Preparing and Presenting Loss of Labor Productivity Claims: Analysis of the Methodologies with Two Exemplars

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Understanding the Nature of Loss of Labor Productivity Claims

It is beyond doubt that losses of labor productivity exist in the construction industry. When a party seeks to recover damages for loss of labor productivity, proving that such losses occur is not the challenge. The challenge is linking cause and effect sufficient for the trier of fact to understand the claim and make the appropriate determination, whether that trier of fact is a panel of a board of contract appeals, a judge on the Court of Federal Claims, a federal or state court judge, or an arbitrator.[1] "The fact that proving the amount of productivity losses is recognized as being notoriously difficult does not abrogate [claimant's] fundamental responsibility to prove by a preponderance of the evidence that a Government action caused its labor to be less efficient than planned and the extent of that impact."[2] There is no absolute standard methodology for demonstrating a loss of labor productivity. In fact, in many cases, it is not only appropriate but also more compelling to use more than one. This article discusses methodologies for demonstrating loss of labor productivity and presents two cases in which the authors were involved as exemplars where the claimants successfully used multiple methods to prove the loss.

Loss of Productivity Claims Arise Normally as Constructive Changes

From an entitlement perspective, loss of labor productivity claims almost always arise as constructive changes, and they almost always are proven through expert analysis and testimony. In *Centex Bateson Construction Co., Inc.*,[3] the VABCA held that claims for loss of labor productivity under a construction contract are constructive change claims that arise under the contract changes provisions. A claimant is entitled to an equitable adjustment computed under the terms of the contract changes clause.[4]

Further, in *Centex Bateson*, the board discussed the nature of inefficiency or impact claims, stating:[5]

> Impact costs are additional costs occurring as a result of the loss of productivity; loss of productivity is also termed inefficiency. Thus, impact costs are simply increased labor costs that stem from the disruption to labor productivity resulting from a change in working conditions caused by a contract change. Productivity is inversely proportional to the man-hours necessary to produce a given unit of product. As is self-evident, if productivity declines, the number of man-hours of labor to produce a given task will increase. If the number of man-hours increases, labor costs obviously increase.[6]

In order to recover for a loss of labor productivity, "the contractor must show the normal or expected level of performance and must also show the extent to which the Government's action impacted that performance, reducing labor efficiency."[7] Although a well-known phenomenon because they are constructive changes—and thus not always anticipated or known when they arise—"[i]t is a rare case where loss of labor productivity can be proven by books and records."[8]

Consequently, loss of labor productivity claims usually depend on the opinions of expert witnesses. In addition, "[i]t has also been recognized that loss of labor productivity is

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difficult to prove with exactitude and that the need to resort to estimates does not necessarily preclude recovery."[9] That said, "the mere expression of an estimate as to the amount of productivity loss by an expert witness with nothing to support it will not establish the fundamental fact of resultant injury nor provide a sufficient basis for making a reasonably correct approximation of damages."[10]

General Points Regarding Proof of the Claim

In order to prove entitlement to an equitable adjustment, a contractor must establish three elements: liability, causation, and resultant injury.[11] The object of the adjustment is to make the contractor whole by paying the reasonable costs incurred due to the impact.[12] As the Court of Claims put it in *Wunderlich Contracting Co. v. United States*, the contractor "need not prove his damages with absolute certainty or mathematical exactitude. . . . It is sufficient if he furnishes the court with a reasonable basis for computation, even though the result is only approximate."[13] Although counsel often cite that part of the *Wunderlich* opinion, counsel and experts should not overlook the next sentence of the opinion: "Yet this leniency as to the actual mechanics of computation does not relieve the contractor of his essential burden of establishing the fundamental facts of liability, causation, and resultant injury."[14] "The objective is to place the contractor in as near the same financial position as he would have been in had the breach complained of not occurred."[15]

Thus, it is well established that the ascertainment of damages or the amount of an equitable adjustment is not an exact science.[16] In an ideal world, claimants would always track costs and "submit actual cost data because such data 'provides the court, or contracting officer, with documented underlying expenses, ensuring that the final amount of the equitable adjustment will be just that—equitable—and not a windfall for either the government or the contractor."[17] But the courts, boards, and many arbitrators recognize that the amount sought by a claimant need not be ascertainable with absolute exactness or mathematical precision. What is essential is that evidence presented is sufficient to enable a court or board to make a fair and reasonable approximation.[18]

That leaves construction lawyers, labor productivity experts, and their clients with their mission: how to best present a loss of labor productivity case where a claimant's labor productivity and cost records may be lacking. Several methodologies are available, and the selection of one or more of them depends upon the quantity and quality of the claimant's estimating and labor productivity records—and, of course, upon the events that unfolded during the construction project. One key point to take away is that oftentimes it is appropriate, or even necessary, to use more than one methodology to prove the discrete elements of an overall claim for a loss of labor productivity.

The available methods of quantification are well known through industry publications, such as those published by the Association for the Advancement of Cost Engineering International and in the upcoming American Society of Civil Engineers' publication on quantifying loss of labor productivity. These include, but are not limited to, the measured mile method (both the project-specific and the similar-project methods); the earned value method; contemporaneous work sampling and worker questionnaires; industry studies (that include the Mechanical Contractors Association of America (MCAA) and the National Electrical Contractors Association (NECA) publications) and academic writings on the concept of cumulative impact; and modified and total cost computations.

As a last resort, where a board finds overwhelming evidence that a loss occurred and that the government was responsible for it, but the contractor was not able to prevail on one of the generally accepted methodologies, a board may take it upon itself to fashion relief for the contractor's loss. In *States Roofing*, the Board declined to accept a flawed measured mile, a flawed modified total cost analysis, and a flawed MCAA Factors analysis offered by a biased nonexpert witness, but given the clear evidence of impacts caused by the Navy, it used the jury verdict approach to award damages.[19]

Yet no prudent counsel or expert should rely solely on such an approach. Rather, largely through a focus on the events that occurred on the project and the available records, counsel and the experts are normally able to analyze the data, follow one of the accepted methodologies, and present a viable claim.

Selecting the Methodology—What Will the Claimant's Records and Testimony Support?

Choosing the most appropriate methodology to identify and quantify the claimant's loss of labor productivity is one of the most important decisions made by the claimant's team. In terms of the expert report and trial presentation, it is critical to distill complicated data into plain-language testimony presented by credible witnesses, in order to convey a narrative that is both comprehensive and compelling. The experience of construction counsel and the productivity expert is essential in making that determination. Choosing the methodology depends on several factors that include, but are not limited to, the following: (1) the type of labor productivity records maintained by the claimant; (2) if sufficient productivity records were not maintained, whether they can be prepared after the fact using the available data; (3) what other types of records exist bearing on cause-and-effect, such as notices, daily reports, cost reports, schedules, time tickets, and photographs; (4) the quality of the fact witnesses (that is, whether they are experienced, credible, and reliable); (5) whether the particular methodology has gained acceptance by the court, board, or panel that will try the case; and (6) what is the prior experience of the trial attorney and the testifying expert in analyzing the data, properly applying the chosen analysis, and preparing a persuasive presentation with effective cross-examination.

Experts and counsel should not arbitrarily limit the presentation to one methodology if the sources of data and discrete claims are different. In the exemplars discussed below, more than one methodology was used successfully for the proof of discrete components of the claims. The available data drove the decision on which methodology to pursue.

The Measured Mile Method

There is little question that the method most preferred to identify and quantify losses in labor productivity is the measured mile. A measured mile analysis compares work performed in one period not impacted by events causing a loss of productivity with the same or comparable work performed in another period during which the work suffered impacts due to productivity-affecting events.[20] Many reported decisions declare the measured mile method the most favored in quantifying losses in labor productivity.

Rather than basing the damage calculations upon estimates with reasoned adjustments, the measured mile method has the advantage of using actual data from the project to determine the cost difference between work performed under normal conditions and work performed under changed conditions.[21] But there are cases that have rejected improperly prepared measured mile analyses, and there are a few reasons for this: (1) the claimant's labor productivity records are flawed, making a reasonable comparison between less-impacted performance and impacted performance impossible; (2) there is no reasonably unimpacted, or less-impacted, area of work or time frame with which to compare to the impacted area or time frame; or (3) there is no reasonably similar "other" project to use as the less-impacted model.

