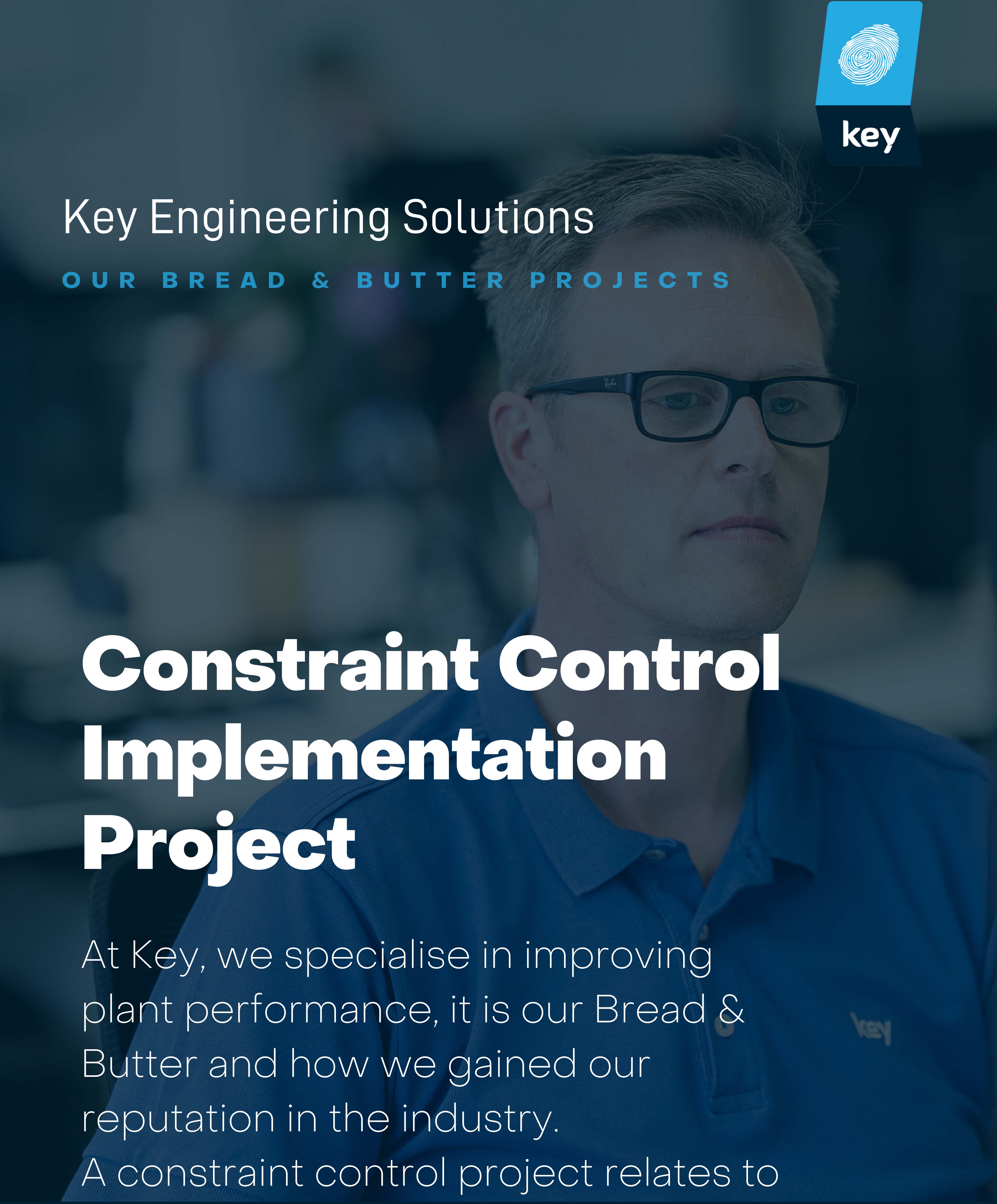

Key Engineering Solutions

OUR BREAD & BUTTER PROJECTS

Constraint Control Implementation Project

At Key, we specialise in improving plant performance, it is our Bread & Butter and how we gained our reputation in the industry.
A constraint control project relates to the configuration and setup of a control philosophy within the customer's control system. The Constraint Control scheme aims to maximise throughput whilst maintaining any process or equipment constraints within limits.

THINK IMPROVEMENT, THINK KEY

What is the Challenge?

The global sustainability transition is pushing up demand for raw resources integral to renewable energy, electric vehicles, and energy storage systems. To meet this demand for minerals, miners set their primary goal to reduce costs and improve productivity to achieve short-term gains while creating long-term value.

