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Calculation the uncertainty in the measurements in the dimensional section

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ABSTRACT

Metrology is the science of conducting the measurement process with determining the percentage of error resulting from the measurement process. This science includes all theoretical and practical aspects of measurement. From three main quantities, length, mass, and time, all other mechanical quantities such as area, volume, acceleration, and power can be derived. Any comprehensive system of practical measurement must include at least three bases, which include the measurement of electromagnetic quantities, temperature, and the intensity of radiation such as light.

In metrology, uncertainty is an expression of the statistical dispersion of values attributable to the measured quantity. All measurements are subject to uncertainty and the measurement result is complete only when accompanied by an associated uncertainty statement, such as standard deviation Measurement errors are divided into two components: random error and systemic error

Random error occurs when repeated measurement results in inconsistent results, even though the measured quantity or characteristic is constant. Systematic error is not subject to the laws of chance. Rather, it appears frequently and consistently, and can be expressed in terms of the accuracy inherent in the measuring instrument or system under study. (Accuracy is the smallest value that can be measured or observed by a measuring instrument or monitoring instrument). The term systemic error may also refer to errors whose arithmetic mean is not equal to zero, in which case taking the mean of the measurements does not cure or mitigate the effect of this error.

The aim and scope of study

The study was dealt with the calculations of the uncertainty for some items in the laboratory of dimension in the metrology department for the period from 1st August to 31th December .

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Introduction

If there is one premise basic to instrumentation engineering, it is this: no measurement is without error. Hence neither the exact value of the quantity being measured nor the exact error associated with the measurement can be ascertained. In engineering, as in physics, the uncomfortable principle of indeterminacy exists. Yet as we have seen in our discussion of interpolation methods，uncertainties can be useful and, like friction often a blessing in disguise.

It is toward a methodical use of measurement uncertainties as a guide to approaching true values that this chapter is addressed. The output in most experiments is a measurement. The reliability of the measurement depends not only on variations in controlled inputs，but also in general, on variations in factors that are uncontrolled and perhaps unrecognized. Some of these factors that might unwittingly affect a measurement are the experimenter，the supporting equipment and conditions of the environment.

Thus in addition to errors caused by the device under test, and in addition to errors caused by variations in the quantity being measured, extraneous factors might introduce errors in the experiment that would cloud the results use of different measuring equipment. Effects of those variables that are not part of the study can be further minimized by taking observations in a random order. This is called randomization。

The important task of measuring the remaining significant errors is approached by taking a member of independent observations of the output at fixed values of the controlled input.

This is called replication。 Staling the above ideas in mathematical terms， each measurement x can be visualized as being accompanied by

an error such that the interval (x± δ) will contain the true value of the quantity being measured. The measurement error, in turn, is usually expressed in tents of two components, a random error e and a systematic error， such that.

Length metrology has a fundamental role to maintain the primary standard of length, the meter and to provide the infrastructure to enable a wide range of dimensional and positional measurements to be made traceable to the meter. National metrology institutes (NMIs) in a number of countries and companies that produce precision high-tech products pay much attention to accuracy-related research with the aim to improve properties of length calibration systems and to specify their uncertainty budget. Metrological programs in the area of length measurement are consistently carried out in the USA, Japan, UK, Germany and other countries. The programmers impel the creation of metrological infrastructure that increases industry competitiveness, supports industrial innovations, and improves control of manufacturing processes and quality. For example, systematic research of accuracy of vacuum nano-comparator, performed in German National Metrology Institute (PTB) in 2000 – 2006, resulted in reducing the measurement repeatability error from 14 nm down to 0.2 nm. NIST, the National Metrology Institute of the USA, is carrying out research on nm-accuracy one dimensional (1D) metrology with the development of components of next generation length scale interferometer. In conceptual design, the system would have a range for 1D the measurements from 100 nm to 1 m with a target expanded uncertainty of from 1 nm to 10 nm.

CHAPTER ONE

1.1. The measurement

The taking of measurements has been necessary since human beings first began trading with their neighbors. In addition to trading, early societies also needed to be able to measure to perform many other tasks. When people turned from leading a nomadic life to settling in one place, other measurements —such as measurement of land and building materials— became important. Our knowledge about early measurement comes from historians and archaeologists, leading us to realize that although the roots of many of the early units of measurement were the same, actual values and their application differed from country to country. Over time, the quality of measurements has improved because of the need for higher accuracy in many fields, as society has become increasingly technology-oriented [1].

Length and mass were the earliest measurements made by mankind. According to some historians, the oldest standard of measurement of mass that can be traced is the bega, a unit of mass used in Egypt in 7000 to 8000 B.C. it is believed that the weights were probably seeds, beans or grains, which were used in conjunction with a rudimentary balance for trading. An example of this is the carat. This was the seed of the coral tree and was called quirat in Arabic. It has now been standardized as 0.2 grams (g) and the word quirat has been corrupted to the present day carat [2].The early length measurements were usually based on parts of the body of the king (the pharaoh). The measurement of length known as a cubit was probably conceived between 2800 and 2300 B.C. in

Egypt. The word came from the latin cubitum, meaning elbow, because the unit represented the length of a man’s forearm from his elbow to the tip of his outstretched middle finger. The cubit was later standardized in a royal master cubit made of black marble (about 52 centimeters (cm) long). This standard cubit was divided into 28 digits (roughly a finger width), which could be further divided into fractional parts, the smallest of these being only just over a millimeter (mm).

