FINAL TOLLGATE

Reducing WIP at a Frozen Food Manufacturer

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Reducing WIP at a Frozen Food Manufacturer

A DMAIC project reduced costly work in process at Kahiki Foods, a manufacturer of Asian frozen foods.

BY JOE LAZZARO, SCOTT SINK AND JOE CERRATO

Kahiki Foods is an expanding, family-run Asian foods manufacturer with about 200 employees in Gahanna, Ohio, USA. The company produces more than 70 different kinds of frozen food products. As is typically the case with rapid growth, some operational processes have been slower to reach maturity, including the optimal management of work in process (WIP), the amount of work that has entered the process but has not been completed.

Kahiki’s inventory management system determined that about 80 percent of all stock-keeping units (SKUs) were scheduled for WIP, which leads to additional labor, increased transportation and extra storage costs. Perhaps most significant, WIP also can destroy flow.

The variation in valuation and costs associated with WIP, referred to as price recovery, could contaminate or mask the understanding of the true shifts in productivity. But because, historically, it was the only metric available in the inventory management software system, the project improvement team decided to use variation (WIP daily valuation) as the project metric. They would evaluate the impact of price recovery over time and strip that effect out.

The objective of this DMAIC project was to reduce the WIP levels to controlled buffers by creating a pull system for the product in order to eventually eliminate WIP creation from the process. The scope of this project reached as far upstream as production scheduling and as far downstream as product packaging.

The core team was comprised of the president of the business, the general manager of operations, the plant process improvement engineer (an industrial engineer and Black Belt) and the process owners from both shifts. The chief financial officer and associated subject matter experts (e.g., production scheduling and quality assurance team members) also were called upon frequently, and most participated in all tollgates.

Problem: The average daily extended value of WIP was $51,565 from August 2009 to December 2010.

Goal: Reduce WIP levels, eventually to $0.

Solution: Create a pull system to signal stop and restart of processing to limit excess WIP.

Results: After the initial trial of improvements, WIP levels were reduced to less than $39,000.
Define

The primary defect (Y) for this project was daily WIP. The primary metric by which WIP levels were measured was the daily extended monetary value of WIP, as recorded by the inventory management software system. The average daily extended value of WIP for the facility was $51,565 from August 2009 through December 2010, with significant day-to-day swings. As noted previously, daily valuation of WIP was utilized as the metric for the primary Y because it was the only metric for the defect for which historical data was available.

In the system that existed when the project started, roughly 80 percent of all SKUs were scheduled for WIP. In addition to the expected benefits from reducing this WIP, the project also revealed cost savings opportunities associated with pallet wrapping, increased sanitation requirements and energy loss issues with increased use of the freezer door.

The voice of the business was loud and clear: Migrate the plant toward zero WIP. The voice of the customer was captured by sales and marketing, and was somewhat causally “distant” from this project, but not ignored in the Define phase.

Measure

A closer look at each product line allowed the team to better understand what was happening on the floor. A thorough capacity analysis of the facility was performed to identify bottlenecks in the process and quantify the true capacity on each line.

The team developed a measurement plan that was comprehensive enough to support the successful completion of the project. Data requirements for all stages of DMAIC were incorporated in the master measurement and evaluation plan in the early part of Measure. Many discussions were held around the proper metric for the primary Y, but the team could not arrive at an operational metric that was sustainable other than what was already being tracked in the inventory management system.

The team continued to work on separating out the impact of any price recovery on the primary Y. Separating price recovery from productivity improvement allowed for the use of a currency metric and, hence, a common denominator across SKUs (inventory items, not product families).

A high-level value stream map (VSM) was created
to depict the current state of the process. The red box in the process map identifies the major choke point in the process and, thus, a major driver for WIP. With deeper investigation, it became clear that WIP had become part of the culture; WIP was the way the work was done. People were not conscious of the costs of this practice and that there were alternative ways to achieve smooth flow and efficiency.

