BOD Reduction at Kahiki Foods

By Jared Frederici with Tim Corall and Scott Sink

Kahiki Foods, located in Gahanna, OH is a premier supplier of high quality Asian-style frozen foods. In December of 2008, Kahiki began receiving extra-strength surcharges from the City of Columbus division of Public Utilities for its water quality. Of the three metrics used to quantify water quality, BOD (Biological Oxygen Demand) accounted for 74% of charges bringing Kahiki's total extra strength bill to an astounding $204,000 for FY 2009. Given these costs and Kahiki's support for the environment and ocean conservancy, a six sigma team was chartered to dramatically reduce BOD levels using the DMAIC roadmap. 6 months post project charter, BOD has been reduced almost 70% with a goal of 95% reduction by Dec 2010.

The Final Tollgate features a Six Sigma project as it would be presented to a panel of company executives at the final project review. The objectives of such a presentation are to communicate significant results of the project and share highlights of how results were achieved. The slides are the project leader's visual presentation and the accompanying text is the verbal presentation. It is assumed that the audience has a basic understanding of Six Sigma.

Define

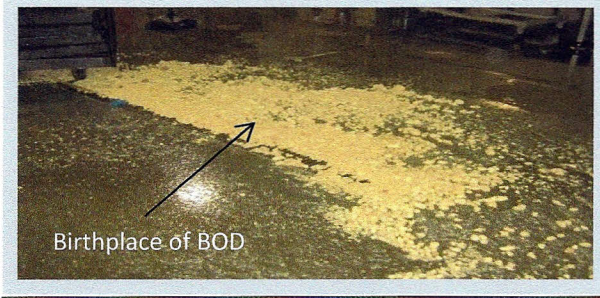
D M A I C

BOD Waste Reduction

Problem Statement: Current operations produce BOD waste levels averaging 3864 mg/L – 1546% higher than the upper spec limit from Columbus City Utilities.

Goal Statement: At least 50% reduction in BOD by 3/15/10 and the creation of a sustainable system capable of reaching a long term target of 95% reduction.

Expected Benefits:
- Dramatic reduction in solid waste entering floor drains
- Increased throughput at various plant processes
- Green initiative for the organization
- $195,000 in direct, hard cost reductions



SIPOC for BOD Waste Reduction

Supplier	Input	Process	Output	Customer
Vendors and Suppliers	Raw Materials	Receive raw materials	Raw inventory	Receiving
Receiving	Raw inventory	Transport raw materials to storage	Raw inventory	Warehouse
Warehouse	Raw inventory	Transport raw materials to processing	Raw materials	Raw Processing
Raw Processing	Raw materials	Process for frying	Processed raw materials	Fryer
Raw Processing	Processed raw materials, oil	Fry	Fried product	Freezer
Fryer	Fried product	Freeze	Frozen product	Packaging, warehouse
Freezer	Frozen product	Transport to storage	Frozen WIP	Warehouse
Warehouse, Freezer	Frozen WIP	Transport to packaging	Frozen WIP	Packaging
Freezer, Warehouse	Frozen product, packaging materials	Package	Finished Product	Warehouse
Packaging	Finished Product	Transport to warehouse	Finished Goods Inventory	Warehouse
Processing, Packaging	Dirty dishes, containers, water	Dish Washing	Clean dishes, containers, dirty water	Processing, packaging, drains
Processing, Packaging	Dirty machines/plant, water, chemicals	3rd Shift Clean	Clean machines/plant, dirty water	Processing, packaging

Define

BOD, which stands for Biological Oxygen Demand, is a measure of water quality and relates to the amount of oxygen required by bacteria to breakdown solid wastes in wastewater. The City of Columbus requires that BOD not exceed 250 mg/L; otherwise extra strength surcharges are applied with the possibility of more severe consequences including full plant closure. Given this, Kahiki's support for the environment and close to $204,000 in surcharges in 2009, Kahiki chartered a six sigma project to dramatically reduce BOD in exiting waste water.

Creation of a good working relationship with the customer (City of Columbus) was paramount at this stage in the roadmap and served as a great starting point. Columbus City provided the team with valuable information about BOD and noted that "BOD starts as food waste entering floor drains". The team created process maps and multiple SIPOC maps to help isolate opportunities for waste to hit the floor and understand the flow of food waste throughout the facility.

Food waste is created at various production processes including raw chicken processing, frying processes, packaging and dishwashing. Food waste that is not thrown away or recycled eventually makes its way to the plant floor, and is sprayed clean into one of 50+ plant floor drains. In each drain there is a filter basket in which some solids are filtered while remaining solids and liquids travel to a main sump. Solids/liquids are pumped from here to a solid/liquid separator which then pumps what's left to a grease interceptor. Finally, waste water leaves the interceptor and travels into the city sewers.

