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FOR WORK STUDY, LET'S GO TO THE VIDEO

Digital technology adds improvement to century-old measurement tool



By Adrienne J. Dickerson and Larry Aft

Although time studies have been used for more than 100 years, the advances in digital recording technology offer some opportunities to improve upon the accuracy of this valuable measurement system.

Work measurement is performed to develop the standard time to perform operations. Time standards traditionally have been defined as the time required by a typical operator, working at a normal pace, to perform a specified task using a prescribed method, with time for personal, fatigue and delay allowed. Time standards, work standards – or just standards – are critical pieces of management information that apply to all kinds of work, including healthcare, manufacturing, assembly and clerical.

Standards provide information essential for the successful operation of an organization. According to the *Manufacturing Engineering Handbook*, this information includes:

- **Data for scheduling:** Production schedules cannot be set unless times for all operations are known. Delivery dates cannot be promised unless times for all operations are known.
 - **Data for staffing:** The number of workers required cannot accurately be determined unless the time required to process the existing work is known. Continuing to manage the workforce requires using labor variance reports. Labor variance reports are also most useful for determining changes in work methods, especially the subtle or incremental changes.
 - **Data for line balancing:** The correct number of workstations for optimum workflow depends on the processing time, or standard, at each workstation. Operation times and setup times are key pieces of this information.
 - **Data for materials requirement planning:** MRP systems cannot operate properly without accurate work standards.
 - **Data for system simulation:** Simulation models cannot accurately simulate operation unless times for all operations are known.
 - **Data for wage payment:** To be equitable, wages generally must be related to productivity. Expected productivity when compared with actual productivity can only be determined through the use of work standards.
 - **Data for costing:** Ultimately, the profitability of an organization lies in its ability to sell products for more than it costs to produce them. Work standards are necessary for determining not only the labor component of costs but also the correct allocation of production costs to specific products.
- Data for employee evaluation:** In order to assess whether individual employees are performing as well as they should, a performance standard is necessary for measurement. Without a standard, it is impossible to determine the level of performance.

The accepted method of performing a time study has been established and is presented in texts such as the *Industrial Engineering Handbook and Work Measurement and Methods Improvement*. "Time study is the analysis of a given operation to determine the elements of work required to perform it, the order in which these elements occur, and the times which are required to perform them effectively."

The classic method includes the following steps:

1. Observe the task in order to determine the content of the work.
2. Identify beginning and ending points for the task.
3. Time the task with a stopwatch in order to measure the time required to complete the job. The time that results is the time standard. This is defined as the time required by the average worker, working at a normal pace, to complete a specified task, with allowance for personal time, unavoidable delays and fatigue. The average worker is one who is experienced and knowledgeable but not the best or worst who performs the task. The normal pace is a pace that can be maintained for the entire workday without causing the worker undue fatigue. It is the pace at which the average worker can work.
4. Determine the performance rate or level of the performance of the worker(s) being studied. The term performance rating or leveling is used in a comprehensive sense. It includes procedures that are designed to adjust observed time values to correspond more closely to the time deemed reasonable and fair for doing the work in question. According to the *Industrial Engineering Handbook*, "In general it is recognized that judgment must be employed in the process."
5. Applying the allowances identifies the procedure of adding time for certain items of work and delays that are not directly related to production assignments. Also from the *Industrial Engineering Handbook*, "It is emphasized of the necessity of establishing allowance factors for each workstation which are consistent with the requirements of that station."
6. After data is collected, the standard is computed. It is desirable to determine whether the sample of readings taken is representative of the job and operator observed. Some criteria must be used for

judging the adequacy of the sample. In developing the criteria, the magnitude of the tolerable error and risk must be stated. The *Industrial Engineering Handbook*, in its second edition, stated that "a criterion for time study measurements might be stated as a sample size such that the resulting arithmetic mean (average time) is not different from the true mean (standard time) by more than +5 percent in more than 5 percent of the cases if a large number of samples were taken. In plain language, this statement demands a sample size such that the chances are 95 out of 100 that the sample mean would not be in error by more than 5 percent."