For volume measurement, containers made out of gourds or clay were filled with seeds of plants. These seeds were then counted to measure the volume. The ancient Egyptians had a variety of volume measures. The most important of these was called the hen, which was about 477 cm3. The Syrians, Phoenicians, Babylonians and Persians also had their own units for volume measure [3].

In the years following the early days of measurement, the Romans introduced measurements called the uncia and the mille. The uncia was the width of a thumb and the mille was the distance a roman soldier covered by walking 1,000 steps [4].

1.2 The Calibration

Measurement is vital in science, industry and commerce. Measurement is also performed extensively in our daily life. The following are some examples:

• Measurements for health care, such as measuring body temperature with a clinical thermometer, checking blood pressure and many other tests:

• Checking the time of day.

• Buying cloth for dresses.

• Purchase of vegetables and other groceries.

• Billing of power consumption through an energy meter.

Accuracy and reliability of all such measurements would be doubtful if the instruments used were not calibrated. Calibration ensures that a measuring instrument displays an accurate and reliable value of the quantity being measured. Thus, calibration is an essential activity in any measurement process.

What is calibration?

According to the International Organization for Standardization publication entitled International Vocabulary of Basic and General Terms in Metrology (published in 1993 and known as VIM), calibration is the set of operations that establish, under specified conditions, the relationship between values indicated by a measuring instrument, a measuring system or values represented by a material measure, and the corresponding known values of a measurand (the parameter that is being measured; Understanding of calibration is not complete without understanding traceability. In the above definition, the known values of the measurand refer to a standard. This standard must have a relationship vis-à-vis the calibration [5].

Traceability: The concept of establishing valid calibration of a measuring standard or instrument by step-by-step comparison with better standards up to an accepted national or international standard[6].

- CALIBRATION OF MEASURING INSTRUMENTS

Essentially, calibration is a comparison with a higher standard that can be traced to a national or international standard or an acceptable alternative.

-Measurement traceability

In most cases, we compare two or three measurements of the same parameter to check reliability and reproducibility of the measurement. A measurement must be traceable to the acceptable standard for it to be compared. Even if it is a single measurement, traceability of the measurement is still very important.

A measuring instrument's reading should be accurate in terms of the physical unit of measurement. The physical unit of measurement, in turn, should be traceable to the ultimate fundamental unit through calibration [7].

1.3 The Uncertainty

An important aspect of an uncertainty analysis concerns the ways on how to express the uncertainties associated with individual estimates or the total inventory. The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines) specify the following: 'Where there is sufficient information to define the underlying probability distribution for conventional statistical analysis, a 95 per cent confidence interval should be calculated as a definition of the range. Uncertainty ranges can be estimated using classical analysis (Robinson, 1989) or the Monte Carlo technique (Eggleston, 1993). Otherwise, the range will have to be assessed by national experts.' This statement indicates that the confidence interval is specified by the confidence limits defined by the 2.5 percentile and 97.5 percentile of the cumulative distribution function of the estimated quantity [8]. Put another way, the range of an uncertain quantity within an inventory should be expressed such that: (i) there is a 95% probability that the actual value of the quantity estimated is within the interval defined by the confidence limits, and (ii) it is equally likely that the actual value, should it be outside the range quoted, lies above or below it. The study was taken the circulations of uncertainty in the section of length and dimensional.

1.4 The accuracy and precision

• A precise measurement is one where independent measurements of the same quantity closely cluster about a single value that may or may not be the correct value.

• An accurate measurement is one where independent measurements cluster about the true value of themeasured quantity [9].The table 1 states different cases of measurement for dial gauge at measured value (10mm) which was shown in the below.

A. Low-precision, Low-accuracy:Theaverage (the X) is not close to the center

B. Low-precision, High-accuracy:The average is close to the true value, but data points are far apart

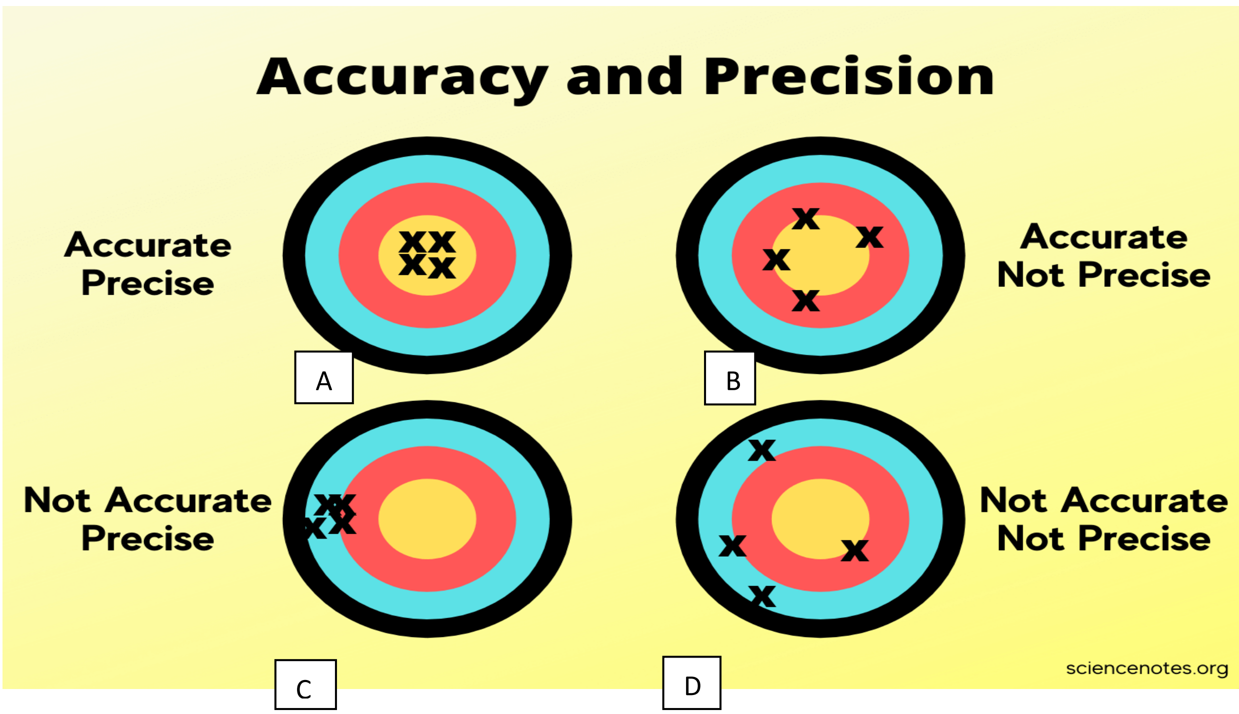
C. High-precision, Low-accuracy:Data points are close together, but he average is not close to the true value