Because 74% of extra strength surcharges are attributed to BOD, this metric would be the team's primary metric however the other metrics TSS (Total Suspended

Beginning in 1961, the Kahiki Supper Club in Columbus, OH has attracted millions of customers to visit "One of the top 100 Restaurants of the 20th Century". Although closed since 2000, Kahiki Foods has grown to be a premier provider of high quality Asian frozen foods. Kahiki Foods produces over 70 products that can be found in retail grocery stores, membership warehouse clubs, convenience stores, and foodservice operations. Kahiki products have become so popular that the Kahiki kitchen has expanded to a 119,000 square foot state-of-the-art facility employing approximately 150 employees. In 2009 Kahiki Foods was named the Food Plant of the Year for Meals and Entrees from RFF Foods and continues to realize enormous growth.

Measure

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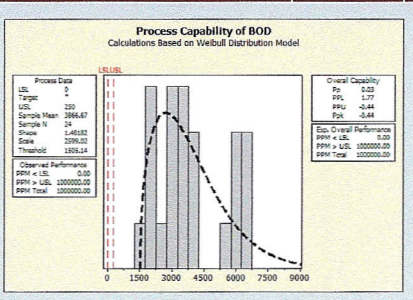
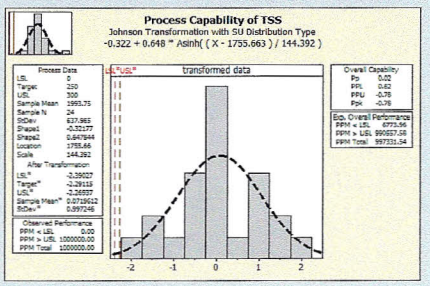
BOD Waste Reduction

Process Capability: Process capability charts were created for BOD and TSS metrics. Both metrics clearly not capable of meeting customer spec with current waste removal system.





Measurement Plan: Success in Measure hinged on the execution of a detailed and efficient measurement plan.

**Many of these metrics had never been recorded so much time was spent developing operational methods of data collection*

What Data We Need	How We Will Get It	Metric	What Do We Do With It?	Progress
Production Data, Historical Lbs Produced, Production Schedule	Compass, H:/K: Drives	Lbs Produced, on a Month to Month Basis – Production Schedule	Correlation between BOD, TSS levels and Production - what effect does our production schedule have on waste output?	Received - ready for analysis
BOD, TSS concentration levels	more frequent sampling from City	mg/L BOD, TSS	This is our primary metric - we will use this as our response variable to see what effects different inputs have on our primary output	City of Columbus to sample once a month for 6 months
Water/Sewer Consumption	City of Gahanna, reading our own meter - water consumption pillar team	Gallons or Gal/hr,min,sec	We need to understand the effect that our water and sewer consumption have on BOD and TSS concentration	Numbers from City of Gahanna (Water and Some Sewer)
Amount of waste entering drains at various plant locations	Sample drain baskets and weigh solids after 2nd shift	Lbs	This will be an extremely important metric as this will help us focus in on the high priority production spots where the most BOD,TSS waste is created	Hector executing sampling plan on Various drains around plant
Solid Waste found at Sump	Drain Basket to capture Time Series data at sump (3 outlets)	Lbs	Will Tell us largest contributor of solid waste from one of three locations - Raw Processing/Fry, Packaging, Dishwashing	Basket Ordered 11/12 - Expected to arrive 11/26 and Sampling will begin
Solid Waste Found at Separator	Drain Basket to capture time series data	Lbs	Will tells us how much solid waste enters separator from sump	Basket Ordered 11/12 - Expected to arrive 11/26 and Sampling will begin

Solids), and TKN (Total Kjeldhal Nitrogen) would still be monitored as the team hypothesized these metrics may be correlated with BOD.

Measure

One of the critical challenges in the Measure phase was that of data collection. Kahiki tracked extra strength levels back to late 2007 however due to a major system change, data from 2008 and on could only be used as representative of the current system.

The standard sampling schedule for Kahiki was 3 site visits per year, each recording 4 samples and taking the average for all metrics. This gave the team 24 data points over 2 years for BOD. For sake of future statistical analysis, the team pushed for monthly site visits to generate more data and also allow for smaller turnaround times for future pilot tests. This came at an extra cost, however in retrospect this decision point was critical to the success of the project in the timeframe given.

