Chapter 20
Impact of Human Factors on Measurement Errors

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ABSTRACT

Measurement is the act or the result, of a quantitative comparison between a given quantity and a quantity of the same kind chosen as a unit. It is for observing and testing scientific and technological investigations and generally agreed that all measurements contain errors. In a measuring system where both a measuring instrument and a human being taking the measurement using a preset process, the measurement error could be due to the instrument, the process or human error. This study is devoted to understanding the human errors in measurement. Work and human involvement related factors that could affect measurement errors have been identified. An experimental study has been conducted using different subjects where the factors were changed one at a time and the measurements made by them recorded. Errors in measurement were then calculated and the data so obtained was subject to statistical analysis to draw conclusions regarding the influence of different factors on human errors in measurement. The findings are presented in the paper.

1. INTRODUCTION

Measurement is a process of gathering information from a physical world and comparing this information with agreed standards (Blanchard, 1973). Measurement is carried out with instruments that are designed and manufactured to give correct measurement (Cannon, 2001; Simon, 2005). They are supposed to maintain prescribed relationships between the parameters being measured and the physical factors under investigation (Carter, 1986). Measurement is essential for observing and testing scientific and technological investigations (Cathy Van Dyck et al., 2005). Instruments are developed
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for monitoring the conditions of physical factors and converting them into symbolic output forms. Measurement error might be because of the measurement system is not accurate enough or precise enough or can be because of the human being involved in the measurement (Chesher, 1991; Embrey, 1996).

The measurement error can occur due to human error because the measuring system has a human component (Dormann et al., 1994) However, while some address human error directly others do so indirectly. Some attempts to eliminate the occurrence of errors altogether whereas others look to reduce the negative consequences of these errors (Douglas et al., 2002). In many works, personal error in a measurement procedure is calculated by taking the ratio of estimated true score or universe variance to observed score variance (Frese, 1991). In some other practical approaches the error was found out as the estimated standard deviation of the score distribution that would obtain if an experiment is done by many examinees (Frese, 1994).

Human error can be understood as synonymous to human performance [i.e., poor performance or failure to perform] (Gawron et al., 1989). Bailey proposed a general, qualitative, model of human performance that is generalisable to all performances situations as given in Figure 1 (Douglas et al., 2002).

It is clear that the model must contain at least three critical elements such as the human operator, his/her task, and the environment in which the task is performed. Although the majority of these elements remain unknown at worst and poorly understood at best, and although the number of factors and their potential interactions can be bewildering, this research work offers some startling benefits in linking such disparate realms as human performance and factors that affect human performance (Helmreich et al., 2000).

The paper presents the results of an experimental study conducted to identify and quantify the impact of a few selected factors on the magnitude of measurement errors by technicians conversant with measurement, inexperienced B. Tech and Diploma holders and B. Tech. students.

The factors that could possibly impact measurement errors were identified and classified as shown in Table 1.

2. DESIGN OF EXPERIMENTS FOR TESTING HUMAN ERRORS IN MEASUREMENT

In order to measure the effect of the Person, Activity and Context related factors given above on measurement errors the following experiments were designed. The parameters chosen to be measured were Voltage, Resistance, Length and Breadth. Experiments were conducted with all

Table 1. Factor lists

<table>
<thead>
<tr>
<th>Person Related Factor (Human)</th>
<th>Work Related Factor [Activity (A) and Context (C)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Intelligent Quotient</td>
<td>1. Instrument differences (A)</td>
</tr>
<tr>
<td>2. Age</td>
<td>2. Time of work (C)</td>
</tr>
<tr>
<td>3. Experience</td>
<td>3. Task differences (A)</td>
</tr>
<tr>
<td>4. Gender</td>
<td>4. Time pressure (A)</td>
</tr>
<tr>
<td>5. Effect of training</td>
<td>5. Environment (C)</td>
</tr>
</tbody>
</table>

Figure 1. Bailey’s qualitative model of human performance