Not all contractors implement controls that allow the contemporaneous development of a unit rate ratio—that is, labor hours required to perform a specific activity of work. This may be changing with the advent of bar coding of materials, such as ductwork or piping systems, and better labor tracking tools. But at present, many contractors do not contemporaneously track the labor required to install discrete components of the work. However, the expert cannot automatically rule out a measured mile analysis.

Even if a claimant's labor productivity records are seriously flawed or its records were not prepared in a manner that anticipated a loss of labor productivity claim, preparing a compelling measured mile analysis remains possible. When the data are sufficient, measured mile analyses are performed in an after-the-fact manner. While few contractors track labor by the discrete material they install, many contractors record labor tracked by the activity of work using coded timecards. From these coded timecards, and using a take-off of materials from the construction drawings, the expert can often determine the actual labor hours required to perform a unit of work. This is called the unit rate ratio of installation, based on the labor hours actually expended to perform an identifiable quantity of work.

For example, a masonry contractor determines acts and omissions of others that impacted its work and made it inefficient. By comparing the timecards of workers in a discrete area of the project that was deemed to be less impacted, the claimant can determine the labor hours required to install a certain type and quantity of concrete block. In performing the same analysis using the labor-coded timecards for areas affected by the adverse conditions, *ceteris paribus*, the claimant can ascertain the productivity rate ratio; that is, the number of blocks that could be set per labor hour in the impacted area or time frame. The difference in productivity between the less-impacted and the impacted area or period is the measured mile ratio that leads to a calculated percent loss in labor productivity.

The benefit is that the measured mile method compares the actual productivity rate of reasonably *similar* material types (but not necessarily exact matches),[22] by the same or similarly skilled crews, on the same project,[23] under similar conditions other than those that caused the contractor's loss.[24]

Impact conditions include the stacking of trades, disruption of the work, lack of reasonable access to work areas, and other recognized categories of impacts. The measured mile method is called "empirical" because it uses data collected on the project under study and not upon industry studies or academic treatises. However, the expert should consider opining on the methods used by the claimant to record actual labor hours by physical areas and/or elements of work. The expert must be able to testify that the labor hours recorded on the time cards or other payroll media that define the labor effort by area of the project or element of work are reliable because the expert will use them to compute the inefficiency factor.

The measured mile method also may allow the expert to disregard the contractor's original bid estimate because the measured mile method only relies on the contractor's actual productivity rate ratio achieved on the affected project. And the measured mile negates the need to isolate the impact of discreet causes on the same work activities.

> As both parties recognized, separating differing site condition-related shells and sand from non-differing site condition-related shells and sand with precision is impossible. In choosing the Measured Mile Method, we believe we are within the well-established principle that the determination of equitable adjustment is not an exact science; where responsibility for damage is clear it is not essential that the damage amount be ascertainable with absolute or mathematical precision.[25]

Another advantage is the measured mile does not amount to a modified total cost computation. In presenting a measured mile analysis, it is essential that the expert connect the effects (the inefficiency factor presented) with the cause or causes of the impact. The expert may present the construction drawings or photographs of the areas being measured to show the similarities of the physical areas, type of materials being measured, and, if possible, examples of the causes of the inefficiencies, such as standing water, stockpiles of materials or debris, trade stacking, or other identifiable causes of labor impacts.

As with all types of inefficiency presentations, credible fact witness testimony can be an essential element of the presentation of the case. Fact witnesses may provide input to the productivity expert and explain the impacting events to the court, board, or arbitrator. Counsel sometimes overlook or take for granted the important connection between the key fact witnesses and the productivity expert. When that occurs, the disconnect often confuses the presentation and reduces the effectiveness of the expert's analysis and testimony. More information about the recommended criteria for identifying and pursuing a measured mile analysis can be found in other references.[26]

While the measured mile is sometimes preferred, the methodology may not be viable. The project labor records may lack physical area or labor hour specificity, they may be inaccurate, they may be lost or destroyed, or they may be unreliable or unusable. In such cases, the construction counsel, expert, and the claimant must consider alternative methods to quantify the claimant's loss of labor productivity.

The Earned Value Method

Moving from the empirical measured mile to other methods that rely on the claimant's estimate—labor hour plan, payment applications, and/or progress reports—can present multiple challenges to the claimant's counsel and expert. Once the expert relies on data not actually collected on the project, each element of the expert's foundational opinion must be vetted and, if found wanting, adjusted.

The earned value method is premised on the fact that documents normally present on a construction project can be used to determine a level of effort required to perform discrete activities on a period-by-period basis. From these determinations, it may be possible for an expert to arrive at conclusions regarding productivity impacts. The earned value method utilizes an evaluated progress amount, usually a percent of progress achieved during the billing or payroll period that is the result of an evaluation and agreement between the contractor and the owner's representative (i.e., the owner's construction manager, architect, or engineer). The contractor's "earned value" is calculated by multiplying the percentage of completion of an item against the planned value of that item. Documents such as approved payment applications replicate this on a monthly basis.

The expert may then decide to compare the earned value with the actual labor hours or dollars expended on each line item of work. For instance, the expert may identify similar line items of work, some performed during less-impacted periods or within discrete less-impacted project areas, and some performed during impacted periods or within discrete impacted project areas. Done properly, such comparisons may result in a reliable labor inefficiency percentage.

The difference, when the actual labor effort exceeds the earned labor effort, *may potentially* represent the contractor's loss of labor productivity. However, such losses may spring from other factors not related to the contractor's actual performance, as discussed below. The identification of the cause-and-effect nexus must support the analyst's findings of actual labor inefficiency for those activities where there was an overrun in labor, earned versus actual.

The table below illustrates an example of a contractor-generated earned value labor plan versus actual spreadsheet.

The earned value method has a number of variables that the expert must vet prior to reaching a conclusion. The absence of a verification of these items may prevent the claimant or its expert from concluding that the labor overrun is actually a loss of labor productivity. The variables include, but are not limited to, the following:

1. Was claimant's labor estimate sound?
2. If the estimate was found to be competent, were the labor hours, or labor dollars, allocated on the payment application form or labor spreadsheet in an appropriate manner so that similar activities of work were shown to take approximately the same level of effort (e.g., front-end loading, if present, can greatly affect this allocation)?
3. For atypical or unique activities of work, how did the contractor estimate the labor plan that was reflected in the payment application form?
4. Were scope change and change order hours or dollars identified and adjusted in the labor plan?
5. How were the progress percent complete values arrived at contemporaneously, by what parties, and with what supporting evidence (e.g., photographs or marked-up contract drawings)?
6. Was the process of identifying and recording the actual labor hours charged to each activity code on the payment application or on the contractor's labor spreadsheet verifiable and sound?

If any variable is erroneous, the conclusions may be flawed. Because the earned value method relies on the original (or adjusted) labor bid and labor plan, and on periodic percent complete assessments, preparing a defensible earned value analysis is a challenging process and should be considered carefully by the claimant's counsel and expert. Claimants also

Contractor-Generated Earned Value Labor Plan[27]

Activity Code	Activity Description	Planned Hours	CO Hrs	Rev Plan	Last % C	Current % C	Earned Hours	PT AH	C Act Hrs	Wk -2	Wk -1	Cw
7550	Inst CHWS&R Mains Area B	500		500	30	50	250	300	450	-75	-150	-200
7570	Inst CHWS&R Brnchs Area B	700	50	750	10	20	150	120	200	-40	-45	-50
7590	Connections @ Mech Equip	100		100	10	15	15	10	12	0	0	3

should note that there is not much legal guidance—positive or negative—on the use of the earned value methodology.