D. High-precision, High-accuracy: All data points close to the true value. All the four cases where showed in Figure 1.1

Table 1The measured values of dial gauge for fourth cases.

The nominal value(mm)	Measure A	Measure B	Measure C	Measure D
10	10.02	10.4	10.28	9.56
10	10.03	9.96	10.29	10.34
10	10.05	10.7	10.31	10.48
10	10.06	9.95	10.32	9.78

Figure 1.1 Explain the difference between the accuracy and precision



The dial gauge

CHAPTER TWO

2.1 Types of errors

The discrepancy between an accepted value of a parameter and an experimentally measured value results from deviations in the manner in which the measurement is carried out. No two measurements are exactly the same. Some deviations can be controlled and some cannot. Those that can, in principle, be controlled by careful adjustment of the experimental procedure are systematic errors. They definite values that can, in principle, be measured and corrected. Systematic errors are sometimes called determinate errors. The most common types error are instrumental error, operator error, and method error. Such errors are often unidirectional, so they slant the result of the measurement. If that is the case, the experiment is said to have a bias. Systematic errors can be corrected only after the nature of the bias is identified. A common determinate error is an incorrectly calibrated instrument that systematically gives results that are either too high or too low. Recalibration of the apparatus should correct this kind of error. In this laboratory, many of the instruments are calibrated before one makes a determination of the value of some unknown parameter. Failure to calibrate the instrument properly is a major source of determinate error

2.1.1 Random Errors

When repeated measurements are taken, random errors will show up as scatter about the average of these measurements. The scatter is caused by characteristics of the measuring system and/or by changes in the quantity being measured.

Random errors always will be observed as long as the readout equipment has adequate discrimination.The term precision is used to characterize random errors. Precision is quantified by the true standard deviation or of the whole population of measurements or, more often , by its estimators the precision index of the data available.

2.1.2 SYSTEMATIC ERRORS

Over and above the random errors involved in all measurements , there are also errors that are consistently either too high or too low with respect to the accepted true value. Such errors, which are termed fixed errors or systematic errors are characterized by the term bias, systematic error is quantified buy the true bias BATA or, more often, by B, the estimate of the limit of the bias. When bias can be quantified, it is used as a correction factor to be applied to all measurements. A zero bias implies that there is no difference between the true value , and the true mean of many observations [2].

However the zero-bias case is rare indeed; and experience indicates a strong tendency to underestimate systematic errors. Systematic errors can be minimized by various methods as, for example, by calibration (Figure 2.1). Calibrations are usually accomplished by comparing a test instrument to a standard instrument. Since such comparisons are not always direct or perfect, we may not succeed in totally determining the bias, that is, the bias may have a random component, but it is essentially fixed, and is never as random as precision errors.

