Editorial

Use of Mechanical Contractors Association of America Method in Loss of Productivity Claims

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Introduction

Productivity is a measurement of work efficiency. It is usually defined as work output divided by work input, e.g., 4 linear feet of pipe per labor-hour. Less than anticipated productivity can cause significant financial loss. If these losses are the result of interferences or events that are not the responsibility of the contractor, the contractor may be able to recover these costs from the responsible party through a loss of productivity claim (Harmon and Cole 2006a, b). These losses are called loss of productivity (LOP). LOP calculation is one of the most important and contentious areas in construction claims. It is contentious for many reasons including the fact that productivity is often not tracked during the course of a project or cannot be tracked. Both causation and entitlement concerning the recovery of LOP are hard to establish (AACE 2004).

There are several methodologies available to calculate LOP. The most favored method for proving LOP is the actual cost method. This method consists of making actual observations and recordings of the lost productivity. At the other end of this continuum is the total cost method in which final costs are compared to original bid (or modified by excluding change orders and self-inflicted problems). Between the two ends of the LOP damage calculation continuum lie other methods, including the measured mile and industry study methods (Jackson et al. 2001). The measured mile approach compares the productivity of an impacted period of the project with the productivity of an unimpacted period. Industry studies, on the other hand, include the Mechanical Contractors Association of America (MCAA) (2011) model, the Leonard (1998) curve, and the Ibbs et al. (2008) curve.

Measured mile is preferred over the MCAA model as long as it is applicable. For example, in the *Appeal of P.J. Dick Incorporated*, the plaintiff presented both a measured mile and a MCAA analysis, and the board chose measured mile method even though the "unimpacted period" of measured mile was based on other similar, not identical works. Another example is the *Appeal of AEI Pacific Inc*. in which the board denied the LOP claim because its expert did not ask AEI for data from any similar project to try measured mile analysis even though he stated in a paper that "the best method for estimating LOP is the measured mile technique and that if unimpacted productivity data are unavailable from a disputed project, a similar project can be used for comparison purposes."

Generally the MCAA model is used by boards and courts (1) when the measured mile method and better methods are not applicable, or (2) to corroborate a LOP estimate that is prepared using some other method (e.g., measured mile, modified total cost, or Ibbs curves).

This paper reviews 14 board and court cases involving the use of the MCAA model. It summarizes and analyzes those relevant legal case opinions and the following observations are made: (1) no board has ever rejected the MCAA model because of inherent limitations in itself; (2) choosing fewer factors is roughly correlated (not in strict statistical sense) with increased success in using the model; (3) contractors must provide detailed explanations and relevant evidence to establish causation for each factor to ensure credibility; and (4) the LOP percentages provided in the MCAA model are based on contractor opinions not empirical studies, and boards and courts thus tend to be conservative in granting any LOP damage.

MCAA Productivity Loss Factor List

MCAA Factor List

In 1968 the Mechanical Contractors Association of America began preparing a labor unit manual that would serve as a reference document on labor staff-hours for pipes, valves, fittings, specialties, and equipment installed by mechanical contractors (MCAA 1994). MCAA first published that reference document (hereinafter referred to as the MCAA manual) in 1971 and has periodically updated it.

Reprinted in Table 1, it contains a series of 16 factors that are used to evaluate the LOP due to change orders. The factor titles, descriptions, and the percentage of estimated impact have remained unchanged since the initial publication.

The MCAA factor list is often used in the claims because of the essential difficulty to prove the damage of productivity loss. Courts have recognized that a plaintiff may recover even where it is apparent that the quantum of damage is unavoidably uncertain, beset by complexity, or difficult to ascertain, if the damage is caused by the wrong (MCAA 2005). One of the most beneficial and advantageous facets of the model is that the MCAA factors require users to consider carefully the narrative facts and project events or milestones with the trends shown by the numbers (MCAA 2005).

Comment about MCAA by Previous Studies

Many previous studies introduced MCAA as one of the industrial researches that can be used to quantify productivity loss. Some of them have provided insights into the use of the method.

The Association for the Advancement of Cost Engineering (AACE) (2004) listed the MCAA factor method as one of the industry methods and commented on all industry methods that (1) the claimant needs to demonstrate entitlement and causation, (2) there must be a showing that there is no better information upon which to estimate resulting damages, and (3) the contractor must show that the impacts encountered on the project rationally fit one or more of these studies.

