Another factor entered into our problem. Being a pioneer work of the most important kind, in an age of conflicting interests, regarding a subject about which little was known, we appreciated fully that no matter what kind of a report was made, it would come in for criticism on general principles, and that this criticism would vary in direct proportion to our failure to take every step possible to transfer the activities of the Committee from the realm of *opinion* to the world of *fact*.

We also realized that we were setting out to appraise that most intangible thing on earth—human reactions. We were not going to assay a mine out-cropping, or a railroad location, or analyze a new form of gas. We were to assay a thing having few if any constants, in a realm characterized by "if," "but," "whereas" and "unless."

The most serious problem which confronted us is well expressed on page 4 of the report:

> It is a fact that no accepted management and labor terminology exists and, further, few units of weighing or measuring the performance of industry or of any plant or department or section thereof have been developed by engineers in a way to be standardized, or to yield results or conclusions on a comparable basis.

These problems, the last one particularly, forced us to consider the development of a *medium of expression*, and the creation of a *yard stick* to measure with.

To the everlasting credit of American engineering, let it be said that the finished product of the eighteen men who served on the Committee, will stand for all time as an outstanding monument to the vision, ability and courage of the members, when once the problems enumerated are fully appreciated. This is not a defense, as no defense of the great work done is needed, but my own personal and honest tribute to the other seventeen men who gave so freely of their time and energy.

At the start, the obstacles in the way seemed insurmountable, for with different plants, in different industries, having different conditions, to be studied by different men, from different angles, some of us felt that we saw our finish before we had even started, and there were times when my heels were frost-bitten if my toes were not.

So far as the principle underlying the development of the questionnaire and evaluation sheet was concerned, a work which was delegated to John H. Williams and the speaker, it was felt that if the medical specialist could take that most complex thing on earth—the human body—and after an examination, diagnose and prescribe, we could well follow the same fundamental plan of assay. Further, if the medical specialist could use a watch to time pulse beats, a gauge for blood pressure, a thermometer for temperature, an X-Ray for observation and chemistry for analytical work, and thereby evaluate, we could develop some means for evaluating our findings. Finally, if the medical specialist, instead of spending days and weeks in thoroughly examining the human body, could by confining his attention to certain definite things, make his examination and diagnosis in a comparatively short time, through proper questioning and observations and tests, we could probably do likewise.

If in surveying a plant we should find that the workmen ground their own tools to conform to their own ideas as to angles, and that they looked after the speeds and feeds of their machines, we could conclude that there was a lack of standardization, with consequent loss in production. This is an important and definite element; a leading question could be prepared to cover it, and the condition could be assayed as the worst possible.

So, falling back on science, there were evolved such principles behind the questionnaire and evaluation sheet as:

1. Analyzing to determine those factors in industry wherein waste might be expected to be discovered.
2. Developing questions, the answers to which would serve as the basis for securing information, as to the relative amount of consideration given to each point covered by the questions.
3. Judging as to the relative degree of lack of effectiveness in those factors examined, and evaluating according to the nature of the information secured.

In developing the questionnaire and evaluation sheet around these principles, the following fundamentals were our guide:

1. Waste and not effectiveness was to be assayed, much as one would study a refuse pile to develop a by-product.
2. A given practice is not wasteful until a better practice has been developed, therefore theoretical standards of excellence should be ignored.
3. Waste is the difference between possible attainment and actual performance, between the average practice and the best known practice.
4. No result is one hundred per cent wasteful.
5. Best known practice would be zero per cent of waste.
6. Responsibility for the cause was as important to appraise as the cause itself.



With principles and fundamentals to guide us, and keeping uniformity and coordination in mind, the task of developing questions and the background was then undertaken, in which work we were fortunate in securing the services of Mr. C. L. Barnum, who rendered valuable assistance, especially on the evaluation sheet development, and whose work should receive especial commendation.

Causes of waste were divided into three main groups:

1. *Organization,* dealing with the human factor.
2. *Technical knowledge,* dealing with physical factors.
3. *Utilization,* dealing with the use of 1 and 2, or performance, or administration in the generally accepted sense.

Naturally it was desired to determine relative responsibility for the causes of waste, so as to deal, as engineers should, in terms of cause and effect, and the following was finally decided upon:

1. Responsibility assayed against *Management.*
2. Responsibility assayed against *Labor.*
3. Responsibility assayed against *Outside Contacts* (the public, trade relationships and other factors).

Questions developed were grouped under key or "leading" questions,[1] in this way enabling an investigator to work by exceptions. We would not stop to examine a man's lungs, if his heart had stopped beating; nor would we ask detail question U 3(d)—"Give amount and percentage of idle time by months for years 1918-1919-1920 commenting on causes of peaks and depressions," if leading question U 3—"Is there any record of idle machine time?" should be answered in the negative. In other words, each key question had a special significance. Negative answers would mean one thing; affirmative answers with supporting data would mean just the opposite condition. Any variation in between these two extremes could therefore be properly weighed, at least in a relative manner. From this it was assumed that one could say whether a thing was "bad" or "excellent" as extremes, and that in between, could appraise a condition as poor, fair and good. As no result is one hundred per cent wasteful, it was decided to use this scale:

| | |
|---|---|
| Excellent | 0% of waste |
| Good | 20% " " |
| Fair | 40% " " |
| Poor | 60% " " |
| Bad | 80% " " |

The premise therefore was that if all questions could be properly classified under key questions, these in turn being grouped under three main causes of waste, points of *possible* waste could be assigned to each cause, the three to total 100 points *possible* waste. Now by multiplying each by the factor representing the estimate, as excellent, good, bad, fair or poor, the *actual* points of waste could be determined. For example, if we arbitrarily assigned 33.3 points against *Organization, Technical Knowledge and Utilization,* or 100 points in all, and called the conditions fair or 40% waste as to *Organization,* good or 20% waste as to *Technical Knowledge,* and poor or 60% of waste as to *Utilization,* the calculation would be:

| | | |
|---|---|---|
| *Organization* | 33.3 × 40% = | 13.3 points waste |
| *Technical Knowledge* | 33.3 × 20% = | 6.7 " " |
| *Utilization* | 33.3 × 60% = | 20.0 " " |
| Total | | 40.0 " " |

Having gone thus far, we could then take each cause and assay the degree of responsibility as between management, labor and outside contacts, by dividing the 33.3 points according to knowledge of the industry, labor relations, trade conditions, local factors and the like, as for instance 11.1 points each.

Having sketched the broad outlines, you can see wherein a breakdown as to assigned points could be made within each group, placing opposite each the estimated factor of waste, multiplying to determine the points of waste.

It was felt that the relative weights decided upon for the three groups should be identical for all plants in the same industry in order to have the results comparable; while the responsibilities of management, labor and outside contacts could vary for different plants *within* an industry, depending upon size, type, conditions and location.

To indicate the variations in the total assigned points in the findings of the committee, let me list the following:

| *Industry* | *Organization* | *Technical* | *Utilization* |
|---|---|---|---|
| Building Trades | 55 | 10 | 35 |
| Men's Clothing | 35.7 | 28.4 | 35.9 |
| Boot and Shoe | 42.5 | 10.5 | 47 |
| Printing | 35 | 35 | 30 |
| Metal Trades | 20 to 35 | 15 to 35 | 37 to 55 |
| Textile | 25 | 45 | 30 |

I mention these variations because of the criticism which might be advanced of the arbitrary nature of the assignment of values. There may be a feeling that the assignments should have been definite, as for instance one-third each for *Organization, Technical* and *Utilization,* on the premise that each was as important as the

[1] See pp. 34-50 of the Report.