Fortunately, there is an abundance of opportunities for improving productivity that lies within most plant's control systems.

The main challenges we constantly see in the existing implementation of the processing plant's control systems are:

- There is a lack of automatic operation. Many things are controlled manually and dependent on the operator input.
- There is no overall control philosophy that controls the plant based on the main plant's limiting constraints, preventing, therefore, maximising throughput.
- Additionally, when there is an overall controlling philosophy installed or an APC system in place, it is generally configured towards improving local performances rather than overall throughput improvement – Not a goal-oriented approach.
- Virtual bottlenecking the plant by setting artificial limits for current constraints. This happens when operators set very conservative setpoints to prevent issues and thereby reduce the plant's overall throughput.

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What good looks like?

When it comes to productivity improvement, there is no better approach than the one described in the Theory of Constraint (TOC). The core concept of the Theory of Constraints is that every process has a single constraint at any given time, and that maximum process throughput can only be achieved if the plant's throughput is always controlled by this identified constraint.

For us at Key, an optimum overall control philosophy that is configured in the Plant's control systems shall have the following characteristics:

- An override control scheme is utilised where the throughput/rate of a particular area of the plant is controlled to effectively maintain multiple process variables
- The control philosophy shall be based on real and tangible bottlenecks that are plant and/or equipment-identified constraints
- The plant's throughput is controlled by the main plant's constraint at a given point in time
- A smooth transition must occur when swapping between constraints. This transition shall not adversely affect the final throughput variability
- Simplified control strategy deemed fit for purpose rather than overcomplicated logic

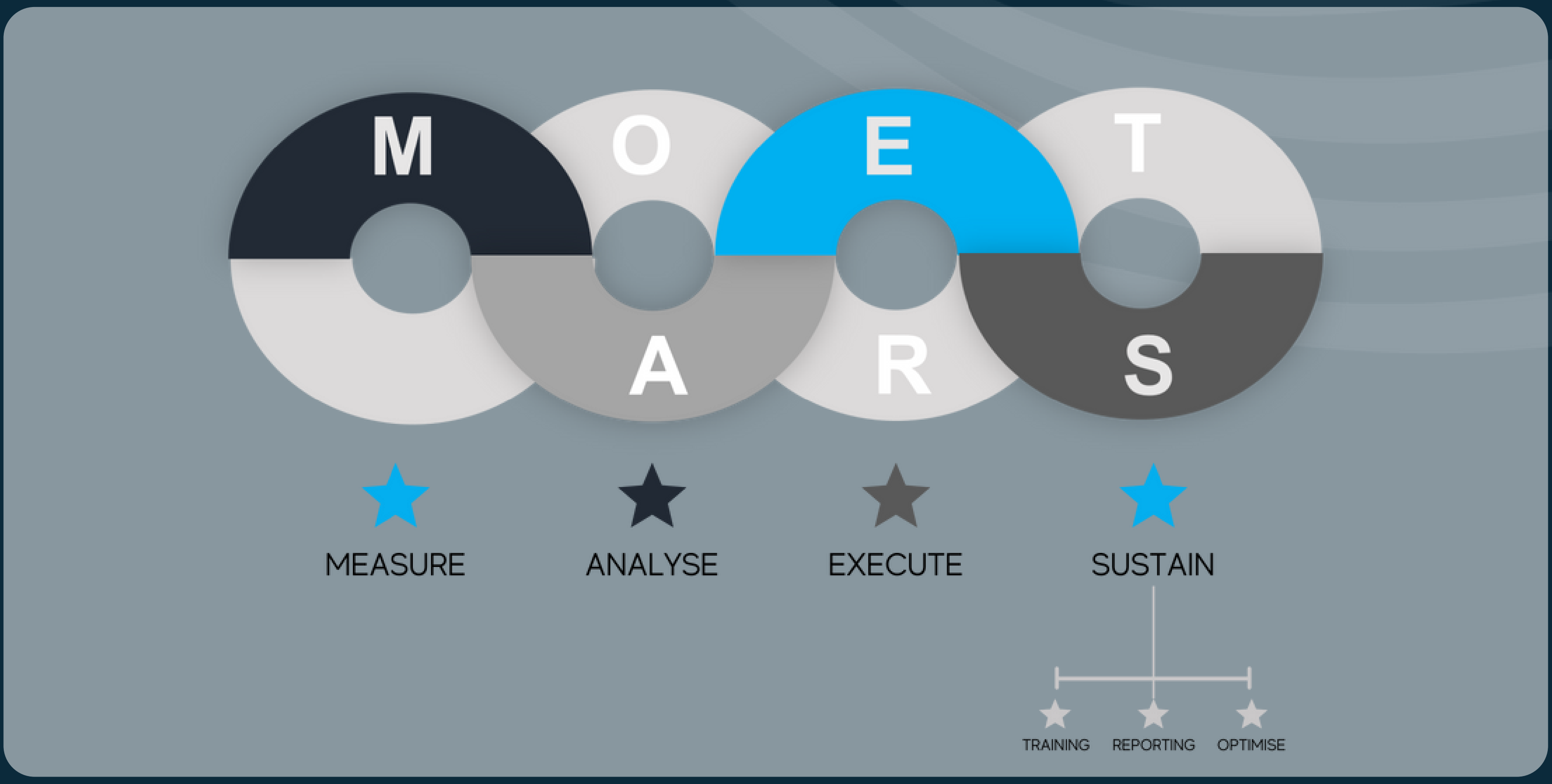
The system itself must be sustainable in time therefore, it will be necessary to:

- Collect data and benchmark plant performance
- Construct Constraint Control documentation
- Perform proper training for operators and engineers supporting the implementation
- Develop a real-time bottleneck or constraint utilisation and/or identification tool
- Provide visual real-time SCADA indication of which constraint is in control of the plant's throughput

Our Approach

OUR BREAD & BUTTER PROJECTS

At Key, we follow a holistic and pragmatic approach for Constraint Control Implementation projects known as the Maestro Approach. Whilst this approach will vary from company to company and plant to plant, the methodology generally consists of four basic steps. These steps are presented serially but in fact can overlap or run in parallel in some cases



Our Approach

1. Measure:

Develop a Visual Constraint identification Tool - Loss Opportunity analysis

In this initial stage, we suggest the development of either a live constraint utilisation tool or a loss opportunity analysis.

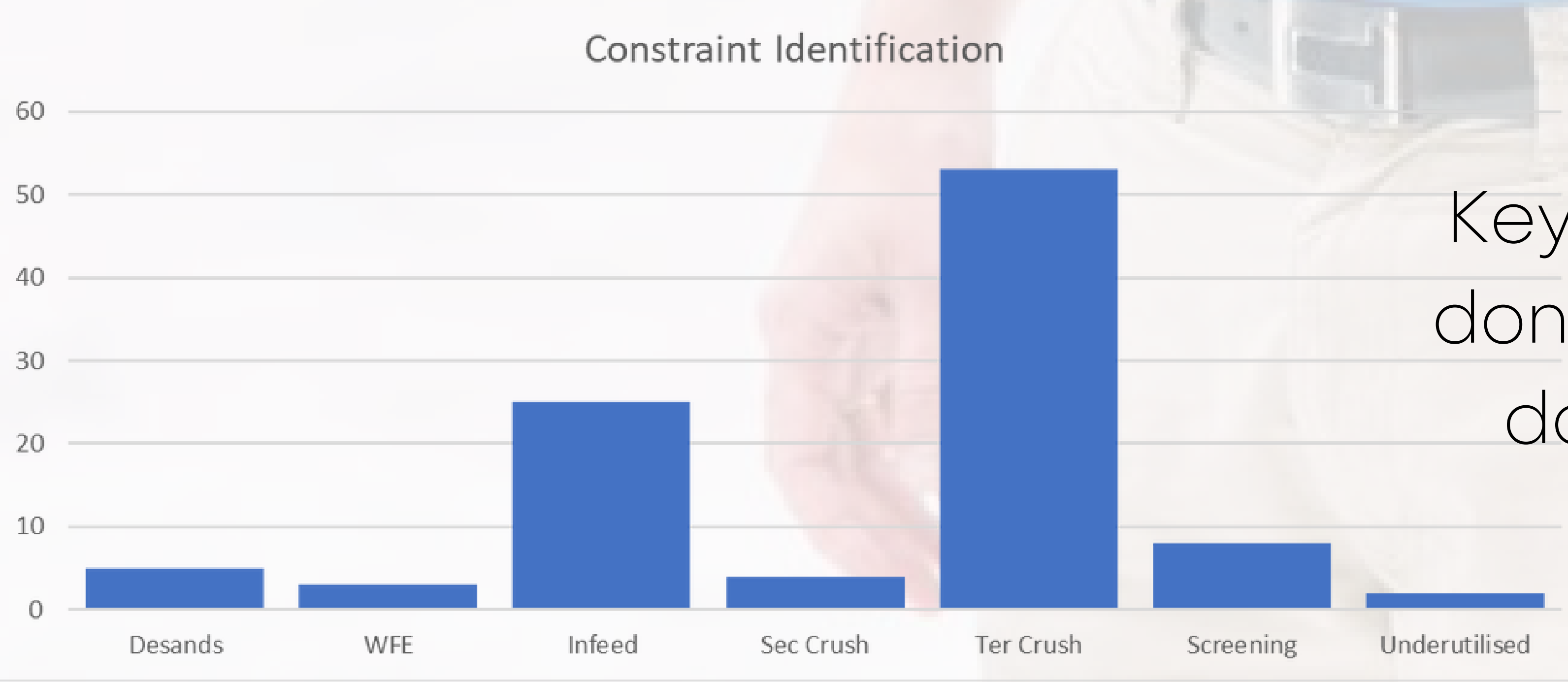
This is just an extension of the standard data analysis process to provide an up-to-date visual indication of the current bottlenecks and or losses. The benefit is that it can provide real-time data to control room operators on where the current bottlenecks are, allowing them to respond and improve by changing the way they operate the plant. This tool is also useful to show when a bottleneck has shifted from one area to another.