Table 1. MCAA Factors (Reprinted from MCAA 2011, with Permission from the Mechanical Contractors Association of America)

Factor	% of loss per factor		
	Minor (%)	Average (%)	Severe (%)
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
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
Reassignment of manpower: loss occurs with move-on, move-off men because of unexpected changes, excessive changes, or demand to expedite or reschedule completion of certain work phases. Preparation not possible for orderly change	5	10	15
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
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
Dilution of supervision: applies to both basic contract and proposed change. Supervision must be diverted to (1) analyze and plan change, (2) stop and replan affected work, (3) take-off, order and expedite material and equipment, (4) incorporate change into schedule, (5) instruct foreman and journeyman, (6) supervise work in progress, and (7) revise punch lists, testing and start-up requirements	10	15	25
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
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
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
Joint occupancy: change cause work to be performed while facility occupied by other trades and not anticipated under original bid	5	12	20
Site access: interferences with convenient access to work areas, poor man-lift management or large and congested worksite	5	12	30
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 and rehandling of substituted materials at site	10	25	50
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
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
Overtime: lowers work output and efficiency through physical fatigue and poor mental attitude	10	15	20
Season and weather change: either very hot or very cold weather	10	20	30

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Harmon and Cole (2006a, b) criticized that the application of factors is largely a subjective exercise because (1) there is a lack of information concerning the participants providing the information (in the MCAA factor list) such as how many years they worked in the industry, title, or experience; (2) there is a lack of description of what constitute a minor, average, or severe conditions; (3) some factors are repetitive; and (4) if improperly applied, the use of this study to quantify the impact to productivity could unrealistically inflate the amount of lost staff-hours.

Dieterle and Gaines (2011) commented that (1) this method fails to differentiate or adequately define minor, average, and severe; and (2) the study was intended as a forward pricing tool to be used in change order evaluations and simply applying the percentages to actual labor costs is expressively not recommended by the publication.

Despite these observations and criticisms, the method is widely used. However, its success rate is uneven in large part because there are no reliable guidelines (Ibbs and Vaughn 2015). This paper presents the results of an analysis of board and court decisions that was in turn used to develop such guidelines for MCAA use.

Case Summary

Fourteen legal cases were found that used the MCAA model to quantify LOP. The basic information about those cases is listed in Table 2. Seven of the 14 cases were successful from the contractor's viewpoint: *S. Leo Harmonay v. Binks Manufacturing Company; Appeal of Fire Security Systems* (1991); *Appeal of Clark Concrete Contractors*; *Appeal of The Clark Construction Group*; *Appeal of Hensel Phelps Construction Company*; *Appeal of Stroh*

Table 2. Basic Information Regarding MCAA Cases

Case	Jurisdiction	Decision time	S or U	Factors claimed by contractor
S. Leo Harmonay, Inc. v. Binks Manufacturing Company	U.S. Court for the Southern District of New York	1984	S	Unspecified
Appeal of Fire Security Systems, Inc.	Veterans affairs board of contract appeals	1991	S	Beneficial occupancy, stacking of trades
Appeal of Stroh Corporation	General services board of contract appeals	1996	S	Crew size inefficiency, weather
Appeal of Clark Concrete Contractors, Inc.	General services board of contract appeals	1999	S	Stacking of trades, concurrent operations, dilution of supervision, site access, reassignment of manpower, competition for labor, overtime
Appeal of The Clark Construction Group, Inc.	Veterans affairs board of contract appeals	2000	S	Morale and attitude, reassignment of manpower, dilution of supervision, concurrent operations, errors and omissions
Appeal of Hensel Phelps Construction Company	General services board of contract appeals	2001	S	Stacking of trades, morale and attitude, reassignment of manpower, concurrent operations, dilution of supervision, and learning curve
Norment Security Group, Inc. v. Ohio Department of Rehabilitation and Corrections	Ohio Court of Claims	2001	U	Morale and attitude and unspecified others
Appeal of Sauer Inc.	Armed services board of contract appeals	2001	U	Stacking of trades, morale and attitude, reassignment of manpower, concurrent operations, dilution of supervision, beneficial occupancy, joint occupancy, ripple, overtime
Appeal of P.J. Dick Incorporated	Veterans affairs board of contract appeals	2001	U	Morale and attitude, reassignment of manpower, concurrent operations, dilution of supervision, learning curve, errors and omissions
Appeal of Fire Security Systems, Inc.	Veterans affairs board of contract appeals	2002	S	Morale and attitude, reassignment of manpower, and dilution of supervision
Appeal of Herman B. Taylor Construction Co.	General services board of contract appeals	2003	U	Morale and attitude, reassignment of manpower, concurrent operations, and dilution of supervision
Sunshine Construction and Engineering v. United States	United States Court of Federal Claims	2005	U	Stacking of trades, morale and attitude, reassignment of manpower, crew size inefficiency, concurrent operations, dilution of supervision, learning curve, errors and omissions, site access, ripple effect
Appeal of AEI Pacific Inc.	Armed services board of contract appeals	2008	U	Stacking of trades, morale and attitude, reassignment of manpower, crew size inefficiency, concurrent operations, dilution of supervision, learning curve, errors and omissions, beneficial occupancy, joint occupancy, site access, and logistics
Appeal of States Roofing Corporation	Armed services board of contract appeals	2010	U	Unspecified

Note: S = successful; U = unsuccessful.