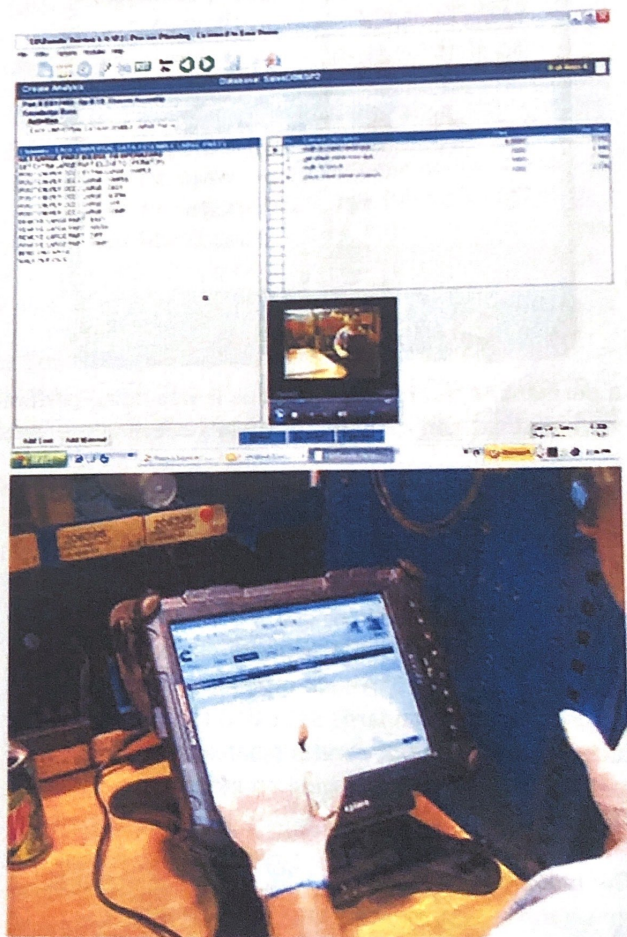
After the standards are developed, they must be maintained.

"It is quite obvious that valid work measurement depends on continued validity on the rigid maintenance of standards and standards procedures throughout the entire enterprise and beyond," according to the *Industrial Engineering Handbook*. Experienced time study engineers have identified what is known as "creeping change." This is the gradual change of a time standard due to changed circumstances, such as alterations in method, workflow or operator behavior. In order to prevent this, standards must be audited on a regular basis and revised when such circumstances are identified.

The new era

Traditionally, time standards were set using a qualified analyst and a stopwatch. Recently, this has been supplanted in large part with computer-based systems paired with mobile devices. As discussed in "New Tools for the Tried and True" in the March 2013 issue of this magazine (then called *Industrial Engineer*), many systems are currently available. The applications and functionality continue to evolve. Note that these are representative products. The authors do not endorse any one provider's products or services.

Quetech's products are designed for performing virtually any type of time study or sampling study, making the data collection process easier, more standardized and more accurate. Using Quetech's WorkStudy+ software to record timing and sampling data electronically means having immediate access to statistical results of the study and eliminating all manual data entry tasks on the back end. Instead of using the traditional stopwatch and paper, the user simply taps an element on the screen whenever the observed activity changes. WorkStudy+ also takes advantage of the larger screens available on today's tablet devices, allowing more information to be displayed on the screen at the same time. All this allows WorkStudy+ to handle even the most challenging types of studies containing thousands of elements, short cycle times or complex notetaking. And to ensure easy adoption into any corporate environment, it is available for a wide range of devices, including Android smartphones and tablets, iOS devices (iPhone, iPad and iPad Mini), as well as Windows tablets, laptops and PCs.



