

Four Ways We Use Measurements

Why do you measure something? Since obtaining a measurement takes time and energy, there should be some payback for this effort, some utility gained. To understand this transaction and the problems entailed therein it is helpful to make a distinction between four different uses of measurements.

DESCRIPTION

One use of a measurement is to describe the item measured. The need to describe might be motivated by idle curiosity, by a need to be informed, or by a desire to have the data for future use; but whatever the motivation, this basic use of a measurement is to answer the question of how many or how much. When a value is used to describe the item measured it is important to understand the limitations of the value used—the uncertainty attached to the value itself. The source of this uncertainty will primarily be the uncertainty in the measurement process. Thus, in order to use data to describe the item measured we will need to have a way to define the uncertainty that should be attached to a measurement.

CHARACTERIZATION

A second use of a measurement, closely related to the first, is to characterize the measured item relative to specifications. Here the measurement is used to take action on the item measured—to characterize the measured item as being within the specifications or outside the specifications. Once again the major source of uncertainty will be the uncertainty introduced by the measurement process. However, instead of attaching our uncertainty to the measurement, we will now need to make adjustments in the specifications in order to make allowances for this uncertainty when we characterize the measured item.

Since the common questions surrounding Description and Characterization are easily answered by understanding the variation of the measurement process, the material in Chapters Three and Four will go a long way to clarifying issues with these two uses.

REPRESENTATION

A third use of a measurement is to represent the product that was *not* measured. Here the objective is to characterize *the product stream* with regard to specifications. In order to do this we have to extrapolate from the product that was measured to the product that was not measured. Of course the basis for such an extrapolation will be the selection procedure used to obtain the product that we did measure. When a measurement is used to represent items not measured there are several sources of uncertainty. The

uncertainty in the measurement process is still present, but now we also have the additional uncertainties related to the representation. The first of these comes from the product variation: since the product not measured will differ from the product measured we have an additional source of uncertainty not present in the description of a measured item. Additional uncertainties of representation will come from the selection procedure (or the lack thereof in some cases). We will need to have a way of making allowances for all of these uncertainties before we can effectively use data to represent the product not measured.

PREDICTION

A fourth use of a measurement is to predict. Here the objective is to characterize future process outcomes. The mechanism used is the characterization of the past behavior of the process. Here we are no longer concerned with classifying some batch of product as conforming or not, but rather with understanding what to expect in the future. When data are used to predict we must be concerned with measurement error, the predictability of the production process, and the combined variation from both sources. Thus, in addition to the sources of variation identified above, there is also the uncertainty associated with the continuation over time.

Since both Representation and Prediction involve extrapolation from the product measured to the product not measured, or not yet produced, a sound basis for this extrapolation will be required. This basis and related issues will be covered in Chapter Eleven and Twelve.

Moreover, since the way you intend to use a measurement will have an impact upon how much you need to know about the sources of uncertainty in that measurement, it is impossible to define a single, simple index for the quality of a measurement system. There are many different aspects of any measurement system. Some of these will affect some uses of data and will have little impact on other uses of data.

This book presents simple and effective techniques that will allow you to identify those things that can hinder your use of measurements. Rather than worksheets with canned formulas and arbitrary guidelines given without motivation or explanation, the emphasis throughout has been upon developing an understanding of techniques of analysis that are both theoretically sound and of practical use. However, in the interest of facilitating the use of EMP Studies, a series of worksheets are provided in the Appendix.

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