DECODING THE MYSTERY OF PRODUCTIVITY CLAIMS

THIS PAPER WAS WRITTEN IN CONJUNCTION WITH A BREAKOUT SESSION AT AGC'S 2021 SURETY BONDING AND CONSTRUCTION RISK MANAGEMENT CONFERENCE.

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Associated General Contractors of America
2021 Surety Bonding and Construction Risk Management Conference

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DECODING THE MYSTERY OF PRODUCTIVITY CLAIMS

I. Introduction

Construction is fraught with risk borne by contractors and subcontractors – when production cannot be achieved as planned, costs can quickly accrue. Despite being one of the most common impacts on a construction project, lost productivity is not easily discerned and even more difficult to calculate and substantiate. Depending on factors, such as availability and reliability of information and documentation, there are several methodologies available for prosecuting a productivity claim. Understanding what to track, how to assemble a claim, and how courts have ruled on these types of claims can be the difference between recovering the costs associated with productivity impacts or realizing a loss.

II. What is Productivity?

1. Production vs. Productivity

Productivity and production are not synonymous; yet the two terms are frequently used interchangeably in the construction industry. Production describes a measurement of output. Productivity is not merely a measurement of output, but a measurement of output relative to input. Put simply, productivity refers to the ratio of output (units produced) to input (typically, labor hours). Production and productivity are defined in Figure 1:

$$Production = Output$$

$$Productivity = \frac{Output}{Input} = \frac{Production}{Time}$$

Figure 1. Production and Productivity

Oftentimes, the term productivity is used interchangeably with efficiency; lost productivity with inefficiency. Higher productivity levels typically allow contractors to increase profitability and improve competitiveness.[1]

2. Calculating Productivity

The output for productivity is general measured in physical units – say 1,000 linear feet of pipe, or 5,000 square-feet of drywall. The input is time-based, typically labor hours. The example calculation in Figure 2 shows the productivity calculation for a sitework contractor who needs to lay 1,000 linear feet of pipe, who estimates they can complete this work in 50 hours:

[1] Construction Productivity: A Practical Guide for Building and Electrical Contractors. (2008). United States: J. Ross Pub.

$$Productivity = \frac{Output}{Input}$$

$$Output = 1000\ LF$$

$$Input = 50\ hrs$$

$$Productivity = \frac{Output}{Input} = \frac{1000LF}{50hrs} = 20\ LF\ per\ hour$$

Figure 2. Sample Productivity Calculation

Output on a project is typically constant: in the absence of changes, there is a set amount of work to be performed. To achieve a desired output if productivity decreases, input must be increased, meaning more manpower or additional hours per person, and thus more input generally means greater cost. Rearranging, our formulas in Figure 1, we can represent the inverse relationship between input and productivity, as shown in Figure 3:

$$\frac{Output}{Input} = Productivity$$

$$Production = Output = Productivity\ x\ Input$$

$$y = mx$$

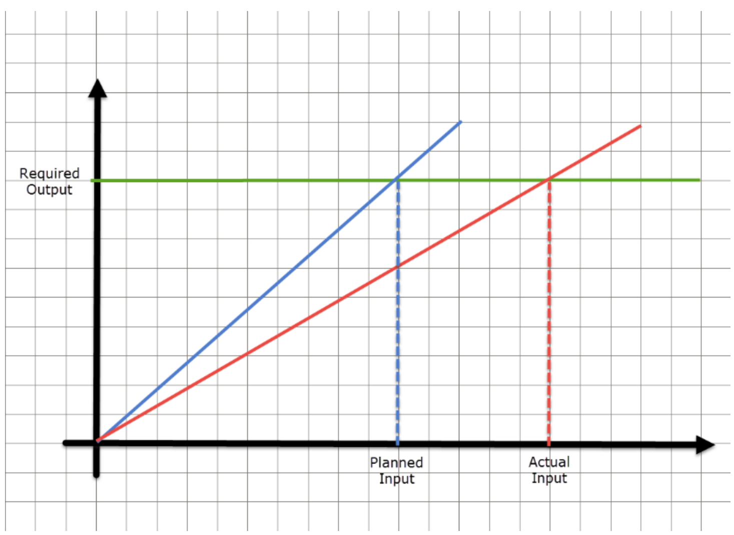

Figure 3. Inverse relationship between input and productivity

In the graphical relationship between input and productivity shown above, the steeper the slope of the line, the greater the productivity being achieved.

III. Factors Impacting Productivity

Numerous factors impact a contractor's productivity, which result in delays and additional costs. Understanding factors that impact productivity allow for mitigative measures to be implemented. Some of these factors are represented in Figure 4, with brief descriptions provided for each:

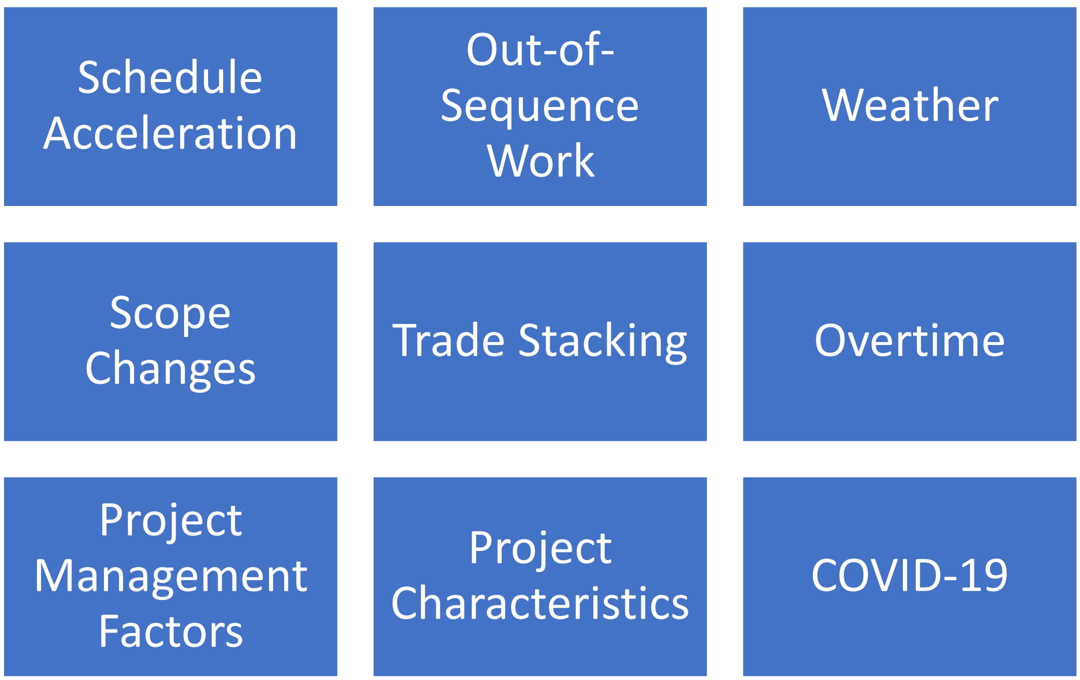

Figure 4. Exemplar factors which impact productivity

1. Schedule Acceleration

Acceleration occurs when the contractor speeds up his work so that he is performing the job at a faster rate than prescribed in the original contract.[2] A contractor may accelerate because they were directed to do so (known as actual acceleration, or directed acceleration) to overcome delays, or when an Owner (or contractor in the case of a subcontractor) refuses to grant a time extension and acceleration is necessary to achieve the unadjusted completion date, known as constructive acceleration. To justify that work has been accelerated, there must be an express order or some action equivalent to an order to comply with the original completion date without regard to excusable delays.[3]

[2] Donald R. Stewart & Assocs., Contracting & Material Co. v. City of Chicago, 20 Ill. App. 3d 685, 692, 314 N.E.2d 598, 604 (1974).
[3] Peter Kiewit and Sons Co., ASBCA, Nos. 9921 and 10440, 1969 BCA 7510, p. 34811 (1969).

