IMPROVE THE CONSTRAINT

TOOL

LEVEL: FOUNDATION
DIFFICULTY: MODERATE

Each manufacturing process has a constraint (bottleneck). Focusing improvement efforts on the constraint is the fastest path to improved productivity.

OVERVIEW

What is a Constraint?

The concept of "the constraint" was introduced by Eli Goldratt in his bestselling 1984 novel *The Goal*. Dr. Goldratt proposed that every complex system, including manufacturing processes, consists of multiple linked activities, one of which acts as a constraint upon the entire system (i.e., the constraint is the "weakest link in the chain").

According to Dr. Goldratt, the constraint should be improved until it no longer limits production, at which point the next constraint should be identified and improved. Over time, Dr. Goldratt developed these concepts into a sophisticated set of tools and methodologies known as the **THEORY OF CONSTRAINTS**†.

Why Improve the Constraint?

A very common problem in manufacturing improvement programs is deciding where to focus resources. Should all equipment be improved? Where should the focus be? Breakdowns? Changeovers? Small stops? Quality? Similarly, a common question at manufacturing companies is where to measure **OEE**† (Overall Equipment Effectiveness) on a production line. At the end of the line? At every step? At some steps?

The answer to both sets of questions is the same – focus on and measure the constraint. The constraint is the fulcrum (i.e., point of leverage) for the entire process. Focusing improvement efforts on the constraint ensures optimal use of resources and is the fastest route to improved productivity and profitability.

Steps to Improve the Constraint

Identify

The first step is to identify the constraint. This step can be challenging, but there are often useful clues and indicators.

Indicator	Description
Work in Progress	Look for large accumulations of WIP (Work In Progress) on the plant floor. Inventory often accumulates immediately before the constraint.
Expediters	Look for areas where process expediters are frequently involved. Special attention is often needed at the constraint to ensure that critical orders are completed on time.
Utilization	Look for equipment with the highest utilization (always has work; usually behind). Management will often be involved because of the unique combination of criticality and problems.
Operators	Ask operators where they think equipment is not keeping up with demand (but also look for other supporting indicators).

Fortunately, even if the constraint is not correctly identified, improving performance of a false constraint will quickly expose the real constraint as the above indicators shift.

Measure

The second step is to build a solid information foundation. For most companies, the "gold standard" for manufacturing performance information is OEE with a breakdown of OEE losses into the **SIX BIG LOSSES**†, and a further breakdown of OEE Availability losses into Down Time Reasons.

There is another layer of complexity when measuring loss that impacts the constraint – it is important to differentiate three kinds of loss:

Loss	Description
Internal	Lost production time caused by the constraint itself. These losses are addressed at the constraint.
External	Lost production time at the constraint caused by upstream or downstream issues. These losses are addressed at the responsible upstream or downstream step.
Schedule	Lost production time because the constraint is not scheduled to operate. These losses are addressed through staffing.

Improve

Improvement actions are focused on improving throughput of the constraint. This does not, however, mean that all improvement actions are performed at the constraint. It is also important to address External Loss, which is handled at the step responsible for the loss condition (referred to as the causal step).

As the constraint is improved, it never really goes away. It simply moves, and another step becomes the constraint. Ultimately, the constraint will move outside of manufacturing – to the marketplace (when capacity outstrips demand).

BENEFITS

In the **short term**, Improve the Constraint answers the question of where to measure performance of the process – at the constraint.

In the **long term**, Improve the Constraint focuses resources where they will have the most significant effect on throughput and profitability.

ROLES

Improve the Constraint involves the following roles:

Role	Description
Manager	Initiate project. Identify constraint. Implement OEE or other loss metric. Audit progress.
Supervisor	Run improvement workshops. Maintain focus on the constraint.
Operator	Capture reason information. Look for incremental opportunities to improve the constraint (e.g., maximize run rate, respond quickly to down time, prepare for changeovers).