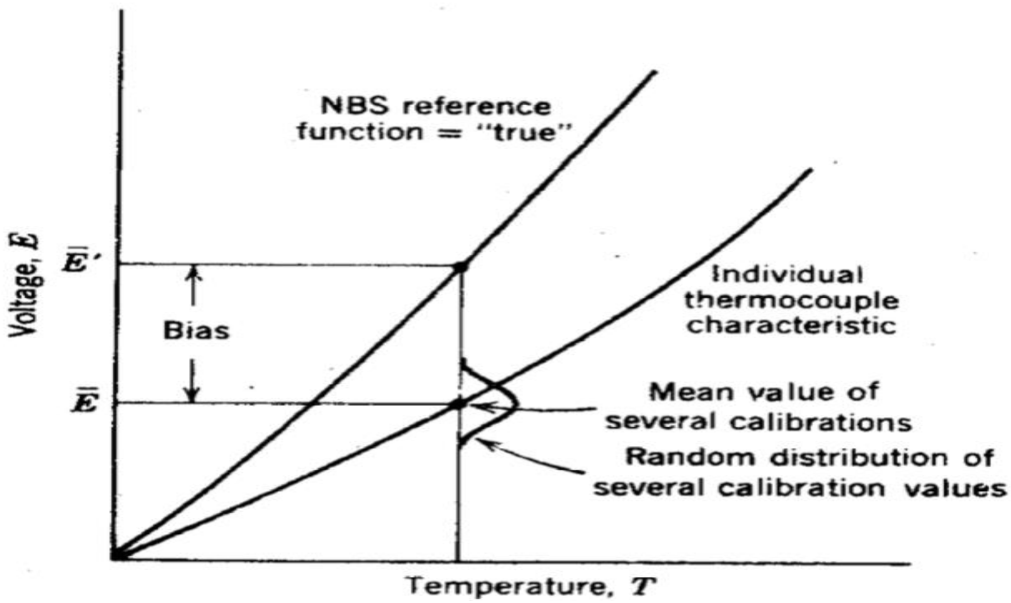


Figure 2.1 Systematic and random errors illustrated for case of thermocouple calibration [2]

The difference between the measured result and the true value.

•Illegitimate errors

–Blunders resulting from mistakes in procedure .We must be careful.

–Computational or calculation errors after the experiment. •Bias or Systematic errors –An offset error; one that remains with repeated measurements (i.e. a change of indicated pressure with the difference in temperature from calibration to use). •Systematic errors can be reduced through calibration •Faulty equipment—such as an instrument which always reads 3%high •Consistent or recurring human errors

- Observer bias –This type of error cannot be evaluated directly from the data but can be determined by comparison to theory or other experiments.

•Random, Stochastic or Precision errors: –An error that causes readings to take random-like values about the mean value. •Effects of uncontrolled variables

•Variations of procedure

–The concepts of probability and statistics are used to study random errors. We think of random errors we also think of repeatability or precision.

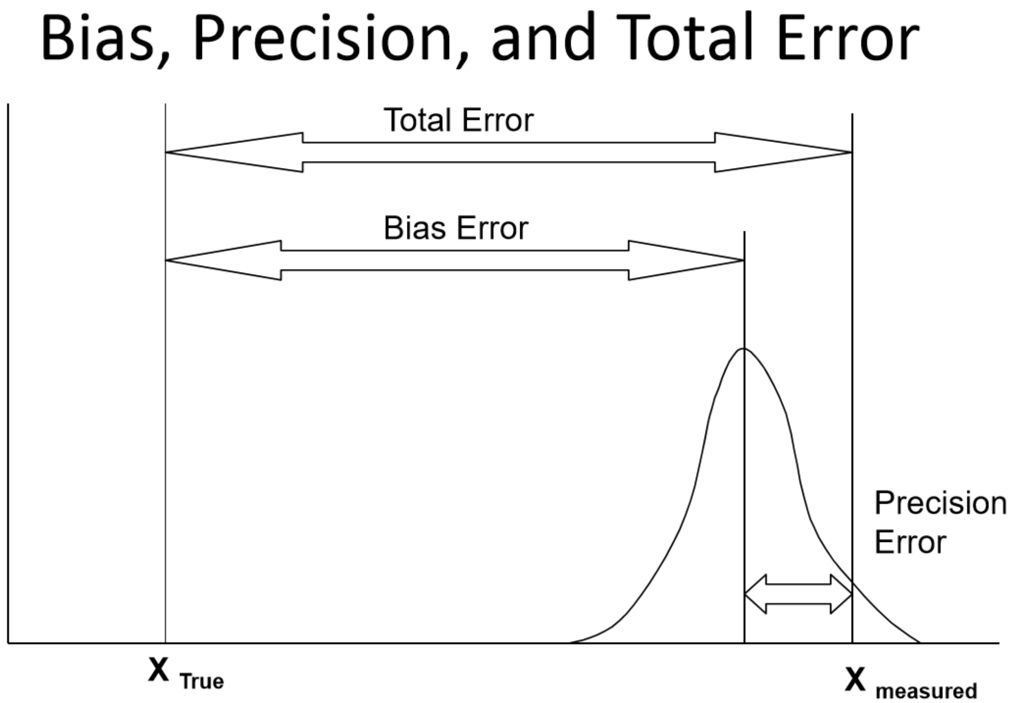


Figure 2.2 The Bias and precision error [2]

2.2 Propagation of Error

•Used to determine uncertainty of a quantity that requires measurement for several independent variables.

–Volume of a cylinder = f (D, L)

–Volume of a block = f (L, W, H)

–Density of an ideal gas = f (P, T)

•Again, all variables must have the same confidence interval [4].

CHAPTER THREE

3.1 STATISTICAL RELATIONS

There are cases in engineering practice, however, when we can presume that the bias is removed, that all errors are of the random type, and that hence the errors can be treated statistically [1],[2]. In this section we overlook for a time the fixed (bias) errors and consider only the random (precision) errors. It is clear that, even in the absence of fixed errors, we are to be denied by the nature of things the ability to measure directly the true value of a variable.

Thus it becomes our job to extract from the experimental data at least two vital bits of information. First we must from an estimate of the best value of the variable. This will he denoted by. Closely coupled with this requirement, we must give an estimate of the intervals, centered on , with in which the true value is expected to lie. This will be denoted by the uncertainty margin that we tack on to [3].