Output following acceleration efforts does not increase in a linear fashion. Rather, there is a drop-off in productivity the more manpower is applied after a certain point (point of diminishing returns). Schedule compression in the form of overmanning the project site often results in significant productivity losses due to less effective supervision, material and/or equipment shortages, and diminished coordination capabilities.

Labor inefficiencies are often seen when personnel levels exceed those that can be effectively managed or adequately supervised. Similarly, when labor requirements exceed the available pool of qualified workers there will typically be a marked decrease in productivity. This is often seen when mandatory overtime or second shift work is implemented to mitigate schedule delays.

2. Out-of-Sequence Work

A contractor's schedule is developed based on project scope, completion requirements, logical relationships, durations, resource availabilities, time constraints, and other information to model a time-based action plan.[4] Schedule planning determines the optimal manner and sequence in which activities are to be performed, to optimize time, cost, and other factors. Therefore, changes to planned sequencing of activities from the original schedule often impact productivity.

Establishing that a sequence change impacted productivity, rather than just shifting activities, is paramount. A causal example of out-of-sequence work that would impact productivity is resequencing the installation of ceiling grid before the installation over overhead sprinkler mains and branch lines. It is easy to visualize the challenge of installing piping through the grid, rather than without any obstructions. A non-causal example would be the sequence of installation for millwork installation along the perimeter of a room and VCT flooring installation, which would have little impact on the other regardless of which occurred first.

3. Weather

A reasonable amount of inclement weather is to be expected on nearly all construction projects. If weather-sensitive tasks are pushed into periods of inclement weather, unusually severe weather is encountered, or there is extreme heat or extreme cold, the contractor is likely to experience an impact to its productivity.[5] For example, masonry work performed in winter conditions may suffer loss of productivity as a result of need to heat water for mortar mix, mobility restriction of workers in winter gear, masonry setting time, protection of completed work from the elements, and other impediments.

In *Luria Bros. & Co. v. United States*, 369 F.2d 701 (Ct. Cl. 1966), the contractor was engaged to construct an aircraft maintenance facility in Pennsylvania and suffered substantial delay because of the government's defective specifications. The contractor was forced to perform

[4] AACE International Recommended Practice No. 91R-16

[5] The U.S. Army Corps of Engineers defines "adverse weather" as "atmospheric conditions at a definite time and place that are unfavorable to construction activities," and "unusually severe weather" as "weather that is more severe than the adverse weather anticipated for the season or location involved." [U.S. Army Corps of Engineers ER 415-1-15]

much of its work during the winter months because of delays for which the owner was responsible. Consequently, the contractor's workforce had to wear heavier clothing and gloves, which reduced labor productivity. The Court held that the contractor was entitled to recover damages for lost productivity caused by the delay.

The National Electrical Contractors Association (NECA) conducted a series of laboratory studies to measure the effects of extreme combinations of temperature and humidity on labor productivity, with temperature and humidity extremes having the greatest productivity impacts, as shown in Figure 5.[6]

Productivity (%)

Relative Humidity (%) \ Effective Temperature (°F)	-10	0	10	20	30	40	50	60	70	80	90	110	110
90	56	71	82	89	93	96	98	98	96	93	84	57	0
80	57	73	84	91	95	98	100	100	98	95	87	68	15
70	59	75	86	93	97	99	100	100	99	97	90	76	50
60	60	76	87	94	98	100	100	100	100	98	93	80	57
50	61	77	88	94	98	100	100	100	100	99	94	82	60
40	62	78	88	94	98	100	100	100	100	99	94	84	63
30	62	78	88	94	98	100	100	100	100	99	93	83	62
20	62	78	88	94	98	100	100	100	100	99	93	82	61

Figure 5. Data from NECA study: The Effect of Temperature on Productivity

4. Scope Changes

Nearly every construction project experiences changes in scope during performance of the work. However, changes beyond those reasonably expected given the nature of the work (cardinal change), or a high volume of changes to the project can lead to decreased productivity. Changes often cause delays and can require the removal of work already in place or the resequencing of the work plan; each of which may have an impact on productivity.

The impact of scope changes can vary based on timing – late changes are typically more disruptive.[7] The cumulative impact of changes on productivity is modeled by the Ibbs curve, as shown in Figure 6, which demonstrates the greater volume of changes on a project, the more productivity will decrease:[8]

[6] Adapted from Table 2.1, NECA study: The Effect of Temperature on Productivity, 2004.
[7] Ibbs, William and Gerald McEniry. "Evaluating the Cumulative Impact of Change on Labor Productivity – an Evolving Discussion." *Cost Engineering*, vol. 50, no. 12, 12 December 2008, pp. 26.
[8] Ibbs, William, Long D. Nguyen and Seulkee Lee, "Quantified Impacts of Project Change," Journal of Professional Issues in Engineering Education and Practice, January 2007, 133(1), 45-52.

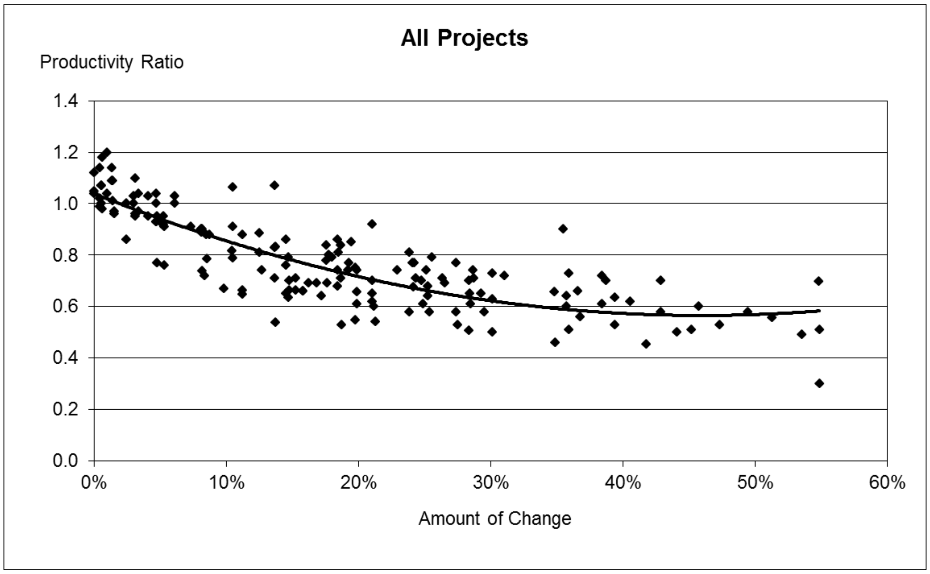

Figure 6. Ibbs Curve for cumulative impact of changes

5. Trade Stacking

Optimal productivity requires each crew member to have sufficient workspace to perform its tasks without interference. When several trades are working in the same space, the likelihood of interference increases which may result in decreased productivity. When there is more labor working in an area than the area can comfortably accommodate the probability of worker interference rises. In such scenarios, trades often experience a decline in productivity relative to the expected level, as shown in Figure 7: [9]

