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Dealing with Cumulative Impact Claims

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When changes in a certain project become numerous and act concurrently, it creates a compounding effect in the life cycle of the project and to this date, there is no definitive standard to calculate such loss of productivity claims. Cumulative impact claims may be one of the most common cases on projects with multiple changes over the course of the project. Many courts and other legislative bodies recognize that there is cumulative impact above and beyond the change itself. However, construction contracts do not typically include adequate language to enable fair and equitable compensation for the unforeseen impact of cumulative change. Also, cumulative impact claims may be one of the most difficult claims to present and prove at trial or in arbitration. The courts and arbitration panels agree that the theory of cumulative impact is reasonable, and that multiple change orders and other types of delays and disruption can negatively impact the performance of the changed work such that a contractor expends additional time, man-hours and costs in completing its original scope of work.

What is Cumulative Impact Claim?

Two things are certain about almost any construction project: (1) there will be changes made during the course of construction, and (2) the client and the contractor will seldom agree on the total effect of those changes on the cost and schedule of the project.

Changes to the work must be addressed on a case by case basis but when the project is overwhelmed with changes, a certain phenomenon is often times experienced. This phenomenon is referred to by industry experts as cumulative impact. This is the result of multiple changes to a project that when taken individually do not have significant impact to the project. Many times, contractors, clients, and project managers do not recognize this impact until it has already occurred.

"One court has compared the notion of cumulative impact to a still pond of water which represents a smoothly running construction project. When one change is introduced to a job, it is similar to throwing a rock into the water and watching the ripples that emanate. Those ripples are the effect that one change has on the project. When multiple changes occur, at different times, multiple rocks of varying sizes are thrown into the pond at various locations. Each rock that is thrown into the pond has its own impact in the form of the ripple pattern it creates. Eventually, if enough rocks are thrown into the pond at different times, there is no simple ripple pattern. Instead, turbulence is created with each stone's ripple patterns impacting the others. Soon, there is no pattern and turbulence and disruption becomes the order of the day. It then takes some time for all the turbulence to settle down in the surface of the water to once again become smooth. Such is the effect on a construction project when multiple impacts are experienced over a period of time. While each change or impact, on its own, may be manageable, when they are introduced together over a relatively short period of time, an impact to the overall progress of the project can be felt [1]."

Courts and boards of contract appeals have studied this phenomenon and have attempted to describe it to provide just and fair adjustments to contractors who have experienced it. However, there is no set formula that is accepted by these judiciary bodies and each case is fact-specific as to cause and effect.

For example, in the construction of a high-end hotel in Egypt, due to aesthetic requirements, the client who was in India has given instruction to change the façade from paint finish to handmade stone finish. When the instruction was issued by the client, first primer and putty were already being applied in more than 50% of the building façade. To implement this change, revised design drawings shall be issued by the designer from Singapore and must be approved by the client in India before sending it back to the project manager in Egypt prior to issuance for construction. The material sample must also be finalized using the same approval process and the sample was commented three times due to its color, texture, and pattern. However, before installation, the contractor has to chip the wall plaster, which resulted to damages in the installed conduits, some blockworks and façade waterproofing system. Then, a new type of plaster has to be applied in the facade to suit the stone finish. Also, the GRC façade cornice which was already 80% fabricated has to be changed into natural stone cornice. Further, it was also shown in the daily reports that there were constant interruptions to the work…

The impact of the above changes is apparent through productivity related issues that result from factors such as re-sequencing of work, trade stacking, overtime, material sourcing problems, weather conditions, labour problems, low morale, shift work and the need for schedule acceleration.

The total impact of the above changes is more than the sum of the individual delay events. Several industry studies were made stating that there is a cumulative impact above the sum of each discrete event.

The Construction Industry Institute (CII) has explained the notion of cumulative impact as follows:

"When there are multiple changes on a project and they act in sequence or concurrently, there is a compounding effect – this is the most damaging consequence for a project and the most difficult to understand and manage. The net effect of the individual changes is much greater than the sum of the individual parts [2]."

Cumulative impact delays usually comes from several change orders, site instruction, RFI's, differing site conditions, suspensions of work, or other work disruptions that are widely recognized as compensable delays.

