February 16, 2007

The ZDM Group LLC

Performance by Design

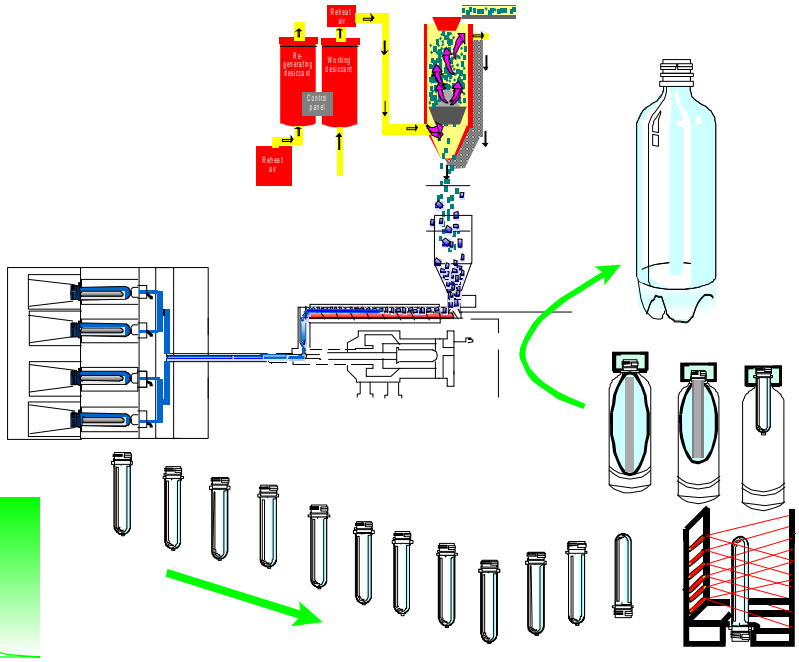
Maximizing Profit Margins with Six Sigma

The Opportunity

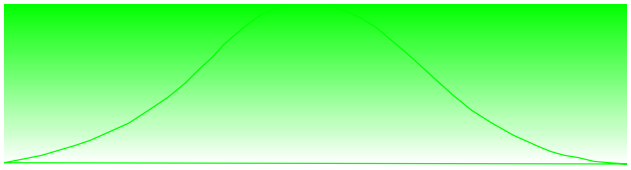
Throughout the 80's and 90's we have heard contrary to the old paradigm -- that the search for quality is synonymous with the search for productivity. We spoke of needing to reduce variation, produce product with consistent properties, and change the focus from inspection to prevention. We were to focus not only on complying with specifications, but also on the stability of the process.

While it was politically correct to say that the organization was proceeding with the new paradigm, many continued working with the old paradigm – "Decide: Do you want quality or productivity?"

The quality department had a position very high in the organization chart, but very little influence in the decisions of business administration. The managers of the manufacturing plants treated the quality department as an imposition. Often, the only duty of the quality department was to inspect for and document defects, and answer any client complaints. Machine operators ignored warnings in the control charts if the quality tests indicated that the product was still in-specification. The plant applied control charts only to properties of the final product, not the process that made it, or the inputs to that process. The efficiency and performance measurement systems separated the quality and productivity numbers.



The result - The typical plastics manufacturer produced only 80% of their potential capacity.



Only 83% of product compiles with specifications. Thus, Effectiveness at producing in-spec parts = 80% x 83% = 66%

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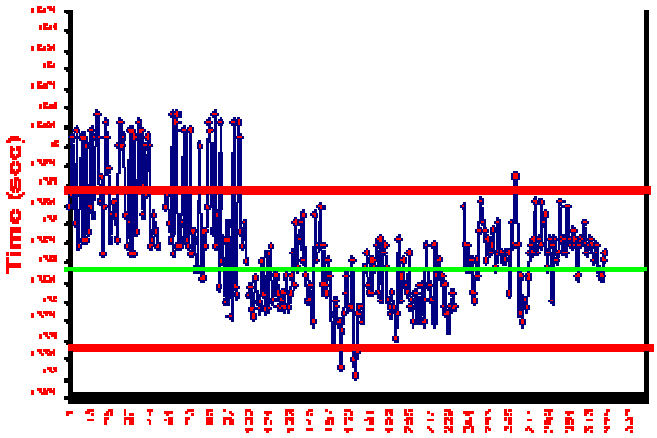
In addition, only 48% of the product is of consistent quality. (In statistical control.)