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Corporation; and *Appeal of Fire Security Systems* (2001). Success in this setting means the contractor received financial compensation for its LOP. The other seven were not successful. Details will be explained in the case summary that follows in chronological order.

S. Leo Harmonay, Inc. v. Binks Manufacturing Company (1984)[1]

This appears to be the earliest legal case that used the MCAA manual to estimate LOP. Harmonay was a piping subcontractor working for general contractor Binks on expansion of an automobile assembly plant in New York. Harmonay claimed it was accelerated by Binks and as a consequence suffered at least a 30% productivity decline across its entire workforce due to "excessive working hours, overly crowded conditions, the unavailability of tools, materials and storage, defendant's delay in supplying drawings and equipment, and the constant revision on the contract drawings."

Harmonay admitted that its vice president read the MCAA manual but had not made detailed computations to arrive at the 30% LOP. He and the company's president both reviewed the project site and working conditions and the company's labor records. Binks countered that the 30% factor was speculative because "the figure was not based on personal observation but on a formula developed in a manual not in evidence."

The board decided that defendant did cause unreasonable and substantial delays to the plaintiff's work and was liable. The board accepted the 30% LOP factor because it was "persuaded by the testimony of Harmonay's president and vice president."

This case is the first case in which the MCAA manual is used, and it is a case in which a MCAA-based LOP claim was successfully made. However, there is no evidence showing which part of the MCAA manual was used to compute the 30% factor of LOP. It seems that the manual was influential but not by itself decisive. Rather, the board was heavily influenced by the experience and testimony of appellant's president and vice president.

Appeal of Fire Security Systems, Inc. (1991)

Automatic Sprinkler Corporation of America (ASCOA), subcontractor of Fire Security Systems, Inc. (FSS), requested additional compensation for LOP for installing a fire sprinkler system in a psychiatric hospital. FSS had to work in various buildings and rooms under occupied conditions that had been depicted as vacant on the contract drawings. It also encountered another contractor working in the same areas. ASCOA used two MCAA factors (stacking of trade and beneficial occupancy) to calculate a 20% productivity loss due to this unanticipated occupied area problem.

The board decided that the government's continued occupation of those areas was a differing site condition and the contractor was entitled to recover additional labor costs. The board agreed to use the MCAA manual as a starting point for the analysis because ASCOA had utilized the manual in its cost proposals and "the government has provided no testimony or evidence that the MCA productivity factors are flawed or unreasonable."

The government rejected the defendant's argument that ASCOA did not provide "a sufficient factual foundation in the record to support the twenty percent factor." However, the board did not accept the ASCOA's claim of 20% LOP for all work. Rather, it awarded 15% for some portions of the project and 20% for others due to beneficial occupancy and trade stacking.

Appeal of Stroh Corporation (1996)

The plaintiff, Stroh Corporation, was the contractor to replace the chillers for a cooling tower at a building in Iowa. Stroh alleged that the government delayed all field works from summer to winter because it refused to close the existing cooling system until the estimated end of the cooling season. In addition, the government insisted on completion within the planned period and Stroh was forced to assign a larger overall crew to accelerate the job. Stroh consulted the MCAA manual and estimated 30% LOP because of weather impacts (severe condition) and 10% impact for crew size inefficiency (minor condition). Stroh interviewed personnel on site and provided causal explanation to support its allegation. For example, for the compression of work, the project superintendent testified that Stroh used a "larger than optimum" crew size and his personal supervisory work was slowed because his duties increased with a larger work crew.

The board agreed on the LOP resulting from delay, and supported the contractor's estimate of 10% impact for nonoptimal crew size conditions. But the board was not persuaded that "the severity of the weather was shown to justify application of thirty percent factor" and instead awarded 25% "representing a compromise between average and severe."

Appeal of Clark Concrete Contractors, Inc. (1999)

Clark Concrete Contractors was awarded a contract for construction of a building for the Federal Bureau of Investigation (FBI). The work of its mechanical subcontractor, Poole & Kent Corporation (P&K), was delayed by the owner's redesign and its labor productivity was adversely affected. P&K used the MCAA model to claim LOP in three parts: (1) work in penthouse (six factors, 60% LOP in total); (2) work on intermediate floors (four factors, 33% LOP in total); and (3) overtime throughout the entire project (15% LOP).

The government's expert objected to use of the MCAA model for the penthouse LOP. Instead, he computed a "measured mile." The board disagreed with this method because the defendant's expert failed show that the "unimpacted period" chosen was really unimpacted, and consequently supported the use of the MCAA model. Application of MCAA for the intermediate floor resulted in a value greater than a total cost claim for those floors, and the board awarded P&K a total cost value LOP. The defendant did not challenge the LOP calculated for overtime, and P&K received its full claim for such.