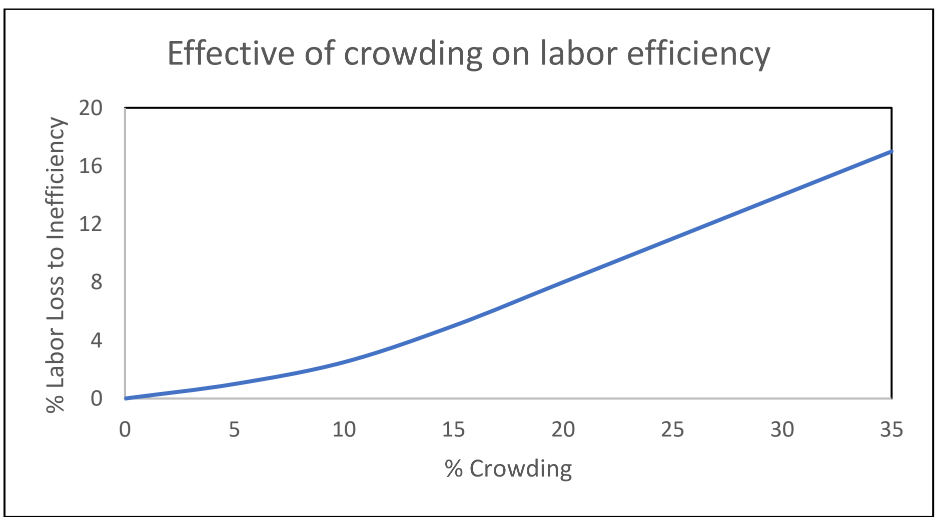

Figure 7. Impact of crowding on productivity

[9] Adapted from Figure 4-2: U.S. Department of the Army Office of the Chief Of Engineers *Modification Impact Evaluation Guide*, 1979).

6. Overtime

Studies have shown the effects of overtime on construction labor productivity. These studies consistently document an inverse relationship exists between the amount of overtime work and labor productivity. Loss of productivity from overtime is commonly attributed to worker fatigue and diminished morale, as well as increased absenteeism, reduced effectiveness of supervision, increased number of safety incidents, lackluster workmanship resulting in more frequent rework, increased accidents, and other factors.[10] Figure 8 illustrates a compilation of various studies based on the amount of hours of work performed and the associated productivity loss.[11] Sustained overtime continues to erode productivity, and can even result in a loss of productivity which offsets the additional workhours.

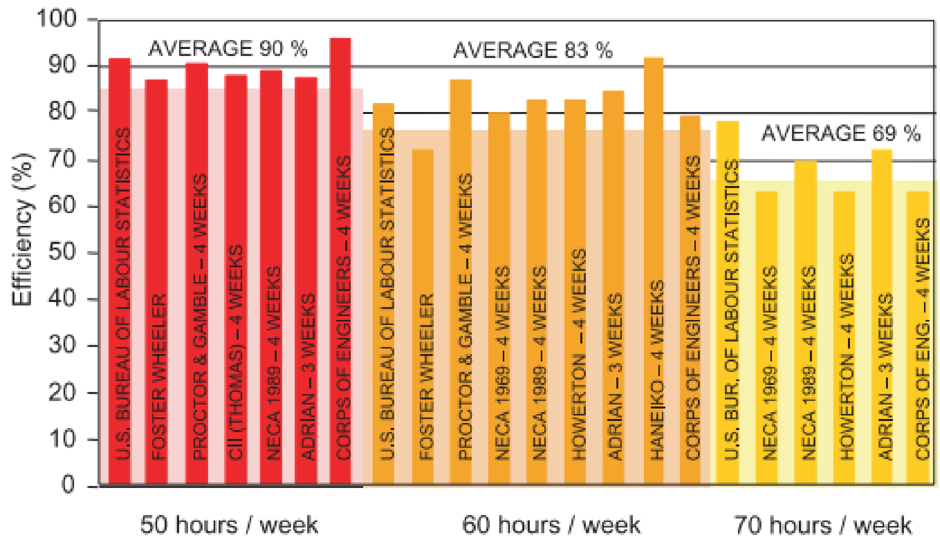

Figure 8. Impact of overtime on productivity

7. Project Management Factors

Poor project management often translates to improper scheduling and coordination of the work. When this occurs, productivity suffers. Failure to manage can result in underutilization of critical resources or produce an incorrect labor crew mix that underperforms. As an example, an improperly managed project mobilization can result in immediate impacts to productivity. If crews are directed to begin work prior to having access to certain areas or key resources being available, the productivity rate of the crew will likely be less than if it had waited until optimal conditions were available. Oftentimes, general contractors demand subcontractors increase manpower or begin work immediately in available areas out of fear of schedule slippage. When such demands occur, it is rarely under conditions that translate to optimal productivity.

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[10] McNamara, J. J., Schwartzkopf, W. (2000). Calculating Construction Damages. United States: Aspen Law & Business.
[11] Scheduled Overtime Effect on Construction Projects, The Business Roundtable Task Force, 1980

8. Project Characteristics

The various characteristics of a project site, such as site access, site conditions, and site layout, among others, can impact productivity.

If a project site is remote, difficult to get to, or has other access limitations then productivity may be impacted as resources are not available as needed to support the optimal prosecution of the work. Additionally, if access to the work area is delayed and the contractor is required to do more work in a shorter period, this produces the detrimental effects mentioned earlier with respect to constructive schedule acceleration.

Site conditions can be affected by physical, logistical, and environmental constraints. Typical detrimental physical conditions can be saturated soils, rocks/boulders, groundwater, and more. Examples of logistical constraints can be security restrictions on a project or availability of equipment. Poor site layout can also affect labor efficiency. Obstructed work areas and limited laydown areas and material handling spaces can slow down productivity. Environmental restrictions can include permitting requirements which bar construction in certain areas or periods.

On a transmission line project in Northern Canada, the contract planned for work to be performing during the winter months after freeze-in on the access roads; however, because of delays which pushed the work into the spring, additional environmental measures, such as bird sweeps and matting were required, which not only had direct costs, but impacted productivity.

9. COVID-19

COVID-19 has posed new impacts to productivity. RSMeans approximates based on a national efficiency average that 60-65% of a workday is spent performing actual installation, as shown in Figure 9:[12]

Study Plans	3%	14.4 minutes
Material Procurement	3%	14.4 minutes
Receiving and Storing	3%	14.4 minutes
Mobilization	5%	24.0 minutes
Site Movement	5%	24.0 minutes
Layout and Marking	8%	38.4 minutes
Actual Installation	64%	307.2 minutes
Cleanup	3%	14.4 minutes
Breaks, Nonproductive	6%	28.8 minutes
Total:	100%	480.0 minutes (8 hours)

Figure 9. Workday breakdown per RSMeans

COVID-19 has resulted in additional necessary tasks in each day, such as the implementation of distancing requirements; site safety requirements, including use of masks and additional PPE, hand washing, and tool sanitizing; and site access changes (such as temperature

[12] https://www.rsmeans.com/what-is-construction-estimating.

scanning or staggered gate admittance) that further erode the amount of time available for production work.

Two construction industry organizations, the Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) and National Electrical Contractors Association (NECA), through its research group ELECTRI International, released reports entitled "Pandemics and Productivity: Quantifying the Impact, Mitigation and Productivity Impacts for Sheet Metal, HVAC and Mechanical Contractors" and "Pandemics and Productivity: Quantifying the Impact," respectively, examining and confirming impacts to Mechanical work and Electrical work as a result of COVID-19.[13, 14] The SMACNA report builds on the data published by ELECTRI.

ELECTRI's report was developed on data collected from across 16 states. The analysis shows that the Coronavirus pandemic and the related protocols and conditions have resulted in impacts across the construction industry. More specifically, ELECTRI notes that there has been a 7% loss in labor hours due to pandemic mitigation activities. Additionally, vertical construction has experienced a 12.4% overall impact resulting from pandemic mitigation tracking. These data show 50 to 60 minutes of lost productivity per employee per day during an 8-hour workday. This productivity loss consists of the combined effects of distancing, access, cleaning and disinfection, pandemic-specific safety trainings and meetings, orientations, medical screenings, PPE trainings and fitting, and administration work, such as additional paperwork and management.

