STATISTICAL PROBLEMS ARISING IN THE ESTABLISHMENT OF PHYSICAL STANDARDS

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1. Introduction

Scientific research, modern technology and commerce depend on the establishment of adequate physical standards and reliable values for the physical and chemical properties of an ever growing list of materials. Workers undertaking to establish these values are inevitably forced to distinguish between precision and accuracy. In fact the task of these workers is to make available such satisfactory standards and values of the properties that the vast majority of measurements made by others involve only comparative experiments. Tremendous care coupled with scientific ingenuity are the traditional earmarks of work directed to the determination of the constants that fill the pages of scientific and engineering handbooks. One might have expected that, along with this care and ingenuity, there would be found an active utilization of statistical techniques. In fact, only in the last decade or so has statistics been given much opportunity to contribute to these exacting scientific tasks.

There are two important reasons why relatively little use was made of statistical techniques. In the first place the early workers often assigned to their work calculated estimates of errors that were subsequently proven to have been most optimistic. The evidence was unmistakable because a later value for a constant, obtained by improved scientific techniques, would differ from the earlier value by possibly fifty times the error assigned to the earlier value. Naturally enough these estimates of the error were soon regarded by experimenters as relatively worthless. The other important reason for the disinterest in statistical techniques is that statisticians themselves were conscious that the successful applications of statistical techniques involved only comparative measurements. The most striking early examples had to do with agricultural field trials. A further obstacle to the use of modern statistical tools was that laboratory experimentation differed in many respects from the agricultural experimentation that was familiar to most applied statisticians. Often physical and chemical apparatus is complex and not easily understood without some background in the physical sciences. Recognition of the opportunities for the successful application of statistical ideas required a good understanding of the complex apparatus used in the experiments.