Given the small amount of data, normality tests were performed and both BOD and TSS were found to be non-normal. By fitting appropriate distributions and transforming the data we were able to characterize both metrics in terms of their statistical capability. As expected, both metrics were highly incapable of meeting customer spec limits.

A demand analysis was performed to understand what "pulls" existed on the waste removal system. As the team began crystallizing potential process inputs, the need for a detailed and accurate measurement plan became apparent. The team turned potential inputs into questions which formed the underpinnings of the measurement plan.

The team gathered data that included historical and current production volume, water and sewer consumption, lbs of waste entering various plant drain baskets, solid wastes found at the sump and interceptor locations as well as data dealing with interceptor/sump pump frequency. As the measurement plan began execution, more data began rolling in for our primary metrics.

Another integral part of data collection was that of sample power. In order to eventually make claims about the data and potentially use hypothesis testing, the team worked backwards from an appropriate sample power to arrive at the appropriate amount of data to collect.

One challenge that arose during data collection was that of data collection visibility. Some of the more critical data points needed came from 3rd shift which is designated solely to cleanup. Developing close relationships and accountability was critical to ensure data integrity for these data points.

Analyze

D M A I C

BOD Waste Reduction

5 Why Analysis: This tool helped the team get to the root of the problem.

Why is there a Gap between Current State and Future State?

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Why aren't BOD levels in customer spec?

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Why are BOD levels too high?

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Why is there too much waste in city sample?

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Why does too much waste flow through Kahiki's Waste Removal System?

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Why does waste enter drains at various prod. points?

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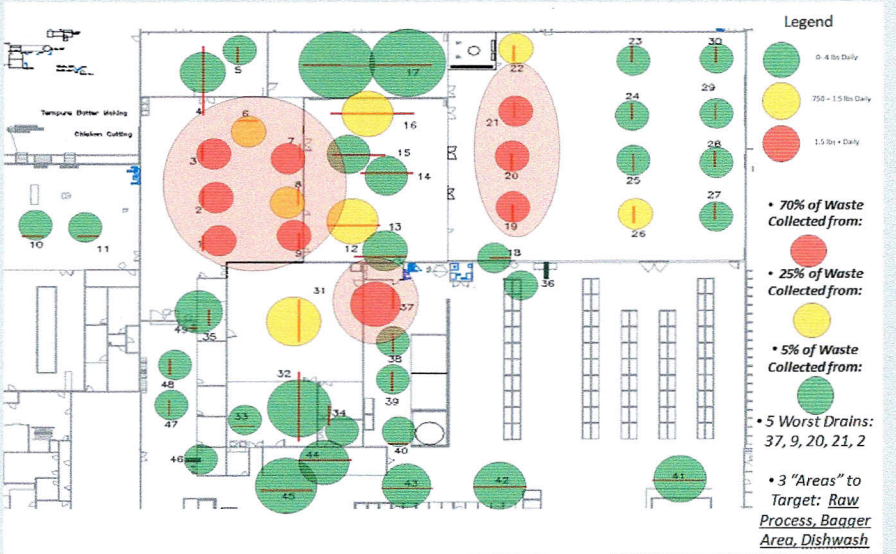
Why is waste created?

↓

Throughput Yield not 100% at every process

Benchmarking: Almost every food processing plant deals with residual food waste. Rather than reinvent the wheel, the team did significant benchmarking.

Plant Floor Drain "Hot Spot" Chart: This depiction shows a heat map of solid waste entering floor drains. This mapping allowed for strategic deployment of solution elements targeting waste problem areas in the plant.



Analyze

Characterizing the look, feel and performance of a potential future state was critical during the beginning portions of Analyze. The team examined best in class industries with regard to BOD and also examined Kahiki's own performance to establish a potential future state for the system. From this, the team did a gap analysis to understand what specifically needs to happen to certain inputs in order for the system to eventually achieve this future state.

Once the gap analysis was performed, it became apparent that certain inputs into the system were more critical than others and also farther away from optimal than others. The team did multiple cause and effect matrices and FMEA's to examine potential inputs and their effect on primary metrics as well as secondary upstream metrics. A fishbone diagram that was performed in the latter stages of measure helped get ideas rolling regarding potential inputs into the system.

Using the data collected from the measurement system allowed for the construction of a drain "hot spot" heat map. This map uses a color scheme to characterize volume of waste found in various plant floor drains. Those drains with red spots (9 drains) account for 70% of the total amount of solids found in all 50+ drains. This tool allowed for an intensive look at potential problem areas in the plant with regard to waste creation. It would also allow for strategic implementation of potential solutions which would target problem areas.