The best way to create a constraint utilisation tool is to split the plant into key streams or areas and determine suitable measures of utilisation.

With a suitable split determined, a percentage utilisation calculation must be determined for each. The exact calculation is dependent on what is the most suitable way to represent when the area is the bottleneck this can often be determined during performance workshops by asking operations how they effectively control the plant.

Finally, using the above calculations on some historic snapshot data, a histogram can be developed to show which area typically has the highest utilisation over an extended period of time. This area can then be considered the most common bottleneck and shows where optimisation efforts should first be focussed.

An example of a very simple implementation is shown below. In this example it shows that tertiary crushing is the bottleneck just under 60% of the time, whilst infeed is the second largest bottleneck.



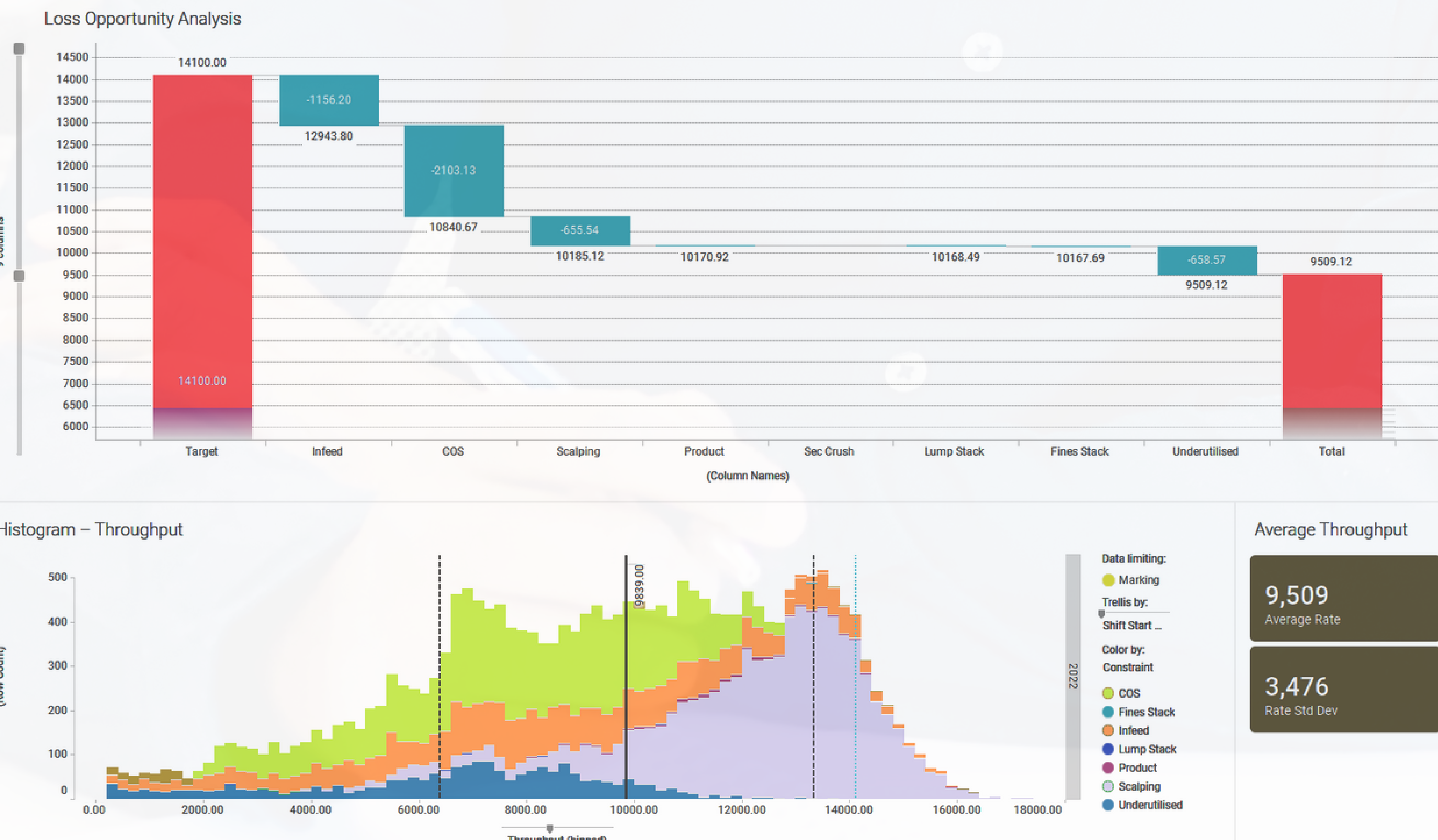
Key Insight: If we don't measure we don't improve

