# SNOWFLAKES, IDENTICAL TWINS, AND PRESS SHEETS

## A LOOK AT PROCESS CAPABILITY

John Compton, Professor Emeritus, Rochester Institute of Technology

A central task of any manufacturing operation is to produce product that meets the customers' requirements. These requirements are often translated into the form of specifications on one or more of the product characteristics. To achieve the highest level of manufacturing quality requires that all of the product produced must conform to the specifications. As a result, the major objective of nearly all quality improvement efforts is to achieve a high degree of conformance to requirements. To this end, it is important to have an understanding of the concept of variability and its relationship to specifications.

The study of quality improvement to a large extent involves the study of variability. The need for such a study is rooted in this fundamental law of nature: variability always exists. Variability is everywhere around us. No two things are exactly the same, no matter how carefully they are chosen or manufactured. The statement is often made that "no two snowflakes are ever identical." In fact, scientists have examined the crystalline patterns of thousands of snowflakes, never finding two that were identical. Perhaps you have known a set of "identical twins." Although at first meeting they may appear to be identical, after many meetings over a period of time it becomes apparent that they are not truly identical. In other words, if the inspection or measurement is close enough, differences will always be found.

This concept can readily be extended to the printing process where thousands of seemingly identical sheets roll off the press. The law of variation guarantees that they will not be identical, no matter what characteristic we measure. Furthermore, it follows that no two rolls of paper, or cans of ink, or printing plates will be identical. When we measure carefully enough, we will always find differences. Variation has been "built in" to the universe. Thus, those quality assurance departments that have been given the charge to eliminate variation are faced with an impossible task!

How are we able to live with such disorder? One answer is that much of the variation encountered is trivial. That we don't worry about the differences in snowflake pattern or between sheets of paper in a ream means that we believe that these differences are small enough to be ignored. This belief (and it can never be more than a belief) must be based on some type of measurement of the objects or events involved. Furthermore, although individual events are never completely predictable, we can indeed discover patterns when we examine large enough numbers of items of the same set. By arranging the observations in a systematic way, we can find "order" in the midst of "disorder." The discovery of such patterns occurs through the collection of data and its interpretation by some simple statistical methods. Thus, one of the first phases in a quality improvement study of a process involves the determination of the amount of variability actually occurring.

Since variation exists in every process, a three-part study, often referred to as a process capability study, is required:

- Find out by measurement the nature of variation actually occurring.
- Determine the amount of variation that is tolerable.
- Compare the variation actually present with that which can be allowed.

The first part of the study involves a) picking a quality characteristic of importance, b) finding a way of measuring it, c) making the measurements on a large enough number of the items (product), and d) determining the amount of variation present in the results.

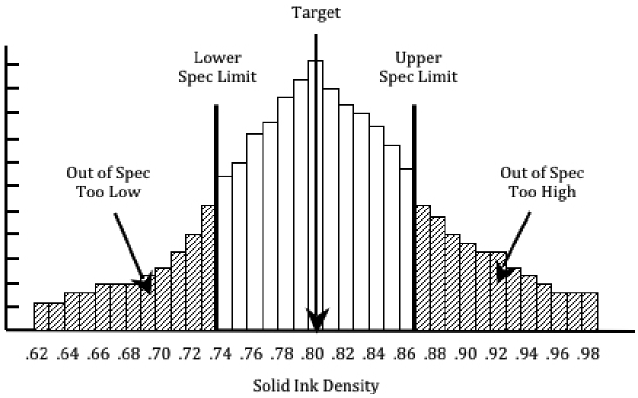
The second part demands that the customers' requirements on the product be expressed in the form of specifications that relate to a measurable characteristic. Specifications typically consist of two parts—the aim and a tolerance. For example, a print standard calls for a total dot gain of 24% +/- 4% for color printing. This means that the desired amount of dot gain is 24%, but if the dot gain is between 20% and 28% it is acceptable. The total tolerance (or allowable variation) is 8% (28% - 20% = 8%). These values have been established by carefully evaluating the appearance of the final product and determining the amount of tolerable change in dot gain. As stated earlier, the goal of the production operation is to turn out product that meets these requirements.

The third part of the study requires a simple comparison of what we have measured to what we can tolerate. The decision will be either that a) the variation is small enough so as not to be a problem or b) the variation is too large and requires that some action be taken.

Consider the following example. The specifications on a certain job call for a solid ink density (SID) of 0.80 +/- 0.10. Thus the aim is 0.80 and the upper spec limit (USL) is 0.90 and the lower spec limit (LSL) is 0.70. The total tolerance is 0.20. Similar jobs have been run on each of two different presses, sheets have been measured, and the results compiled.

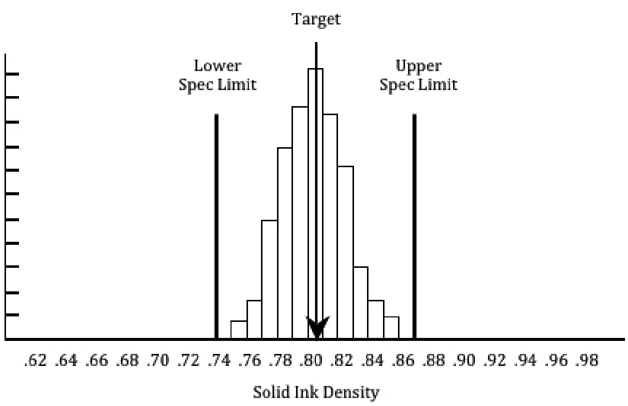
The results from Press A are shown in **Figure 1** where it can be seen that the amount of variation actually present exceeds the total tolerance. In other words, if this press is used to print this job, a considerable amount of non-conforming product will be made, some of which will likely end up in the hands of the customer.

*Figure 1: Press A (Not capable of completely meeting requirements)*




The results from Press B are shown in **Figure 2**. Here it can be seen that the amount of natural variation present is well within the tolerance set for the process. Nearly all of the product printed on this press will meet the customer's needs, meaning less scrap, less re-work and better productivity.

*Figure 2: Press B (Very capable of meeting requirements)*




Considering this particular job and its specifications, Press A has a low process capability, while Press B has a high process capability. Press B is obviously the better choice for this job.

In summary, when addressing the desire to improve quality, we must remember that variability always exists and it is necessary to determine its magnitude. Specifications are used to describe the amount of variation we can tolerate. A comparison of the two allows for decisions to be made that will often lead to quality improvement.