KEY INSIGHTS

Understand External Loss

External Loss is production time lost at the constraint, where the cause of the loss is non-constraint equipment. In other words, the constraint itself is fully operational, but problems with upstream or downstream equipment cause a loss at the constraint. External Loss can:

- Stop production at the constraint (Availability Loss)
- Slow production at the constraint (Performance Loss)
- Require the constraint to produce additional pieces to replace pieces made defective by downstream equipment (Quality Loss)

External Losses are typically placed into the following three categories:

Category	Description
Starved	Production time lost at the constraint, where the constraint stops or runs slowly because of a lack of raw materials on the process infeed.
Blocked	Production time lost at the constraint, where the constraint stops or runs slowly because of a buildup of finished materials on the process outfeed.
Downstream Quality	Production time lost at the constraint, where additional parts need to be produced because of downstream quality issues.

Instead of locally optimizing non-constraint equipment, focus on how that equipment affects the constraint. Other losses at non-constraint equipment should be a secondary focus.

Capture Reasons

Capturing reasons for Down Time is essential for developing effective improvement actions. In the case of External Loss, it is important to first identify the causal step (i.e., the non-constraint equipment that caused the loss). Then, promote the non-constraint reason up to the constraint to create a complete picture of losses that affect the constraint.

Information	Description
Equipment	Identifies the equipment that caused production time to be lost at the constraint.
Reason	Describes the problem. For External Loss, this is the problem occurring at the non-constraint.
Duration	Magnitude of the loss. Used to prioritize actions.

Recognize That Constraints Move

There are two reasons why the constraint may move:

- The constraint has been improved to the point that another process step has become the constraint (and the new focus of attention).
- A particular product may temporarily move the constraint to a different step in the process.

The first case is simple – focus your attention on the new constraint. The second case is more nuanced. It's hard to have a well-controlled process with a frequently moving constraint. So, design your process to avoid it. If that's not possible, you may need an automated system to manage the necessary information (a causal down time solution).

Leverage Capacity

It is often possible to achieve quick wins by challenging schedule and capacity assumptions. Simply put, look for ways to get more production time on the constraint. For example:

- Staff and operate the constraint through breaks
- Schedule additional shift time at the constraint
- Schedule production runs in a way that minimizes changeovers at the constraint

Keep in mind that OEE does not measure Capacity Loss (time that the constraint is not scheduled to operate). Capacity Loss is typically measured with **TEEP**† (Total Effective Equipment Performance).

Look Beyond the Constraint

When does it make sense to look beyond the constraint? There are two answers to this question. The easy answer is when non-constraint equipment affects the constraint (i.e., whenever there is External Loss). The more subtle answer touches on the question of local (non-constraint) optimization.

Imagine a non-constraint step where 12 operators are cheerfully engaged in moving boxes on and off a piece of equipment (as a pure waste activity, adding no value whatsoever). This is an extreme example designed to make a simple point; there can be benefits from local optimization. Just remember that optimizing the constraint should be the primary focus.

LEVEL AND DIFFICULTY

The Level is Foundation. Focusing on the constraint is fundamental to improving productivity for multiple step manufacturing processes (i.e., production lines).

The Difficulty is Moderate. Some of the concepts and processes are likely to be new and challenging (e.g., identifying constraints, understanding External Loss).

RATE YOURSELF

How good is your site at improving the constraint? Answer ten simple questions to see how close you are to a model implementation.

Question	✔
1. Has the process constraint (bottleneck) been identified?	
2. Is throughput of the constraint the primary focus of attention?	
3. Is OEE measured at the constraint (and only the constraint)?	
4. Are the Six Big Losses measured for additional loss information?	
5. Are reasons captured for all constraint Down Time?	
6. Are Internal and External losses clearly differentiated?	
7. Is the causal step and reason identified for External Losses?	
8. Are schedule and capacity evaluated to improve the constraint?	
9. Is Downstream Quality monitored for impact to the constraint?	
10. Have you successfully "resolved" (moved) the initial constraint?	

†This topic is also available as part of the XL Improvement Framework.