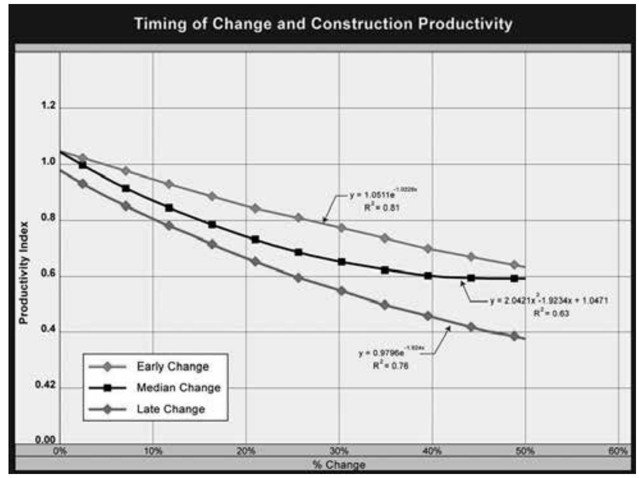
Cumulative Impact

The concept of cumulative impact is well recognized and is certainly not a novel concept when used to categorize the causes of a loss of labor productivity. In *Centex Bateson Construction Co. Inc.*,[28] the VABCA provided a common definition of cumulative impact:

> Direct impact is generally characterized as the immediate and direct disruption resulting from a change that lowers productivity in the performance of the changed or unchanged work. Direct impact is considered foreseeable and the disrupting relationship to unchanged work can be related in time and space to a specific change. Cumulative impact is the unforeseeable disruption of productivity resulting from the "synergistic" effect of an undifferentiated group of changes. Cumulative impact is referred to as the "ripple effect" of changes on unchanged work that causes a decrease in productivity and is not analyzed in terms of spatial or temporal relationships. This phenomenon arises at the point the ripple caused by an indivisible body on two or more changes on the pond of a construction project sufficiently overlap and disturb the surface such that entitlement to recover additional costs resulting from the turbulence spontaneously erupts. This overlapping of the ripples is also described as the "synergistic effect" of accumulated changes. This effect is unforeseeable and indirect. Cumulative impact has also been described in terms of the fundamental alteration of the parties' bargain resulting from the change.[29]

In the 1980s, contractors began to recognize that in many instances, they were not recovering all their costs when performing change order work. This was especially true when there were substantial amounts of change. This phenomenon spurred considerable academic research, led by Charles Leonard, who analyzed the records of fifty-seven different Canadian projects. From that work, he developed statistical "regression curves" that generally showed (1) larger amounts of change led to great loss of productivity and (2) there was roughly a ten percent threshold, meaning that projects with ten percent or more changed work typically encountered a loss of productivity that was over-and-above the amounts recovered in the approved change orders. Leonard's work was valuable but flawed for several reasons. The projects were typically small, averaging under $10 million in contract value. That, in turn, calls into question the resources of the contractors performing the projects. Secondly, and perhaps most importantly, the projects were drawn from the files of a claims consultant and, thus, may not truly represent the industry. It may be useful for the expert presenting a cumulative-impact loss of productivity calculation to review the published critiques of the Leonard study. The cumulative impact study published by Professor William Ibbs, Ph.D., of the University of California at Berkeley (and one of the authors of this article), addressed the deficiencies of the Leonard study.[31]

Figure 1. Ibbs's Loss of Productivity Curves[30]



The Ibbs study sprang from the response to growing interest in the cumulative impact phenomenon. The Construction Industry Institute commissioned researchers at the University of California at Berkeley to conduct a broader, more representative study of the quantitative effects of changes on labor productivity. Professor Ibbs worked with owners and contractors and has collected data from 172 projects for the past twenty years. He obtained all project data (e.g., productivity, actual project hours, change orders, contractor errors, etc.) directly from project principals and he adjusted for self-inflicted problems and other anomalies. The projects include both domestic and foreign work, as well as public and private projects with different delivery systems. They range in size from $2 million to $14 billion, with a median value of $44 million. This provides a set of data that is more representative of the construction industry.

In addition to the impacts the amount of change has on productivity, the Ibbs study also explored the impact of the time of the change. A key finding of that study is that the timing of change is important to the loss of productivity. Figure 1, above, demonstrates this effect. In Figure 1, the vertical axis measures the Productivity Index (PI), and the horizontal axis measures the amount of change. The three curves depict the consequences of time: They identify the effect of "early," "median," and "late" changes. PI is the ratio of planned productivity to actual productivity, and so a PI above 1.0 represents good project performance.

Figure 1 also demonstrates that projects with late changes may encounter much more disruption. For example, at ten percent of change, the late curve has a twenty percent productivity loss, whereas the normal curve has a ten percent loss. Moreover, early and normal projects that have small amounts of change (less than four percent) may still encounter a PI value greater than 1.0, whereas late-change projects always demonstrated a PI value less than 1.0.

When planning to use statistical analyses such as the Ibbs study, it is important for the claimant and its expert to understand how the data were collected, the types of projects that were included in the study, and when the changes occurred on the project under study. The expert should be able to describe how the change-related labor hours were collected, how the timing of the changed work was established, and how the actual contract labor hours were computed. The formula for calculating the loss of labor productivity using the Ibbs study requires potential adjustments to the labor hour data. For instance, the claimant's estimate should be evaluated to determine if it was reasonable, and if errors are discovered, those hours must be adjusted in the calculation. Similarly, adjustments to the actual hours must be made if any self-inflicted errors are identified, such as bid errors or field execution errors by the contractor.

A labor productivity analysis based on an industry study depends on the project-specific records, which may include the claimant's estimate, changes in scope (approved or unapproved), or the claimant's self-inflicted issues such as rework. The expert presenting a cumulative impact study must have independently reviewed the claimant's labor data and have reached conclusions based on the formulae and methods described in the published study along with the project records and fact witness interviews.

Methods Based on Industry Studies and Academic Treatises

There are many oft-cited industry studies on estimating a contractor's loss of labor productivity, and this writing will not attempt to identify all, or even a majority, of them. There are academic publications that go beyond a discussion of the types of various elements of inefficiency and provide a means to estimate those losses. The industry and academic studies that provide a means of quantifying loss of productivity that are most often seen in hearings and trials are the MCAA factors,the MCAA publication on overtime inefficiency that includes the overtime tables published by NECA, the overtime inefficacy study published by the Business Round Table (BRT), the overtime study published by Dr. Randolph Thomas and Karl Raynar for the American Society of Civil Engineers (ASCE), and the Ibbs study. All of the aforementioned studies and the resulting data and charts may be found in the MCAA publication cited herein.

Often, relying on an industry study is necessary when an empirical method, such as the measured mile, is not able to be used.

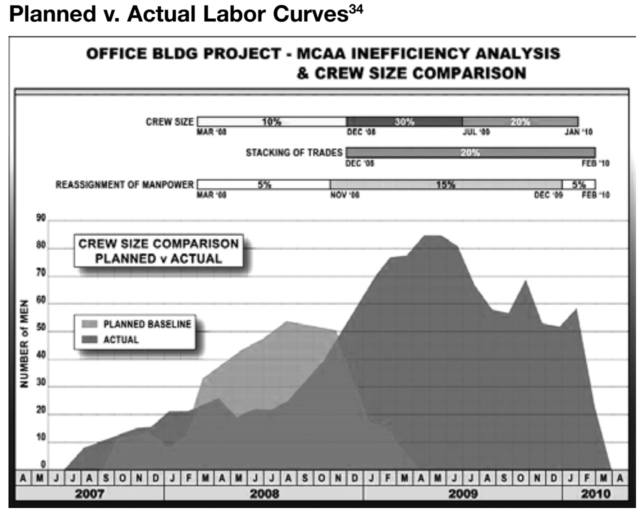
> Our Board has recognized that it is somewhere between impractical and impossible to maintain cost records identifying and separating inefficiency costs. For this reason, we have utilized the productivity factors from the MCAA Manual, published by the Mechanical Contractors Association of America, to estimate the extent of impact on labor productivity in the absence of better evidence, such as a "measured mile" analysis. This is appropriate where the record indicates a negative impact on the productivity of a contractor's workforce. *Clark Construction*, *supra.*, at 52, 418-19, citing *Fire Security Systems, Inc.*, VABCA No. 3086, 91-2 BCA ¶ 23,743.[32]

The MCAA Factors

The MCAA factors were first introduced in 1971 and contain sixteen factors, or potential causes of labor inefficiency. The sixteen factors and their descriptors have remained unchanged since their initial publication and have achieved wide acceptance at the major Boards of Contract Appeals, most notably at the former General Services Board of Contract Appeals, the Veterans Administration Board of Contract Appeals, and the Civilian Board of Contract Appeals. The factors have been accepted over objections that they are inherently subjective, as subjectivity is overcome by the MCAA's admonition to apply them based on the expert's reasoned judgment in light of the facts of the particular project.[33] Applied properly, the MCAA factors allow a claimant, or the claimant's productivity expert, to estimate the claimant's labor losses with the required level of specificity, normally based on fact witness interviews and a thorough review of the project records.