Our Approach

1. Measure (Continuation):

Develop a Visual Constraint identification Tool - Loss Opportunity Analysis

A loss opportunity analysis could also be developed. The loss opportunity analysis is a more in-depth data analysis in which rate is added to the calculations and a bottleneck is identified based on the amount of loss that constraint has incurred. It allows the operators and managers to quantify the loss in terms of the throughput rate they are aiming to achieve.



Our Approach

2. Analyse

Understand current benchmark and the potential improvement opportunities

If you don't measure, you don't improve. It is hard to measure your progress if you don't know where you start and where you end up.

In this stage, we will understand where the biggest bottleneck of the plant is and perform benchmarking to determine how is the plant performing before the works on implementing/updating the plant's main control system philosophy is taken place.

It is important to use the loss opportunity analysis to prioritise the focus area, then perform a detailed breakdown on how to improve the controllability of the area. There are some standard analysis to assess the existing control performance in the identified area such as PV vs. SP analsys, SP distribution, etc.

Our Approach

3. Execute
Implement the Constraint Control Logic

In this stage, we will implement our Constraint Control Logic within the existing Plant's Control Systems.

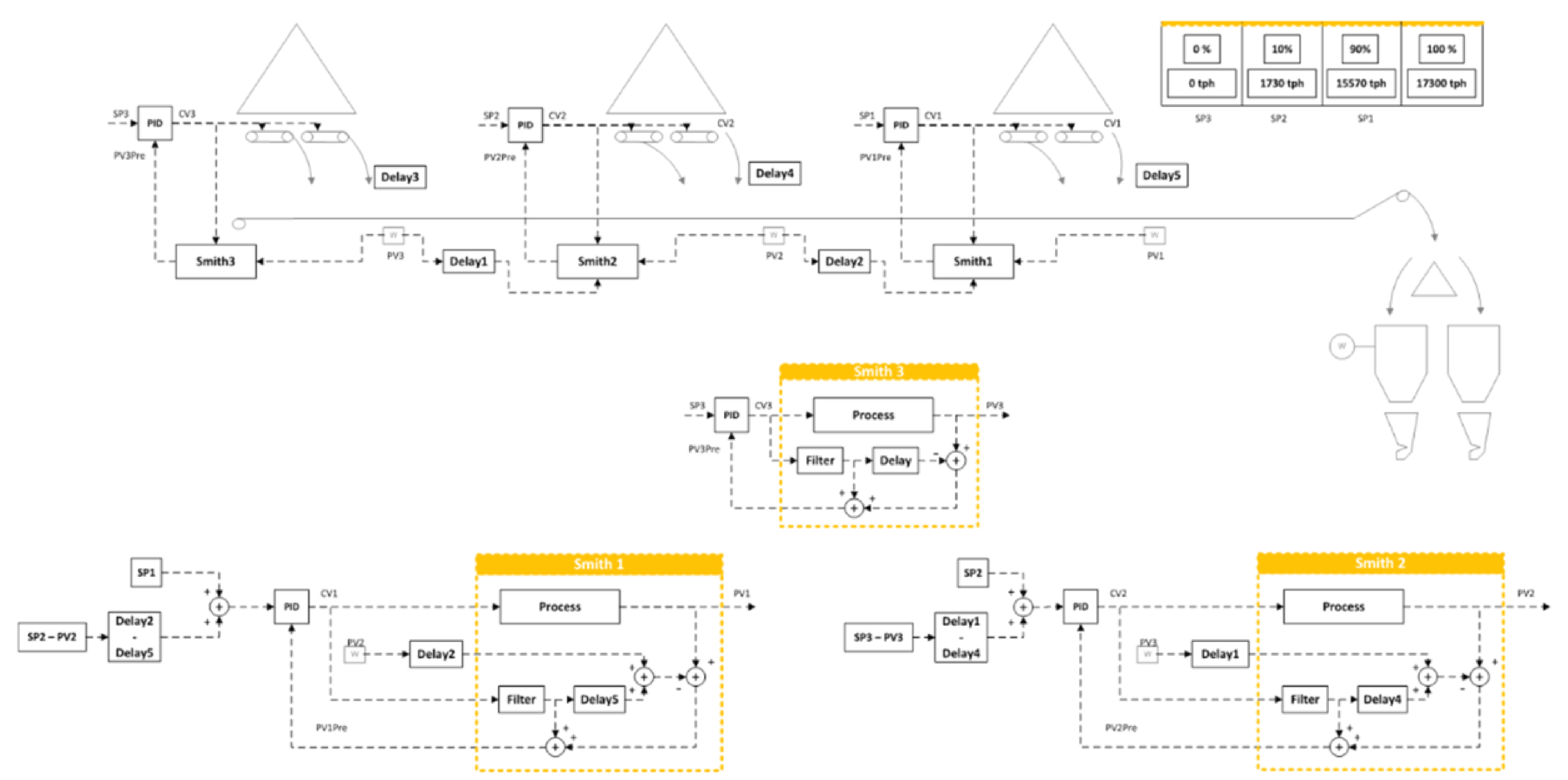
When properly constructed and tuned, this philosophy can ensure that the process is always actively running to at least one constraint and is able to respond in a timely manner.