Appeal of The Clark Construction Group, Inc. (2000)

The Clark Construction Group (plaintiff) made this appeal on behalf of P&K, the principal plumbing and mechanical subcontractor, and United Sheet Metal Company (USM), P&K's principal subcontractor. This appeal involved construction of a 400-bed hospital and separate energy center.

Efficiency of work was adversely affected due to site contamination and site dewatering problems. P&K used three methods (measured mile, MCAA, and modified total cost) to estimate that inefficiency. P&K's project manager, P&K's expert, and USM's senior project manager applied the MCAA manual independently to quantify LOP. The defendant's expert questioned the utility of the MCAA manual for quantifying LOP, basing his opinion on the ambiguity of the factor definitions and the ambiguous instructions on how to apply them.

The board rejected all three calculations provided by the plaintiff because it thought that the measured mile analysis used an improper baseline, the MTC was a total cost variant, and the contractor's MCAA-based LOP calculation was unreasonably large. A jury verdict method[2] was employed to arrive at an award. The board used the MCAA manual itself to develop this jury verdict estimate, and commented "despite the inherent subjectivity of the MCAA factors, the record here demonstrated that the MCAA method was a widely used industry standard method of accounting for the impact of inefficiency on mechanical work."[3] Dilution of supervision, site access, and morale and attitude factors were applied.

Appeal of Hensel Phelps Construction Company (2001)

Hensel Phelps Construction Company (HPCC) constructed a new building for the federal government, and Trautman & Shreve, Inc. (T&S) was its mechanical subcontractor. During the contract the government issued multiple change orders that caused LOP for both HPCC and T&S. T&S's expert used six MCAA factors to access the LOP impact (stacking of trades, morale and attitude, reassignment of manpower, concurrent operations, dilution of supervision, and learning curve). He testified that his assessment was based on "his knowledge and the project documents, his analysis of an as-built schedule, his experience in the construction industry and his expertise in assessing labor productivity losses." He did not use the percentages contained in the manual but used his own knowledge of the circumstances to estimate the losses.

The defendant's expert spoke disparagingly of the use of the MCAA inefficiency factors. In his opinion, the MCAA model "lost credibility over the twenty years they were in use." The board, however, disagreed with the defendant's expert and pointed out that he had limited experience in mechanical construction and in the use of the MCAA factors. The board found T&S's expert's report and testimony highly credible and awarded T&S its claimed amount.

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***Norment Security Group, Inc. v. Ohio Department of Rehabilitation and Correction* (2001)**

Norment Security Group (Norment) was the contractor performing detention and security work in prison. It claimed LOP impact damage caused by the defendant's failure to provide a workable schedule, properly coordinate the project, and provide timely access to the jobsite. Norment's expert used the MCAA model to calculate this impact at 25% LOP impact.

The court rejected the LOP claim because "the testimony and evidence was insufficient to prove that the alleged damages proximately resulting from defendants' actions or inactions." Additionally, the court found that plaintiff's MCAA-based calculations were "arbitrary and speculative" and did not represent a reliable measure of damages. The court gave an example of morale and attitude, stating that plaintiff's estimate of the subjective factors in the manual were not supported by the greater weight of the evidence.

***Appeal of Sauer, Inc.* (2001)**

This contract at issue called for Sauer to finish the interior of a refit building at a submarine base. The claim arose from changes to another on-site contractor's schedule. Sauer's vice president consulted several Sauer employees and used the MCAA manual to calculate LOP impact. He testified that his estimate was based on reviewing "documents, photos and videos in conjunction with the MCA Bulletin items." He applied nine factors (stacking of trades, morale and attitude, reassignment of manpower, concurrent operations, dilution of supervision, beneficial occupancy, joint occupancy, ripple, and overtime), but found the result calculated was "astronomical." He then "melded documents and facts he was aware of into a reasonable value he had experienced."

This claim was rejected because the board found that statements in the contract did not support the claim and Sauer used the estimate of its own employee, not an independent expert. The board also criticized Sauer's failure to explain how if formed its LOP estimates.

***Appeal of P.J. Dick Incorporated* (2001)**

The project involved in this appeal was the construction of a clinical addition to a Veteran's Affairs (VA) medical center. P.J. Dick Incorporated's (PJD's) performance was affected by electrical design deficiencies and acceleration ordered by the government. PJD claimed for inefficiency based on a "measured mile" analysis. There was no period during which branch circuits installation was not impacted so the plaintiff's expert derived a measured mile based on feeder circuit work. PJD's expert used the MCAA model as an alternative approach and applied six factors (morale and attitude, reassignment of manpower, concurrent operations, dilution of supervision, learning curve, and errors and omissions) to calculate LOP. The board awarded the contractor damages based on its measured mile analysis, disregarding the MCAA-based claim.