Significant benchmarking was done on multiple companies in the food processing industry. Because the majority of food processing facilities have to deal with the issues of waste creation, the team wanted to know about best in class practices and also root cause identification. One salient example came from a company similar to Kahiki in terms of volume and products made which served as a tremendous resource during this phase of DMAIC.

Regression analysis was performed to examine statistical relationships between inputs and a 5 why analysis was performed using the expertise of the team, subject matter experts and also benchmarked companies to investigate root causes. This combined with the results from the C&E Matrices, FMEA and benchmarking all led to the root of the problem: Waste creation at production processes.

The regression results also helped the team understand relationships involving water consumption, production volume and sump pumping practices. The team also did significant biological research to identify specific substances with regard to their invididual contribution to BOD.

Improve

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BOD Waste Reduction

Improved Solid/Liquid Separation: Inefficient solid/liquid separation from FMEA led to a pilot test using a more efficient separator.

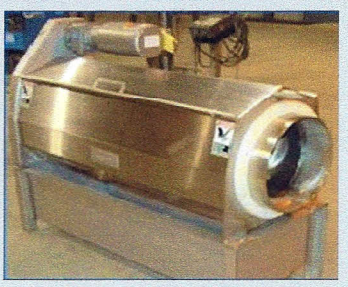
Reducing Waste Creation: Various projects were initialized to increase throughput and decrease the amount of waste created at the source.

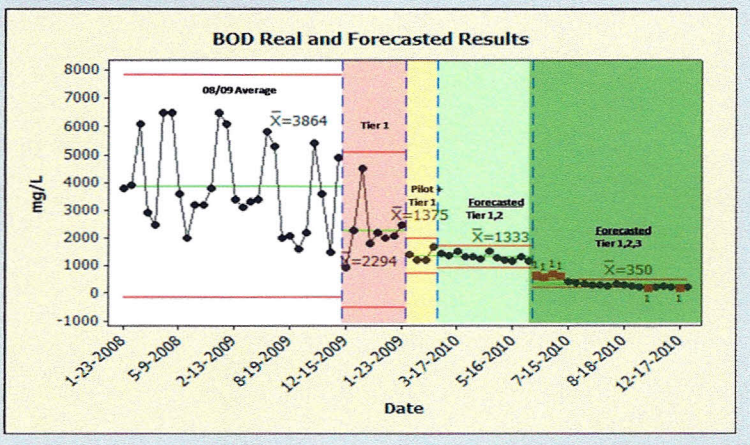
Employee Training: Simple but effective employee training was implemented regarding waste practices in relation to BOD

Best Practice Identification: Going hand-in-hand with training, best practices were identified at various production points encouraging BOD sensitive waste handling practices.

WAP Committee: A "Waste Awareness Program" Committee was formed with production employees to help serve as the acting body regarding best practice ID.

Error Proofing: Adding visual SOP's, closing off drains and posting metrics greatly reduced defect opportunities.





Improve

From the enormous body of literature available, the team was able to see how other companies had utilized different solution to reduce BOD. From this, custom solutions were brainstormed and implemented specific to Kahiki's individual needs. Solutions were broken down into 3 Tiers of solutions and teams were created to tackle improvements posted to the action register:

Tier 1 solutions involved those improvements that were "Just Do It's" and involved simple and more efficient cleaning methods, proposed pilot testing of a more efficient separator, employee training, and initialization of various projects to increase throughput yield. Many of these solutions were implemented as the project progressed into Improve and Control.

Tier 2 solutions were improvements that were slightly more involved and needed further development before deployment. Some of these solutions came in the form of creating a Waste Awareness Program Committee, error proofing, formal SOP's regarding sump and interceptor maintenance/pumping and other best practice identification on the plant floor regarding batter and sauce handling.

Finally, tier 3 solutions were those improvements that would serve as ongoing projects to extend throughout the end of the year. These solutions would take time to develop and careful consideration would have to be paid to deployment and especially sustainability. Long term throughput projects to eliminate waste at the source were initialized which attacked various areas of production according to the drain heat map. One exemplar project dealt with adding a thickening agent to egg roll fillings which would absorb moisture and increase throughput on the egg roll line thus reducing opportunities for waste to hit the floor. Similar projects were started which aimed to produce in smarter, more efficient ways.

Another critical long term component of the tier 3 solutions involved the formation of a preventive maintenance program that would attack potential leaks across all production equipment to reduce those waste creation opportunities.

Furthermore, the WAP committee and other focused improvement teams would continually develop, post and enforce best practices. This set of improvements would serve as ongoing efforts given that "best" practices one day, can be "better" practices the next day.

Finally, Kahiki also investigated more efficient and green waste removal methods. Many service-based companies will collect food waste and turn this into animal feed and/or fuel rather than sending all solids to the landfill. Better waste practices allowed Kahiki the opportunity to investigate these waste removal options.