Comparison of Industry Studies

The Effects of Change Orders on Productivity - Leonard Study (1988)

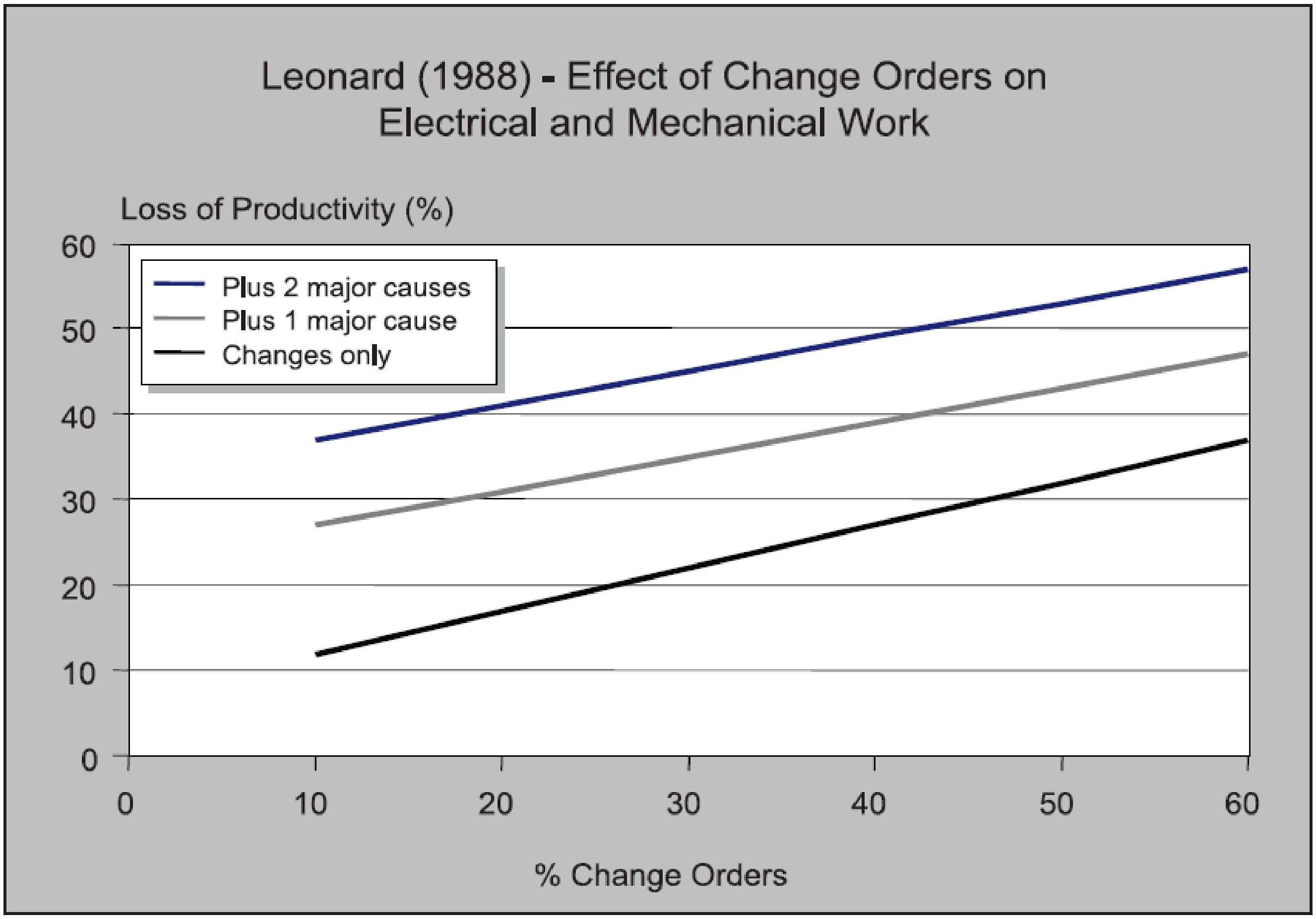
The "Leonard Study [3]" made by Charles A. Leonard was the first attempt to determine the cumulative impact of multiple changes on construction labour productivity. The study aimed to correlate three separate relationships between change orders and loss of productivity: 1) frequency of change orders; 2) average change order value; and 3) the percentage of change order man-hours compared with base scope man-hours. Only the last relationship could be proven statistically relevant:

"The results indicate a significant direct correlation between the labor component of change orders and the loss of productivity, for both civil/architectural and electrical/mechanical works. These losses are exacerbated by the added presence of the major causes of productivity losses such as acceleration and inadequate scheduling and coordination [4]."

To identify and quantify the impact of change orders on productivity, Leonard studied 90 construction disputes occurring on 57 different projects. The projects involved the construction of a variety of commercial and institutional buildings and industrial plants. He prepared three models to predict the loss of productivity on other projects, one model for civil/architectural work, one for mechanical/electrical work, and one for a combination of the two.

The results of Leonard's research were shown in two graphs, one for civil and architectural work and the other for electrical and mechanical work. Figure 1 depicts the result of Leonard study for electrical and mechanical work.

Figure 1. Impact of Changes on Mechanical and Electrical Work.



Leonard measured the "percent change orders" in terms of the sum of change order hours divided by the total actual hours less any hours attributable to contractor's culpabilities. It should also be noted that Leonard calculated the loss of productivity using "measured mile" which will be discussed in the following context.

