



## *Achieving Customer Specifications Through Process Improvement*

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Achieving customer specifications is an important job of the quality assurance professional. Specifications define the difference between acceptable and unacceptable products and are at the heart of customer satisfaction. The ability to consistently deliver product within specifications often determines whether the supplier will continue to do business with the customer.

The most certain way for the supplier to achieve the goal of delivering product within specification is to adopt Statistical Process Control (SPC) methods. SPC provides the means to achieve and maintain stable production processes that are capable of meeting specifications.

An improved process is achieved by better coordinating the design of the process with the specifications of the product. A fundamental aspect of this improvement process is to recognize that processes, no matter how closely monitored, will have variation. This variation is well defined when a process is in a state of statistical control (i.e., is varying randomly without large, assignable variations).

The second component is to measure how well the process can meet specifications. This is called process capability. Figure 1 illustrates the defect rates associated with different levels of process capability. By reducing process variation, the supplier increases his capability to meet specifications and thereby reduce the amount of out-of-specification product.

Cpk	Sigma Level	Calculated Number of Out-of-Spec Products
1.00	3	2700 ppm
1.33	4	63 ppm
1.67	5	0.57 ppm
2.00	6	2 ppb

**Figure 1**  
Relation of Process Capability (Cpk) with a Theoretical Amount of Out-of-Specification Product

Figure 2 shows the formula for Cpk, an index commonly used to describe process capability. Cpk takes into account the target level, acceptable amount of risk and product variation, and provides a convenient snapshot of process performance.

$$Cpk = \text{Minimum}[(USL - \text{Mean})/3S \text{ or } (\text{Mean} - LSL)/3S]$$

For example, given:

$$\text{Mean} = 12.5 \quad LSL = 11.5$$

$$\text{Std. Deviation, } S = 0.2 \quad USL = 13.5$$

$$\begin{aligned} Cpk &= \text{Minimum}[(13.5 - 12.5)/3(0.2) \text{ or } (12.5 - 11.5)/3(0.2)] \\ &= \text{Minimum}[1/0.6 \text{ or } 1/0.6] \\ &= \text{Minimum}[1.67 \text{ or } 1.67] \\ &= 1.67 \end{aligned}$$

Referring to Figure 1, this yields a 0.57 parts per million defective, commonly called a 5 sigma process.

**Figure 2**  
Calculation of Cpk

- Process  
Capability Index

In order to achieve high quality, the supplier must keep the process in a state of statistical control. This means that the process must not be affected by special causes or unpredictable variation. The supplier can be assured that the process is in statistical control, if they properly develop a process control plan and monitor the process using techniques such as control charts.

The final step is that the supplier should continually reduce the level of process variation using continuous improvement techniques. This in turn improves product quality and further reduces the risk that out-of-specification product will be made. As a result, the supplier can set meaningful specifications and the processor will worry less about product failure caused by an out-of-specification ingredient.

Since food processing often uses natural products which are frequently non-homogeneous, process capabilities tend to be lower than in industries which use homogeneous starting materials. We have found that usable guidelines are  $Cpk > 2.0$  for sanitation,  $Cpk > 1.33$  for pilot plant, and  $Cpk > 1.0$  for natural product processing. By using continuous process improvement methods to push capability as much as possible, the food processor will both reduce costs and the chance of shipping out-of-specification products.

## Process Improvement and Capability Studies at Con Agra (Case Study)

Changing tastes of consumers and marketing trends of restaurants, particularly fast-food restaurants have increased the use of fully cooked and sliced muscle meat products in prepared food. An example is the popularity of add-on meats to sandwiches.

The portion control of the slices enhances our market position by fulfilling customer's desire to deliver a consistent product to the consumer. Reducing variation in product slice weight has a large impact on our bottom line. The customer demands and the government agency requires that the amount of product in the package, on average should be at least as much as the label on the package states. This is especially critical for packaged consumer products which must meet governmental labeling requirements. However, to remain profitable and to be cost effective to shareholder and customer alike, we avoid overfilling. Using SPC, ConAgra has achieved a



fair and effective balance between under- and overweight products. This results in significant savings and gives ConAgra an advantage over others suppliers who have less control of their processes.

ConAgra Refrigerated Prepared Foods uses SPC along with a structured program of continuous monitoring and improvement to optimize product weights. We routinely analyze portion weight data to identify out of control situations and capability to meet the product specifications. If there is an incompatibility between the specifications and process, the normal procedure is to improve the process.

### Manufacturing Process

Pre-cooked muscle meat in the form of circular sheets are provided by an improved method developed at ConAgra Refrigerated Prepared Foods. Grinding the muscle meat to break down the connective tissue also increases the surface area to allow better penetration of the seasoning. The meat blend is de-aerated by vacuum which minimizes voids while increasing the development of the protein exudates for binding of the muscle meat pieces.