The SMACNA report follows a similar approach to the ELECTRI report. It was developed with over 20,000 labor hours collected from sheet metal, HVAC, and mechanical contractors across 21 states. The report shows an 8.7% labor hour loss due to pandemic mitigation requirements such as management of PPE, safety meetings, cleaning and disinfection, access rules, extra administration time, and other factors. Additionally, the report finds an additive 9.2% productivity impact, which results in a total 17.9% productivity impact due to the pandemic. The data show over 85 minutes of lost productivity per employee per day during an 8-hour workday.

The SMACNA report compiles the ELECTRI and SMACNA data to evaluate the impact that the COVID-19 pandemic has caused on the construction industry. Analyzing over 113,000 man-hours, the report finds on average, 8.8% of trade-hours lost because of COVID-19.

IV. Contractual Considerations and Procedural Entitlement

When advancing a claim – be it delay, differing site condition, productivity, or another – an understanding of contractual provisions and necessary procedural requirements is essential.

[13] McLin, Michael, Doyon, Dan, & Brian Lighter (2020). Pandemics and Productivity: Quantifying the Impact – Mitigation and Productivity Impacts for Sheet Metal, HVAC and Mechanical Contractors. New Horizons Foundation.

[14] McLin, Michael, Doyon, Dan, & Brian Lighter (2020). Pandemics and Productivity: Quantifying the Impact – Initial Findings and Recommendations – May 2020. ELECTRI International.

1. Notice Requirements

Contractor's must be cognizant of any timing and notice restrictions in bringing productivity claims. What is the triggering event? Is it upon knowledge of the disruption? Within how many days of the event must notice be provided? In *Fru-Con Constr. Corp. v. United States*, 43 Fed. Cl. 306 (1999), the court affirmed an award of $206,950 in assessed liquidated damages against the contractor because the contractor failed to provide adequate notice that its productivity losses were caused by unusually severe weather.

Generally, though, with government contracts, courts have not strictly construed notice requirements. Rather federal courts and boards have ruled that where government is otherwise aware of the changes causing the disruption, the notice requirement has been met.[15] Some even held that verbal notice is sufficient even where contract calls for written.[16] The bottom line though is that the best time to provide notice and act is when the triggering event first occurs or when the impacts are first realized.

2. How is the Productivity Claim Characterized in the Contract?

Contractors must carefully review their contract to find the applicable contract provision(s) that speak to a productivity claim. This may be a Changes clause, or Differing Site Conditions clause. A productivity claim is different from a pure delay or extension of time claim. Sauer, Inc. v. Danzig, 224 F.3d 1340, 1348 (Fed. Cir. 2000) discusses the difference between the two types of damages: disruption damages may be present even if project completed on time, where greater costs were incurred because of disruptive events that forced claimant to accelerate, resequence, increase manpower, etc. There does not have to be a delay for the productivity claim to be actionable.[17]

Contracts may also include restrictive provisions or exculpatory clauses, such as a waiver of consequential damages or waiver of claims for lost profits, productivity, "soft costs", etc., as well as a no-damages for delay clause. The enforceability of these clauses varies by state, and by public or private work.[18] Even where there may be a no damages for delay clause in a contract, some courts have found that such a clause would not preclude a claimant from recovering for disruption.[19]

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[15] Ace Constructors, Inc. v. United States, 70 Fed. Cl. 253, 272 (2006).
[16] See Sheppard v. United States, 113 F. Supp. 648 (Ct. Cl. 1953); A.R. Mack Constr. Co., ASBCA 50035, 01-2 BCA ¶ 31,593 (2001).
[17] See, e.g., Appeals of States Roofing Corp., ASBCA No. 54860, 10-1 B.C.A. (CCH) ¶ 34356 (Jan. 12, 2010) (distinguishing between delay and loss of productivity and rejecting argument that contractor could not recover damages for the lost productivity without demonstrating that the impacted activities affected the completion schedule); City. of Galveston v. Triple B Servs., LLP, 498 S.W.3d 176 (Tex. App. 2016).
[18] Watt Tieder prepares a 50-state survey of key issues related to construction and engineering contracts, which includes enforceability of clauses such as no-damages-for-delay and waivers of consequential damage: https://50-state.watttieder.com/50stateanalysis#modal2
[19] See e.g., United States ex. rel. Wallace v. Flintco Inc., 143 F.3d 955 (5th Cir. 1998) (explaining that, under Texas law, a no damages for delay clause does preclude recovery for productivity impacts when there is active interference with the contractor's performance).

3. Proving Entitlement to Claim

To prove a claim for loss of productivity, a contractor generally bears the burden of proof for three elements: (1) liability; (2) causation; and (3) resultant injury for the impact of changes.[20] These elements generally must be proven by a preponderance of the evidence, meaning that the evidence must establish that it is more likely than not that each of these factors is present, and to recover for inefficiency a contractor must show "fundamental triad of proof":[21]

- Liability: Owner contractually responsible for impact, i.e., proof that the owner's actions or inactions changed the contractor's costs for which the owner is legally liable;
- Causation: Impact caused labor overruns;
- Injury/Resultant Cost Increase: Impact caused compensable loss.

(1) Liability

To establish entitlement on a claim for lost productivity, the contractor must focus first on the nature of the impacts and then on the cause of the impacts, identifying the entity or entities that bear responsibility. The first question to answer regarding entitlement to a productivity claim is "Who is Responsible?"

To state the obvious, if the Contractor is responsible for disruption, it must bear the loss, but if the cause of the disruption was due to the Owner, then the Owner will be liable.[22]

(2) Causation

Causation is the toughest element of the three to prove. This is especially true for impacts that are not immediately felt or known when experienced. Thus, the contractor may miss a window of opportunity to develop a claim-oriented written record at a time when the recollection of its personal is still fresh. For example, in _*Centex Bateson*_, a contractor recognized the *individual* impact of changes to the work during negotiations with a project owner.[23] However, only with the benefit of hindsight did the contractor later appreciate the cumulative effect and disruption caused by the more than 1,500 separate "events" directed consisting of various contract changes, both unilateral and bilateral, requests for information, and alleged constructive changes. In support of its cumulative impact claim, the contractor presented limited contemporaneous support, and as a result, the claim was rejected. The administrative board responsible for hearing the dispute agreed with the project owner reasoning, in part, that there was a lack of contemporaneous project records to support the contractor's claim.[24]

[20] See, e.g., George Sollitt Const. Co. v. United States, 64 Fed. Cl. 229, 237 (2005).
[21] Centex Bateson Constr. Co., VABCA Nos. 4613, 5162-5165, 99-1 BCA P30,153, 149,258, aff'd, Centex Bateson Constr. Co. v. West, 250 F.3d 761 (Fed. Cir. 2000); George Sollitt Const. Co. v. United States, 64 Fed. Cl. 229, 237 (2005) (Preponderance of the Evidence Standard)
[22] Stroh Corp v. Gen. Serv's Admin., GSBCA No. 11,029, 96-1 BCA ¶ 28,265.
[23] Centex Bateson Constr. Co., VABCA Nos. 4613, 5162-5165, 99-1 BCA ¶ 30,153, 149,258, aff'd, Centex Bateson Constr. Co. v. West, 250 F.3d 761 (Fed. Cir. 2000).
[24] See also, Clark Construction Group, Inc., VABCA No. 5674, 00-1 BCA ¶ 30,870 (denying claim due to lack of contemporaneous project records).