While cases based on schedule-related time impact analyses are usually overflowing with schedule diagrams and charts, experts sometimes overlook the use of focused trial graphics to explain the loss of labor productivity. Oftentimes, the loss of labor productivity on a project is not linear but modulates over time as events change on the project. Taking a temporal approach to measuring a loss of productivity based on industry studies can increase the credibility of the expert and the reliability of the expert's identification of the causes and the resultant effects. By way of example, Figure 2, below, is a chart overlaying the MCAA factors selected by the expert with

Figure 2. MCAA Factors Overlaying Planned v. Actual Labor Curves[34]



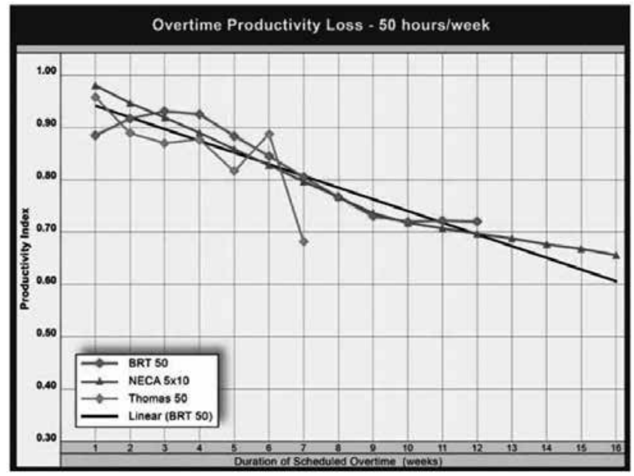
the planned and actual labor curve. Note that the MCAA factors do not remain constant in this example but modulate with the changing conditions on the project, allowing the expert to testify with greater specificity.

The MCAA's project management and labor inefficiency publication has been endorsed by NECA, the Sheet Metal and Air Conditioning National Association, and the American Subcontractors Association as being applicable to the trades those associations represent. When applied by an experienced labor productivity expert, coupled with credible fact witness input and testimony tied reliably to the project records, the MCAA factors can be a useful means of estimating a contractor's loss of labor productivity. Because the industry study methods are not empirical but cite to data not created specifically for the project under study, the proponent should recognize the potential weakness of industry studies. Moreover, in many cases, the data underlying the particular study may no longer exist, thus preventing a review of the means of data collection or their sources. Though based on studies, the MCAA Bulletins are not "published and peer reviewed" in the scientific sense.[35] Whether a theory or technique has been subject to peer review and publication bears on its admissibility.[36] But at the same time, "peer review is not a sine qua non of admissibility."[37] Peer review and publication do not guarantee reliability, or vice versa. So the fact that the MCAA factors have not been formally peer reviewed does not necessarily render them unreliable.[38]

The NECA, BRT, and Thomas Overtime Inefficiency Studies

As with the MCAA factors, data supporting the NECA and BRT overtime inefficiency curves no longer exist and so there is no ability to analyze further the source data. Also, these studies are not peer reviewed.[39] The data for the Thomas overtime inefficiency curve exists and the writing, published by the ASCE, was peer reviewed. The data have been combined in comparative curves and tables allowing a claimant or its expert to estimate the contractor's loss of labor productivity arising from an overtime schedule. While only the Thomas overtime curve was peer reviewed and the underlying data exist, the MCAA's publication is very similar with respect to the shape of the various overtime inefficiency curves based on the intensity level of the overtime schedule worked. Such comparisons can aid the claimant or its productivity expert in quantifying the contractor's loss of labor productivity when working an extended-overtime schedule. An example of the comparative overtime inefficiency curves derived from a comparison of the NECA, BRT, and Thomas data is illustrated by Figure 3, above.[40]

Figure 3. Overtime Loss Curve[40]



Cost-Based Methods—the Modified and Total Cost Methods

The total cost and modified total cost approaches are not analytical methodologies; they are arithmetical computations of damages based on an original estimate and final costs. They offer no particular insights as to where, why, or how the labor losses occurred. They are not always favored by triers of fact,[41] 1and only in certain cases is the modified cost method suitable as the primary approach for a claimant to cast its loss of labor productivity claim.

> The Modified Total Cost Method was derived from the Total Cost Method which the Court described as a method of "last resort" to be used in "extraordinary circumstances where no other way to compute damages was feasible." *Servidone Constr. Corp. v. United States*, 931 F.2d 860, 861–62 (Fed. Cir. 1991). The theory was developed to "prevent the government from obtaining a windfall stemming from the plaintiff's inability to satisfy all of the elements of the total cost method." *Youngdale & Sons Constr. Co. v. United States*, 27 Fed. Cl. 516, 541 (1993). The Total Cost Method requires the contractor to prove: (i) the impracticability of proving actual losses directly; (ii) the reasonableness of its bid; (iii) the reasonableness of its actual costs; and (iv) the lack of responsibility for the added costs. *Servidone*, 931 F.2d at 861. To use the Modified Total Cost Method, we are to use the four elements identified in *Servidone* as "the starting point" from which to adjust a contractor's recovery to reflect its inability to prove any of the four elements. *See Boyajian v. United States*, 423 F.2d 1231 (Ct. C1. 1970); *MacDougald Constr. Co. v. United States*, 122 Ct. C1. 210 (1952).[42]

However, the modified total cost approach does have a role in virtually every loss of productivity computation and presentation even if it is not the primary approach.

It is often helpful to the claimant to demonstrate to the trier of fact that if there is an award of the labor hour adjustment derived from one of the analytical methods, such as a measured mile or the MCAA factors, there will be no windfall to the claimant. Applied appropriately, the modified total cost calculation takes the total labor hours expended on a project and subtracts therefrom the claimant's estimated labor hours, its change order and scope change hours, its time and material ticket hours, and, finally, its adjustment for any bid errors, self-inflicted labor inefficiencies, and hours spent reworking improper installations. In so doing, the claimant can make a comparison between the remainder (the modified total labor hour loss) and the inefficient hours arrived at using one of the other methods of analysis. The modified total cost analysis allows the trier of fact to understand the unclaimed labor hour balance, assuming the results of the more particularized analysis methodology is less than the labor hours resulting from the modified total cost computation.

Two Exemplars of Presenting Successful Loss of Labor Productivity Claims

Loss of Labor Productivity: Stromberg Metal Works, Inc., and Welch & Rushe, Inc., National Museum of American History, Washington, D.C.

Welch & Rushe, Inc., and Stromberg Metal Works, Inc., provided mechanical, plumbing, and sheet metal work on the Public Space Renewal Project at the National Museum of American History. In its 2017 decision *Turner Construction Company*,[436] the Civilian Board of Contract Appeals upheld their loss of labor productivity claims. The project involved major structural, architectural, mechanical, electrical, and plumbing modifications. The prime contractor and its subcontractors encountered concealed and differing site conditions that affected their labor productivity and schedule.

Welch & Rushe and Stromberg used two different methodologies to present their loss of labor productivity claims. The available records they maintain drove the selection of the particular methodologies. The sheet metal subcontractor, Stromberg, had experience using the measured mile method, and during construction, the productivity expert and Stromberg's project executive evaluated the scope change documents, productivity records, and the contract drawings to establish the areas of the building where the impacts were minimal and the areas where Stromberg anticipated substantial impacts. Stromberg maintained careful labor tracking and documented the quantities of ductwork installed in each of the designated areas of the ceiling plenums. Stromberg also established a photographic record. At the hearing, credible fact witnesses testified to support the measured mile analysis, resulting in a recovery of Stromberg's entire labor inefficiency claim.