Along with the high-level VSM, the team created more detailed VSMs to address specific product lines. A value stream/product-family-level analysis was done to examine the following attributes of the system for possible WIP:

**Line priming** – This activity, part of the standard operating practices, used WIP at the beginning of each shift so that packaging was able to start immediately, even before food processing had started. This allowed associates downstream to begin working right at the start of the shift. The team determined that line priming represented about $10,000 a day in the Y metric.

**SKU stratification** – By dividing up the process into individual SKUs, the team could better understand which product lines were the main contributors to WIP levels. From this data collection and initial analysis of current-state process capability, the team discovered that the chicken line represented the bulk of the WIP: 42 percent, or roughly $20,000, a day in the Y metric. However, the root cause of the high level of WIP was believed to have come from lack of production harmonization.

**Production harmony** – This idea came about through the measurement of imbalances in the value stream, particularly between processing and packaging. To understand the harmony (or lack thereof) for these value streams, the team conducted a detailed choke-point analysis. The analysis involved exploring and verifying the theoretical maximum throughput for each piece of equipment, followed by a value stream line-balancing analysis. Production harmonization involves the integration between production scheduling and operations, and is the reason that the project’s scope extended upstream to production scheduling.

After analyzing the current-state process capability and the initial cause-and-effect diagram, the team believed that $40,000, or 80 percent of the defect, came from issues with production harmonization.
The strategy in Analyze was to increase the engagement of the team in analysis and in identifying solutions.

The team used a four-step process. The first step was to establish whether the process owners and employees viewed “zero WIP” as a realistic goal; all stakeholders indeed felt that this was doable. Step 2 was to share what was learned in the Measure phase about current-state process capability.

Next, in Step 3, the team began its root cause analysis from the “front door” rather than the “back door.” It determined what it would have to do to close the performance gap – to go from more than $50,000 in average daily WIP to $0. In Step 4, the team inferred the forces that held it back from this goal – that is, the root causes of WIP.

In Steps 3 and 4, the following obstacles were identified: overproduction, lack of attention to WIP, continuation of processing while packaging was down, outdated process yield standards, lack of a five-day schedule lock, overordering, and lack of understanding of production harmony.

The team then performed a 5-why analysis on these elements to see if any common root causes contributed to these obstacles. Three root causes surfaced: 1) lack of production harmony between processing and packaging, 2) equipment downtime and 3) line priming. The choke-point analysis from Measure was audited and built out to create a scheduling tool, outlining the different SKUs and their production rates. This enabled the team to understand which combinations of SKUs can be scheduled in parallel so that WIP is not created.

**Improve**

The enhanced choke-point analysis completed in Analyze verified the chicken processing and packaging rates for each chicken SKU. It became clearer to the team that X pounds per minute (lb/min) of chicken can be processed; therefore, only X lbs/min or less can be scheduled for packaging in order to operate free of WIP. This revelation led to the development of a balancing tool to assist in production leveling, which was repeated for the other production lines. The data also was used to justify production buffers to control WIP.

The improvement strategy was two-fold. First, the team implemented a pull system between processing and packaging. In the event that a packaging line goes down, upstream processes are temporarily stopped.
until the issue is resolved. For each line, an optimal buffer was defined based on the equipment throughput found during the capacity analysis. A standard operating procedure (SOP) was created, instituting clear stop and start signals to minimize WIP buildup during downtime and not exceed the defined buffer. The SOP was audited during a two-week pilot test, and a final version was updated for use on the floor.

The second part of the strategy was to develop a method of eliminating WIP that occurs before the shift ends. The team created a tool that estimates the time it takes to package WIP, based on the capacity analysis data. The user inputs the number of pallets of WIP and the tool calculates the amount of time needed to package that WIP, based on the SKUs scheduled for that day. Line supervisors can then shut down processing earlier and package existing WIP before the shift ends.

During the two-week trial run, there was a downward shift in WIP levels. In Stage 1, the average WIP level (current state) was $51,838, with a standard deviation of $28,282. During the trial period (Stage 3), the average WIP level was $38,689, with the standard deviation being $12,354. The team tracked WIP levels before and during the project, and then during and after the pilot.