***Appeal of Fire Security Systems, Inc.* (2002)**

Fire Security Systems constructed a fire safety project for the federal government. It claimed that its efficiency was adversely affected because its crews encountered suspected asbestos almost as soon as pipe installation began. FSS used three MCAA factors (morale and attitude, reassignment of manpower, and dilution of supervision) to estimate a 70% LOP.

The defendant's expert denied the existence of LOP based on observations that FSS's crews were "working at the same pace throughout the period of pipe installation" and had actually "achieved greater labor efficiency than it had estimated in its bid." The board did not agree on his assertion. Based on the defendant's expert's observations, the board instead concluded that because plaintiff reported asbestos almost as soon as the pipe installation began, there would be no useful "measured mile" analysis possible for this claim.

The board adopted the use of the MCAA model but the requested amount was significantly reduced. Morale and attitude was the only factor recognized by the board and considering "the amount of ambient air testing regularly performed and the defendant's prompt remediation," the impact was considered to be minor (5%).

***Appeal of Herman B. Taylor Construction Co.* (2003)**

Herman B. Taylor Construction Co. alleged LOP during construction of a U.S. courthouse and post office. Its LOP was due to additional crew moves caused by delay due to flawed drawings and delays in response to requests for information. The plaintiff estimated LOP using four MCAA factors: morale and attitude, 20%; reassignment of manpower, 10%; concurrent operations, 5%; and dilution of supervision, 10%. However, these crew moves were not properly documented and plaintiff's consultant admitted that the productivity study applied only to mechanical trades and that Taylor's own forces were primarily "helpers for clean-up, set-up, that sort of thing."

Defendant's expert explained that the MCAA bulletin (MCAA 1994) was not intended to prove LOP, but to illustrate what types of productivity loss might occur on a mechanical project. The board rejected Taylor's LOP impact claim. Reasons included that (1) plaintiff underbid its labor cost, and thus it was unable to demonstrate the original staffing levels; (2) plaintiff did not submit adequate proof of labor inefficiency, the proof was based on "crew moves" that lacked substantiation; and (3) use of the MCAA bulletin was inappropriate because the labor allegedly made inefficient by the government were laborers, not mechanical workers.

***Sunshine Construction and Engineering v. United States* (2005)**

Sunshine Construction and Engineering claimed LOP due to defective specifications on a government education project. Plaintiff's expert planned to use the MCAA manual to quantify LOP, but the government's expert pre-empted him by arguing that the MCAA manual "was not recognized as an accepted approach by his peers or any trade association." That expert also cited the following passage in the manual: "the material contained in this manual is intended to assist you in planning and is not meant to provide absolute costs nor percentages which would be incurred. Each project, locale, situation is unique and variances will occur even within the same jurisdiction. These factors listed are intended to serve as a reference only. Individual cases could prove to be too high or too low."

Plaintiff in response adopted defendant's expert's analysis and calculations, which were based on a modified total cost method. The board did not support this claim, however, because plaintiff failed to "sustain the predicate for loss of productivity by showing that the Corps was responsible for the underlying causes of delay due to the defective plans and specifications."

***Appeal of AEI Pacific Inc.* (2008)**

The dispute arose in a public school renovation project in which the contractor, AEI, alleged delay and other costs associated with numerous design clarification and variation requests. AEI's expert had published an article in which he said that "the best method for estimating LOP is the measured mile technique and that if unimpacted productivity data are unavailable from a disputed project, a "similar" project can be used for comparison purposes."

However, he admitted in this case that he did not ask AEI for data from any similar project. Instead, he prepared a LOP damage claim based on the MCAA model, using 12 factors to perform his analysis.

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For each week he assigned a judgmentally derived percentage of loss to each factor he deemed existed on the project. However, he never spoke to anyone from AEI and never visited the site, and kept no records explaining his rationale for assigning a particular percentage to a particular factor. For example, one of the factors he cited was loss of morale, however AEI's president testified that he did not believe morale was a problem on this project.

The government's expert criticized the contractor's use of the MCAA model in this matter, pointing out that "the purpose of the bulletin is to help prepare original estimates and change orders, not to quantify damages." He contended that the percentages of loss in the appendix are "both extremely generous and unsupported by studies of actual projects." He argued that plaintiff misused the MCAA technique by applying all 12 factors cumulatively to both base contract and change order hours. He also argued that the contractor's expert failed to causally tie his analysis to actual events onsite, and concluded that AEI was entitled to an equitable adjustment for LOP in the range of at most 2 to 5%. The board adopted the testimony of the government's expert and awarded AEI 2% LOP damages.