"Because the disruptive impacts were constant and pervasive, Welch & Rushe could not identify a portion of its work that was not affected by these factors for the purposes of performing a measured mile analysis."[44] And "because Welch & Rushe worked with different materials and different sizes of pipes, identifying a 'measured mile' analysis would have been difficult."[45] Thus, the productivity expert chose to utilize an industry study methodology—in this case, using four of the MCAA factors.[46] Critically, "Welch & Rushe's superintendent explained how each of these factors was appropriate, given the difficulties that Welch & Rushe experienced on the project."[47] Before interviewing the fact witnesses or preparing the impact analysis, the productivity expert reviewed Welch & Rushe's labor and material estimate. The expert determined that Welch & Rushe underbid the labor hours and made the appropriate upward adjustment of the as-bid hours within the expert report. The board cited with approval the necessary adjustments in reaching its decision, noting that "Welch & Rushe made several adjustments to its labor hours prior to the application of the MCAA factors."[48] The expert, supported by Welch & Rushe personnel, testified to a forty-two percent labor inefficiency factor based on the application of the MCAA's labor inefficiency publication and the four MCAA factors used in the analysis. The board awarded Welch & Rushe the claimed impact percentage that was derived from the MCAA factors in its labor inefficiency claim, largely because it was bolstered by the testimony of credible fact witnesses and included the necessary adjustments to its labor hours prior to the application of the factors.

Loss of Labor Productivity: NB Kenney Company, McCormack Courthouse and Post Office Building, Boston

NB Kenney Company, Inc., was the mechanical subcontractor on the renovation of the John W. McCormack Post Office and Courthouse, a circa-1920s art deco, twenty-three-story tower located in Boston's financial district. NB Kenney's loss of labor productivity claims were upheld by the Civilian Board of Contract Appeals in a 2019 decision.[49] The prime contractor's construction counsel (who also presented the NB Kenney claim) and its productivity experts used three distinct methodologies to prove the loss of labor productivity. In the first instance, they determined that there were very similar piping arrangements running in the ceilings on the majority of floors of the building. On the impacted floors, the "additional mechanical and plumbing labor and loss of productivity [arose] from the design team's failure to properly coordinate overhead ceiling drawings and the numerous changes that were issued by the Government through RFI responses and other directives."[50] "The record also documents numerous other significant changes, including the shaft changes, that disrupted the flow of work on the floors."[51] The measured mile analysis is appropriate in this instance, as it does not necessarily require separate analysis for each impact in the impacted area.[52] Although the mechanical contractor did not maintain contemporaneous labor productivity records, it did keep labor timecards coded to each floor. Because the mechanical systems were very similar in type and quantity between the floors, a productivity rate ratio could be established comparing the less-impacted and significantly impacted floors. And a measured mile loss of productivity factor was calculated using the differential productivity rates actually achieved by the construction crews on the floors.

The bases for the loss of labor productivity were described to the board by the claimant's project executive. His testimony was critical as he witnessed the work and the project conditions firsthand, which allowed him to attest to the problems encountered in a credible manner. He also testified as to how the labor records were maintained on the project. The board found the "measured mile analysis to be generally reasonable in using the average productivity of floors 5, 6, and 8 as the standard un-impacted measure of productivity for NB Kenney."[53] The board approved that analysis but reduced the hours by twenty percent to adjust for self-inflicted inefficiencies.[54] Other areas of the project were not susceptible to a measured mile analysis, requiring the use of other methodologies to demonstrate NB Kenney's productivity losses. The building contained a large mechanical basement and sub-basement that contained the main air-handling equipment including multiple chillers, pumps, and heat exchangers. NB Kenney's labor productivity in the basement and sub-basement suffered from several discrete impacts, including numerous design changes and concealed conditions.[55]

Due to the pervasive and ongoing nature of the impacts in the mechanical basement and sub-basement, it was not possible to segregate each causal factor in order to make a definitive loss of labor productivity analysis. The construction counsel and the productivity experts relied on the MCAA's published materials on labor disruption and overtime inefficiencies to prepare a loss of labor productivity quantification—and again, NB Kenney's fact witness testimony provided the essential foundation for the analysis. The Board approved the analysis using "the Mechanical Contractors Association of America (MCAA) factors of reassignment of manpower, crew size inefficiency, site access, dilution of supervision, and overtime." The experts rigorously applied the factors to the specifics of the case. "For each week of work in the basement, [the experts] applied an MCAA inefficiency percentage depending on severity and type of impacts."[56]

Finally, in the vertical piping shafts, construction counsel and the productivity experts determined that the changes and design defects within the various shafts were so profound and pervasive the mechanical subcontractor could be compensated fairly only by the use of a modified total cost methodology. The experts prepared a modified total cost analysis, finding NB Kenney incurred a loss of labor productivity in the shafts of $720,389. Once again, supported by credible fact witness testimony from the prime contractor and NB Kenney, the Board ruled in favor of the subcontractor, finding that "[t]he record compellingly demonstrates that the inefficiencies in NB Kenney's work was caused primarily by the shaft redesign and the substantial impact on the mechanical work in the shafts as a result of the changes."[57]

Evidentiary Issues and a Practical View on Introducing an Expert's Application of the Methodologies

Depending on the forum, claimants seeking to introduce expert testimony regarding losses of productivity may be called to clear the evidentiary hurdles applicable to expert testimony. Those vary by jurisdiction. In addition, the height of the hurdle tends to depend on the forum. That is, there may be a spectrum among arbitration panels, boards of contract appeals, and state or federal courts. Arbitrators and boards of contract appeals are not less demanding or rigorous in weeding out unsupported opinions, but they do tend to have much more experience with construction claims and thus may be more willing to allow the testimony subject to close scrutiny or rejection in the award or decision—which is likely the intent of Rule 702. Be advised of the need to properly disclose expert testimony during discovery where the expert opinion is offered as lay opinion by nonexperts. The line between testimony submitted under Federal Rules of Evidence 701 and 702 is easy to cross and may lead to exclusion of critical testimony.[58] In refusing to consider lay testimony on a measured mile calculation, the court in *Flatiron* wrote:

> As the advisory committee notes explain, "[T]he distinction between lay and expert witness testimony is that lay testimony 'results from a process of reasoning familiar in everyday life,' while expert testimony 'results from a process of reasoning which can be mastered only by specialists in the field.'"[59]

The guiding principles are set forth in the Federal Rules of Evidence regarding admission of expert testimony.[60] Because most states have similar rules or at least rules based on similar concepts, many concepts this article discusses should apply in state courts as well. Federal Rule of Evidence 702 gives courts "gatekeeping" responsibility for ensuring that expert testimony presented to a jury is sufficiently relevant and reliable.[61] Under Rule 702 and *Daubert*, it's for the court to decide whether proffered expert testimony is reliable. The test is a "flexible" one.[62] The Supreme Court has offered some factors to guide the analysis: (1) "whether a theory or technique can be (and has been tested)"; (2) "whether it has been subjected to peer review and publication"; (3) "whether, in respect to a particular technique, there is a high known or potential rate of error and whether there are standards controlling the technique's operation"; and (4) "whether the theory or technique enjoys general acceptance within a relevant scientific community."[63]

Rule 702's advisory notes outline some additional factors: (5) whether the expert's proposed testimony was developed independent of the litigation or expressly for the purpose of testifying, (6) "whether the expert has unjustifiably extrapolated from an accepted premise to an unfounded conclusion," (7) "whether the expert has adequately accounted for obvious alternative explanations," (8) "whether the expert is being as careful as he would be in his regular professional work outside his paid litigation consulting," and (9) "whether the field of expertise claimed by the expert is known to reach reliable results for the type of opinion the expert would give."[64] This is not the whole universe of factors a court can consider when deciding whether to admit expert testimony. Nor must a court consider them all.[65] Which factors to use, and how to use them, are questions for the trial court on the facts of the case before it. Under Rule 702 and *Daubert*, how a court will treat expert testimony based on one of the methodologies likely turns on how the expert applies the method to the facts. After all, claim methodologies require adequate analysis of the project-specific facts and records to meet the requirements for admission of expert testimony.