Effectiveness at producing consistent quality parts = 80% x 48= 38%

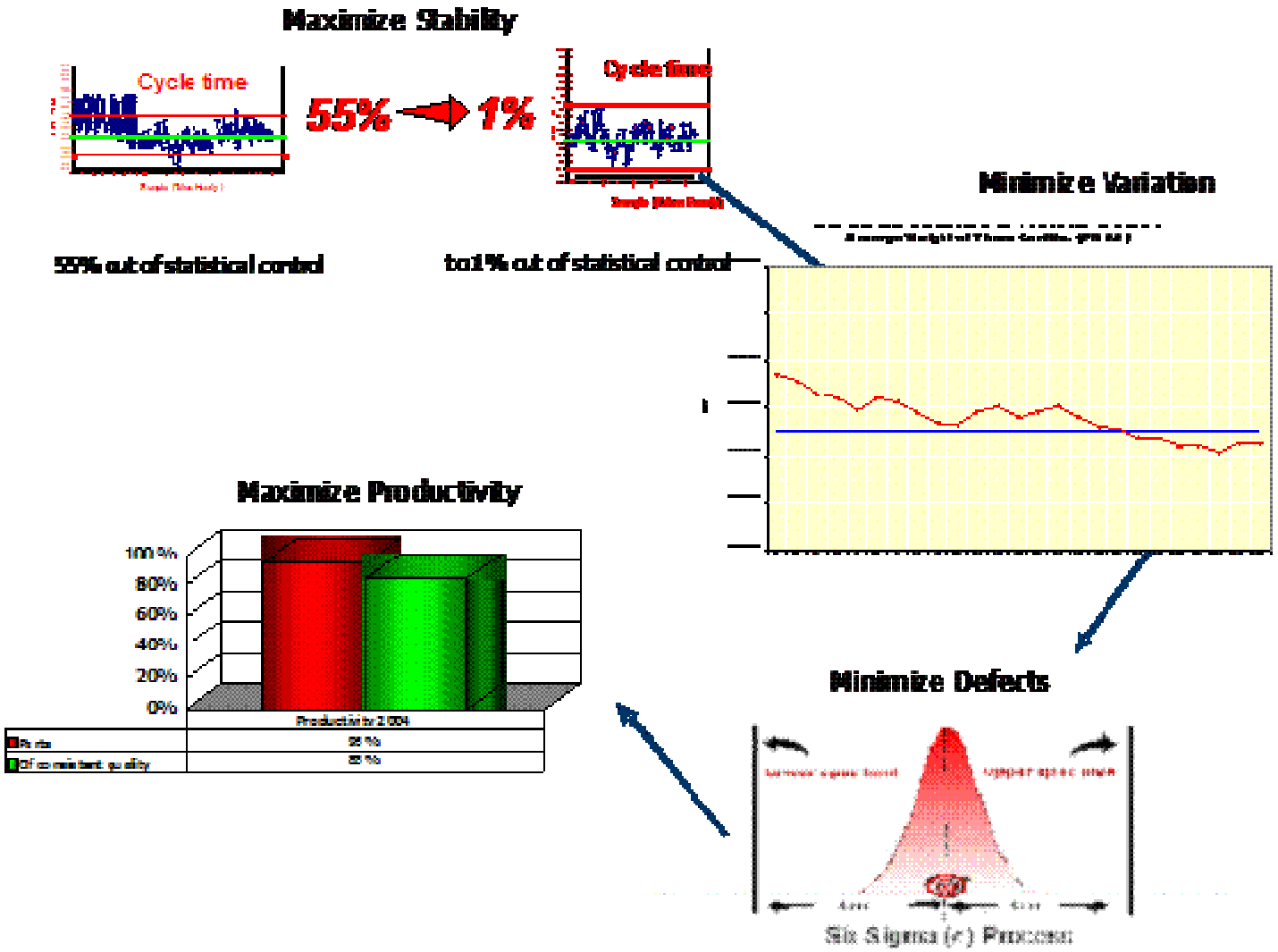
Why? Because the process of decision-making is:

- Non-Scientific
- Non-Statistical
- Only based on local considerations

Symptoms of this older methodology are:

- Longer manufacturing cycle times - 5% or 10 % longer than necessary
- Inefficient use of raw materials – 1% loss in yields can mean high $
- High scrap rates – often costly tons per year
- Traditional quality plans focused on inspection
- Arbitrary process changes
- Frequent line stoppages due to equipment breakdown
- Unreliable sensors for process measurement
- Maintenance activities that are too late
- No confidence in measurements
- Uncontrolled or improperly designed auxiliary equipment systems

The Goals



The objectives are clear –

This case study shows us the potential impact:

Annual Production Before ---------- 342,575,000

Annual Production After ----------— 525,083,000

Productivity Gain ---------- 182,508,000

% Productivity Gain ----------— 53%

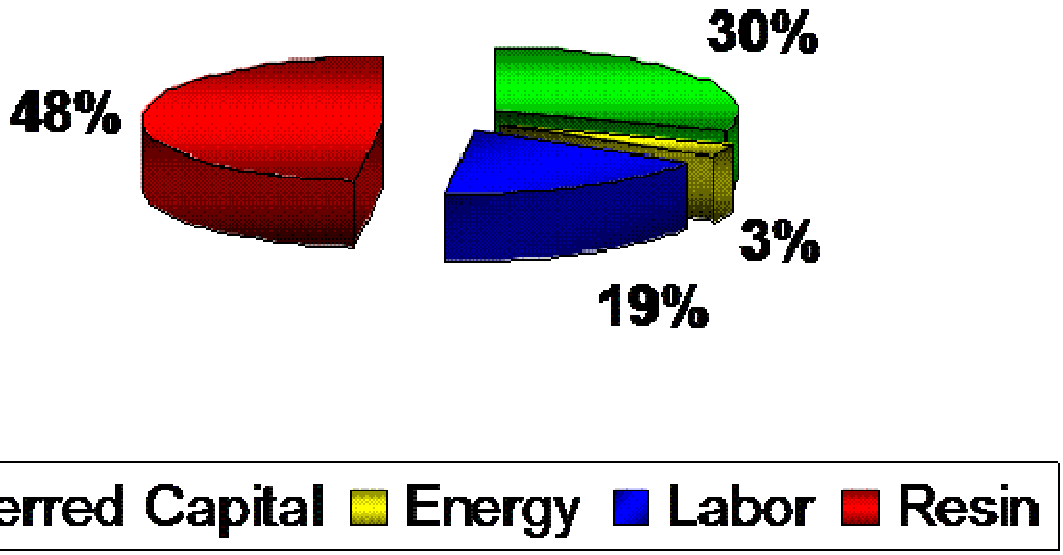
Returns for Quality Defects Before ---- 11,810 PPM (1.18%)

Returns for Quality Defects After ------ 443 PPM (0.04%)

Reduction in Returns ----------—11,367 PPM

% Reduction in Returns ----------— 96%

Increased Profitability
Annual Savings = $952,954



Changes in Paradigms and Culture

Traditional Business

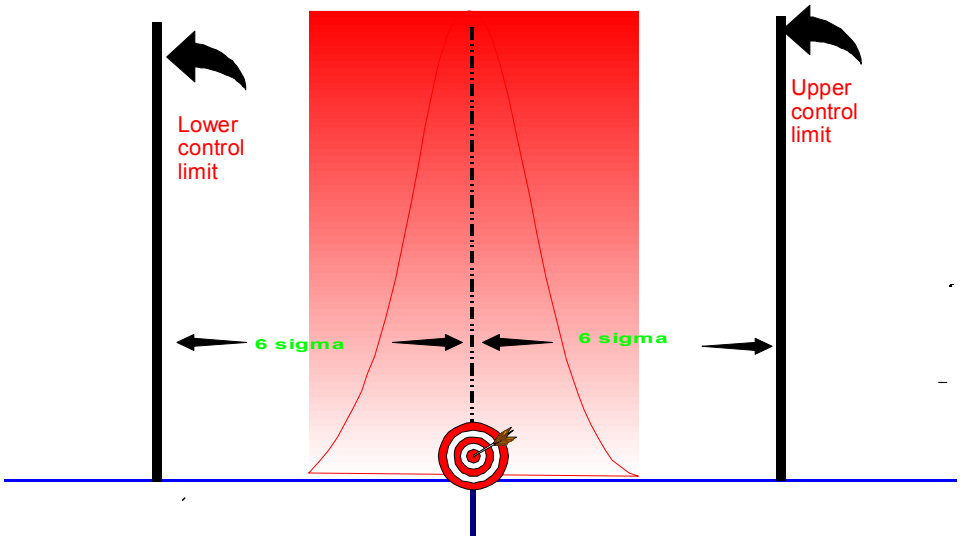
- Measures its success in quality and productivity separately.
- Quality system is based upon inspection of final product.
- Defines quality as parts in specification.
- Measures only finished product.
- Does not trust and does not have evidence of the reliability of their quality measurements.
- Thinks that the objectives of production and quality are in conflict.
- Does not have time for preventive actions or for routine maintenance.
- When conducting preventive maintenance, it's based only on the recommendations of equipment providers or their own arbitrary routines.
- Is illiterate in statistical vocabulary.
- Standard Operating Procedure when the client requests tightening tolerances is to refuse what is reasonable or necessary.
- Resolve problems with knowledge of the process based upon a series of myths created internally and by "experts" from outside the company.

