

REDUCING VARIATION

The Role of Statistical Process Control in Advancing Product Quality

by Timothy M. Young, Ph.D.

Many experts consider the American quality revolution of the 1980s a response to an American quality crisis that reached economic proportions. The conditions of the business quality crisis of the 1980s are very similar to the current economic crisis faced by U.S. businesses and especially the wood composites industry.

The current economic crisis of unprecedented oil prices and a severe decline in housing starts with constrained capital markets have some wood composites companies renewing their emphasis on variation reduction, cost savings, and quality improvement. The original quality revolution of the 1980s led to the use of statistical process control (SPC) with an emphasis on variation reduction.

The use of SPC and statistical methods for variation reduction are core philosophies of Continuous Improvement and Total Quality Management. SPC, Design of Experiments, and the use of statistical methods to quantify variation are key principles of the more contemporary Six Sigma Quality and Lean Six Sigma (LSS) philosophies. Six Sigma Quality and LSS philosophies promote reduction in long-term variation so that only 3.4 parts per million defective are manufactured. What business person would disagree with such philosophies?

Taguchi's popular philosophy in Japan of minimizing variation around the target has existed since the 1970s and has been widely documented as a key philosophy for reducing costs and improving product quality. Taguchi's philosophy also promotes moving the target towards specification limits as variation is reduced where costs savings are easily realized, e.g., lower weight targets due to variation reduction, lower thickness targets due to variation reduction, lower resin targets due to variation reduction, energy savings from lower targets, etc.

Traditional quality control suffers in that it is reactive to problems with an overemphasis on inspection and sorting. Continuous improvement philosophies are proactive with a focus on prevention and early detection of problems. Continuous improvement philosophies are data-driven with the use of defensible statistical methods for diagnosing problems. Opinions are discounted in data-driven continuous improvement philosophies.

Continuous improvement of wood composite manufacturing processes is based on using statistical methods to quantify variation. Shewhart (1931) and Deming (1986, 1993) categorized variation as "natural or common-cause variation" and "special-cause variation." Quantifying natural variation is considered by many notable scholars to be the genesis of continuous improvement, i.e., if variation cannot be quantified, how will variation be reduced?

Natural variation comes from the system, e.g., variation within a flaker, variation between flakers, variation within a press platen, variation between platens, variation within a former, variation between formers, variation between operators, etc. Special-cause variation results from an assignable cause, e.g., machine stop, flaker blade damage, platen damage, shift-change, etc. Both natural and special-cause variation represent a cost to any wood composites manufacture. Most scholars agree that special-cause variation should be identified and investigated vigorously using statistical tools, team meetings, engineering studies, etc. Natural variation and special-cause variation are accurately quantified by use of the Shewhart control chart.

I believe there are essential steps towards variation reduction and continuous improvement. The steps are:

- Change is dependent on the culture of a manufacturing facility, i.e., if the present culture of the work force and management will not accept data-driven decision-making, and the use of statistical methods to diagnose sources of variation that lead to avoidable costs, do not dedicate resources to continuous improvement at this type of manufacturing facility. Intellectual capital is an underutilized resource in most manufacturing facilities.
- Develop a data warehouse system of sensor data and a secure electronic database of destructive test results. Link these data sources real-time with modern data fusion methods. Ensure that appropriate and verifiable time-lagging of sensor data is done in the fused database. Verify the data quality of all databases. Continuous improvement cannot be initiated without high-quality data.
- Quantify the measurement variation of key process sensors and measurement devices. Reduce the variation of unacceptable measurement variability for important measurement devices. Avoid hand-held measurement devices if possible. Use histograms to verify data quality.
- Link key product attributes desired by the customer with what Deming called the “critical few” process variables that influence these product attributes. The use of market analysis can identify highly desirable customer attributes. Statistical methods such as design of experiments (deductive reasoning) and data mining (inductive reasoning) can help identify the “critical few” process variables that influence the key product attributes. Note many statistical methods require the process to be in a state of statistical control with constant variance in order for such methods to be accurate in quantifying the “critical few” process variables.
- Quantify the cost of variation to the organization using the Taguchi Loss Function. Develop an acceptable loss function for your mill.
- Implement control charting of key product attributes and the “critical few” process variables to quantify natural variation and special-cause variation. Control charts are an early detection tool for preventing problems. Do not require operators to maintain a large number of control charts. Train key management and operations personnel in the use and understanding of control charts.
- Use the cost-adjusted Pareto Principle as a method for prioritizing sources of variation that will be investigated, e.g., organize types of special-cause variation by cost to the organization. The cost-adjusted Pareto Principle leads a direct focus on sources of variation that are the most detrimental to the business performance of the organization.
- Use root-cause analysis and the Ishikawa philosophies of organized brainstorming (e.g., Ishikawa diagram or Fishbone chart) to categorize sources of variation for the key product attributes and the “critical few” process variables. Adopt developing “Fishbone” charts within “Fishbone” charts to work upstream towards root-causes of sources of variation.
- Adopt the scientific method or the “Plan-Do-Check-Act” cycle of the aforementioned steps. Variation reduction and continuous improvement do not have a stopping point, it is a journey.

Competitive pressures in the wood composites industry are not likely to subside in the near-term. Many believe the industry is undergoing a permanent restructuring towards mills that are highly competitive. Variation reduction and continuous improvement through the use of statistical methods represents a proven method of reducing costs without investment of funds or capital.

If you cannot accurately quantify variation, how will you reduce variation? ■

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