Many cases provide guidance on the acceptance of expert testimony in loss of labor productivity claims. Several examples highlight the common themes.

Rejected Inefficiency Analyses

Although noted as the "gold standard," sometimes a measured mile analysis amounts merely to pyrite. In *Southern Comfort Builders*,[66] the court rejected Southern Comfort's measured mile calculation because there was no adequate comparison between the impacted and unimpacted work. Remarkably (or perhaps strategically), Southern Comfort sought to compare its productivity with similar work performed by *another contractor*.[67] In addition, the court noted that "[a]nother flaw in SCBI's measured mile analysis is that in its calculations, plaintiff's final average labor costs under the measured mile analysis is [sic] greater than the total cost calculations. This presents a fundamental problem because, as [the expert] admitted, a total cost analysis represents the maximum amount a contractor could possibly receive."[68]

In *Clark Concrete Contractors, Inc.*,[69] the former GSBCA rejected the GSA's use of a measured mile analysis to rebut a mechanical subcontractor's MCAA factors–based analysis supporting its claim for loss of labor productivity. According to the board, GSA "knocked the underpinnings from [its] own analysis when [its expert] acknowledged, on cross-examination, that he did not know whether the work [claimant] performed during his base period was really unimpacted or whether it was comparable to the work the firm performed in the [impacted period]."[70] Apparently the unimpacted period "was actually heavily impacted . . . and the work performed by [claimant] was different in different parts of the building; the basement involved almost exclusively plumbing, whereas the penthouse involved no plumbing at all."[71] Therefore, the board rejected the analysis as it concluded there was no basis to conclude the work was comparable—a fundamental predicate of the measured mile method. The board proceeded to accept the MCAA factors as "the best way presented" to calculate the claimant's loss of labor productivity.[72]

In *Herman B. Taylor Construction Co.*,[73] the former GSBCA declined to accept a labor inefficiency claim based on crew moves, citing three faults in the analysis. First, the board found the appellant underbid its labor and "consequently was unable to demonstrate that its original labor staffing was reasonable."[74] Second, although appellant based the claim on an excess number of crew moves, the board determined the claim "lacked substantiation, both as to the number of crew moves that were originally planned for the project and the actual number of crew moves that were made."[75] Finally, the board noted its general acceptance of the MCAA Bulletin PD2 in proving inefficiency claims[76] but declined to apply it to common laborers (as opposed to skilled craft labor).[77]

Piracci Corporation[78] highlights the importance of connecting expert analysis to underlying facts and witness testimony. There, the former GSBCA rejected the claimant's claim, noting that its "entire argument rests on a series of theoretical constructs bearing no relation that we can see to the reality of what occurred."[79] Specifically, the claimant sought to recover its project-wide overtime charges, but the board concluded that "even taking the claim items with the full scope given them by appellant, we could not attribute more than a small fraction of the total overtime to them."[80] The board also rejected applicaton of the MCAA factor to extended overtime because the actual overtime was merely spot overtime.[81]

In *North American Mechanical, Inc*.,[82] the court rejected the claimant's measured mile analysis due to an inadequate sample size for the work comprising the unimpacted area. The claimant's expert "used only 30 'unimpacted' hours on a project on which [the claimant] bid over 32,000 labor hours to complete. That represents less than a tenth of one percent (0.09375%) of the total project hours."[83] The court noted that the "small sample size can detract from the value of statistical evidence."[84] The court also rejected the claimant's MCAA factors analysis because the expert "testified that he did not 'hone in on' the MCAA analysis but instead felt he 'did enough' so that he 'felt comfortable . . . that there was something there.'"[85] The court noted the obvious point that the claimant's expert "failed to take the next crucial step of analyzing the specific conditions of the Project to assess the extent and impact of any condition to arrive at an appropriate inefficiency rate."[86]

Similarly, the result in *Trane US Inc. v. Yearout Service, LLC*,[87] highlights the need for adequate foundation when presenting to a cold court. The case reinforces the notion that the claimant cannot prevail when the analysis does not "hone in on" the MCAA publication at issue and fails to provide an adequate foundation for the use of the particular methodology nor a link to the underlying facts of the project. A claimant should always link industry studies with facts of the particular case, a condition lacking in the *Trane* analysis.

In *Trane*, the court excluded the use of the MCAA's data on overtime and second-shift productivity, as neither the court nor the claimant's expert had actually reviewed the underlying predicates supporting their use. Therefore, in judging Federal Rule of Evidence 702's standards, the court was left in the unenviable position of attempting to understand the published data's reliability on the limited information presented to it.[88] The court determined that the claimant had not "reliably applied the principles and methods to the facts of the case" as Rule 702 requires. The court noted that the claimant applied the inefficiency percentages to nonconsecutive weeks, despite MCAA guidance that "a return to a normal 40-hour schedule tends to 'reset' the productivity of a crew."[89]And the court noted the claimant based its analysis solely on the project's payroll records without investigating the project to ensure the analysis applied. The court also excluded the claimant's shift-work-inefficiency testimony because there was no investigation of the conditions at the project; nor did the claimant provide any basis for the percentages of impact that it had assumed.[90] A claimant should always recognize that the MCAA factors are not to be applied in a vacuum;[91] rather, "[i]n assessing productivity loss, the MCAA Factors are generally used as a guideline as interpreted by experienced project personnel familiar with the specific circumstances of a particular job and contractor."[92] A key lesson from *Trane* is that industry studies, standing alone, cannot *replace* expert testimony applying those factors thoughtfully to the facts of the project and providing the proper foundational background for using the study.

Common Themes in Accepted Loss of Labor Analyses

These cases demonstrate that a key touchstone is linking the expert's analysis with the factual predicates of the contractor's performance and the fact witness testimony. The VABCA considered factual predicates for loss of productivity claims in *Fire Security Systems, Inc*.[93] While the board disagreed with the appellant's argument that frequent demobilizations and remobilizations resulted in a loss of productivity, the board agreed that there was a loss of productivity based on the "Morale and Attitude" MCAA factor due to the "paranoia factor" associated with frequent encounters with previously undisclosed asbestos.[94] Remarkably, the appellant prevailed even where it expended fewer labor hours than bid.

> The Government argues that, because the Contractor actually expended less labor hours than it had estimated in its bid, it has not proven that it was in any way impacted by the presence of asbestos. This ignores the possibility that Appellant may have overestimated the amount of pipe and sprinkler installation effort needed and/or that it worked in an efficient manner. In either case, a contractor in a fixed-price contract is entitled to any labor cost savings that it may experience, just as it is out of luck if it underestimates the amount of effort involved in the contract work.
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> The Government's position that there was no demonstrated inefficiency caused by the asbestos problems begs the question of whether, without the impact of the presence or suspected presence of friable asbestos on the workers, they could have been even more efficient. Since FSS reported suspected asbestos almost as soon as the pipe installation began, there is no "normal" work period by which to measure the impact, thus no useful "measured mile" analysis would be possible for this particular claim. This is why the industry has resorted to the use of productivity factors such as those in the MCAA Manual.[95]

In *Hensel Phelps*,[96] the contractor prevailed in its loss of labor productivity claim due to the careful analysis of the project records and thoughtful application of the MCAA factors. The contractor asserted losses of productivity based on six of the MCAA factors: stacking of trades, morale and attitude, reassignment of manpower, concurrent operations, dilution of supervision, and learning curve.[97] In addition, because the impacts to Hensel Phelps's labor productivity "varied over time and from building to building," Hensel Phelps evaluated three separate time periods and the impacts to labor productivity on each building.[98] This "permitted [Hensel Phelps] to take into consideration specific events in making his evaluation of T&S's productivity losses."[99]

Another case, *Stroh Corporation*,[100] highlights a claimant's inefficiency losses arising from compression of its construction schedule. There, the claimant successfully linked credible fact witness testimony with thoughtful expert analysis. Regarding the foundational fact witness testimony, the board gained confidence in the superintendent, noting that he "had substantial experience in successfully completing this type of project."[101] Stroh's expert witness "took its actual costs from cost reports and multiplied them by a ten percent factor from the MCAA manual. Given the testimony of Stroh's employees and its expert witness, this was a reasonable and supportable percentage to use for this purpose."[102] The board, however, adjusted Stroh's weather-impact claim seeking to the apply a factor of 30 percent. The reason was that

> [t]here is substantial testimony that for a substantial portion of the performance period, severe winter weather, particularly cold temperatures and wind chill, impeded labor productivity. To compensate for the fact that at least some of the outdoor work would have been performed in October and early November, in relatively moderate conditions, and for the lack of evidence as to daily temperatures and conditions, we conclude that a factor of approximately twenty-five percent, representing a compromise between average and severe seasonal conditions, should be applied.[103]

Finally, boards may accept the MCAA factors when the parties previously used them to price disputed claims during the project. In *Appeal of Fire Security Systems, Inc.*,[104] the board recognized this course of dealing and the lack of contrary evidence submitted by the government.

