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# Application of the New ASTM Standard for Job Productivity Measurement in Construction

By Dr. Perry Daneshgari  
& Heather Moore

**T**he United States construction industry has represented 14 – 25 percent of the entire world's construction for the last century, amounting to one trillion dollars in annual contribution to the U.S. Gross Domestic Product (five to six percent). Overall, the U.S. has enjoyed one of the highest productivity increases of her workforce when compared with all the other nations. With less than 4.5 percent of the world population, the U.S. controls more than 40 percent of the world's wealth. The national increase in productivity of all industries is, however, not mirrored in the construction industry (see Figure 1). According to the National Institute of Standards and Technology (NIST), the construction industry is a major contributor to the U.S. economy; however, its contribution to the national productivity lags the national average. The productivity cannot be improved to be at par with the rest of the nation unless it is correctly measured, and the measurement acted upon for improvement.

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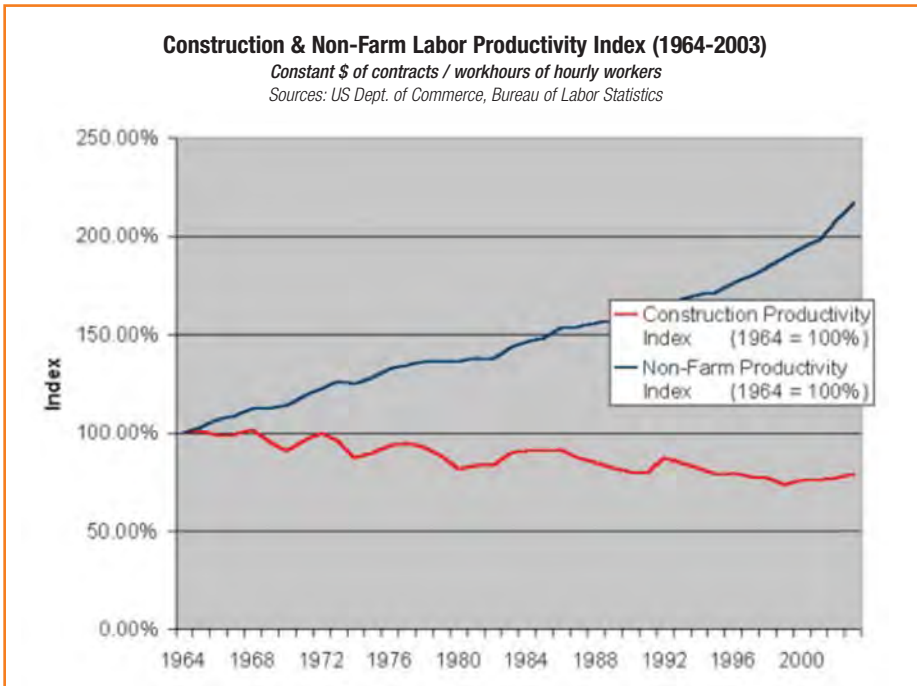


Figure 1: Productivity of U.S. Construction Industry vs. All Industries  
 (Source: Teicholz, Paul. "Labor Productivity Declines in the Construction Industry: Causes and Remedies." AECbytes Viewpoint. Issue 4, April 14, 2004.)

Construction has a new standard for measuring job productivity to combat this situation. The American Society of Testing and Materials International (ASTM) has recently adopted a new standard for measuring construction productivity at task, project, and industry levels. The new standard ASTM E2691-09 is a fast-paced and real-time measurement of productivity, which relies on the true input from the field for measuring construction put in place, and reflects on any gains or losses of productivity instantaneously. The new standard is called Job Productivity Measurement or JPM. In addition to the rate of productivity, JPM will measure the change of rate of productivity during the same time frame it measures the job progress.

The motivation for the standard is linked to a widely-recognized need for productivity improvement in construction. What gets measured gets managed, and without a standard and correct measurement, the industry has suffered for decades.

The ASTM standard E269, developed by the authors, can help reduce construction cost by more than 30 percent, allowing American construction companies to be more competitive nationally and internationally. By adopting this program the U.S. government will help reduce the cost of shelter by 30 percent.

By using the standard to measure productivity on a project, an electrical contractor identifies the productivity trends of any given job as well as the field response to individual cost codes. The graphed productivity trends model the job, enabling the contractor to visualize, monitor, and root-cause the labor

productivity variation from the field's perspective. This insight into the job provides the user with a way to manage the causes of labor productivity variation and ultimately, to manage the relationship between the labor productivity and job profitability.