Control

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BOD Waste Reduction

Post Improvement Results:
BOD (3/15/10): **1375 mg/L ≈ 70% Reduction**
TSS (3/15/10): **790 mg/L ≈ 61% Reduction**
Expected Hard Cost Reduction 2010: **$178,365**
Strong downward trend and system becoming capable of reaching target spec limits.

Control Plan Element 1: Continued employee training is critical to sustainability and will exist for current and new employees.

Control Plan Element 2: Sustainability hinges on employees active in the solution process. WAP committee brings together employees for BOD.

Control Plan Element 3: Error proofing in the form of visual SOP's, posted metrics and closed floor drains decrease defect opportunities.

Control Plan Element 4: Accountability is paramount. Implementation stretches across all shifts, across all areas of the plant. Delegating and assigning responsibility is key.

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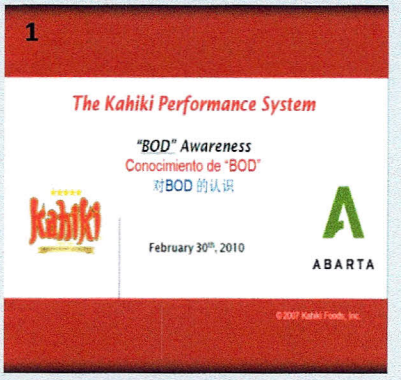

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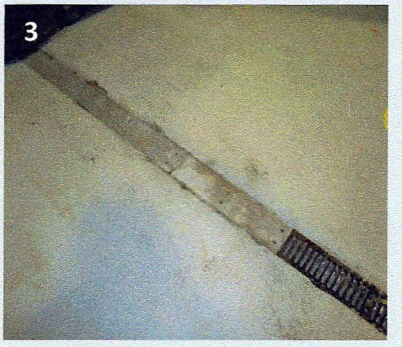

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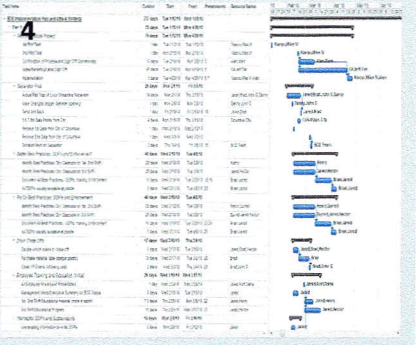

Control

Immediate results were staggering. Six months post project charter, Kahiki had realized close to a 70% reduction in BOD and a 61% reduction in TSS. Sustained levels would generate an expected $178,365 in savings for fiscal year 2010. However, this was just the tip of the iceberg as the continued development and completion of tier 2 and 3 solutions throughout the end of the year are projected to realize a 95% reduction in extra strength levels. However, these continued results depend on sustainability

Control hinges on employee presence not only in solution development, but also in solution control. With a detailed and lengthy implementation plan, there were many failure modes that needed to be addressed in control.

Continued employee training as new practices and procedures were developed was very important, however one potential failure mode is that of hiring new employees. Training documents were put together for all new-hires with a short quiz to be completed to ensure BOD is mentioned prior to actually stepping foot in the plant.

To keep production employees involved and active with regard to waste practices, a WAP committee was formed which serves to actively engage employees in the process of creating and enforcing SOP's across the plant floor. This committee also give employees a chance to be a leader in the plant among their peers as a spokesperson for efficient and green waste handling practices.

Error proofing was a critical element in control as reducing opportunities for defects to occur greatly reduces the chance for BOD to be created. Floor drain covers were installed to act as visuals to let employees know that these drains are not meant for solid food waste. Visuals of SOP's and best practices were posted at the point where the opportunity existed. Metrics were posted in common spots to show the positive results of employee efforts. This acted as a way to keep employees engaged and not detach them from the results they created.

Accountability was also key to the success and sustainability of the project. Because there were many actions required in the implementation plan, everyone must be accountable for their portion of the solution.

This project has helped Kahiki realize tremendous results with regard to BOD reduction. The benefits come in the form of hard cost reductions and also as a green initiative for the business and will hopefully encourage other companies to pursue better waste practices.

Jared Frederici was the project leader and is a black belt candidate at Ohio State studying Industrial and Systems Engineering. Tom Corall Mark Novak and Brad Goolsby continue to lead future implementation at Kahiki for further BOD reduction. Dr. Scott Sink, Program Director for LS Certifications College of Engineering/ISE, Ph.D., P.E., helped coach the belt candidate throughout the cycle of the project.