In contrast, in *Lamb Engineering*, the contractor successfully argued for inefficiency costs resulting from differing site conditions by providing detailed documentation and even video evidence of the differing site conditions.[25] It is with good reason that contemporaneous project records are the best resource for demonstrating causation.

(3) Resultant Injury

Finally, the must prove that incurred damages. The case law does not require proof to an exactitude, but it does require proof to a reasonable degree of certainty concerning the fact and amount of damage incurred.[26] Courts are more likely to accept some degree of approximation when responsibility for damage is clear, but a reasonable basis for computation should be provided.

4. Contractual Defenses to Claims

It is important for contractors to understand potential contractual defenses to a claim to avoid potential claim pitfalls.

A no-damages-for-delay/disruption clause may be an enforceable provision that serves as defense to a productivity claim. Some courts have found, however, that no damages for delay clauses will not apply to deny a contractor's claim of disruption or lost productivity.[27] A minority of jurisdictions limit the application of no damages for delay clauses by statute. For example, California and Colorado law prohibit the enforcement of no damages for delay clauses in state and local public contracts and subcontracts as against public policy.[28] Washington State and Ohio extend this public policy concern by prohibiting the enforcement of no damages for delay clauses in all contracts.[29]

To the extent that enforcement of a no damages for delay clause is not prohibited by statute and to the extent it applies to disruption claims, the common exceptions to the enforcement of these provisions should be considered before determining if this clause constitutes any bar to recovery. These exceptions are:

- Active interference;
- Bad faith breach;
- Delays that amount to abandonment of the contract; and
- Delays not within the contemplation of the parties.

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[25] *Lamb Engineering & Construction Co.* EBCA No. C-9304172, 97-2 BCA ¶ 29,207.
[26] See, e.g., Luria Bros. & Co. v. United States, 369 F.2d 701 (Ct. Cl. 1966) (weather related impact).
[27] See e.g.,
(1) United States ex. rel. Wallace v. Flintco Inc., 143 F.3d 955 (5th Cir. 1998) (explaining that, under Texas law, a no damages for delay clause does preclude recovery for productivity impacts when there is active interference with the contractor's performance);
(2) John E. Green Plumbing & Heating Co. v. Turner Constr. Co., 742 F.2d 965, 966-67 (6th Cir. 1984) (distinguishing lost productivity damages from delay damages and awarding the subcontractor damages for interferences despite a no damages for delay clause);
(3) Blake Constr. Co. v. C.J. Coakley Co., 431 A.2d 569 (D.C. 1981).
[28] Cal. Pub. Cont. Code § 7102; Colo. Rev. State. § 24-91-103.5.
[29] Wash. Rev. Code § 4.24.360 (2010); Ohio R.C. § 4113.62(C)(1).

In addition to exculpatory clauses, contractors should be wary of any rights to claims which may be released through release waivers, and especially change orders. When negotiating change orders, consideration should be given to whether the scope of release includes inefficiencies related to any particular change event. The inclusion of a broadly drafted release may limit a contractor's ability to make such claims. For example, language such as "full compensation for the changed work" and that it was releasing the owner "from any and all liability" attributable to the change, has been found to bar a related claim for cumulative impact.[30] Similarly, a release which waives "all claims for delays and disruptions resulting from, caused by, or incident to such modifications or change orders" will likely be sufficient to bar subsequent cumulative disruption and delay claims.[31]

V. How Productivity Impacts are Calculated

The quantification of productivity impacts is a highly contentious topic within the construction claims arena. Damages pertaining to lost productivity are typically not tracked by contractors or are impossible to identify contemporaneously unlike direct costs stemming from a scope adjustment or other discrete change. Consequently, establishing both causation and entitlement with respect to lost productivity damages is problematic in most dispute scenarios. Further complicating such instances is the absence of a consensus amongst construction professionals as to the ideal method of calculating damages resulting from lost productivity. There are several calculation methodologies available to quantify labor inefficiency costs. The appropriateness and validity of most methods are subject to challenge depending on the specific scenario. Such considerations make establishing a uniform agreement on the issue practically impossible.

AACE Recommended Practice 25R-03 provides an overview of the most common methods of calculating productivity loss damages and offers a hierarchy of methods to employ. This hierarchy divides the different methods into five general classifications. The classifications, listed in order of preference, are shown in Figure 10:

Figure 10. Preferred methodologies for calculating loss productivity damages

[30] BellBCI Co. v. United States, 570 F.3d 1337 (Fed. Cir. 2009).
[31] Atl. Dry Dock Corp. v. United States, 773 F. Supp. 335, 338-39 (M.D. Fla. 1991); see also AEI Pacific, Inc., ASBCA No. 53806, 2008 WL 436928 (2008) (finding that certain impact claims were barred by releases in contract modifications).

1. Project-Specific Methodologies

Courts, Boards, and other legal forums have demonstrated a predilection for damage calculations that directly relate to the project that is the subject of the claim and rely on contemporaneously prepared documentation. As such, techniques relying on project-specific data should be utilized whenever possible. The primary project-specific methodologies are the measured-mile and the earned value analysis.

ii. Measured Mile

While there is no consensus on the best method for calculating productivity losses, the measured mile approach is widely acknowledged as a highly favorable methodology.[32] A measured mile analysis compares identical tasks in an impacted and non-impacted period to calculate the productivity loss caused by a known disruption.[33] The measured mile is viewed favorably because its calculations contemplate actual contract performance rather than relying on initial estimates. In other words, it compares actual performance with actual performance; not theoretical or planned performance.

There are certain requirements that must be adhered to if the method is to be employed. The availability of reliable contemporaneous productivity data and the ability to identify a valid unimpacted period on the project (the “measured mile” period) are the two biggest barriers to entry for use of this methodology. Identifying the measured mile period – that is, a period of unimpacted progress of work congruent with impacted productivity – may be challenging or impossible. Oftentimes, a contractor’s scope is impacted from the onset thereby making the establishment of a non-impacted period impossible. In such instances, use of the measured mile method is typically not appropriate.

While it may be difficult to identify an uninterrupted period, the other significant impediment to using the measured mile method is the availability of reliable, contemporaneous productivity data. The measured mile requires contemporaneous project-specific progress, resource, and performance data for both the impacted period and a comparable period of unimpacted progress. Most contractors do not have the project controls processes in place to adequately track productivity. The data collection and monitoring efforts involved in tracking productivity on active construction projects often exceed the perceived benefit in the eyes of most contractors. This view often changes after a contractor experiences a damaging productivity impact and it attempts to recover its damages. If the sufficient contemporaneous productivity data is available, then the measured mile method remains available for use in calculating damages.

As a best practice, contractors should implement reporting measures for production output to better position themselves for evaluation of labor productivity impacts. This is particularly true when repeated “production” activities serve as the basis of work. The applicability of the measured

[32] Carter, J. D., Coppi, D. F., Cushman, R. F., Gorman, P. J. (2000). Proving and Pricing Construction Claims. United States: Wolters Kluwer Law & Business. Pp. 87.

[33] McNamara, J. J., Schwartzkopf, W. (2000). Calculating Construction Damages. United States: Aspen Law & Business. Pp. 64.

mile method requires the non-impacted work to be comparable to the impacted work thereby allowing for a likewise comparison of labor efforts.

iii. Earned Value Analysis

In circumstances where insufficient physical unit production data is available, the concept of earned value analysis can be employed to demonstrate a loss of productivity. Earned value analysis evaluates how much time and budget should have been spent and compares it to the amount of work completed to date.[34] In other words, this method compares what was completed versus what was anticipated, i.e., the expected earnings per labor hour versus actual earnings per labor hours expended.

