

believing that their apparatus and methods are not unqualifiedly to be recommended for exclusive use in time studies.

16. Mr. Taylor himself in the following quotation made by the Gilbreths from "Shop Management"—"What the writer wishes particularly to emphasize is that this whole system rests upon an accurate and scientific study of 'unit times,' which is by far the most important element in modern management"—spoke as the enthusiastic originator and performer seeking a following. It did not take me long to learn to make allowances for the enthusiasm and not to take it quite so seriously as all that; just the same as I am not taking the claims and statements made by the Gilbreths quite so seriously as their ardent and persistent work naturally has prompted them to make these. Yes, as has universally been my experience through all these many years, the preliminary and preparatory work and reform that I have had to do to put a concern in a condition for worth-while time studies and task setting of any kind, has been more effective of waste elimination and all around good than the work resulting from the subsequent time studies taken; and I can make the positive assertion that this has not been due to the fact that a stop-watch was used and not a more refined timing device.

17. In regard to the criticism of the manner in which Mr. Merrick chooses each of his final unit times from the records made by his stop watch studies of a great number of each of these, I cannot see but that it is as scientific as a majority of determinations made in other fields of engineering, except when pure mathematics alone is involved. Such determinations are in the end based on certain assumptions that we know to be only approximately correct. Thus we never know the exact ultimate strength or elastic limit, of any material we intend to put into an engineering structure; but we nevertheless assume something definite,—that is, we guess, and trust to luck that our guess is near enough correct to serve for practical application in a theoretical formula the correctness of which is even open to some suspicion, but which represents the latest and best available to us.

18. Again, in calculating the weight of a complex structure it is considered the best practice to calculate as closely as possible, on a purely assumption basis of the exact density of the materials implied, the weight of each of its constituent parts, and only, if at all, to round off the final figures of the sum of the individual weights calculated for each kind of material and of the entire structure.

19. Viewed separately each individual weight of such a sum looks indeed as a preposterous pretense at an ability to predetermine with precision that which is fully realized to be a mere approximation. In the final analysis it all means only a consistent manner of guessing at the value of each part, and trusting to the probability of a partial compensation of the individual errors, to give us a relatively more correct weight of the structure as a whole than the weights arrived at for the individual parts. And I surely cannot imagine that anybody would contend that the individual times consumed in performing motions by human beings are more nearly constant than the weight of materials produced from engineering drawings and specifications, or that a small error in predetermining the former as a basis for a fair contract between a worker and his employer, is more serious than an error in the predetermination of the latter as a basis for a fair engineering contract.

20. But when it comes to the criticism of attempting to use a stop watch for the determination of operations so short that probable error in the observation and recording of its time value may equal or even exceed the time value, it certainly is more than justified; and we are all greatly indebted to the Gilbreths for having persisted in their efforts—apparently long since crowned with eminent success—to devise instruments and methods which make the measuring of such minute elements of time possible.

21. They have thereby opened up a whole new world for scientific investigation, comparable perhaps with those that the microscope and the telescope each did, as compared with the circumscribed field of the simple magnifying glass.

22. My contention is meant to be only the equivalent to claiming that the magnifying glass has still its legitimate use along with the microscope and the telescope. In fact, when occasionally a time element is met with which is too short for even an approximate determination by a stop watch, along with time elements so determinable to a satisfactory degree, all we have to do is to fully realize this, and then either neglect it altogether or let a guess at it go in for what it is worth; just the same as it does not make any appreciable difference in the total weight of a large structure, if we either absolutely neglect or overestimate the absolute weight of one or two small parts of it.

23. One reference I think the Gilbreths might well have left out in their indictment of the stop watch, is the fact that, when first used for time studies, it

was often concealed and used in observing a worker clandestinely; for they also admit that this is no longer being done, and I will add, has not been done since I became associated with Mr. Taylor. Hence that statement can have no other effect than to prejudice the reader against the stop watch in an unnecessary and unwarrantable manner.

24. So far as my knowledge goes—with one single and deplorable exception never likely to be repeated—no direct disciple of Mr. Taylor has ever timed a worker without heeding Mr. Taylor's injunction not to do so without properly preparing the way and obtaining the full consent and cooperation of the worker, a thing that is absolutely independent of the kind of timing device used. And still, we must admit that the Gilbreth motion picture-machine precludes even the possibility of clandestine observation; but I cannot see that it necessarily implies the consent and full cooperation of the worker.

25. And now, finally, let us turn to the very opening paragraph of the paper under consideration, namely: "Planning and control and all other functions of management depend first, last and all the time upon the standards upon which they are based. These standards, in turn, depend upon the fundamental data from which they are derived. The fundamental data for determining standards are obtained by motion study and time study," and see if we ought not also to accept that clear and confident statement with reservations as in fact already implied in my previous contentions.

26. Planning in an industry, while the very essence of scientific management, can never be a very exact thing for short periods at a time, for modified requirements by customers and unforeseeable accidents to materials and machines, etc., constantly upset our forecasts; but with our plans before us in a very tangible manner, we can re-cast our plans as often as such disturbances occur, somewhat in the same manner as railroad schedules are always subject to accidents and disturbances due to adverse weather conditions.

27. In fact, I know of a concern that inaugurated a scheduling system, more than a generation ago when the idea was a new one, but soon gave it up, not because of the difficulty of estimating near enough for the purpose, from the piece rates in use and the limit put on the worker's earnings, the time each job would take; but because of the constant upsetting brought about by time lost because machine castings contained hidden defects that such partial machining alone could disclose. By the present time, however, we have learned not to let such matters discourage us completely; we

resolutely re-arrange our schedules every time such difficulties occur to a greater extent than the time "safety factor" adopted allows for, just the same as the railroads, whose inefficiency we are all wont to deride, never for a moment consider giving up their schedules no matter how often or how badly these become deranged. On the contrary, under such conditions all the available efforts of a railroad management are for the time being concentrated on re-establishing the schedule.

### III. A DEFENSE OF THE STOP WATCH

By DWIGHT V. MERRICK<sup>1</sup>

1. There is very little that I can add to what has already been covered by Mr. Barth.

2. Mr. Gilbreth in his remark emphasizes that by his motion picture method he is able to show an operator a one best way of performing his work by a study of a picture taken on the best operator. Mr. Gilbreth further emphasizes that the time element is only secondary and can be used if desired.

3. There are many instances where feed and speed data are far more important factors than the handling time data, and then a study of a picture of a one best method performance becomes secondary. In such cases timing with an ordinary stop watch is close enough. To illustrate: at Watertown Arsenal I set times on jobs covering as much as 120 hours with very little time study preparations, and when I told Mr. Barth of this he expressed considerable surprise; but when informed that the greater portion of the job was machine time, dependent on the feeds and speeds which were determined by the slide rule, he realized that the handling time was an insignificant factor. In some instances this handling time was as low as five per cent of the whole, and in most cases on the large machine tools, on long jobs, it averaged about ten per cent.

4. This was also the case at Bethlehem in the early days. There the rates were set entirely by the slide rule and a small allowance made for handling time.

5. In recent years my work has often been of such a nature that I have felt the need of a more accurate time-measuring device than the ordinary stop-watch. This work was of a highly repetitive kind and required intense application on the part of the observer to record his readings, as the time of performance of each operation was of short duration.

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