**Throughput Consulting, Inc. Article – for Publication**

# Gage R&R Thoughts and Ideas

Several weeks back one of TheMonty.com readers asked about performing Gage R&R Studies on hardness testers. I thought I'd share in some detail my thoughts and experience. First, a brief summary of just what a Gage R&R study is and when, I think, it is actually useful. Then I'll propose methods to use for Brinell and Rockwell testers.

The purpose of a Gage R&R study is to quantify what percentage of a specification range is "consumed" by the natural variability of a gage and its operators (reliability and repeatability). So the numerator is the variance and the denominator is the specification range. Generally, a percentage above 20% is unacceptable and below 10% is considered quite good. Stated another way, if you are using a gage whose variability consumes more than a fifth of the specification's tolerance range, then it is not reliable and repeatable enough; and if less than one tenth the specification range, then it's judged quite adequate. Consider these numbers as a "rule of thumb" as different international standards and customer specifications may have specific requirements. Remember, an R&R Study does not calibrate the gage, nor does it attest to the accuracy of the gage.

The variance, or numerator, is a statistically derived number. It is the only number of the two that you can affect immediately. Accordingly, I'll focus only on it. And, because spreadsheets are readily available for making the R&R calculation, I won't discuss them here. A web site where such a template is available is http://www.isixsigma.com/dictionary/Gage_R&R-147.htm

Gage R&R studies should be done when the gage is first used and then at intervals - say yearly. These studies can and should be used to provide documented evidence that gages remain in good condition. Further, these studies provide evidence that operators are qualified to use the gage, as well.

In the specific case of hardness testing, our heat treating industry faces the simple fact that hardness specifications were around for many decades before Gage R&R studies came into being. The result is that most specification ranges are simply much too tight to pass an R&R study. For example, we often get tooling to harden to a specification range of two or three Rockwell points. Well, darn, the test blocks we use to check the calibration of our Rockwell testers are usually plus and minus one point. So obviously, we're cooked before we even start the study. This has brought pressure to improve hardness testing methods, and to open up specifications.

Let's address a Gage R&R methodology for Brinell testing first. If you do not have an imaging device to read the Brinell impression, you cannot possibly conduct a successful Gage R&R study. I conducted a

comparison study on a set of ten test blocks with three operators, ten samples and three measurements each sample. The measurements were made first with a Brinell scope and then with a camera. The resulting numerator for the scope was thirty Brinell points and, for the camera, three. I safely conclude that these reading devices are about ten times more repeatable and reliable than employees using a Brinell scope.

Now, for Rockwell testing. I want to contrast two key observations. First, when Rockwell testing parts, an inspector will adjust the anvil to the part, make the first impression (seating the anvil) on the first piece, and then ignore the result. He will proceed from there, making two or three more impressions and AVERAGING the result on that and all subsequent pieces. These averages are what he reports.

Now, when the same person does an R&R Study, he will most likely record discrete hardness readings, not the average of two or three. This method will result in a larger variance (numerator). I take the position that the Gage R&R study should be conducted in exactly the same way as inspection data are measured and reported; that is, by averaging two or three readings from each part. You are thinking, gads, this is a lot of testing, and you are right. But the variance (numerator) is reduced by about half. If you are concerned about the expense for the test blocks, collect those that are used up and get a friendly machine shop to grind them down. Yep, perfectly "legal." Just mark and keep them put away so that they can no longer be used for calibration checks. Remember, an R&R Study does not check the accuracy of the hardness tester!

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