As with the measured mile, the earned value approach requires identification of periods for comparison. Such periods must allow for comparison of planned and actual performance during non-impacted and impacted periods. As such, the ability to identify a non-impacted period is a prerequisite for use of an earned value technique. While this technique is not a total cost approach, as it contemplates progress and cost of work in progress, it does require demonstration that the bid or estimate data being relied upon is realistic. Additionally, the earned value analysis should compare similar quantities and similar activities and exclude change orders when evaluating labor hours and progress.

1. Project Comparison Methodologies

What if there was no unimpacted period to establish a measured mile? A contractor can look to other similar scope of work on the same project or similar projects as a yardstick for productivity. When there is insufficient contemporaneous project documentation or productivity data available, it is recommended that either a comparable work study or comparable project study be employed to support claims for lost productivity. These techniques still consider a contractor's actual productivity, rather than theoretical or study-based data, but rely on less directly comparable contemporaneous data than the measured mile or earned value methodologies.

i. Comparable Work Study

In a comparable work study, the contractor estimates the productivity on the impacted portion of work and compares it to a non-impact portion of work similar in nature to that of the impacted portion. This effectively substitutes the standard measured mile for one based on a similar but not identical scope of work on the same project.

ii. Comparable Project Study

In a comparable project study, the non-impacted baseline productivity rate used for comparison is based on that achieved for the same type of work on a similar project. When using comparable project data to demonstrate productivity loss it is important to review and establish

[34] Gibson, Roger. A Practical Guide to Disruption and Productivity Loss on Construction and Engineering Projects. Germany, Wiley, 2015.

that there was no unimpacted period on the subject project that would permit a measured mile. While such an approach provides the "next best" option for calculating productivity, may be met with skepticism given the variables and factors that inevitably differ between the comparable project and the subject project. As such, comparable project studies should be viewed as secondary options to project-specific calculation methods. However, this method also can help further a measured mile by bolstering the analysis. Showing the non-impacted productivity during the measured mile period is comparable to unimpacted comparable project helps establish reliability of the non-impacted productivity rate.

3. Specialty Industry Studies

If neither of the project-specific or project-comparison techniques are available, recommended practice is to rely on specialty or general industry studies to quantify loss of productivity damages.

Specialty industry studies are mostly commissioned by construction associations and organizations and are typically based on data compiled from actual construction projects. Some such studies measure the effects of acceleration, learning curve, overtime, and weather effects, among others. Most of these subject-specific productivity studies are either peer-reviewed scientific articles written on factors affecting labor productivity in construction projects or studies published by recognized labor associations and industry groups (Business Roundtable, Construction Industry Institute, etc.).

Contractors encounter a variety of challenges when developing loss of productivity claims based on specialty industry studies. The main challenges are to demonstrate entitlement and causation, to establish that the subject project ran into situations like those demonstrated in the specialized studies, and to demonstrate the reasonableness of estimated increased time and/or costs.

4. General Industry Studies

General industry studies are typically used when specialized studies are not applicable and when sufficient contemporaneous and project specific project documentation (such as detailed and/or reliable labor and production tracking records) do not exist to demonstrate the productivity loss. Calculations relying on general industry studies are subject to additional scrutiny because they are not project or subject specific and thus are less demonstrably applicable to the situation giving rise to the claim being prepared. T

Some examples of general industry studies include the U.S Army Corps of Engineers Modification Impact Evaluation Guide, and the productivity loss factors established by Mechanical Contractors Association of America (MCAA), a list of 16 factors affecting productivity, as shown in Figure 11, wherein the severity of the impact (Minor, Average, or

Severe), determines the percent of loss fact to apply to the labor costs for the resultant productivity impact :[35]

[35] Mechanical Contractors Association of America (MCAA), (2020). ‘‘Change Orders, Productivity, Overtime: A Primer for the Construction Industry.” Rockville, Md. 135-136

Factor	Percent of Loss per Factor		
	Minor	Average	Severe
1. STACKING OF TRADES: Operations take place within physically limited space with other contractors. Results in congestion of personnel, inability to locate tools conveniently, increased loss of tools, additional safety hazards and increased visitors. Optimum crew size cannot be utilized.	10%	20%	30%
2. MORALE AND ATTITUDE: Excessive hazard, competition for overtime, over-inspection, multiple contract changes and rework, disruption of labor rhythm and scheduling, poor site conditions, etc.	5%	15%	30%
3. REASSIGNMENT OF MANPOWER: Loss occurs with move-on, move-off men because of unexpected changes, excessive changes, or demand made to expedite or reschedule completion of certain work phases. Preparation not possible for orderly change.	5%	10%	15%
4. CREW SIZE INEFFICIENCY: Additional workers to existing crews "breaks up"original team effort, affects labor rhythm. Applies to basic contract hours also.	10%	20%	30%
5. CONCURRENT OPERATIONS: Stacking of this contractor's own force. Effect of adding operation to already planned sequence of operations. Unless gradual and controlled implementation of additional operations made, factor will apply to all remaining and proposed contract hours.	5%	15%	25%
6. DILUTION OF SUPERVISION: Applies to both basic contract and proposed change. Supervision must be diverted to (a) analyze and plan change, (b) stop and replan affected work, (c) take-off, order and expedite material and equipment, (d) incorporate change into schedule, (e) instruct foreman and journeyman, (f) supervise work in progress, and (g) revise punch lists, testing and start-up requirements.	10%	15%	25%
7. LEARNING CURVE: Period of orientation in order to become familiar with changed condition. If new men are added to project, effects more severe as they learn tool locations, work procedures, etc. Turnover of crew.	5%	15%	30%
8. ERRORS AND OMISSIONS: Increases in errors and omissions because changes usually performed on crash basis, out of sequence or cause dilution of supervision or any other negative factors.	1%	3%	6%
9. BENEFICIAL OCCUPANCY: Working over, around or in close proximity to owner's personnel or production equipment. Also badging, noise limitations, dust and special safety requirements and access restrictions because of owner. Using premises by owner prior to contract completion.	15%	25%	40%
10. JOINT OCCUPANCY: Change cause work to be performed while facility occupied by other trades and not anticipated under original bid.	5%	12%	20%
11. SITE ACCESS: Interferences with convenient access to work areas, poor man-lift management or large and congested worksites.	5%	12%	30%
12. LOGISTICS: Owner furnished materials and problems of dealing with his storehouse people, no control over material flow to work areas. Also contract changes causing problems of procurement and delivery of materials and rehandling of substituted materials at site.	10%	25%	50%
13. FATIGUE: Unusual physical exertion. If on change order work and men return to base contract work, effects also affect performance on base contract.	8%	10%	12%
14. RIPPLE: Changes in other trades' work affecting our work such as alteration of our schedule. A solution is to request, at first job meeting, that all change notices/bulletins be sent to our Contract Manager.	10%	15%	20%
15. OVERTIME: Lowers work output and efficiency through physical fatigue and poor mental attitude.	10%	15%	20%
16. SEASON AND WEATHER CHANGE: Either very hot or very cold weather.	10%	20%	30%

Figure 11. MCAA Productivity Factors

One use of industry studies that may not be immediately apparent is their use in preparing a schedule analysis in support of a productivity claim. If the claimant is including a delay component in the claim, they can utilize impact factors from industry study data to prepare a prospective Time Impact Analysis (TIA) demonstrating the impact of the productivity loss on the project's critical path, as shown in Figure 12:

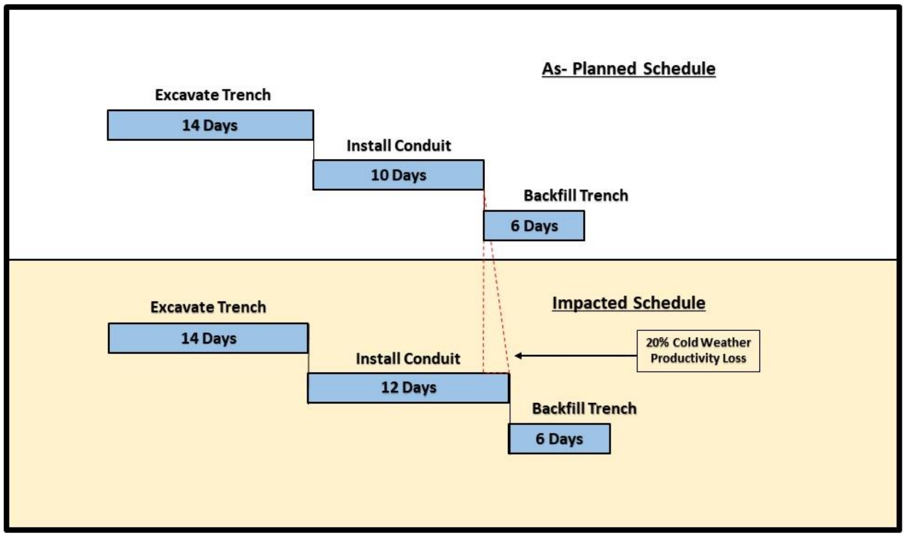

Figure 12. Productivity impact factor used in Time-Impact Analysis

Courts and review boards have accepted industry studies, although success has varied. The success of calculations based on industry studies, or lack thereof, can likely be attributed to inadequate establishment of causation. below provides a survey of outcomes for productivity loss calculations based on these studies.[36]

Factor	Number Cases in which Factor Asserted	Number of Successful Cases	Success rate	Rank
Reassignment of Manpower	9	2	0.22	11
Dilution of Supervision	9	3	0.33	6
Morale and Attitude	8	3	0.38	5
Concurrent Operations	8	2	0.25	9
Stacking of Trades	6	3	0.50	2
Learning Curve	4	1	0.25	9
Errors and Omissions	4	0	0.00	12
Site Access	4	2	0.50	2
Crew Size Inefficiency	3	1	0.33	6
Beneficial Occupancy	3	1	0.33	6
Joint Occupancy	2	0	0.00	12
Ripple	2	0	0.00	12
Overtime	2	1	0.50	2
Logistics	1	0	0.00	12
Season and Weather Change	1	1	1.00	1
Fatigue	0	0	0.00	12

Figure 13. Review of MCAA factor success rate in select cases

36 Ibbs, W. & Sun, Xiaodan, "Proposed Improvements to the MCAA Method for Quantifying Construction Loss of Productivity," Department of Civil and Environmental Engineering – University of California, Berkeley, May 2016, 56.

The use of productivity factors from industry studies are more likely to be successful when a contractor narrows its usage to fewer factors and more easily understood factors, focusing on establishing causation for the factors being pursued, and supporting this with backup. With MCAA factors, courts have rarely considered the use of the "Severe" factor, typically allowing the "Minor" or "Average" adjustment. Pairing impact factors with relevant fact and expert testimony is a means of bolstering this methodology.[37]

5. Cost Basis

At the lower end of the favorability spectrum are productivity loss calculations based on cost-basis methodologies, most often presented using the Total Cost Method and Modified Total Cost methods.

i. Total Cost Method

The consensus least-favorable method of quantifying damages is the total cost method which is simply the contractor's total costs on the project (plus allowable markups) less the contractor value. The difference is the total cost overrun experienced on the project and is the value of damages claimed under this method. Because the method provides the maximum allowable recovery for the contractor, it is viewed favorably by those seeking recovery. Another appeal of this method is its simplicity as minimal effort is required to calculate the damages.

Because the method relies on the assumption that every dollar incurred above the bid estimate is due to an excusable impact for which the claimant is entitled to recovery, it is viewed with extreme skepticism by the respondent and courts alike. To use the method, the claimant must demonstrate it can satisfy a four-part test.[38] If the claimant can satisfy the four-part test, the use of the method may be allowable. The four-part test requires demonstration of the following:

1. It's nearly impossible to determine the loss by counting individual costs
2. The original bid must have been realistic
3. The actual costs must have been reasonable
4. And the Claimant must not be responsible for the overrun.

i. Modified Total Cost Method

This calculation takes the same approach as the Total Cost Method, but also factors in bid errors by the contractor, as well as other contractor or subcontractor-responsible issues. In making such considerations, the modified total cost method is a more reasonable approach since it does not assume the contractor executed the project flawlessly and deducts the value of such non-recoverable issues and inefficiencies from the claim value accordingly.

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[37] *See Turner Constr. Co.*, 17-1 B.C.A. (CCH) ¶ 36739 (Apr. 14, 2017).
[38] McNamara, J. J., Schwartzkopf, W. (2000). Calculating Construction Damages. United States: Aspen Law & Business. Pp. 15.

While the modified total cost calculation is more complex than the total cost method, it is a fairer method of quantification. The modified total cost method still requires the claimant demonstrate satisfaction of the above-mentioned four-part test. And while it is viewed more favorably to the total cost method, the modified total cost method is still viewed as an inferior method to the other techniques described above.

VI. Contractor Considerations

1. What Method to Use?

The availability of reliable productivity data and contemporaneous project documentation will typically dictate what method should be employed on a productivity claim. While each claim scenario is unique, the hierarchy described above offers a general framework for choosing a methodology.

While we discussed the varying levels of preference between methodologies among the industry, fact finders have both accepted and rejected the various types of methodologies to varying degrees. Table 1 below summarizes a survey of productivity claims across 138 U.S. court and board cases using various methodologies and the outcome: [39]

Disruption Method	Cases Referencing	Accepted	Not Accepted	Acceptance %
Measured Mile	30	16	14	53%
Earned Value	7	3	4	43%
Comparison to Similar Projects	1	0	1	0%
Modified Total Cost	23	6	17	26%
Total Cost	24	5	19	21%
Productivity Factors	36	9	27	25%
Visual Observation / Judgment	17	5	12	29%
Total	138	44	94	32%

Table 1. Acceptance percentages for productivity methodologies across 138 cases

A visualization of the data is provided in the bar chart in Figure 14:

[39] Data from: Dale, W. Stephen, and D'Onofrio, Robert M., Construction Schedule Delays. United States, Thomson Reuters, 2018.