To set up the base-line productivity for a project, JPM starts with the process of establishing a Work Breakdown Structure (WBS). Figure 2 is a picture of the process of creating the WBS, involving several foremen, the general foreman and project manager for the electrical contractor on the project, and the superintendent for the general contractor attended as well. To create the WBS, they referenced the electrical drawings for the project, and the project managers' and estimators' knowledge of the project and contract. At this stage, the WBS only defined the work and cost codes. The important outcome of the WBS step is to develop the structure for the JPM reporting that will match the way that the installers will be able to visualize the work, which makes the reporting of observed percent complete for JPM more accurate and reliable, and easier for the foreman.

Once the WBS is developed, the field provides input on the budgeted hours associated with the WBS elements. Their input is critical here, since no job is built the way it was estimated. The estimated hours can be a reference point, but in order for the JPM to be accurate and useful to improve productivity on a project, the field's budget must be used. Once a baseline construction budget has been established, the work is tracked with regular frequent updates from the field. While current informa-



Figure 2: Process of developing the WBS

tion comes with every update, productivity trends can be seen in just a few update cycles. JPM projects the productivity through the end of the job based on individual cost codes, giving early warning signals regarding the outcome of the job.

Figure 3 is a sample of the commercial application of JPM, Job Productivity Assurance and Control (JPAC®). JPAC® positioning above the baseline indicates the project is proceeding more productively than planned; positioning below the baseline indicates the project is proceeding less productively than planned. Even more important than the actual positioning is the trend: is the job or cost code becoming more or less productive as the work proceeds and the situation changes?

For example, consider the following job (see Figure 4) as tracked with JPAC®. The overall job is showing a special cause variation evident in the downward trend of five consecutive points, each lower than the last (the difference from expected productivity is lower and lower each week). If the components of the job are separately evaluated (see Figure 5) in order to further identify the causes it becomes clear that most of the job is progressing as expected except one cost code. To further identify the causes of variation in a job, the job is segregated into cost codes.

In this example, the installation of conduit is the underlying source of the productivity decline. Figure 6 shows the productivity trends of another job. The driving cost codes, those that severely impact the overall productivity, can be seen in Figure 7 as conduit and wire. However, another cost code, distribution equipment in this case, is identifying another potential problem that, if left unchecked, will impact end-of-job profitability.