***Appeal of States Roofing Corporation* (2010)**

This appeal involved the repair work to the roof cells on a building located in Norfolk, Virginia. States Roofing Corporation (SRC) argued that the owner's design changes and differing site conditions significantly altered the original work and caused a decrease in crew productivity. SRC used the measured mile method to quantify LOP impact and offered a MCAA analysis as an alternative check.

The board rejected the contractor's calculation, finding measured mile was of "marginal support" due to the use of estimated production rates and the contractor's lack of experience with such work. The MCAA model was also rejected because the analysis was prepared by the contractor's president, not an expert, making it "impossible to disregard the inherent subjectivity" of this method. A jury verdict was finally used for estimating the quantum of the LOP impact.

Discussions and Observations

Based on these 14 cases, some general observations and conclusions about the nature and use of the MCAA model can be made. They are presented in the following subsections.

There Is a Decline in Success Rate

The MCAA model has been used many times during the past 20 years, but the success rate for contractors has generally declined in recent times, as can be seen by inspection of Table 2. Prior to 2000 the model was successfully used in five of five published cases; since 2001 it has been successful in only two of nine cases. One possible explanation for this trend is that boards and courts have recently imposed a more stringent standard for proving LOP claims, requiring proof by either the actual cost or the measured mile technique. Training of field managers and advances in computer technology may have played a role in this trend, too, leading the courts to conclude that the state of the practice requires more pinpointed and contemporaneous damage calculation methodologies.

Opposing experts have over time become better informed about the model and its weaknesses and are thus better prepared to rebut its use. For instance, defense experts have noted that (1) the model is not intended to prove and quantify loss of productivity retrospectively [*Herman B. Taylor Construction Co.* (2003), *Sunshine Construction and Engineering* (2005), and *AEI Pacific* (2008)]; (2) the model's factors and instructions are ambiguous [*Clark Construction* (2000)]; and (3) the loss percentages are generous and unsupported by empirical studies [*AEI Pacific* (2008)].

However, despite these defense objections, no board or court has overtly cited any of these arguments as a basis for rejecting a MCAA-based claim. That is, the inherent nature of the model has not been questioned by them. Rather, the overwhelming reason for MCAA-based claim rejection is contractor failure to prove causation as discussed subsequently.

Select Less Factors and Focus on More Successful Factors

Another observation that emerges from this research is that the number of factors claimed seems to be roughly and inversely associated with the likelihood of successful MCAA use[4]. Successful cases used, on average, four factors, whereas unsuccessful cases typically used nine. One explanation for this is that more factors may be overstating or be seen to be overstating the claim, which in turn impugns the credibility of the claim. *Sauer* is an example. In this case, Sauer's expert used 9 of the 16 factors, and the resulting LOP calculation was so "astronomical" that the expert himself even admitted under testimony that it was unrealistic. The court thus ruled against the contractor.

It is also observed that some factors are more successful than others. Table 3 shows the number of times each factor has been used in the 14 cases and the number of times that factor was present in a successful claim. Trade stacking, site access, and overtime have the highest success rate (aside from weather, which was only cited in one case). Overtime and weather have not been used as frequently, perhaps because there are other research models that are specifically focused on overtime and weather effects (e.g., Clapp 1966; Grimm and Wagner 1974; Thomas and Yiakoumis 1987; NECA 2004; MCAA 1968). Such models have a stronger research base and a singular focus, which makes them more credible and popular.

In addition, error and omissions has been used and rejected four times and fatigue has never been used. A possible explanation is that these causal triggers are more distant from the construction workforce and the linkage to loss of productivity is accordingly more tenuous. Joint occupancy, ripple, and logistics have been rarely used in these published decisions, perhaps because of the vagueness of terms such as "ripple."

Table 3. Frequency and Success Rates for MCAA Factors

Factor	Number cases in which factor asserted	Number of successful cases	Success rate
Reassignment of manpower	9	2	0.22
Dilution of supervision	9	3	0.33
Morale and attitude	8	3	0.38
Concurrent operations	8	2	0.25
Stacking of trades	6	3	0.50
Learning curve	4	1	0.25
Error and omissions	4	0	0.00
Site access	4	2	0.50
Crew size inefficiency	3	1	0.33
Beneficial occupancy	3	1	0.33
Joint occupancy	2	0	0.00
Ripple	2	0	0.00
Overtime	2	1	0.50
Logistics	1	0	0.00
Season and weather change	1	1	1.00
Fatigue	0	0	0.00

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Demonstrate Causation for Each Factor

Every LOP claim must show causation, liability, and damages[5]. Demonstrating causation is especially important in the eyes of the court. One advantage of the MCAA model is that it contains a list of 16 factors that are well known and understood in the construction industry to cause LOP. However, it is not sufficient for the contractor to assert the mere presence of a factor. A detailed linkage must be shown between some causal event and the resulting consequence.[5]

Noteworthy MCAA cases that failed to demonstrate causation in sufficient detail are *Sauer*, *Norment*, *AEI*, and *Herman B. Taylor*. Broadly speaking, the claimant contractors in these cases used the MCAA model as a checklist of factors that they believed impaired their labor productivity, but did not provide sufficient evidence explaining how the presence of a factor (e.g., weather) impaired productivity.