3.1.1BEST VALUE AT A GIVEN INPUT

When an output X is measured many times at a given input, the mean value of X is simply

$$\bar{x} = \frac{1}{N}\sum_{k=1}^{n} x_k \qquad (3.1)$$

where Xk is the value of the kth observation (called interchangeably the kth reading or measurement) and N is the number of observations in the sample.

It is a mathematical fact that the arithmetic average defined by equation(3.1) is the best representation of the given set of Xk

Many times in engineering, a tabulation of how the, Various values of X occur in replication is well approximated by the Gauss--Laplace normal distribution relation [5]

$$f(x) = \frac{1}{\sqrt{2\pi\sigma}} \exp\left[-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right] \qquad (3.2)$$

where the factor has the normalizing effect of making the integral of f(X) over all values of X equal unity, and where represents the true standard deviation of X, which in turn is well approximated by

$$\sigma = \left[\frac{1}{N}\sum_{k=1}^{n}(x_k-\mu)^2\right]^{\frac{1}{2}} \qquad (3.3)$$

The standard deviation of a normal distribution o-f X has the following characteristics:

1. measure the scatter of X at a given input, that is, it is a measure of the precision error .
2. has the same units as X.
3. is the square root of the average of the sum of the squares of the deviations of all possible observations from the true arithmetic mean

For any engineering applications this is not good enough, and wider intervals must be expected to express greater confidence. For example, 95.46% of the data can be expected to fall within the +2delta interval, and 99.73% within +3delta.

We are assured that X is a very good estimate by the large size of the sample.

We may ask, however, how typical a single observation of X. is as we have just seen, one answer is X ±3σ (at 99.73%) (3.4)
Statement (3.4) indicates that the interval is expected to include 99.7% of the time.

The precision index of the single sample is defined in terms of the residuals and is patterned after equation (3.4) as

$$S = \left[\frac{1}{N-1}\sum_{k=1}^{n}(x_k - \bar{x})^2\right]^{\frac{1}{2}} \qquad (3.5)$$

where the factor (N-1) is used in place of the usual N in an attempt to compensate for the negative bias that results from using X in place of in forming the differences. However, a negative bias unfortunately still remains in the small estimate of the standard deviation S, the obtainable does not equal delta, the desired

3.1.2 Student's Distribution

Recognizing this deficiency, a method was developed by the English chemist W.S.Gosset (writing in 1907 under the pseudonym "Student"), by which confidence intervals could be based on the precision index S of a single small sample. He introduced the "Student's statistic whose values have been tabulated in terms of degree of freedom miu and the desired degree of confidence (quantified by the probability pi) Careful perusal of these values will show that the t statistic inflates the confidence interval (i.e.the uncertainty margin) so as to reduce the effect of understand deviation delta when a small sample is used to calculate S.

Degrees of freedom can be defined in general as the number of observations minus the number of constants calculate from the data.

According to equation(3.1), X has N degree of freedom, whereas by equation (3.4), S has N-1 degree of freedom because one constant, X, is used to calculate S. The answer to the question, how typical is a single observation of X, is, in terms of S and t, (to a given probability p)

$$X = \pm T_{v,p} S \qquad (3.5)$$

3.2 Uncertainty Analysis

In order to estimate the uncertainty of actual measurements. We must remember that errors can be divided into two categories, bias and precision errors. The true value of a quantity is related to the mean of several measurements by: $x' = \overline{x} \pm U_x (P\%)$

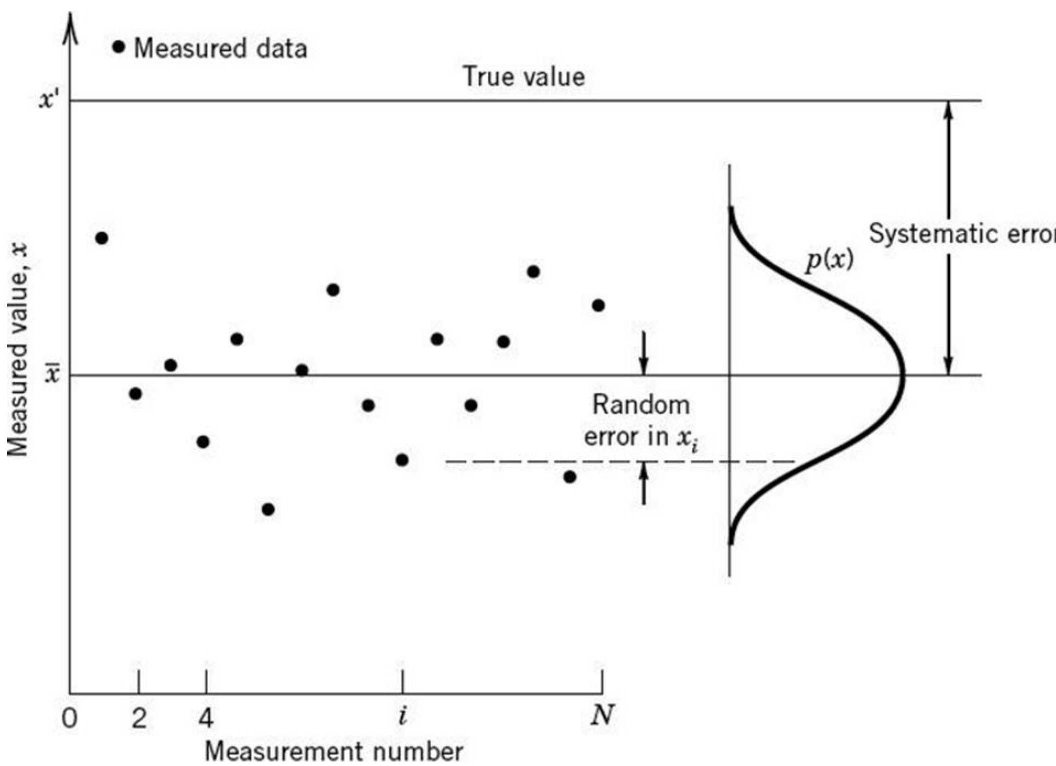


Figure 3.1 Distribution of errors upon repeated measurement [3]