The stuffing of the final blend yields consistent, unitary logs of circular cross section and a diameter of 4.18". The logs are cooked to an internal temperature of 160°F, then chilled in a blast chiller to a temperature of 26-28°F for 2-3 hours prior to slicing to insure a smooth slicing process. The casing is removed prior to slicing and slice thickness can be adjusted using conventional meat slicers. The slice surface is essentially free of separable seams between abutting surfaces of the original muscle meats from which it was formed. Therefore, restaurants and fast-food purveyors are provided with ready-to-serve or microwave heatable round slices with consistent diameters.

Slice weight for each product and product line is measured at least once per hour, the results entered into the computer, and corrective action taken as needed. If more than two consecutive weight checks are below the declared net weight then all products are retained to the last acceptable check. By controlling the running average for each product, all products are within specs and as a group their weight equals or exceeds the total declared weight.

Technical services examines the "capability" of all processes to determine if the processes are producing within specifications. Figure 3 illustrates this analysis using X-Bar and Range control charts and a histogram. During initial process startup, statistical analysis revealed that the process was stable but the variability made it incapable of meeting specifications.

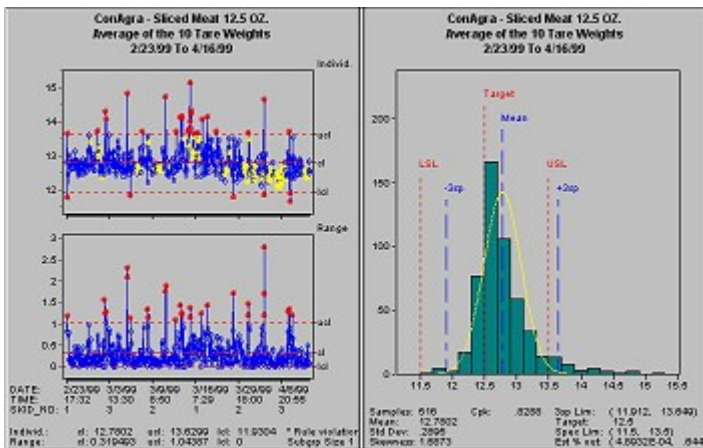


Figure 3



As shown in Figure 3, the process frequently exceeded the upper specification level (USL) but never fell

below the lower specification level (LSL). The customer on average received more than the declared weight of a product but never less. Thus, Con Agra was over-filling product while not exceeding the Maximum Allowed Variation (MAV) as mandated by National Conference of Weights and Measures.

This excess overweight was unnecessarily expensive. The problem was identified, and a corrective action team formed. This team included Corporate Technical services, plant operations, quality assurance, engineering personnel, and line operators. The investigation revealed that the slicing machinery needed improvement.

The charts in Figure 4 show the resulting reduction in process variation. The team determined that tighter control on slicing temperature and regular maintenance of the blade of the slicing machine would improve slice-weight control. The team worked closely with line operators to implement these improvements.

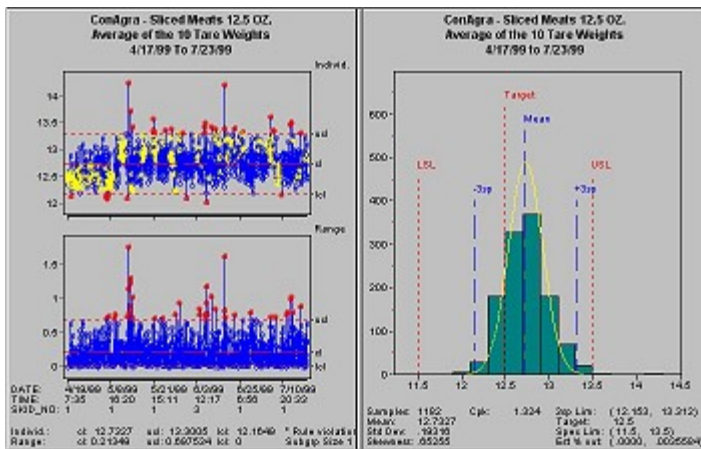


Figure 4



As a result of the team's efforts, we greatly improved the process capability. The original Cpk was 0.8288 with a calculated 0.64% of the production overweight. After the process adjustments, the Cpk increased to 1.324, and our calculated overweights were reduced to only 63 per million portions.

High capability production gives us more than the confidence that we will routinely deliver product within specifications. When we are highly capable, we can tolerate a shift in the process without losing our production. An example of this is the large safety margin we maintain in sanitation (*Food Quality Magazine*, May 1998). When line conditions were altered, our process capability changed from Cpk = 12.2 to Cpk = 1.495. Since Cpk = 1.495 is still highly capable, we had the opportunity to correct the process shift with the confidence that we were still shipping safe food products.

In the above case of meat slice portions, a shift from the original Cpk = 0.8288 to Cpk = .67 (2 sigma process) would increase our calculated overweights from 0.64% to 4.54%. Such a shift substantially increases the amount of product given away for no compensation.

## Conclusion

ConAgra successfully monitors control points using SPC to push continuous quality improvement. This permits us to develop highly capable processes that both meet our customer needs and minimize our production costs. As a result we establish ourselves as both a more dependable and more profitable vendor.