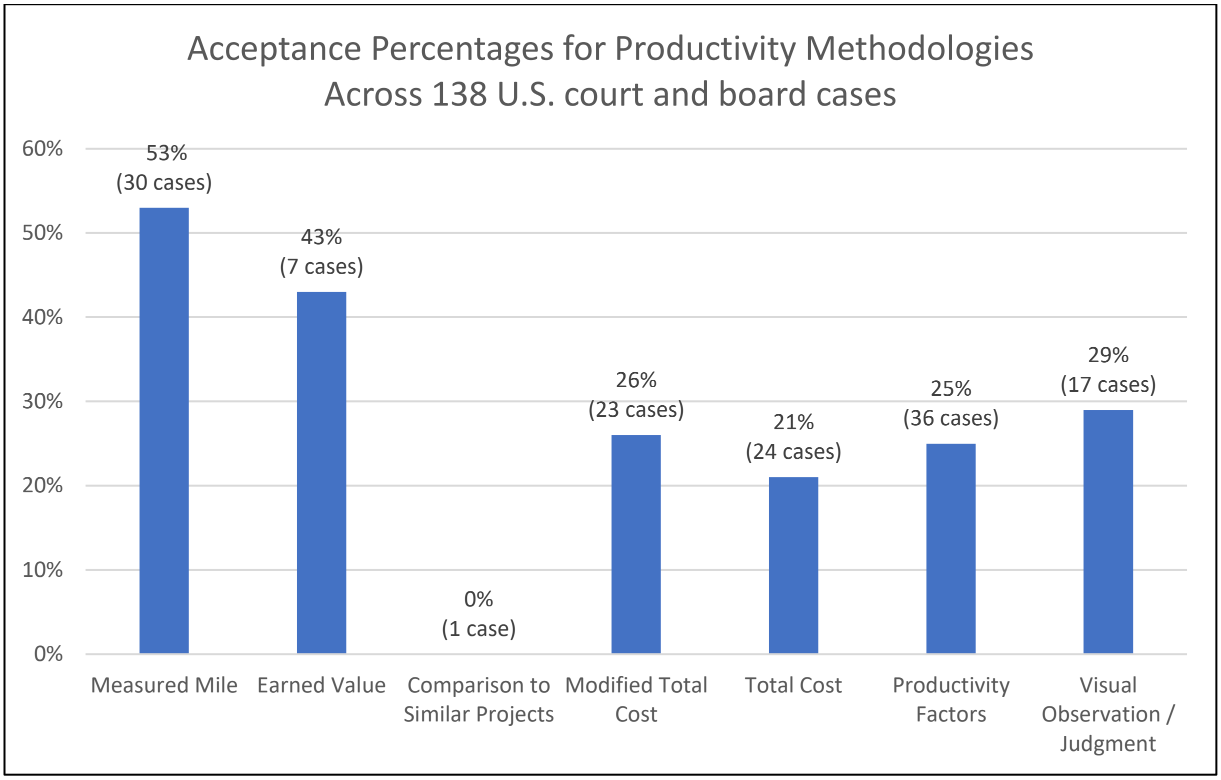

Figure 14. Acceptance percentages for productivity methodologies across 138 cases

Turner v. Smithsonian was a museum renovation project in Washington, D.C. with numerous contractor and subcontractor claims, including subcontractor claims for delay and disruption costs of approximately $7 million.[40] Subcontractors in the matter asserted labor inefficiency claims which arose from "hazardous material abatement, MEP interferences, and continuing design changes," as well as "inefficiencies and delays attendant to limited site access and unforeseen security requirements." With several subcontractors pursuing claims, the weight of the methodologies used was evident in the Board decision. Despite many of the subcontractors being impacted by the same disruptions, and witnesses for Turner and each of the subcontractors testifying to the impact of the disruptions which required a resequencing of work, the Board found that only *some* of the subcontractors proved their costs – two out of three using measured mile, one out of two using industry study factors. For the subcontractor whose claim using factors from industry studies was rejected, the Board determined that while the subcontractor's witnesses "testified persuasively that crews become less efficient after working a series of sixty-hour weeks" they failed to provide the industry publication which supported its alleged 34% inefficiency rate or provide any expert testimony to support its application of the factor used.

2. Justifying the calculation method

After determining the appropriate technique for calculating productivity loss damages, it is important to justify its use. If you are unable to use a preferred method, it is important to rationalize and document the reasoning. Given the preference for the measured mile or other project-specific

[40] Turner Constr. Co., 17-1 B.C.A. (CCH) ¶ 36739 (Apr. 14, 2017).

methodologies, it is critical to establish why such methods are not available when using another method. Use of a less-preferrable method without justification will certainly be challenged. Perhaps there was no impacted period, or there was not adequate contemporaneous documentation to use one of the preferred methods. The opposing party may try to discredit your findings by noting a contractually required or industry recommended practice that is a preferred (and demonstrably available) method and by performing its own analysis using a preferred method which yields a smaller damage value.

3. Recommendations / Best Practices

Several "best practices" should be observed by contractors, starting before a contract is executed. Contracts should be carefully reviewed to ensure comfort with provisions in place that could limit the ability to prosecute or recover certain types of claims. If a bid is based on any assumptions or qualifications, they should be captured in the contract. Reliance on a proposal as a basis of the contract may be problematic if the proposal is not incorporated by reference or as an exhibit. It may also be beneficial to establish unit prices for force account work in the contract, such as a daily rate for equipment.

Good recordkeeping throughout the entire project is essential for productivity claims.[41] Contractors should establish robust project controls and document management to allow for tracking and recording actual labor productivity. Keeping adequate records and understanding how actual productivity compares to planned productivity allows for the best outcome: mitigation of impacts and resultant damages but provides the next best outcome as well: protection of one's rights to a claim through issuance of proper notice, and recovery of damages through contemporaneous documentation and claim preparation.

Implementing more defined procedures will allows for easier identification and assessment of sources of risk, greater ability to manage those risks during the project and mitigate exposure when events arise that increase risk, and document events that may affect each party's respective share of responsibility for claim events. When issues arise, an appropriate method for tracking the issue, including cost coding, should be considered. Comprehensive daily reports can also help facilitate claim recovery and reduce time needed to prepare claim. By "telling the story" through the daily report, with all relevant information, such as manpower, management personnel, subcontractors, other trades onsite, temperature / weather conditions, shift time / hours, work being performed and locations of work performed, equipment onsite, standby time, deliveries received, inspections scheduled, deficiencies corrected, stoppages / delays, accidents / incidents, it becomes possible to reconstruct what transpired months or years later when preparing a claim or litigating.

Since the measured mile is the preferred method for productivity claims, foresight should be granted in how to develop the metrics needed to pursue such a claim if a disruption occurs and a project goes awry. This may require tracking daily quantities of work completed for each activity for the manpower provided. Creating a measured mile early in a project when work is typically performed with minimal impacts for work activities which will continue throughout will avoid the

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[41] AACE International Recommended Practice No. 25R-03

headache of trying to recreate a timeline and productivity analysis after the fact. Recording adequate detail and breaking down the work performed by discrete area will assuredly aid in measuring productivity impacts, and if a crew works on two or more tasks in each day, time should be tracked discretely for the tasks.

When changes to the planned activities arise, these events should be documented. This can include directives to work in multiple areas if that conflicts with what the schedule contemplates, stacking from other trades, out-of-sequence work, access issues, field-directed changes, and damage from other trades. Project conditions and status of work should be frequently documented with photographs and video. New technologies, such as 3D capture and site documentation software allow for even greater tracking of work-in-place than what was once typically an intensive administrative task.

It is also prudent to always obtain native copies of project schedules and updates (such as a .xer file generated in Primavera P6, or .mpp file generated in Microsoft Project). Even if you do not have a means of opening the native file, they should be collected, as advancing claims will likely require a schedule analysis, which can most effectively be performed with native schedule files.

Contractors should also seek to provide timely notice when issues arise, document verbal discussions, and obtain written authorization over verbal directives, and obtain signed acknowledgements from client / Owner, even when entitlement may be disputed (for example: obtaining signed tickets verifying time and materials even if the issue is in dispute). It may also be prudent to pursue change orders incrementally during the work, if practical, especially if an activity is to span several weeks, rather than accruing large costs to be reviewed later, and be mindful of release language when executing change orders.

Finally, a post-mortem should be performed after each project. For improved productivity in the future, identify methods that worked best and those that require improvement. When contractors repeatedly perform similar work, a measured-mile database, where similar projects are grouped, and measured mile data is compiled, may be beneficial for supporting productivity impacts via a comparable project study. This can be a method of proving future productivity claims, as well as validating assumed productivity rates for preparing estimates for new work.

Understanding productivity claims and how to document and prepare them does not just offer a means for recovery in the event of an impact, but a method for approaching project execution to minimize the impacts in the first place.