In the picture below, feed rate control implementation is presented.

In this example, there are three stockpile vaults feeding onto one conveyor system. For this system, the key objective was to ensure that a consistent feed rate of 17,300 tph was maintained.

A secondary objective was to allow for suitable blending functionality by allowing different percentages of feed to be taken from each stockpile.

In this case, a simple set point ratio divider was provided (top right) to control the percentages. Smith predictors were also used to eliminate the effect of dead time and feed forward controls implemented to allow downstream vaults to compensate for any peaks or dips in rate from the vaults prior.



Our Approach

4. Sustain by
Training, Reporting & further Optimising

Once the final control philosophy has been implemented, further work is required to ensure that it is sustainable. As human beings, it is natural for us to automatically resist change in life. The same rings true for most control room operators when it comes to changes in the way they operate their plant. As a result, there will always be difficulty in getting acceptance of any newly implemented control philosophy. To overcome this, the following actions are recommended:

1. Prior to turning on the new control scheme, take the time to sit with each crew and explain how the control scheme works. Use pictures and sketches to explain how they will effectively maintain control of the plant.

2. Take the time to receive feedback from control room operators on what they believe are good methods to control the plant. Use this to explain how you can assist with the use of PID control.

3. Let the operators feel like they are a part of the final solution. People are more willing to buy into an idea if they feel that they came up with it.

4. Initially provide a safety net in the way of an enable/disable feature for the new control philosophy. This will give them the confidence not to resist the implementation knowing that they can fall back to their old ways if issues are encountered.

Our Approach

4. Sustain by
Training, Reporting & further Optimising (Continuation)

5. Ask for the operators to complete a log detailing any issues that occur along with the time and date. This will allow for detailed analysis of what may have gone wrong.

6. Make sure that the final implementation is as visual as possible. For an operator to feel comfortable, he needs to know exactly what is controlling the plant and why, otherwise it may be switched off.

7. Listen to the concerns raised by the operators. Whilst they may not be correct, you never know when they may discover something that has been missed.

Another important consideration for sustainability is ensuring that the system is easily maintained. This includes the preparation of any familiarisation documentation, the coaching of site engineers and presenting the benefits to management. All of these actions will encourage significant buy-in from site personnel and ultimately assist to ensure that the implementation will be maintained for years to come.

