UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Uncertainty Measuring and Evaluating the Measurement of Gauge Block by Universal Measuring Machine

Thesis submitted in accordance with the requirements of the Universiti Teknikal Malaysia Melaka for the Bachelor Degree of Manufacturing Engineering (Manufacturing Process)

by

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I hereby declare that this report entitled **"UNCERTAINTY MEASURING AND EVALUATING THE MEASUREMENT OF GAUGE BLOCK BY UNIVERSAL MEASURING MACHINE"** is the result of my own research except as cited in the references.

Signature	:	....
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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Process). The members of the supervisory committee are as follow:

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ABSTRACT

This is an approach to the uncertainty analysis that needs to be evaluated so that it will become the guidelines to the other measuring process. Thus, in this project, the utilization of several gauge blocks as samples that must be compulsory in determining the capabilities measuring and evaluating under particular condition. In fact, with the data taken by using the Universal Measuring Machine (UMM) as the apparatus, it must take into account about the possibilities errors that gives the influential results. In this case, some related equations supposed to be applied in conjunction to prove the results obtained. After performing the analysis of those factors, this study produces some better solutions for this kind of errors and it can be a benchmark for the other experimental process. The uncertainty evaluation is conducted according to Guide of Expression on Uncertainty in Measurement (GUM). Therefore, once this research is completed, the final approach is to try to adapt the factors that have been identified in the measurements to reduce the errors. Thus, the evaluating of uncertainty can be minimized synchronizing with the errors reduction from the measurements exposure.

ABSTRAK

Ini merupakan salah satu pendekatan kepada 'uncertainty analysis' yang mana ia perlu untuk dinilai supaya menjadi panduan kepada sebarang bentuk proses pengukuran. Maka dalam projek ini, beberapa 'gauge block' dijadikan sebagai sampel dalam menentukan kebolehupayaan mengukur and menilai di bawah sesuatu keadaan atau syarat-syarat tertentu. Malah dengan pengambilan data dengan menggunakan 'Universal Measuring Machine', ia mestilah mengambil kira kemungkinan faktor-faktor yang mempengaruhi keputusan. Dalam hal ini, beberapa persamaan yang berkaitan harus diaplikasikan bagi memastikan keputusan yang diterima itu adalah benar dan terbukti. Selepas menganalisis kesemua faktor ini, kajian ini seharusnya dapat menghasilkan penyelesaian yang lebih baik tentang kepelbagaian kesalahan supaya ianya boleh diaplikasikan pada eksperimen-eksperimen lain sebagai tatatanda atau garis panduan. Kemudian kajian ini perlu menghasilkan 'uncertainty evaluation' berdasarkan pada 'Guide of Expression on Uncertainty in Measurement (GUM)' secara lengkap. Pendekatan akhir adalah mengumpulkan segala maklumat dan menterjemahkannya terhadap faktor-faktor yang dikenalpasti bagi mengurangkan kesalahan. Maka 'uncertainty evaluation' dapat dikurangkan selari dengan pengurangan kesalahan hasil daripada kesan ke atas proses pengukuran.

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DEDICATION

For my beloved parents, my family, my fellow friends and also to those who always give me courage and supports for all these times.

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ANSI	–	American National Standards Institute
ASME	–	American Society of Mechanical Engineers
ASTM	–	American Society for Testing and Materials
BIPM	-	Bureau International des Poids et Mesures
CIPM	-	International Committee of Weight & Measure
CMM	–	Coordinate Measuring Machine
CNC	-	Computer Numerical Control
CTE	–	Coefficient of Thermal Expansion
EQ	-	Emotional Quotient
GUM	–	Guide of Expression on Uncertainty in Measurement
IQ	-	Intelligence Quotient
ISO	–	International Standards Organisation
N	-	Newton
NIST	–	National Institute of Standards and Technology
SI	-	System International
UMM	–	Universal Measuring Machine
°C	–	Celsius
Pa	–	Pascal
CO_2	–	Carbon Dioxide
L	–	Length
ΔL	–	Changes in Length of the object
ΔT	–	Temperature Changes
α_L	–	Coefficient of Thermal Expansion
δ	–	Uncertainty of Quantity
S^2	–	Estimation of Variance of Type A
v_i	–	Number of Degrees of Freedom
U^2_j	–	Variance of Type B

$\bar{d}$	–	Mean Diameter
s	–	Standard Deviation or Standard Error of the Mean
U	–	Expanded Uncertainty
u_c	–	Combined Standard Uncertainty
k	–	Coverage Factor
μm	–	micrometer (1 millionth of a meter) (metric unit)
μin	–	microinch (1 millionth of an inch)
mm	–	millimetre (metric unit)
in	–	inch
m/s	-	meter per second
°F	-	Fahrenheit
nm	-	Nanometer
λ	-	Wavelength
Eq.	-	Equation
met	-	Metabolic rate
$W.m^2$	-	Works X Area

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CHAPTER 1
INTRODUCTION

1.1 Background of Project

Most of us imagine that experimentation almost relates to the data taking in a laboratory. Obviously, it can be defined as making measurements in a laboratory not only data taking that is conducted by any engineers but also investigating the circumstances occurred due to the research. On the other hand, the actual data taking portion of a well-run experimental program generally contributes just a small percentage of the total time and effort expended.