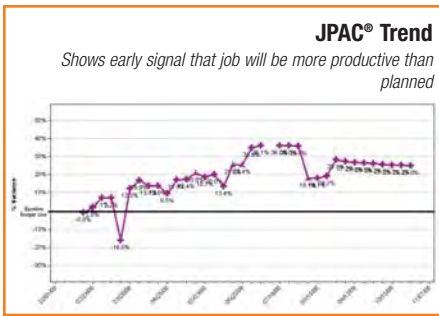


Figure 3: Sample of the commercial application of JPM

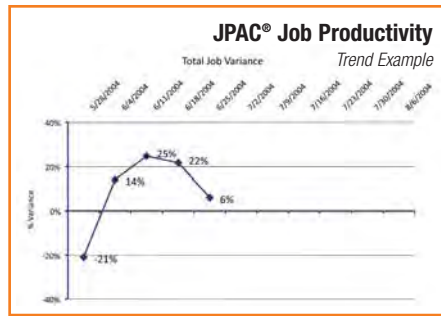


Figure 6: Example Productivity Trend

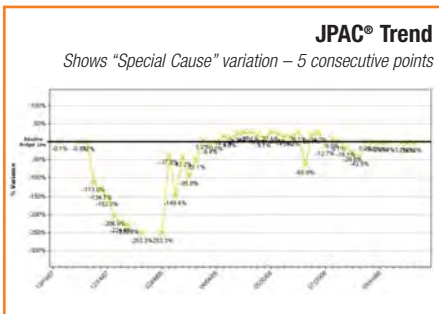


Figure 4: Example of JPAC® showing a special cause variation

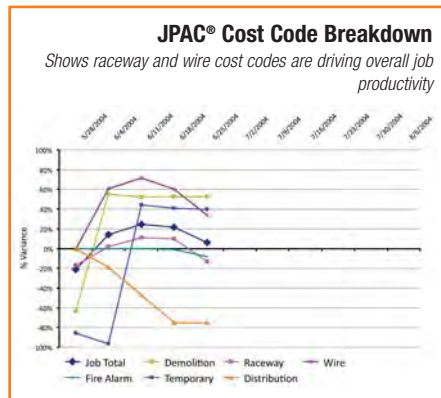


Figure 7: Cost Code Breakdown

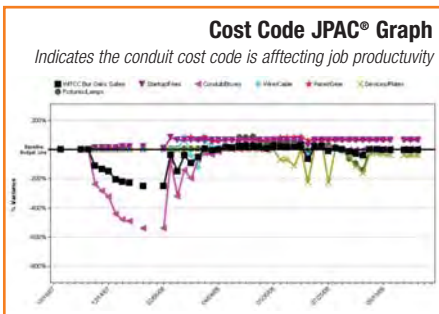


Figure 5: Separated evaluation of job components

The process for measuring productivity beyond the total job begins with the development of a common language: a defined cost code system of high level "activity codes." They should be used consistently across projects on a company-wide (or division-wide) basis. Different divisions doing other types of work may need to use a different set of cost codes, but each division should only have about 15 to 20. Of those, only seven to 10 different codes will generally be used to break down any one job. JPM tracks productivity on jobs by monitoring, and then rolling up, the productivity on the standardized cost codes.

The work breakdown structure is used to segment the cost codes further into activities that are specific to the project, which includes the activities from the field's perspective, which are more than likely not thought of during the estimate. For example, activities such as layout, labeling, clean-up, commissioning, and others are all identified up-front so their contribution to the final installation can be measured and tracked.

On the job, the electrician reports the "Observed Percent Complete" for each of the tasks he has worked on during the update period. These completed percentages are compared with the high level cost code labor hours submitted weekly for payroll. If the observed completion is outpacing the planned hours, the job is deemed to be ahead and therefore more productive.

On any job, two to four cost codes will generally be the "driving cost codes" that encompass the majority of the work, and are weighted accordingly in the graph reporting.

One of the most misunderstood concepts in the construction industry is the difference between productivity and production. Due to the nature of accounting principles used to manage company profitability, most measurements of job productivity really are book keeping measurements of production and not measurements of productivity.

The existing methods claiming to measure productivity primarily focus on accounting measures such as Earned Value Analysis (EVA) and lack the capability to report the ongoing events on the jobsite in time to make decisions or adjustments that would improve productivity. Accounting methods are primarily after-the-fact reporting of quantitative or earned value measures and offer no information for improving productivity of the construction project as it unfolds.

The ASTM Standard E2691 states, "Job Productivity Measurement (JPM) is a new standard practice for

measuring construction productivity by measuring work performed compared to construction put in place. JPM measures quality of the construction outcome by measuring observed completion of the project as accepted by the customer. Use of this practice will reduce the need for end-of-the-job inspection on construction projects by providing ongoing and periodic feedback on errors, repairs, and rework. These issues will be resolved as they are identified with JPM as the job progresses."

By measuring productivity and its changes during construction projects, the issues impacting productivity can be identified and resolved, resulting in better productivity on jobsites, which will elevate construction productivity at a national level. A measurement method that will periodically and continuously inform the stakeholders of productivity losses to allow for corrective action does not exist. JPM was developed to address this kind of deficiency by measuring construction productivity at three levels: task, project, and industry. With this method, electrical contractors can measure their productivity, general contractors can also benchmark the productivity of different contractors, and the government can monitor the overall industry's productivity to identify areas where research and innovation could help the industry become at par with the other industries in the U.S.

Additionally, JPM provides an early warning signal for construction performance. It measures ongoing productivity changes, trends, and anomalies resulting from changes on a construction jobsite, which enables contractors, project managers, supervisors, and foremen to react and improve productivity as the construction project unfolds.

Contractors who apply JPM tracking will be able to improve their cash flow and profitability. By correctly recognizing progress on jobs, they can accurately bill for the work that has been done, thereby improving their cash flow.

## IN·SIGHTS

*Dr. Perry Daneshgari is the President of MCA, Inc. and has been actively helping various industries to improve productivity and profitability. He has published over 50 papers in magazine articles, has published three books, and holds numerous degrees and certificates.*

*Heather Moore has worked on developing and applying the concepts of Agile Construction® in the field on hundreds of construction projects with several contractors. Her focus is on measuring and improving productivity. She holds an industrial engineering degree, an MBA from University of Michigan, and is pursuing a PhD in construction management at Michigan State University.*

*Dr. Daneshgari will be a presenter at the 54th Annual IEC National Convention & Electric Expo. To hear his presentation, please join him on Thursday, October 13, at 9:15 a.m. for his session, Pre-Fabrication Design.*