> However, the record shows that ASCOA utilized the MCA productivity factors in its cost proposals that were incorporated into [a contract amendment]. While the Government's apparent recognition of these factors in negotiating [the contract amendment] does not automatically establish the reasonableness of using the MCA productivity factors in this appeal, it does provide evidence that the MCA factors are a reasonable starting point for the Board's analysis. We also note that the Government has provided no testimony or evidence that the MCA productivity factors are flawed or unreasonable.[105]

Conclusion

The challenge in proving a loss of labor productivity is linking the effect (loss of productivity) to the cause(s). Even though proof of such losses may be challenging because direct evidence of the effect of the impact may be lacking, this does not alleviate the need to "prove by a preponderance of the evidence that a Government action caused its labor to be less efficient than planned and the extent of that impact."[106] To meet the evidentiary challenges and provide a compelling trial narrative, it is critical to connect the various sources of proof. In so doing, trial counsel and the expert witness can link compelling fact-witness testimony and the proper methodology (which is selected in large measure by the extent of the available data) with clear and robust expert analysis and testimony. In many cases, it is more compelling to use more than one methodology to prove the loss.

Endnotes

1. Clark Constr. Grp., Inc., VABCA No. 5674, 00-1 BCA ¶ 30,870.

2. *Id.* (citing Centex Bateson Constr. Co., Inc., VABCA Nos. 4613, 5162–65, 99-1 BCA ¶ 30,153; Dawson Constr. Co., Inc., VABCA Nos. 3306-08, 3309-10, 93-3 BCA ¶ 26,177, *aff'd sub nom*. Dawson Constr. Co. v. Brown, 34 F.3d 1080 (Fed. Cir. 1994); Triple "A" S., ASBCA No. 46866, 94-3 BCA ¶ 27,194; Bechtel Nat'l, Inc., NASA BCA No. 1186-7, 90-1 BCA ¶ 22,549).

3. 99-1 BCA ¶ 30,153, *aff'd sub nom*. Centex Bateson Constr. Co. v. West, 250 F.3d 761 (Fed. Cir. 2000) (unpublished table decision).

4. Clark Constr. Grp., Inc., VABCA No. 5674R, 00-2 BCA ¶ 30,997.

5. *Clark Constr. Grp*., 00-1 BCA ¶ 30,870.

6. *Id.*

7. Stroh Corp. v. GSA, GSBCA No. 11029, 96-1 BCA ¶ 28265 (citing Sw. Marine, Inc., ASBCA No. 39472, 93-2 BCA ¶ 25,682).

8. Luria Bros. & Co. v. United States, 369 F.2d 701, 713 (Ct. Cl. 1966).

9. *Stroh Corp*., 96-1 BCA ¶ 28265 (citing *Luria Bros*., 369 F.2d at 713).

10. *Luria Bros*., 369 F.2d 701.

11. Wunderlich Contracting Co. v. United States, 351 F.2d 956, 968 (Ct. Cl. 1965); Servidone Constr. Corp. v. United States, 931 F.2d 860 (Fed. Cir. 1991); Dawson Constr. Co., Inc., VABCA-3306 et al., 93-3 BCA ¶ 26,177, at 130,321.

12. Piracci Constr. Co., Inc., GSBCA No. 6007, 82-2 BCA ¶ 16,047.

13. *Wunderlich Contracting Co*., 351 F.2d at 968 (citations omitted).

14. *Id.*

15. L.L. Hall Constr. Co. v. United States, 379 F.2d 559, 567 (Ct. Cl. 1966).

16. Hensel Phelps Constr. Co. v. GSA, GSBCA Nos. 14744, 14877, 01-1 BCA ¶ 31,249.

17. S. Comfort Builders, Inc. v. United States, 67 Fed. Cl. 124, 146–47 (2005).

18. Elec. & Missile Facilities, Inc. v. United States, 416 F.2d 1345 (Ct. Cl. 1969); Specialty Assembling & Packing Co. v. United States, 355 F.2d 554 (Ct Cl. 1966); *Wunderlich Contracting Co*., 351 F.2d 956; Clark Concrete Contractors. Inc. v. GSA, GSBCA No. 14340, 99-1 BCA ¶ 30,280, at 149,746.

19. States Roofing Corp., ASBCA No. 54860, 10-1 BCA ¶ 34.356.

20. *See, e.g*., Advanced Eng'g & Planning Corp., ASBCA Nos. 53366, 54044, 05-1 BCA ¶ 32,806, at 162,325; Clark Constr. Grp., Inc., VABCA No. 5674, 00-1 BCA ¶ 30,870. *See also* Thomas E. Shea, *Proving Productivity Losses in Government Contracts*, 18 Pub. Contr. L.J. 414 (1989).

21. Optimum Servs., Inc., ASBCA No. 59952, 16-1 BCA ¶ 36,490 ("the Measured Mile Method had been accepted by the courts and this Board as an appropriate method for calculating loss of productivity costs"); U.S. Indus., Inc. v. Blake Constr. Co., 671 F.2d 539, 547 (D.C. Cir. 1982) ("comparison of the cost of performing work in different periods is a well-established method of proving damages, which frequently has been used in breach of contract cases") (citing Anvil Mining Co. v. Humble, 153 U.S. 540 (1894); Abbett Elec. Corp. v. United States, 142 Ct. C1. 609 (1958)); States Roofing Corp., ASBCA No. 54860 et al., 10-1 BCA ¶ 34,356, at 169,667 ("We have accepted the measured mile approach as an appropriate method of determining impact to productivity."); Bay West, Inc., ASBCA No. 54166, 07-1 BCA ¶ 33,569, at 166,302–03 (Board accepted the measured mile approach in determining damages for encountering stiff clay during dredging operations); W.G. Yates & Sons Constr. Co., ASBCA Nos. 49398, 49399, 01-2 BCA ¶ 31,428, at 155,210 ("[W]e accept Yates' use of [the Measured Mile] methodology as an acceptable vehicle for determining incurred labor inefficiency costs due to the Government's defective specification."); DANAC, Inc., ASBCA No. 33394, 97-2 BCA ¶ 29,184, at 145,152, *aff'd on recon*., 98-1 BCA ¶ 29,454 (use of the "good period vs. bad period" method of analysis in comparing the contractor's cost performing work during periods affected and unaffected by government-caused disruption); Int'l Terminal Operating Co., ASBCA No. 18118, 75-2 BCA ¶ 11,470 (ASBCA adopted method of computing excess costs in a terminal services contract by comparinge tons handled per direct labor hour during the period affected by the change with the tons handled per direct labor hour during a period unaffected by the change).

22. Clark Concrete Contractors, Inc., GSBCA No. 14340, 99-1 BCA ¶ 30,280.

23. If a measured mile analysis cannot be performed on a project because there was no reasonably unimpacted area or time frame, a "similar project" analysis may compare the productivity achieved on the impacted project to another project not measurably impacted. To prevail using this technique, the expert must perform an exhaustive analysis of the "similar project" to demonstrate the congruity of building type, size, materials, labor, and supervision skill sets in order to form a basis for the reasonableness of the expert's conclusions.

24. *Clark Concrete*, 99-1 BCA ¶ 30,280.

25. *Optimum Servs*., 16-1 BCA ¶ 36490 (citing Elec. & Missile Facilities, Inc. v. United States, 416 F.2d 1345, 1358 (Ct. C1. 1969); *see also* Wunderlich Contracting Co. v. United States, 351 F.2d 956, 968 (Ct. C1. 1965)).