World Class Business

- Measures its success in terms of productivity of parts produced with consistent quality.
- Quality system is based upon the prediction and prevention. Instead of focusing on inspecting the final product, the company monitors the manufacturing process and its inputs.
- Defines quality as parts in specification and in statistical control.
- Measures the whole process and its results.
- Has a system of verification to continually validate the reliability of their process measurements.
- Thinks that the strategies that result in consistent quality also result in optimal productivity.
- Invests its time primarily in activities that prevent problems, thus needing little time to correct problems when they arise.
- Preventive maintenance is based upon functional analysis of the process and prediction of maintenance needs and frequencies using control charts.
- All personnel can communicate in statistical terms.
- Standard Operating Procedure when the client requests tightening tolerances is to initiate a study to verify if it is feasible and how to accomplish it.
- Resolves problems with knowledge gained from the application of scientific methods and flexible beliefs that change with statistical evidence.

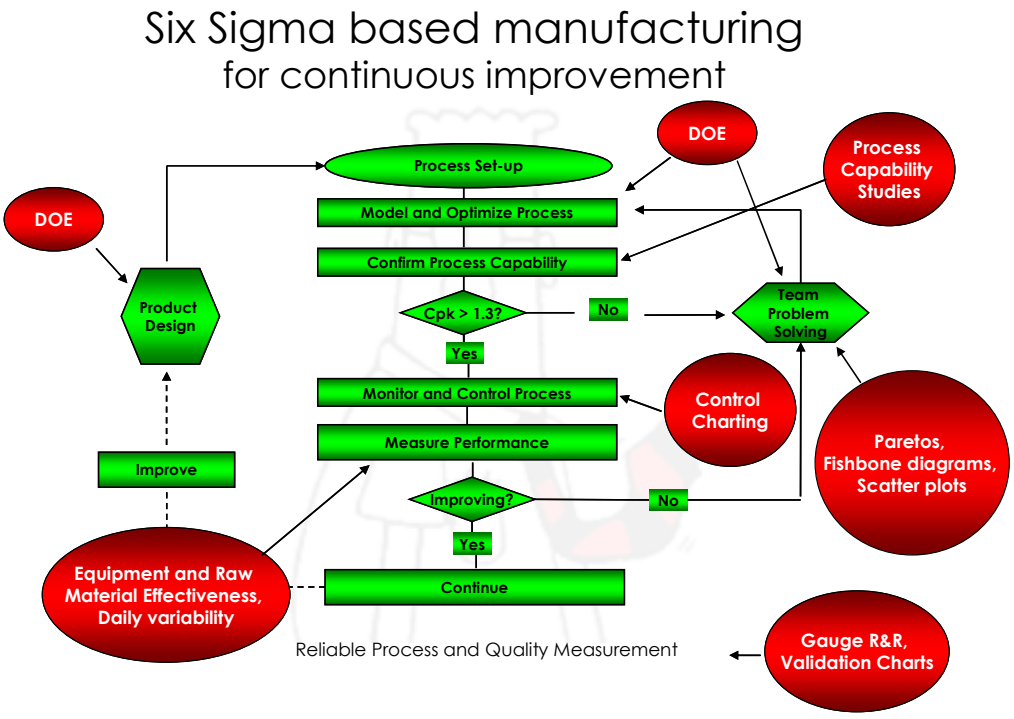
A Six Sigma Process versus a Six Sigma System

A "Six Sigma" process is a process that produces 3.4 DPM or less and has a distance of six standard deviations (sigma) between the mean (average) value of the process and the specification limits.