A Levene’s test was used to prove that a significant shift occurred between the standard deviation of two non-normal continuous data samples: the baseline-state WIP level (Stage 1) and the solution trial-period WIP level (Stage 3). Using an alpha level of 0.05, the test yielded a test statistic equal to 7.95 and a p-value of 0.00. Because the p-value was less than 0.05, the null hypothesis was rejected and the team concluded that the standard deviation of Stage 3 was significantly less than that of Stage 1.

Mood’s median test also was used to show that the median of the Stage 3 data set was significantly less than the median of Stage 1 at an alpha of 0.05. The Mood’s test – selected because the samples were not normally distributed – yielded a chi-square of 23.75 and a p-value of 0.00, providing sufficient evidence to conclude that there was a significant shift in the medians between Stages 1 and 3.

The solution elements indicated that they might serve to lower WIP levels and also reduce the variation in the process. These improvements were approved and a full rollout began immediately. There were many
the final tollgate

operational bugs to work out in the new system, but
the sponsors and Champion believed that the solution
should be implemented and fully supported the rollout
and the progression of the project to the Control phase.

Control

The team developed and put into place five
Control elements: 1) a sustainable, visible measure-
ment system for the \textit{Y} and key x\textapos;s; 2) an SOP for
training and operating procedures, plus execution of
the initial training; 3) accountability measures (e.g.,
process capability sustainability of the primary \textit{Y} built
into the process owners' performance management
systems and annual objectives); 4) a project transition
action plan, which passes the baton from the project
manager to the accountable agents to sustain the new
performance levels; and 5) failure mode and effects
analysis to determine what could go wrong and what
should be done to correct those problems.

The capacity analysis document displays all of the
theoretical maximum throughputs for each piece of
equipment on the floor. To ensure that the document
is accurately maintained, the entire team was shown
how to update the document, including how to edit
specifications for existing products, add new products
and edit equipment settings. The production operating
system manager serves as the document owner. Line
leaders for each shift then would transfer the responsi-
bility to each senior or lead employee on the line to
continue to maintain the piloted improvements.

Sustainability of this project is important to
increase shareholder value for Kahiki. If proper asset
efficiencies are not maintained, any inefficiencies will
be compounded as the company expands. Elements
of WIP management specific to this project include
increasing the use of just-in-time processing and also
rationalizing production quantities through the use
of optimal buffers.

\begin{table}
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\begin{tabular}{|l|c|c|}
\hline
\textbf{Task} & \textbf{Monitoring Frequency} & \textbf{Responsibility} & \textbf{Contingency Plan} \\
\hline
Ensure the pull system solution and WIP elimination initiative is sustained on chicken production line & Daily & Product line supervisor & Utilize WIP elimination tooset to shut down processing early \\
\hline
Ensure the pull system solution and WIP elimination initiative is sustained on stix production line & Daily & Product line supervisor & Utilize WIP elimination tooset to shut down processing early \\
\hline
Ensure the pull system solution and WIP elimination initiative is sustained on egg roll production line & Daily & Product line supervisor & Utilize WIP elimination tooset to shut down processing early \\
\hline
Maintain capacity analysis & Monthly & Production operating system manager & Incorporate update into weekly planning \\
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\hline
\textbf{Time Frame of Stage} & \textbf{Stage} \\
\hline
Before project (Aug. 1, 2009 – Jan. 1, 2011) & 1 \\
\hline
During project (Jan. 1, 2011 – May 8, 2011) & 2 \\
\hline
During pilot (May 9, 2011 – June 8, 2011) & 3 \\
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Joe Lazzaro has completed his Black Belt foundation training and
soon will earn his Green Belt certification. He is a full-time employee
of Nestlé USA. Joe Cerrato is a certified Black Belt and the lead
process improvement engineer for Kahiki. Scott Sink, Ph.D., P.E., is
an executive in residence at The Ohio State University (OSU) and
also the Integrated Lean Sigma certification program director for the
College of Engineering at OSU.