project plan to have a maximum of 300 tasks. Doing so, makes it easier for management to effectively focus their attention (which is a constraint) on successful implementation. Very large projects are managed effectively by relatively small project network plans. The ones used to build the North Sea oil-rig (\$4B) and the overhaul of the largest cargo airplane (the C5) each have less than 300 tasks. While it is possible to effectively manage a project plan of more than 300 tasks using CCPM software, it is better to not exceed 300 tasks. The logic for why this is the case is explained in more detail in the Projects TSTT.

Freezing at the task level is needed after the other changes have been made for departments in which BMT is still problematic. The resource manager of that department will need to freeze at least 25% of the tasks that are on the list to be completed by the resources.

Finally, the full kit freezing mechanism ensures that a resource does not start work on a task unless all the elements necessary to complete the task are already available. In some cases, it is possible to have enough of the elements available to start the task. Starting the task without the full kit can lead to unnecessary BMT.

## **Summary**

This BOK paper provided an explanation of how to apply the six-step SOTSOG process using three examples. This process is very helpful for significantly improving any subject matter chosen using the TOC theory and applications. To learn more about the SOTSOG process, a video of my webinar, in addition to the pdf of the presentation, is available at the following link: <https://www.tocico.org/page/UnderstandingmoreabouttheStandingontheShouldersofGiantsProcess>. In that webinar, I provided two different examples of applying the SOTSOG process.