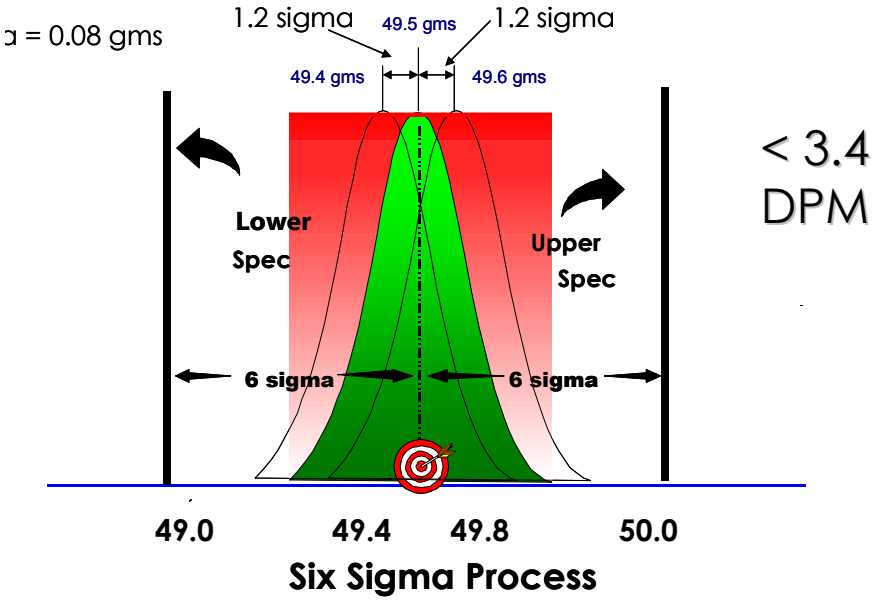
The capability index Cpk = 2 indicates a Six Sigma process.

A "Six Sigma" system is a system where the important decisions about processes and quality are



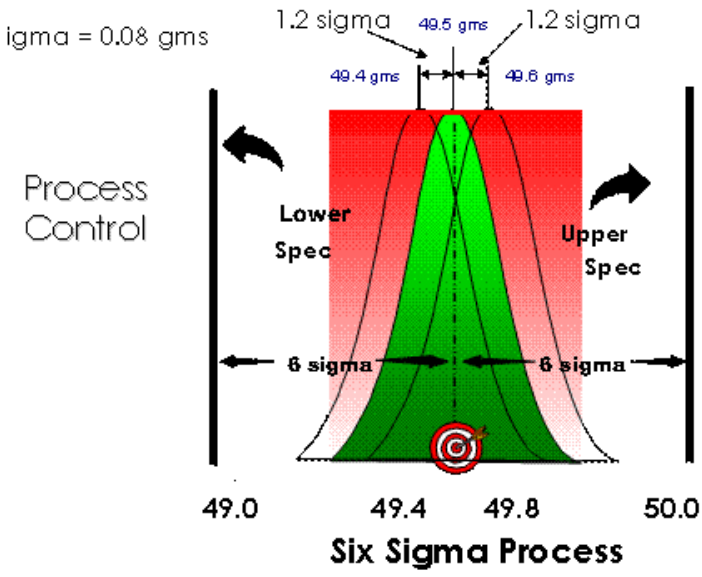
The goal of having a Six Sigma process is important, but more valuable is the goal of controlled processes that are capable at Six Sigma levels. To over-emphasize the goal of Six Sigma is inadequate. To achieve a Six Sigma process without maintaining stable processes and without a culture that is focused on the search for ways to reduce variation, returns us to being a traditional organization that is satisfied to achieve product in specifications.

Variation in preform weight provides the perfect example of how achieving a process in specification or a Six Sigma process is not adequate. In the following example, we have a Six Sigma process (Cpk = 2).



