

# **Critical Factors in Model Construction for Uncertainty Estimation – Sensitivity Analysis and Design of Experiments**

Speaker/Author: Dr. Salvador Echeverria-Villagomez  
CENAM  
Queretaro, Qro., Mexico  
saleche@cenam.mx

Co-Author: Carmen Marina Trejo-Morales

## **Abstract**

One of the first steps in the process of uncertainty estimation is the modeling of the measurement process. Modeling is, by itself, a process that can be rather complex if the phenomenon is new or little familiar, or if the measurement is performed under difficult to control conditions.

The modeling can be approached from different perspectives and with different levels of breadth and depth. A model can be simply a measurement equation with a control and a noise variable, or the equation of a physical law with several control variables and noise, or a model that involves control variables with correlations and noise, or maybe a not explicit expression of the physical or chemical law that represents the phenomenon.

A single phenomenon can be modeled in different ways, depending on:

- The degree of knowledge about the phenomenon.
- The level of control that can be achieved on the measurement conditions.
- The level of noise and non controlled variables (including the variety of non-controlled possibilities).
- The level of uncertainty that is expected or desired.

Many times, measurements at the NMI or laboratory level classify with high degree of knowledge about the phenomenon, high level of control on the measurement conditions, low level of noise and small expected uncertainty. Then, perhaps the main problems of modeling are in the classification and solution of the model.

However, for new or little familiar phenomena, or for measurements under very variable and difficult to control conditions, the situation can be almost opposite: low degree of knowledge about the whole phenomenon and low level of control on the measurement conditions (perhaps because ‘the system’ is not easily isolated), with high level of noise and, more or less, high relative expected uncertainty. This is the situation in many industrial measurements, testing and chemical or biological measurements. Then, model construction is considerably more difficult.

The paper will present some considerations about model construction under these circumstances, as well as some recommendations for the use of tools or methodologies as sensitivity analysis or design of experiments. It will also present some criteria for selection of the measurand (sometimes more than one), control variables and monitoring variables.