26. C. William Ibbs, *Measured-Mile Principles*, 4 J. Legal Aff. & Disp. Resol. in Eng'g & Constr., no. 2, May 2012, at 31; C. William Ibbs & Josh Chittick, *Practical Ways to Identify Measured Miles*, 9 J. Legal Aff. & Disp. Resol. in Eng'g & Constr., no. 1, Feb. 2017.

27. MCAA, Change Orders, Productivity, Overtime: A Primer for the Construction Industry 166 (2020).

28. VABCA Nos. 4613, 5162–65, 99-1 BCA ¶ 30,153.

29. *Id.*

30. C. William Ibbs, *Impact of Change's Timing on Labor Productivity*, 131 J. Constr. Eng'g & Mgmt., Nov. 2005, no. 11, at 1219–23; MCAA, Change Orders, Productivity, Overtime: A Primer for the Construction Industry 199 (2020).

31. C. William Ibbs, *Quantitative Impacts of Project Change: Size Issues*, 123 ASCE J. Constr. Eng'g & Mgmt., Sept. 1997, no., 3, at 308–11; C. William Ibbs, *Impact of Change's Timing on Labor Productivity*, 131 J. Constr. Eng'g & Mgmt., Nov. 2005, no. 11, at 1219–23.

32. Fire Sec. Sys., Inc., VABCA Nos. 5579 et al., 02-2 BCA ¶ 31,977.

33. Clark Constr. Co., Inc., VABCA No. 5674, 00-1 BCA ¶ 30,870 (citing Fire Sec. Sys., Inc., VABCA No. 3086, 91-2 BCA ¶ 23,743; Stroh Corp., GSBCA No. 11029, 96-1 BCA ¶ 28,265).

34. MCAA, Change Orders, Productivity, Overtime: A Primer for the Construction Industry 43 (2020).

35. *See, e.g.*, Clark Constr. Co., Inc., VABCA No. 5674, 00-1 BCA ¶ 30,870.

36. Kumho Tire Co., Ltd. v. Carmichael, 526 U.S. 137, 149 (1999).

37. Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 593–94 (1993).

38. *Compare* Buck v. Ford Motor Co., 810 F. Supp. 2d 815, 823–24 (N.D. Ohio 2011) (excluding expert testimony as "unreliable because his theory has not been tested and it has not been formally peer-reviewed"), *with* Wagoner v. Exxon Mobil Corp., 813 F. Supp. 2d 771, 802 (E.D. La. 2011) (permitting expert testimony based on studies not published in peer-reviewed journals and noting cross-examination could address study weaknesses).

39. H. Randolf Thomas & Karl A. Raynar, Scheduled Overtime and Labor Productivity: Quantitative Analysis, 123 ASCE J. Constr. Eng'g & Mgmt, no. 2, June 1997.

40. Seulkee Lee & C. William Ibbs, UC Berkeley, Understanding and Quantifying the Impact of Changes on Construction Labor Productivity: Integration of Productivity Factors and Quantification Methods, Constr. Mgmt. Tech. Rep. (Dec. 2007); MCAA, Change Orders, Productivity, Overtime: A Primer for the Construction Industry 222 (2020).

41. S. Comfort Builders, Inc. v. United States, 67 Fed. Cl. 124, 146–47 (2005).

42. Optimum Servs., Inc., ASBCA No. 59952, 16-1 BCA ¶ 36,490; *see also* Propellex Corp. v. Brownlee, 342 F.3d 1335, 1339 (Fed. Cir. 2003); *S. Comfort Builders*, 67 Fed. Cl. at 146–47.

43. Turner Constr. Co. v. Smithsonian Inst., CBCA No. 2862, 17-1 BCA ¶ 36,739.

44. *Id.* at 17.

45. *Id.*

46. *Id.*

47. *Id.*

48. *Id.* at 17–18.

49. Suffolk Constr. Co., Inc., CBCA No. 2953, 20-1 BCA ¶ 37,488, *amended on reconsid.*, 2020 WL 1894731 (C.B.C.A. Apr. 13, 2020).

50. *Id.* at 43.

51. *Id.*

52. Optimum Servs., Inc., ASBCA No. 59952, 16-1 BCA ¶ 36,490.

53. *Suffolk Constr. Co.*, 20-1 BCA ¶ 37,488, at 43.

54. *Id.*

55. *Id.* at 44.

56. *Id.*

57. *Id.* at 42–43.

58. Flatiron-Lane v. Case Atl. Co., 121 F. Supp. 3d 515, 542–43 (M.D.N.C. 2015).

59. *Id.* at 543.

60. Fed. R. Evid. 702.

61. Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579, 597 (1993); *see also* Kumho Tire Co., Ltd. v. Carmichael, 526 U.S. 137, 147 (1999) (holding the *Daubert* standard applies to all expert testimony, not just the "scientific" variety).

62. *Daubert*, 509 U.S. at 594.

63. *Kumho*, 526 U.S. at 150 (quoting *Daubert*, 509 U.S. at 592–94) (internal quotations and alterations omitted).

64. Fed. R. Evid. 702, adv. comm. notes to 2000 amendments (citations omitted).

65. *Kumho*, 526 U.S. at 141 (noting that the *Daubert* factors "neither necessarily nor exhaustively appl[y] to all experts or in every case"); *id.* at 150 ("The conclusion, in our view, is that we can neither rule out, nor rule in, for all cases and for all time the applicability of the factors mentioned in *Daubert*, nor can we now do so for subsets of cases categorized by category of expert or kind of evidence.").

66. S. Comfort Builders, Inc. v. United States, 67 Fed. Cl. 124 (2005).

67. *Id.* at 150.

68. *Id.*

69. GSBCA No. 14340, 99-1 BCA ¶ 30,280.

70. *Id.*

71. *Id.*

72. *Id.*

73. GSBCA No. 15421, 03-2 BCA ¶ 32,320.

74. *Id.*

75. *Id.*

76. *Id.* (citing Hensel Phelps Constr. Co. v. GSA, GSBCA No. 14744 et al., 01-1 BCA ¶ 31,249).

77. *Id.*

78. GSBCA No. 6007, 82-2 BCA ¶ 16,047.

79. *Id.*

80. *Id.*

81. *Id.*

82. N. Am. Mech., Inc. v. Walsh Constr. Co. II, LLC, 132 F. Supp. 3d 1064 (2015).

83. *Id.* at 1080.

84. *Id.*

85. *Id.* at 1081.

86. *Id.*

87. No. 5:17-cv-42, 2019 WL 2553100 (M.D. Ga. June 20, 2019).

88. *Id.* at *3.

89. *Id.* at *5.

90. *Id.*

91. *See, e.g.*, Clark Constr. Grp., Inc., VABCA No. 5674, 00-1 BCA ¶ 30,870.

92. *Id.*

93. VABCA No. 5579 et al., 02-2 BCA ¶ 31,977.

94. *Id.*

95. *Id.*

96. Hensel Phelps Constr. Co. v. GSA, GSBCA No. 14744 et al., 01-1 BCA ¶ 31,249.

97. *Id.*

98. *Id.*

99. *Id.*

100. Stroh Corp. v. GSA, GSBCA No. 11029, 96-1 BCA ¶ 28,265.

101. *Id.*

102. *Id.*

103. *Id.*

104. VABCA No. 3086, 91-2 BCA ¶ 23,743.

105. *Id.*

106. Clark Constr. Grp., Inc., VABCA No. 5674, 00-1 BCA ¶ 30,870 (citing Centex Bateson Constr. Co., Inc., VABCA Nos. 4613 et al., 99-1 BCA ¶ 20,153; Dawson Constr. Co., Inc., VABCA Nos. 3306–08, 3309–10, 93-3 BCA ¶ 26,177, *aff'd sub nom.* Dawson Constr. Co. v. Brown, 34 F.3d 1080 (Fed. Cir. 1994); Triple "A" S., ASBCA No. 46866, 94-3 BCA ¶ 27,194; Bechtel Nat'l, Inc., NASA BCA No. 1186-7, 90-1 BCA ¶ 22,549).