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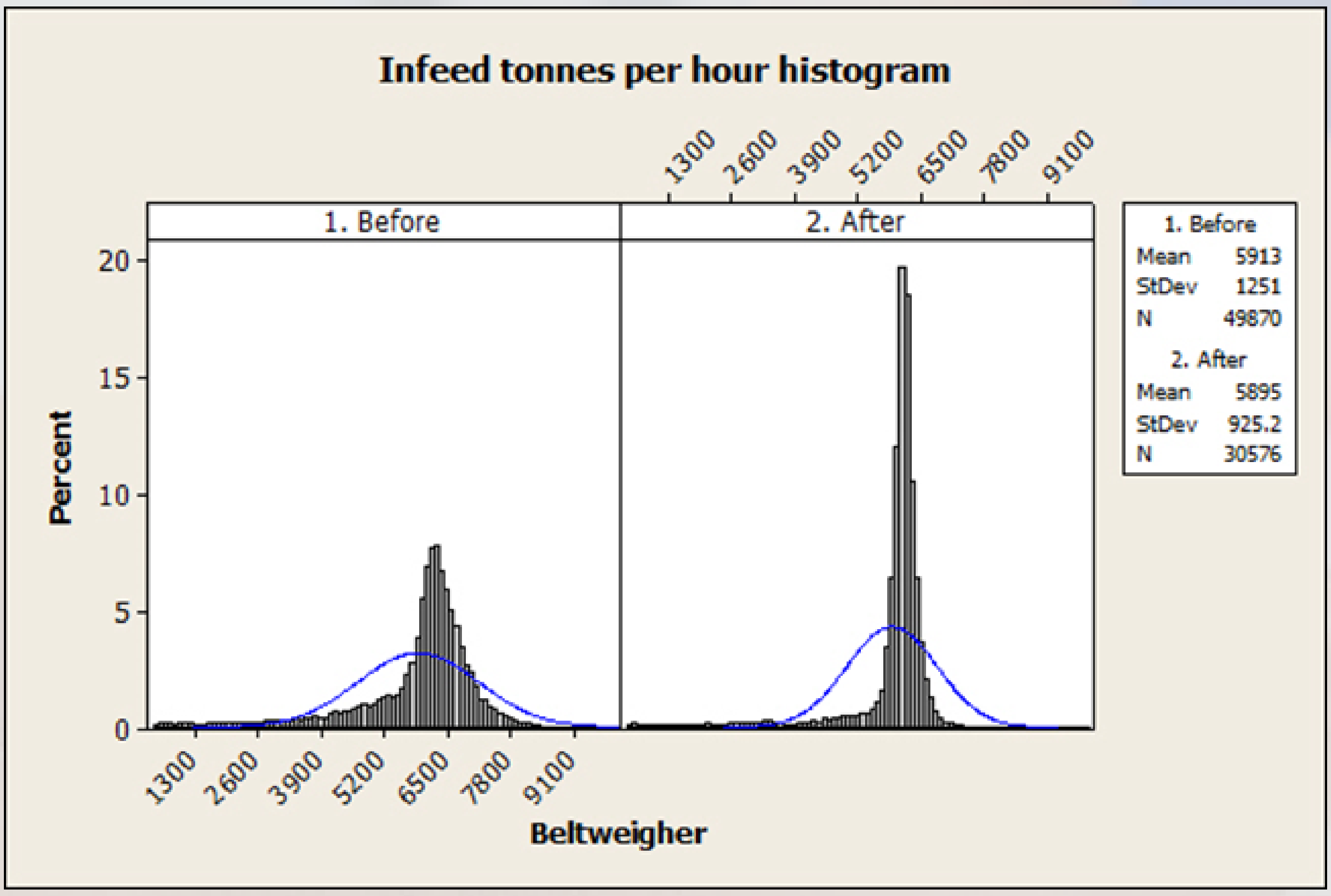
Key Insight:
Excellence = Quality x Acceptance