Experiments are an essential and integral tool for engineering and science in general. By definition, experimentation is a procedure for testing (and determination) of a truth, principle, or effect. However, the true values of measured variables are seldom (if ever) known and experiments inherently have errors, e.g., due to instrumentation, data acquisition and reduction limitations, and facility and environmental effects. For these reasons, determination of truth requires estimates for experimental errors, which are referred to as uncertainties. Experimental uncertainty estimates are imperative for risk assessments in design both when using data directly or in calibrating and/or validating simulation methods.

Coleman et. al. (1999) stated that rigorous methodologies for experimental uncertainty assessment have been developed over the past 50 years. Standards and guidelines have been put forth by professional societies (ANSI/ASME, 1985) and international organizations (ISO, 1993). Recent efforts are focused on uniform application and reporting of experimental uncertainty assessment.

The quantitative assessment method was to be compatible with existing methodologies within the technical community. Uncertainties that are difficult to quantify were to be identified and guidelines given on how to report these uncertainties. Additional considerations included: integration of uncertainty analyses into all phases of testing; simplified analysis while focusing on primary error sources; incorporation of recent technical contributions such as correlated bias errors and methods for small sample sizes; and complete professional analysis and documentation of uncertainty for each test. Coleman et. al. (1995, 1999) found that the uncertainty assessment methodology has application to a wide variety of engineering and scientific measurements, which is an update to the earlier standards.

The calculation of uncertainty for a measurement is an effort to set reasonable bounds for the measurement result according to standardized rules. Since every measurement produces only an estimate of the answer, the primary requisite of an uncertainty statement is to inform the reader of how sure the writer is that the answer is in a certain range.

Measurements are accompanied by measurement errors. The uncertainty in the sign and magnitude of a measurement error is called measurement uncertainty. To put this statement in mathematical terms, errors that occur in measurement are random variables that follow statistical distributions. The uncertainty due to a specific error is equal to the standard deviation of the error distribution.

The total error in a measurement is comprised of errors from several possible sources. Among these are parameter error, random error, resolution error, operator bias, sampling error, environmental error, etc. Each error follows a statistical distribution with a standard deviation. According to Castrup (2000), there is an uncertainty associated with each error source. The total uncertainty in a measurement is composed of these uncertainties.

1.2 Problems Statements

i. Reduction of measurement errors due to the range value possible to have huge differences.
ii. In obtaining the influential of the measurement in the uncertainty so that it will adapt to the particular factors.
iii. Get the segregation of each data analysis so that it could interact with uncertainty evaluation.

1.3 Objectives of Project

i. To identify the possibilities of errors occur during measuring of gauge blocks.
ii. To investigate the influence of end effects of gauge blocks on the measurement results.
iii. To perform the uncertainty evaluation according to Guide of Expression on Uncertainty in Measurement (GUM).

1.4 Scope of Project

This project is about to investigate the uncertainty analysis in measurement of gauge block using Universal Measuring Machine (UMM). Thus, the process should be done in the particular condition so that we could identify the discrimination on certain data and results. Thus, the utilization of some gauge blocks with different sizes are applied and the measurement are done repetitively e.g. for 50 data.

In this case, the measurements errors are identified through the collected data based on the appropriate parameters such as length of gauge blocks (temperatures influence), person who performed the task, and also the test of equipments used. At the same time, the factors that influence of errors can be traced out indirectly through the observation. Once it is investigated, the uncertainty analysis will take over involving particular calculations and equations so that it will be correlated to the Guide of Expression on Uncertainty in Measurement (GUM).

Thus, to get more clear about this project, there is a flow of measurement (refer Figure 1.1) shows the progress and the main method of this measuring activities that will have the correlation with uncertainty analysis. Besides, the Gantt chart as in Appendix A will describe details on the progress of this thesis.

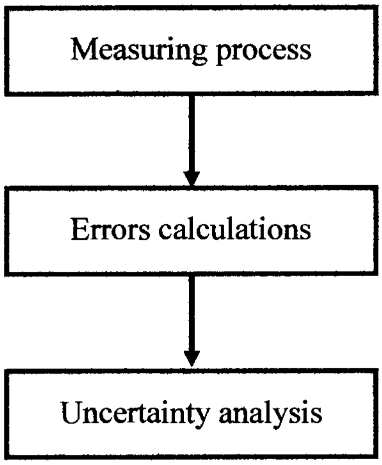

Figure 1.1: Flowchart of measurement process