< 3.4 DPM

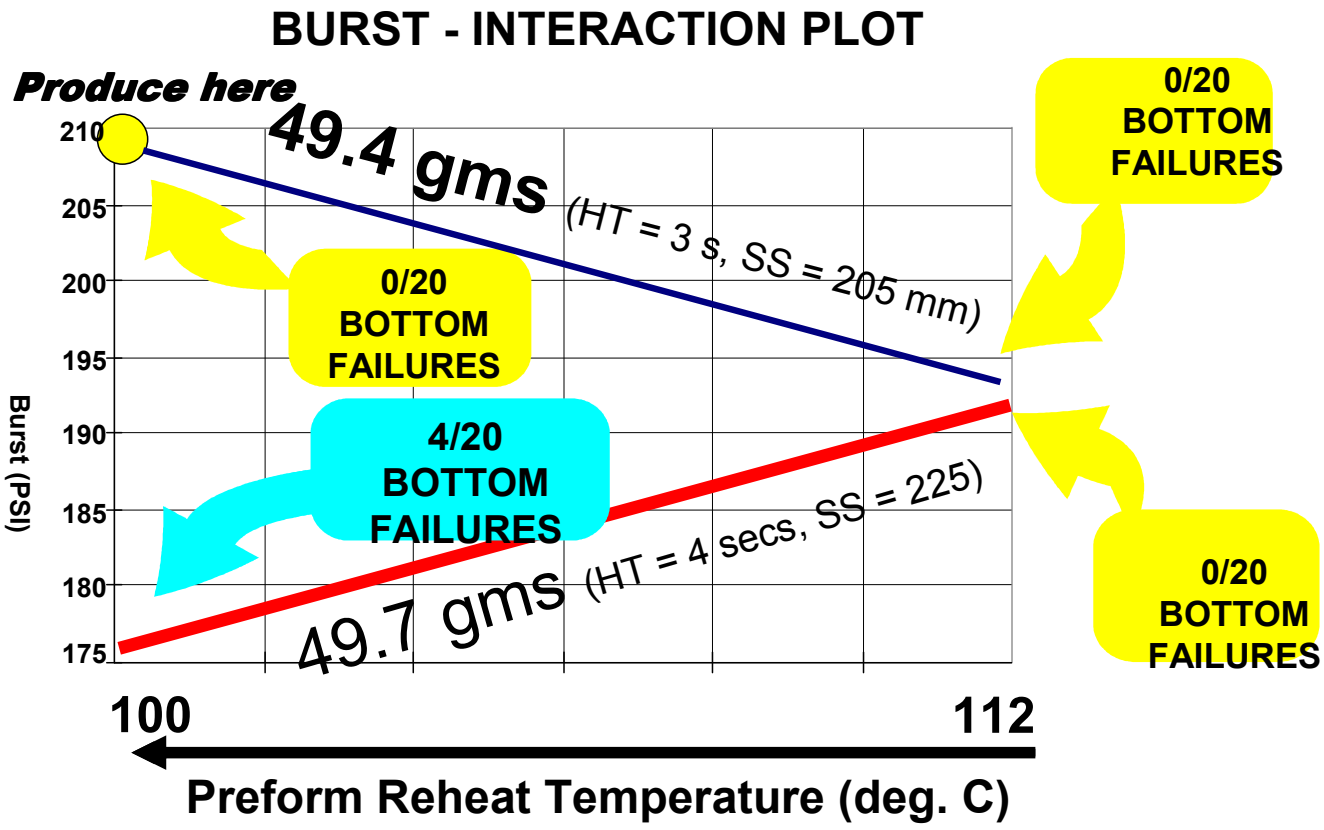
Assume that a change of hold time in the injection machine is provoking a change in the average weight of the preforms between 49.4 and 49.7 grams. Both sample groups of pre-forms show good visual quality, but one group (49.7 grams) is more com-pacted than the other (49.4 grams). Both are clearly within specification and the deviation of the average is within the normal consideration for a Six Sigma Process.



1,000,000 DPM

Of the final product due to raw material inconsistency

An interaction plot shows us the effect of this change in the process mean. We see that when the preform has a 49.7gram weight that 25% (5/20) of the samples fail in the base due to internal pressure testing if we reheat the preforms at 100°C. On the other hand, with a 49.4gram preform we don't encounter any base failures between 100°C and 112°C.



It looks like Taguchi is right. Not only does this show us the fallacy of being satisfied only with being in specification with a good Cpk, but this led us to investigate the causes. We have repeatedly observed this phenomenon with statistically significant evidence in various additional cases.

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