$$u_o = \pm \frac{1}{2} \text{ resolution } (95\%) \tag{3.6}$$

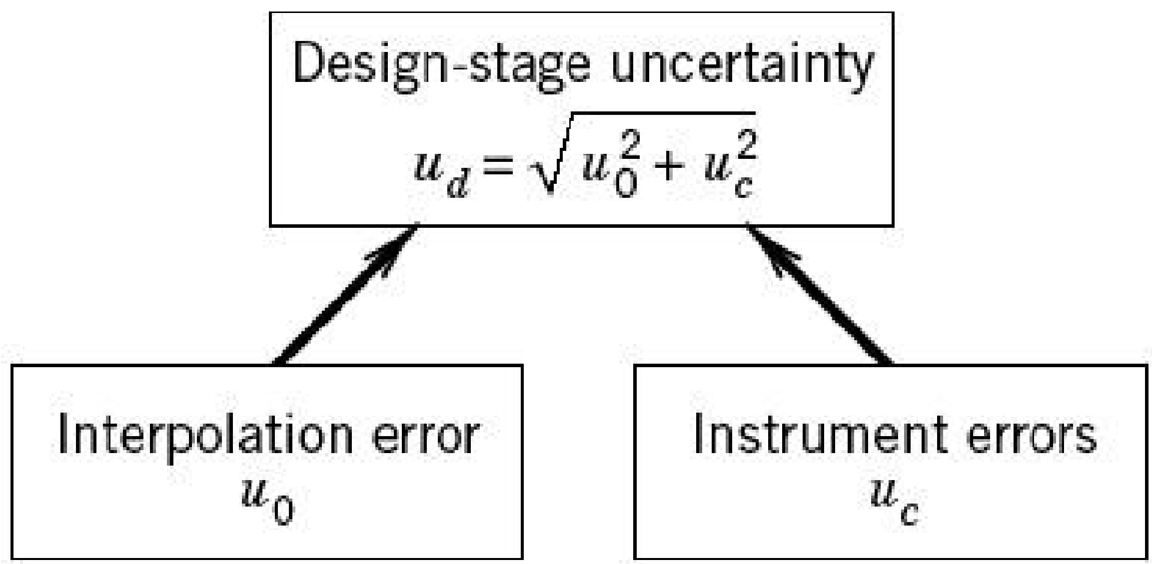
Instrument uncertainty, uc, is an estimate of the systemic error

Combining Elemental Errors: RSS Method

$$u_x = \pm\sqrt{e_1^2 + e_2^2 + \ldots + e_k^2} \tag{3.7}$$

As a general rule P = 95% is used throughout all uncertainty calculations. Remember ±2δ accounts for about 95% of a normally distributed data set

3.2.1 Design-Stage Analysis



Error Sources Errors can arise from three sources:

Calibration

Data Acquisition

Data Reduction

EXAMPLE 1 : Use the RSS method to calculate the Uncertainty for the caliper showed in the below figure in the laboratory of dimensions with range 200mm , resolution 0.01mm , U geo =0.0 µm the readings were 10,10,10,10,10,10,10,10,10

SOLUTION:

From readings we concluded that S.d =0.0

U ref = $\frac{0.2}{2} = 0.1$ µm

U drift=$\frac{0.1}{2}$= 0.05 µm

U res =$\frac{10}{2\sqrt{3}} = 2.89\ \mu\text{m}$

U δt = L*α*δt =200*11.5*10^{-3} *1 =$\frac{2.3}{1.73} = 1.33$

U δα =L*δα*Δt = 200*2*10^{-3}*2 =$\frac{0.8}{1.73} = 0.46$

U rep =$\frac{S.d}{\sqrt{3}} = 0.0$

U geo =$\frac{0.0}{\sqrt{3}} = 0.0$

U compound = $\sqrt{\text{U ref}^2 + \text{U drift}^2 + \text{U res}^2 + \text{U δt}^{\ 2} + \text{U δα}^{\ 2} + \text{U rep}^2 + \text{U geo}^2}$

=$\sqrt{0.1^2 + 0.05^2 + 2.89^2 + 1.33^2 + 0.46^2 + 0.0^2 + 0.0^2}$

=4.17 µm

U expanded = $2 * Ucomp$

=2*4.17

=8.3 µm

EXAMPLE 2: Use the RSS method to calculate the Uncertainty for the sieve showed in the below figure in the laboratory of dimensions with aperture size= 0.3mm where the obtained results of calibration were showed in the below table , U geo =0.0 mm