EASE Work Measurement software and EASE Universal Standard Data was developed in plain English language (methods-time measurement) data. EASE groups MTM2 elements into rolled-up, plain English language elements. The EASE system requires use of EASE's process planning software to analyze a video of the task and then pick or search the appropriate elements with the EASE activity folders. EASE technology includes the availability of a client server, web-based or SaaS labor standards software application. With a web browser, EASE will support any hardware device such as PCs, laptops, tablets and smartphones.

iSampler iPhone App, shown above, automates all aspects of work sampling. A new work sampling study can be set up with just a few taps – name of study, time and days, start and end date, activity template, MTBB (mean time between beeps). Once a study has started, the app causes the iPhone to ring at random intervals. The mean time between rings can be set to suit the study. An observation recording screen automatically opens the activity template (chosen during setup), and single taps record the activities for each person. You can describe "other" activities not covered by the template by tapping in the name field.



Custom templates can be uploaded easily to all iPhones participating in the study. The app can be used for self-study and for studying groups. If many people are being studied, the app will continue to query until all the people's activities have been accounted for. The app records all activities and displays the number of observations of each activity and percentages. Observers can download data to their desktop in an Excel format. Once in Excel, the data from multiple observers can be aggregated for larger studies and reports.

Let's go to the video

Video recently has entered the process.

Organizations are seeing the value in establishing a permanent record of the task as it was being performed when the standard is set. Any question about work method can be determined by reviewing the video.

Companies such as Timer Pro offer video linked to analysis. According to its website: "Video time and motion accurately documents and times any task while simultaneously isolating the nonvalue-added work content. Video supported analysis creates an unchallengeable history of the current process state. Each and every task observation can be instantly replayed for review and analysis."

This poses a new problem relating to video production. Issues such as camera placement, work methods and playback capability affect the accuracy of the standards set using the merged technologies. Without careful planning and execution, videos can provide an incomplete record of the task being performed.

The industrial engineers at IISE Solutions have had considerable experience using video to set standards using both traditional timing methods and predetermined time systems. The following part of the article suggests some best practices regarding the use of video in the work measurement process. Just as the mobile-device



time study software enhances the engineer-and-stopwatch process, video offers additional enrichments for time study performance. With video equipment being much more affordable than in the past, almost anyone can afford at least some basic equipment, such as a digital camcorder or cellphone video.

Starting with the classic time study methods listed in steps one through six above, we can improve the process by incorporating video in several ways during steps one, two and three. In step one, as we observe the task in order to determine the content of the work, we'll add some additional considerations for video use. The basic structure of the study will be very similar to an in-person observation, and for an unfamiliar process it may be best to conduct a few in-person time studies to establish line(s) of sight, working relationships with subjects, motion patterns, etc. Sample video can be collected and reviewed for content at this time as well. As with any project of this type, your relationship with the study subjects is of the utmost importance. Make sure you establish a good working relationship with the study subjects before video is introduced.



Careful consideration of video angles allows capture of multiple views that enable more comprehensive analysis (e.g., in conjunction with MTM or other predetermined time systems), ergonomic analysis and potential improvement in the process itself. Angles for consideration include bird's eye (directly above looking down on the process for study), eye level, rear view and lateral (side) views. Often, multiple views (and therefore multiple cameras) may be necessary to capture the entire work process. These videos can later be synced and combined on screen so that viewers can see multiple angles at the same time.

In step two, we still need to identify beginning and ending points for the tasks. Keep in mind that tight spaces or even mobile work areas, e.g., vehicles, can be accessed using "action cameras" such as GoPro, Oly, Garmin and so on. Different lens options, such as wide-angle lenses, also might provide better options for capturing clear visual information.

In step three, we have options now for timing the task with a stopwatch/ mobile app in order to measure the time required to complete the job. Times can be collected during the initial observation/video session, or engineers can collect times from the video later. Static video, i.e., from a tripod or otherwise mounted camera, is best as motion of the camera can be distracting and make accuracy more difficult. There are a variety of mounting options for small cameras and even adjustable tripods for cell phones.

Recording plusses and minuses

Video offers many benefits that increase the flexibility of time studies.

