to do this very thing, and a larger number of economists; and on the organization committee are members of your own Society who are going to help form this association.

I have no illusions on the subject. I do not think that we are going to stabilize the dollar this year. We never lock the door until the horse is stolen. We had no safety at sea until a Titanic disaster; no police department until some daring burglary; no fire department until a conflagration. We have got to suffer the ups and downs of an unreliable dollar until the people are educated and are willing in the light of suffering to apply the right remedy. But I think it is the duty of us who see this to work in the right direction, and if it takes a whole generation, as it may, to put this thing across practically. The effort that we shall put forth will be as nothing compared with the tremendous boon that we will thereby gain for business in the prevention of social injustice, in the prevention of these disastrous business cycles. A stable dollar will provide for all future generations one of the great essentials, it seems to me, of civilization.

IN the September number of *Management Engineering* is an editorial on the stop-watch time-study symposium published in our June issue, from which we quote nearly in full.

Throughout the discussion, it may be remarked, there seems to run a lack of appreciation of perspective. The stop-watch is a measuring device, as is likewise the motion-picture camera when used to time operations in industry. Such operations differ widely. Any amount of refinement of apparatus and method in studying to improve the operation of a typewriter is unquestionably justified, while the machining of a gun forging is so simple and the operations of so long duration that the simplest kind of a measuring device is adequate.

From another point of view operation studies may be made for several purposes: to improve the performance of the operation, to furnish data for rate setting, or to secure information for job specification.

It is earnestly to be hoped that the discussion so ably begun will be continued until these and other limitations are formulated and accepted. The editor of the matter appearing in the BULLETIN asks for further evidence, particularly in regard to actual times and costs. Building upon this request *Management Engineering* ventures to ask for the answers to the following:

What are the limitations of application of the stop-watch and the motion-picture camera in time studies? What is the relative accuracy of each device? What factors cannot be recorded by each? The Gilbreths state that the stop-watch does not record surrounding conditions nor anything regarding the methods of the superexpert or the best demonstrator obtainable. Carl G. Barth says of the micromotion method that even the application of a microscope to the films themselves cannot possibly show the condition of repair of the machine, the correct shapes and settings of the tools, nor the spindle revolutions and the feeds of the machine observed.

Again *Management Engineering* ventures to ask a question or two: What degree of skill is needed to interpret stop-watch observations on the one hand, and the motion-picture films on the other? What is the relative cost in each case of making the observations, and what the cost of their interpretations into a form to be used for improving an operation or process, or determining standard times or setting rates?

It is said of Lord Kelvin that whenever a new project was presented to him his first question was—"How much?" We need to know "how much" in regard to these contrasted devices and methods for operation study.

The basic criticism of stop-watch time-study made by the Gilbreths is inaccuracy. This is referred to again and again in their indictment and closure. In the early paragraphs of the indictment occurs this statement, the italics being theirs: "Every statistician knows, and to most students of science it would seem almost axiomatic, that *final averages are no more accurate than the data from which they are derived.*" This is supported by two quotations from "Elements of Statistical Method" by Willford I. King. These are: "The total can be no more accurate than its most faulty item," and "The absolute accuracy of a total can be no greater than that of the most inaccurate item composing it." That is, a statement in regard to the inaccuracy of final *averages* is supported by quotations concerning the accuracy of *totals*.

If the authors had read further into the section of King's book from which the second sentence is taken, they would have discovered this comment: "This fact that the probable error of the average of a number of items is less than that of any single item is of great value in scientific work." And again, "Even the personal bias of the observers tends to be eliminated by the averaging process." The relation between the possible and the probable error in an average is also given in this same section: *"Hence, the possible error of an arithmetic average is equal to the average possible error of the items in the series.* In obtaining this possible error, we assumed that all the errors were in a similar direction. As a matter of fact, however, the chances that this will be true are very remote when the number of items is large and the errors are of the compensating type. The *probable* error of the arithmetic average is therefore only a fraction of the possible error. If E = the possible error of the arithmetic average, the probable error of the same is approximately $E/\sqrt{n}$." (n is the number of items.)

Final averages are probably therefore not so inaccurate as the indicters of stop-watch time-study would leave us generally to believe.

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