No of aperture	Pitch	One pitch	Width	Size
1	4.994	0.4994	0.2	0.2994
2	5.109	0.5109		0.3109
3	5.113	0.5113	0.212	0.302
4	5.143	0.5143		0.300
5	5.151	0.5151	0.25	0.303
6	5.160	0.5160		0.266
7	5.130	0.5130	0.24	0.273
8	5.140	0.5140		0.274
9	5.156	0.5156	0.24	0.276
10	5.151	0.5151		0.272
			Ave	0.284

The sieve of measurement

SOLUTION:

$\delta.d=\sqrt{\frac{\sum_{1}^{n}(\overline{x_1}-\bar{x}_i)}{n-1}}=$

$$\sqrt{\frac{\sum(0.2994-0.284)^2+(0.3109-0.284)^2+(0.302-0.284)^2+(0.3-0.284)^2+(0.303-0.284)^2+(0.266-0.284)^2+(0.273-0.284)^2+(0.274-0.284)^2+(0.276-0.284)^2+(0.272-0.284)^2}{9}}$$

From readings we concluded that S.d =0.017mm

U ref = $\frac{0.004}{2} = 0.002$ mm

U drift=$\frac{0.005}{\sqrt{3}}$= 0.0029 mm

U res =$\frac{0.001}{2\sqrt{3}} = 0.0003\ \text{mm}$

U δt = L*α*δt =200*11.5*10^{-3} *1 =$\frac{2.3}{1.73} = 1.33$

U δα =L*δα*Δt = 200*$2*10^{-3}$*2 =$\frac{0.8}{1.73} = 0.46$

U rep =$\frac{S.d}{\sqrt{3}} = \frac{0.017}{\sqrt{10}} = 0.005$ mm

U geo =$\frac{0.0}{\sqrt{3}} = 0.0$

Uun.cor.Error=$\frac{0.01}{\sqrt{3}} = 0.0058$

U compound = $\sqrt{\text{U ref}^2 + \text{U drift}^2 + \text{U res}^2 + \text{U δt}^{\ 2} + \text{U δα}^{\ 2} + \text{U rep}^2 + \text{U geo}^2}$

=$\sqrt{0.002^2 + 0.0029^2 + 0.0003^2 + 1.33^2 + 0.46^2 + 0.0^2 + 0.0^2}$

=0.0086 mm

U expanded = $2 * Ucomp$

=2*0.0086

=0.0173 mm

3.2.1 Error Propagation

Most measurements are subject to more than one type of error. We need to estimate the cumulative effect of these errors. It is unlikely that all of the errors will be in one direction - more likely there will be some cancellation. The root-sum-squares (RSS) approximation is a good estimate:

$$\begin{aligned} U_x &= \pm \sqrt{e_1^2 + e_2^2 + \ldots + e_k^2} \\ &= \pm \sqrt{\sum_{j=1}^{K} e_j^2} \ (P\%) \end{aligned} \qquad (3.8)$$

Since the overall result may be more sensitive to some errors than to others, we need to consider the functional relationships between the output and the various inputs.

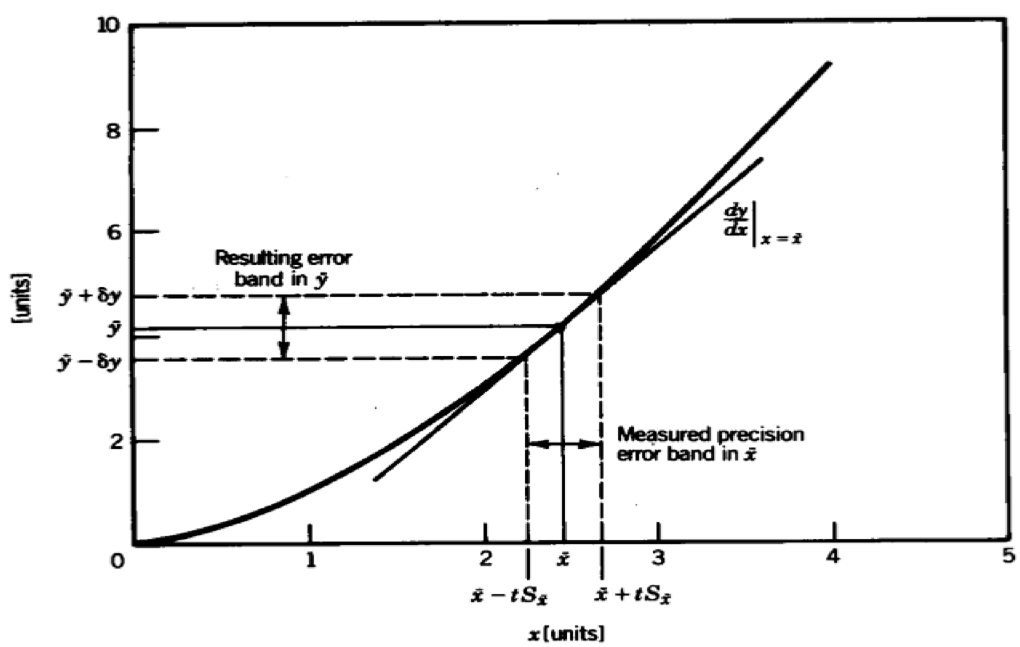


Figure 3.2 Relation between a measured value and a resultant [4]

The uncertainty in the dependent variable will be related to the uncertainty in the independent variable by the slope of the curve.