Nowadays the contractor needs to provide causation proof for each of the factors it uses. For example, the contractor in *Fire Security Systems* (2002) identified three factors (morale and attitude, reassignment of manpower, and dilution of supervision). The board checked fact witness testimony and daily logs, and determined that reassignment of manpower and dilution of supervision did not occur on this project. But it was convinced by extensive testimony of site supervisors that morale was damaged and productivity impaired, and made an award to the contractor.

Do Not Blindly Rely on Data Provided in the Manual and Make Estimate Conservatively

The LOP percentages contained in the MCAA manual have been questioned by both defendant experts and boards. In *AEI*, the owner's expert considered the percentage of loss in the MCAA list as both generous and unsupported by studies of actual projects.[6] He argued that no owner would consider paying a 25% premium for dilution of supervision when the contractor could easily bring in another field engineer and superintendent to accomplish the same thing. The board agreed with his assertion. In *Norment* the contractor's expert estimated LOP due to inadequate scheduling and coordination based on data provided in the manual. The board rejected the claim partially because it believed that the contractor's use of the manual's percentages was "arbitrary and speculative" and did not "represent a reliable measure of damages."

The MCAA manual's LOP percentages are problematic in another way: the manual does not provide guidelines on how to determine the severity level. As a result, boards have been conservative when using MCAA and have never used "severe" ratings in any of these published LOP awards. For example, in

Table 4. Percentages Used for Successful Cases

Factor	Requested	Awarded
Appeal of Fire Security Systems, Inc. (1991)		
Beneficial occupancy	20% (minor-average)	15% (minor)
Stacking of trades	20% (average)	15% (minor-average)
Appeal of Fire Security Systems, Inc. (2001)		
Morale and attitude	30% (severe)	5% (minor)
Reassignment of manpower	15% (severe)	0% (none)
Dilution of supervision	25% (severe)	0% (none)
Hensel Phelps Construction Co. v. General Services Administration[a]		
Period two building D as an example		
Reassignment of Manpower	10% (average)	10% (average)
Appeal of Clark Concrete Contractors[b]		
Penthouse		
Stacking of trades	20% (average)	20% (average)
Concurrent operations	15% (average)	15% (average)
Dilution of supervision	5% (less than minor)	5% (less than minor)
Site access	5% (minor)	5% (minor)
Reassignment of manpower	10% (average)	10% (average)
On floors		
Concurrent operations	10% (minor-average)	N/A
Dilution of supervision	10% (minor)	N/A
Reassignment of manpower	10% (average)	N/A
Overtime		
Overtime	10–15% (minor-average)	10–15% (minor-average)
Appeal of Stroh Corporation		
Crew size inefficiency	10% (minor)	10% (minor)
Weather	30% (severe)	25% (average-severe)
Appeal of Clark Construction Group[c]		
Dilution of supervision	[c]	10% (minor)
Site access		5% (minor)
Morale and attitude		5% (minor)

[a]For *Hensel Phelps* the detailed information about the percentages is not publicly available. But the board has concluded "the percentages which he (the contractor) used, when compared to those recommended by MCAA, tend, on the whole, to be conservative. By far the majority of his estimates fall between the percentages recommended on the MCAA chart for either 'minor' or 'average' disruptions."
[b]The court ruled that the contractor was responsible for 29% of the delay to part of the project and held the owner responsible for the balance, 71%.
[c]For *Appeal of Clark Construction Group*, estimates were developed by three different experts and that information would be too voluminous to recap here. Details can be found in the decision. The allowed amount is in general to the lower side of the estimates.

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Stroh the contractor provided substantial detail describing the weather including (1) the work that had to be performed outdoors and on the roof of the building and argued that it was "significantly colder on top of a ten-story building than on the ground"; (2) the wind and other weather elements necessitated the wearing of heavy clothing, which significantly slowed the work; and (3) interviews of people onsite.[7] Nevertheless, the board reduced the contractor's claim for "severe" 30% LOP (which is "severe" in the manual) to 25%, "representing a compromise between average and severe seasonal conditions."

This pattern of awarding LOP rates that are lower than those requested by the contractor can be seen by reviewing the successful cases, which are listed in Table 4. Of course, contractors are undoubtedly asking for higher-than-justified rates as part of their bargaining strategy, knowing that the LOP percentages will eventually be bargained downward.