OUR BREAD & BUTTER PROJECTS

Constraint Control Implementation

Benefits to you

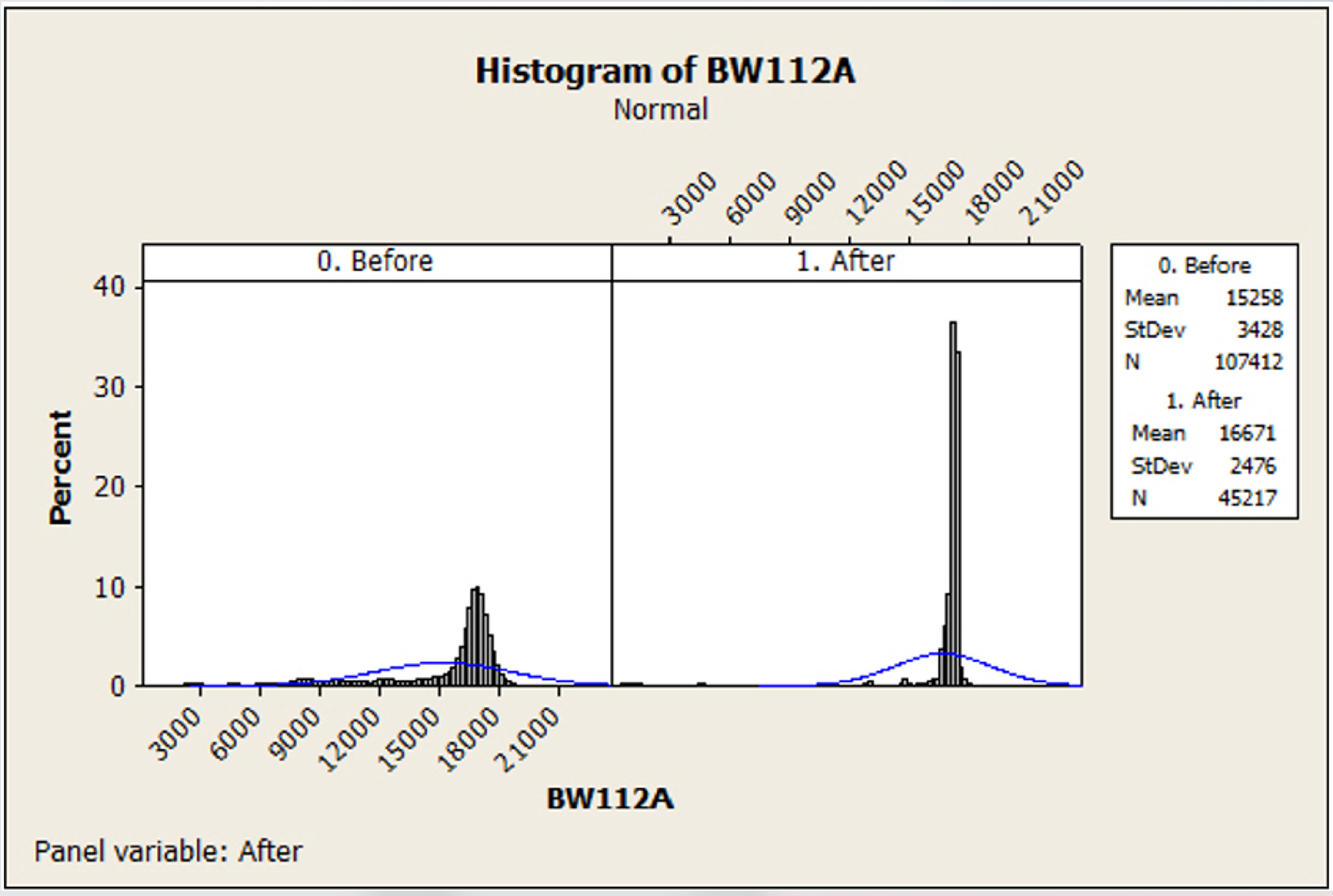
When implemented successfully, the results and benefits of the implementation of a constraint control philosophy can be easily recognised. The realised benefits typically include a reduction in variability, increased throughput, clearer identification of plant bottlenecks, reduced reliance on individual control room operator skill level, automatic response to shifting constraints and overall satisfaction of those working with the system. The following figures demonstrate some of the actual improvements realised from this methodology.



The figure above shows an example of the reduction in variability obtained with the implementation of a new constraint control philosophy. Whilst at the time of analysis there was no increase in mean, the significant reduction in variability allowed the operations team to have the confidence to increase the maximum set point without the risk of overloading due to overshoot.

Constraint Control Implementation

Benefits to you (Continuation)



The figure above shows a very similar improvement in variability and also an increase in average rate by more than 9%. With the reduction in variability, even further increases in average rate are expected in the near future as yet again the operations team becomes more comfortable with increasing the desired set point.

When implementing new constraint control philosophies, it takes more than just control system programming to get it right. Understanding the process, analysing the data, challenging designs and obtaining support from all stakeholders are all actions that will make a good implementation successful. The task of optimising existing processing plants can be both simple to follow and a very rewarding experience but requires careful planning to ensure it is sustainable. It is always important to remember that if we do not continually challenge the status quo, we will struggle to improve.


Key Engineering Solutions
BREAD & BUTTER PROJECTS
Ready to get started?
We are ready to help
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