$$u_y = \left(\frac{dy}{dx} \right)_{x=\bar{x}} u_x \qquad (3.9)$$

$$R = f_1\{ x_1, x_2, \ldots, x_L \} \qquad (3.10)$$

The true mean R' can be obtained from the sample mean R with a precision ± uR

$$R' = \overline{R} \pm u_R\,(P\%) \qquad (3.11)$$

$$\overline{R} = f_1\{ \overline{x_1}, \overline{x_2}, \ldots \overline{x_L} \} \qquad (3.12)$$

$$u_R = f_2\{ u_{x_1}, u_{x_2}, \ldots u_{x_L} \} \qquad (3.13)$$

In order to account for the different sensitivities of the measurement to different inputs, we define a sensitivity index:

$$\theta_i = \frac{\partial R}{\partial x_i} \Big|_{x=\bar{x}_i} \quad i = 1, 2, \ldots, L \qquad (3.14)$$

$$u_R = \pm \sqrt{\sum_{i=1}^{L} (\theta_i u_{x_i})^2}\ (P\%) \qquad (3.15)$$

CHAPTER FOUR

Conclusion and Recommendations

4.1 Conclusion

Since laboratories may calculate uncertainties using different methods and report them using different coverage factors, it is a bad practice to report an uncertainty without explaining what it represents. Any analytical report, even one consisting of only a table of results, should state

Whether, the uncertainty is the combined standard uncertainty or an expanded uncertainty, and in the latter case it should also state the coverage factor used and, if possible, the approximate coverage probability. A complete report should also describe the methods used to calculate the uncertainties. If the laboratory uses a shorthand format for the uncertainty, the report should include an explanation of the format.

The uncertainties for environmental radioactivity measurements should be reported in the same units as the results. Relative uncertainties (i.e., uncertainties expressed as percentages) may also be reported, but the reporting of relative uncertainties alone is not recommended when the measured value may be zero, because the relative uncertainty in this case is undefined. A particularly bad practice, sometimes implemented in software, is to compute the relative uncertainty first and multiply it by the measured value to obtain the absolute uncertainty. When the measured value is zero, the uncertainty is reported incorrectly as zero. Reporting of relative uncertainties without absolute uncertainties for measurements of spiked samples or standards generally presents no problems, because the probability of a negative or zero result is negligible.

It is possible to calculate analytical results that are less than zero, although negative radioactivity is physically impossible. Laboratories sometimes choose not to report negative results or results that are near zero.

4.2 Recommendations

1. Uncertainty estimates should account for both random and systematic effects in the measurement process, but they should not account for possible blunders or other spurious errors. Spurious errors indicate a loss of statistical control of the process.

2. The laboratory should report each measured value with either its combined standard uncertainty or its expanded uncertainty.

3. The reported measurement uncertainties should be clearly explained. In particular, when an expanded uncertainty is reported, the coverage factor should be stated, and, if possible, the approximate coverage probability should also be given.

4. A laboratory should consider all possible sources of measurement uncertainty and evaluate and propagate the uncertainties from all sources believed to be potentially significant in the final result.

5.Each uncertainty should be rounded to either one or two significant figures, and the measured value should be rounded to the same number of decimal places as its uncertainty.

6. The laboratory should report all results, whether positive, negative, or zero, as obtained, together with their uncertainties

References

[1] National Standards Commission, Australia, Leaflet No. 6 (October 2002).

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نـــــــبذة مختصـــــــــرة

علم القياس هوعلم إجراء عملية القياس مع تحديد نسبة الخطأ المترتبة على عملية القياس. ويشمل هذا العلم جميع النواحي النظرية والعملية في القياس. ومن ثلاث كميات رئيسية هي الطول والكتلة والزمن يمكن اشتقاق جميع الكميات الميكانيكية الأخرى مثل المساحة والحجم والتسارع والقدرة. وأي نظام شمولي للقياس العملي يجب أن يتضمن ثلاث أسس على الأقل، تشمل قياس الكميات الكهرومغناطيسية، ودرجة الحرارة، وشدة الإشعاع مثل الضوء.

في علم القياس ، يكون الارتياب في القياس هو تعبير عن التشتت الإحصائي للقيم المنسوبة إلى الكمية المقاسة. تخضع جميع القياسات لعدم اليقين وتكون نتيجة القياس كاملة فقط عندما تكون مصحوبة ببيان عدم اليقين المرتبط بها ، مثل الانحراف المعياري وتنقسم أخطاء القياس إلى مركبتين: الخطأ العشوائي، والخطأ النظامي ويقع الخطأ العشوائي عندما يؤدي تكرار القياس إلى نتائج غير متسقة مع بعضها، وذلك على الرغم من أن الكمية أو الخاصية المقاسة ثابتة لاتتغير. أما الخطأ النظامي فهو لا يخضع لقوانين الصدفة، بل إنه يظهر بشكل متكرر ومتناسق، ويمكن التعبير عنه بمفهوم الدقة المتأصلة في أداة القياس أو النظام الخاضع للدراسة (والدقة هي أصغر قيمة يمكن قياسها أو رصدها بواسطة أداة القياس أو أداة الرصد). وقد يشير مصطلح الخطأ النظامي أيضًا إلى أخطاء متوسطها الحسابي لا يساوي صفرًا، وفي هذه الحالة فإن أخذ متوسط القياسات لا يعالج أو يخفف من تأثير هذا الخطأ.

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بحـــــــث

حساب اللاتاكدية في القياس
في شعبة الابعاد الهندسية

2021

اعداد
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