With video, we gain the ability to add "instant replay" to our repertoire. Engineers can review discrepancies and verify times if needed. Having the option of watching video again also allows the engineer to collect multiple sets of data on the same process observation, such as times and activity counts. Engineers also can study the same process observation from different angles, and they have the potential to expand scope later in the project without needing additional time studies.

Another benefit is the ability for practically unlimited people to view the process. In a live study you are limited by space, but a good video allows unlimited viewing and study. Additionally, with basic editing (many free video editing programs are available), you can tie video clips to standard work, post it on



websites, distribute it for training purposes and more.

Video also gives us the ability to calibrate multiple engineers for a time study using the same data sample. It also offers the potential to save costs because it allows a nonengineer to collect data via video, organize it and submit only the relevant portions for time study or analysis.

Study subjects/operators can review the video for a greater understanding of the time study process, their contribution and the opportunity to provide feedback or insight. And video time-stamps allow quick access to specific tasks for reference or study.

And last, but not least, if best practices are captured during the study process, there is no need to film the operations again later for documentation or training materials.

However, complications can arise from introducing new technology to an established process, and time studies are no different. For example, people often are wary of being

on video, so a good relationship must be established between engineer and subject prior to the work being performed. Keep in mind that employers or unions may have restrictions regarding the use of video in the workplace. Management should obtain consent from everyone who may be recorded.

Sometimes it is difficult to get a clear view of the entire process for study due to equipment or other objects obstructing the view. A large work area with significant walking or distance may make video studies inconvenient.

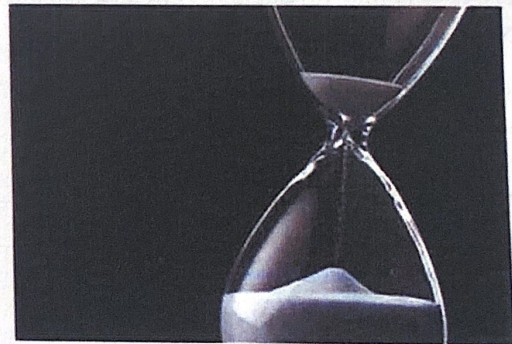
Sometimes fixed camera angles are insufficient and roving cameras are required. This may require more expensive technology (e.g., a different camera or image stabilization lenses).

Management must avoid the temptation to rely too heavily on a small number of recorded observations. Remember that the overall goal of time studies is still to identify the typical operator and represent the time while working at a normal pace. A sufficient range of samples is still necessary for a robust time study.

Having video cameras present may initially influence the way employees behave and extend the familiarization process before employees forget the cameras and work naturally.

Customers may inadvertently be captured on video. This is a consideration in some industries, such as healthcare.

Accuracy is always the key to using time studies to develop standards, and digital capture is a powerful tool for ensuring accuracy. As standards age and require



Predetermining time

Industrial engineers use predetermined motion time systems to analyze manual operations or tasks, using the information to set standard times for workers. MTM (methods-time measurement) is a predetermined time system with publicly available research and data, according to *Engineered Work Measurement*.

regular periodic maintenance, a digital record allows for unprecedented comparison to current processes and documentation of what was captured in the original standard. Video brings us the ability to eliminate any confusion and also provides a format for identifying methods improvement. The ability to observe any task in slow motion presents nonvalue-added activities with clarity. If a predetermined time system such as MTM is used to develop standards, the video record provides an accurate and consistent basis to identify allowed times. The video serves as a training tool to refresh experienced workers or consistently demonstrate standard practices for new hires.

The authors of the fourth edition (1987) of that book, Delmar W. Karger and Franklin H. Bayha, describe how Harold B. Maynard, Gustave J. Stegemerten and John L. Schwab developed the research in the 1940s at the Methods Engineering Council in Pittsburgh. MTM2 is the second generation of that research.

Many factors ultimately will influence the design of your time study activities, and video is another tool to consider as you approach a project. Often, the potential benefits outweigh the additional costs or complications, and both aspects should be considered during the planning phase of any project.

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