However, in most of the successful cases, the contractors requested percentages that fell into minor and average slots. The only counter example was *Fire Security Systems* (2001), in which the contractor applied a "severe" LOP impact for all three factors it requested. As a result, the board significantly reduced the estimated LOP and only awarded morale and attitude with a "minor" impact.

Recommendations

Based on the observations and analysis presented previously, the following are the recommendations for using the MCAA model:

1. Use fewer factors rather than more factors. Successful claims used four factors, unsuccessful claims used nine. Choose factors that are closer in terms of causal link to owner actions and more definitive (e.g., overtime or weather). Factors such as fatigue and error and omissions may be difficult to allocate responsibility because they are more distant and thus not easily linked to owner action or inaction. Avoid vague factors such as fatigue, logistics, and joint occupancy;
2. Establish causation for each factor. Explain clearly when, where, who, and how productivity were affected. Evidence that may help support a causation argument can come from project documents, witness interviews, and expert opinions. Failing to provide detailed explanations can doom a claim. In *Sauer*, as an example, the board rejected the LOP claim explaining that there was too little evidence on how and why productivity was lost. It also volunteered that the claim would have been strengthened by using an expert to conduct the analysis.
3. Do not blindly rely on the LOP damage percentages contained in the MCAA manual. Those percentages were developed by surveying contractors who have a vested interest in assigning larger percentages to these factors. Moreover, there are no definitions for the three severity levels suggested and some of the factor definitions are ambiguous. Two different people applying the MCAA model to the same disrupted project could arrive at very different LOP percentages because of this lack of definition. It is therefore recommended that LOP estimates using the model be made conservatively, and be made using project records, fact witness interviews, and an experienced expert who can persuasively explain the analysis.

Summary and Conclusions

LOP calculation is one of the most important and contentious areas in construction disputes. The MCAA model is one widely accepted method used to quantify LOP in construction claims. This paper summarizes relevant legal cases and discusses issues regarding use of this method. Fourteen LOP cases have been found using the MCAA model, seven of which were successful. Contractor application of the model and court and board comments contained in those 14 published decisions are summarized in this paper.

There is a decline in success application rates of the model after 2001. However, no board has ever rejected it because of inherent limitations in the model itself. Rather, rejections have been due to either failure to establish causation or improper, nonconservative application of the LOP factors and percentages.

It is also found that (1) choosing fewer factors is roughly correlated with increased success in using the model, (2) contractors must provide detailed explanations and relevant evidence to establish causation for each factor to ensure credibility, and (3) the LOP percentages provided in the MCAA manual are based on contractor opinions, not empirical studies. Boards and courts therefore tend to be conservative in granting any LOP damage.

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Story Parchment Co. v. Patterson Parchment Paper Co., 282 U.S. 555 (Feb. 24, 1931)

S. Leo Harmonay, Inc. v. Binks Manufacturing Co, 597 F. Supp. 1014, 1984, U.S. Dist. LEXIS 22438 (Oct. 26, 1984)

Sunshine Construction and Engineering v. The United States, 64 Fed. Cl. 346 (Fed. Cl. 2005)

Endnotes

[1]The subsections of this paper also contain the date of the court or board decision; e.g., Harmonay was decided in 1984. This was done so that the reader can follow the emerging chronology of decisions about the MCAA method.

[2]Jury verdict is a LOP quantification method. When a contractor cannot calculate its damage with any certainty, it leaves the computation to the discretion of the court by way of the jury verdict method. This approach is typically employed when there is clear proof that the contractor was injured, but there is no reliable method for determining damages (Long 2005).

[3]The board apparently believed that P&K's MCAA computations were "back-fit" to a total cost calculation. It discarded P&K's calculations using MCAA but computed and awarded a LOP damaged amount itself that utilized the MCAA framework.

[4]Only 14 cases were available for review in this article, so the sample size is small. Precise statistical analysis of the data is not possible, so all statistics reported in this paper must be viewed in that context.

[5]*Appeal of Acme Missiles & Construction*: "Broad generalities and inferences are not sufficient." *Story Parchment Co. v. Patterson Parchment*: "Courts and Boards of Contract Appeals exhibit some leniency in accepting contractor proofs of the *amount* of damages, but they hold contractors to a more rigorous standard in examining *proof of causation*." Liability refers to entitlement. It has two components: a legal right to recover based on contract or the owner's breach of the contract and evidence that the owner did something to hinder the contractor's performance. Causation requires the contractor to prove that the loss of productivity was caused by the owner's conduct or actions, rather than by the contractor's failure. Resultant injury requires the contractor to quantify LOP properly (Jones 2003).

[6]MCAA admits that it "does not have any records indicating that a statistical or other type of empirical study was undertaken in order to determine the specific factors or the percentages of loss associated with the individual factors" (MCAA 2011).

[7]The contractor's supervisor reported that "there were days we had to step in and out of wind to warm up when your hands get so cold you can't hang onto tools and stuff."

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