

Example of Six-Sigma Isogrammetric™ Analysis Method¹--SSIAM™

Six-sigma performance begins with *goal setting* and ends with *measurement* of achieved performance. If six sigma or a lesser-targeted goal is not achieved, then process tuning and/or re-engineering is required. And, we cannot know how we are doing unless the proof-of-performance measure is in *sigma-level* terms.

Every factory manager, production engineer, and line foreman needs to be able to answer these key questions about every controlled process, at any given time:

- ✓ What are my defectives?
- ✓ Is this six-sigma performance?
- ✓ What is my sigma-level performance for every process?

Production goals are keyed by benchmarks and target values for every process, sub-process, and control system on the factory floor. The parameters include process yield, control setpoints, and tolerances for process variables. Note that *perfection* is unlikely--there will always be defectives. *Defectives are defined as errors, faulty parts or actions, and out-of-tolerance variables.*

Example: Consider a process that requires *registration* of two controlled actions, images, or components (hitting a moving target): e.g., print-to-image, punch-to-image, emboss-to-mark, cut-to-mark, etc. Registration is continuously monitored with periodic data collection. Actual register error is measured in sets of nine data points per *proof-of-performance check*. The goals are:

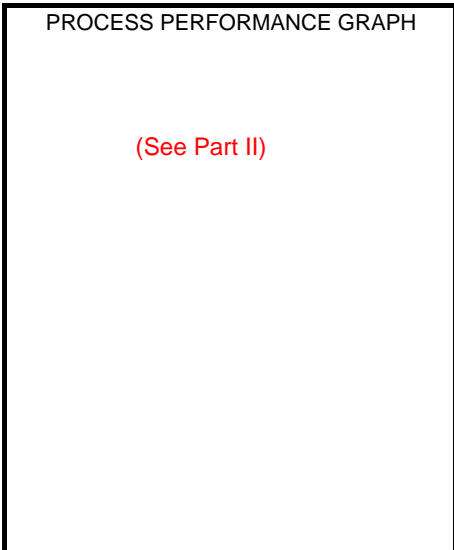
Strategic goal	6 sigma (<4 dpM)
Minimum goal (corrective action req'd)	4-1/2 sigma (1 dpK [99.9% yield])
Control setpoint	0
Tolerance	± 0.005 inches

The process control behavior is sometimes irregular (not Gaussian) and worst case, cycles between high and low values of a range.

The observed max/min excursions are different for different machines (or processes) due to operator skill factors, non-uniform process dynamics, materials variation, machine wear-and-tear, and other usage/age special causes. For five machines A through E, the results (in mils) are:

- Error
- A—ranges between +1 and -1 (0,1,1, 0,-1,-1, 0,1,1)
 - B—ranges between +2 and -2 (0,1,2, 0,-1,-2, 0,1,2)
 - C—ranges between +3 and -3 (0,1,3, 0,-1,-3, 0,1,3)
 - D—ranges between +4 and -4 (0,1,4, 0,-1,-4, 0,1,4)
 - E—ranges between +5 and -5 (0,1,5, 0,-1,-5, 0,1,5)

During the test, there is *no discovered scrap* and all measured data are within tolerance! ***Is this six-sigma performance?***
Which machines, if any, require corrective maintenance?



The achieved sigma-level for each machine is shown on the accompanying Isogrammetric™ Process Performance Graph. (See Part II). By calculating statistical mean and sigma values using appropriate formulas, we are able to show the probable yield on an isogrammetric graph that consists of a family of curves of constant process yield (isograms). Note that the ordinate (y-axis) is a measure of process capability, and the abscissa (x-axis) is the mean-value shift from target in sigma measure.

¹ Protected by U.S. Patent 5,715,181 and copyright 1998-2004.