hampering operating conditions; (4) the method used by some or all of the operatives may be inferior to the best known methods; (5) some or all of the operatives may be withholding attention and effort.

A performance standard, to be valid, must always refer to a specified work content, performed by a specified method, with specified conditions as to operating space, light and the like. The *best* performance standard refers to merely necessary work content, the best known appliances for the purpose, the best operating conditions and the best known method. However, given *any* specified work content, specified appliances, specified conditions and specified method, a valid performance standard can be determined for that combination. The determination is by elementary time study. It is by comparison of the standards for such combinations that the *best* combination and best performance standard can be determined. Furthermore, a comparison of these standards of various combinations will measure the comparative efficiency of various alternative appliances, various alternative methods and the like.

To illustrate, our eleven operatives were not all using the same method either of creasing armhole seams or of pressing shoulders. B and L were creasing armhole seams by a method which careful time study showed should consume 0.295 minutes per armhole seam; D's method should consume 0.52 minutes, F's, 0.53 minutes, that of A, E, and N, 0.58 minutes, while that of C, K and O should consume 0.815 minutes. At these various rates the combined output per hour of the eleven men should be 1255.5 armhole seams as against 2,233 if all used the quickest of these methods. In other words the average efficiency of the methods used was only 56.2 per cent. But compared with the 1255.5 units per hour they *should* have produced even by their various methods, they actually produced only at the composite rate of 626.8 seams per hour; their application of effort averaged only 50 per cent of what they were capable.

Thus the 28 per cent efficiency with which this operation was being performed is explained by the fact that the methods used were, on the average, only 56.2 per cent effective and the operatives themselves were only 50 per cent effective in effort and attention. The product (0.562 x 0.50) gives the 0.28 or 28 per cent efficiency.

The 72 per cent of waste in the performance of these two operations is to be divided between inferiority of methods and deficient application of operatives, in proportion to the arithmetic complements of these two efficiency percentages. Thus, the complement of 56.2 per cent is 43.8 per cent (a waste percentage); of 50 per cent is 50 per cent. Dividing 72 in proportion, we get 33.6 per cent waste assigned to inferior methods and 38.4 per cent to deficient application; thus

	Waste Factors Per Cent	Waste Distribution Per Cent
Inferior Methods	43.8	33.6
Deficient Application	50.0	38.4
	93.8	72.0

In like manner the efficiency of method in pressing shoulders averaged 68.9 per cent and of operatives' application 58.5 per cent (See Appendix A). The waste factors corresponding to these are 31.1 and 41.5 per cent respectively. Dividing the 59.7 per cent of waste proportionately, we assign 25.6 per cent of waste to inferior methods and 34.1 per cent waste to deficient application.

These two operations, which are really parts of a larger operation called "finish pressing" were held *necessary* to produce the quality of product required by the manufacturer. The several operators were performing various sections of work that were determined to be unnecessary. The time averaged on all these was found to be about 45 per cent of all the time averaged on the whole operation.

The above mentioned standards referred to certain specified appliances and specified conditions which were uniform for all the operatives. We did not go into the question of whether these were the best for the purposes, although we migh very well have done so. However, the above is sufficient to illustrate the measurement of waste by causes.

While it is possible to measure waste both as a whole and with reference to each cause by application of the above described methods, this was not done, to any great extent at least, in the waste-in-industry investigation. Time and money would not permit even if employers and employees had been willing. The data used in the foregoing illustration was gathered by myself and assistants while I was Consulting Production Engineer for the Clothing Manufacturers' Association of New York. For purpose of a quick assay a much shorter method had to be devised—a method that measured *by interpreting signs* rather than by comparing actual with standard performance. Hence the questionnaire and the field report evaluation sheet. However, the engineers lacked faith in the accuracy of the measurements afforded by the latter, and for the most part relegated them to the position of appendices.

This does not mean, however, that no measurements were made. The writer made free use of the measurements made by himself and assistants during eighteen months work in the clothing industry. Mr. Sanford Thompson has spent a quarter of a century applying scientific management to building construction and has collected and tabulated such a mass of standard data, that from the mere specifications and the record of man-hours put in on a given construction proposition he should be able to make a reasonably accurate measurement of the percentage of wasted time. Mr. John Williams had spent years doing the same thing in the printing industry. Indeed, every engineer brought to his assay a mass of experience in his industry such that the fresh observation of nine or thirteen or seventy-three plants was largely a matter of checking up to ascertain whether conditions still were what they had been.

This is in part the answer to your friend's criticisms as to the inadequacy of the investigations. For my own part, I have observed literally scores of cutting departments, inside shops and contracting shops in New York City and most of the *large* plants in Baltimore, Chicago, Cleveland and Rochester. I know that the description of conditions in the clothing plants is correct. My associate's description of conditions and methods in Boston plants agree with my own observations 100 per cent. Although I am not very well acquainted with the other investigators, I know enough about Mr. Thompson and Mr. Williams to believe implicitly that they have given fair pictures of their industries.

Your friend interprets the assignment of "points waste" to two decimal places as an unwarranted pretense at fine accuracy. It is not really so. It is the product of dividing 100 per cent unequally among 47 items and then applying to these results as bases, the agreed on percentages of 20 per cent for "good," 40 per cent for "fair," and so on. Appendix C reproduces the working sheet on which Mr. Cooke, Mr. Carlin and I arrived at our final determination of "Assigned Points." If your friend will go over this and the accompanying explanation carefully he will see the appearance of pretension to fine accuracy was unintentional and unavoidable.

Your friend *missed* the *real* defect of the field work evaluation sheet. This defect is as follows: The "assigned points" sum to 100 per cent, which is not 100 per cent of the possible waste. What part of the possible product this is, whether 100 per cent or 1 per cent, is not stated. Hence to say that the average waste percentage for clothing plants is 64 per cent (p. 119), is not equivalent to saying that they lose 64 per cent of their possible product, but that they lose 64 per cent of what they *can* lose. "Assigned points" in this form will show very well the *relative* importance in a specific plant or industry of organization defects, utilization defects, and technical defects, and of the various factors within each class, and may, therefore, constitute a valuable guide to sequence in which various improvement steps should be taken. However, for the purpose of measuring waste there should be substituted a set of maximum waste factors. (See App. C.)

Now as to your friend's criticism of the division of responsibility between management, labor and outside contacts. Who but management is responsible—

(1) if a business is not provided with an up-to-date organization Chart (K1) (See p. 119);

(2) for the form of organization—functional or by individuals (K 2);

(3) for lack of specific definition of function or fields (K x);

(4) for failure to standardize operations as to work content and methods (T 8);

(5) for failure to determine proper performance standards (U 19);

(6) for failure to properly instruct workers in quality and best methods (K 7½);

(7) for failure to provide the best equipment as standard in each operation (T 4 and T 6);

(8) for failure to maintain this equipment in proper operating condition (T 5);

(9) for that lack of planning and shop administration that lets operatives run out of work (U 5); and so on.

Perhaps your friend cannot see why any part of the waste due to faulty organization should be assessed against labor and outside contacts (See K 2, p. 120). I didn't see it myself until Mr. Cooke pointed out that it is one thing to properly define and assign functions and another to get work people (who know or like one executive better than another) or the outsider (who always wants to see the *owner*) to take a matter to the right functionary. However, if your friend will fill out the questionnaire for his own business, make up an evaluation sheet, and go systematically and painstakingly down the 47 items and assign responsibility on the basis of (1) opportunity for initiative, and (2) opportunity for cooperation or obstruction, I venture the opinion that his individual results will sum not far differently from the engineers'.