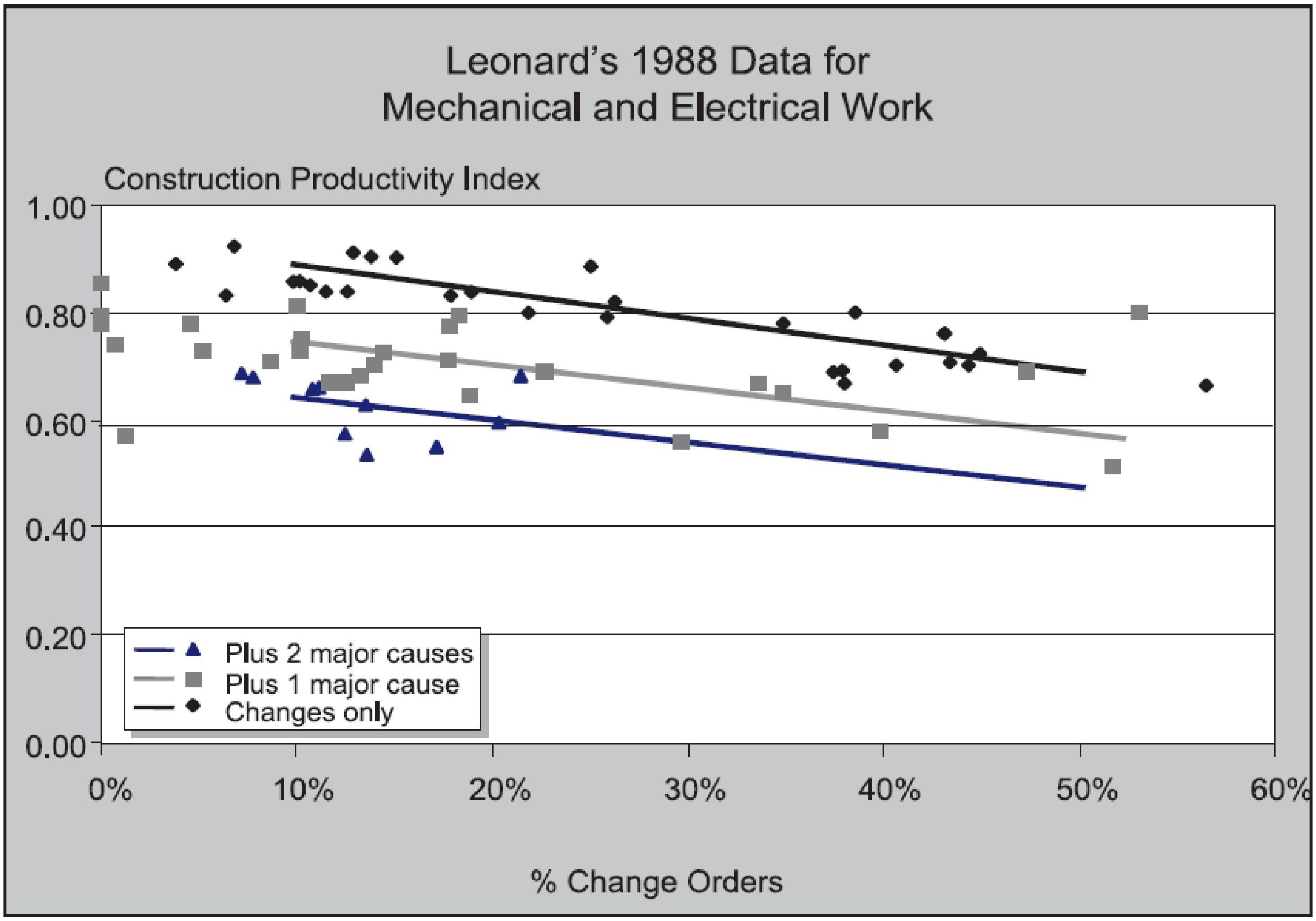
In the measured mile methodology, the delay analyst should determine the "normal" hours from which the lost hours could then be established. In cases, where the normal hours could not be determined "earned" hours were used to calculate the lost hours. If the contractor's estimate was reasonable, then earned hours were the estimated hours. If the contractor's estimate was not reasonable, the earned hours were modified to put them in line with the bids.

Leonard calculated the productivity index ("PI") as the ratio of earned hours vs. actual base hours. The formula for loss of productivity (LOP) was calculated as follows:

$$LOP = (1 - PI) \times 100\% \qquad \text{(equation 1)}$$

LOP was the ratio of the unproductive labour hours spent on the original scope of work. As stated earlier, Leonard has classified projects between civil/architectural work and mechanical/electrical work. He also established differing levels of impact based on the effect of changes only, or changes plus either one or two major causes as shown in Figure 2. Leonard described these so-called "major causes" as acceleration, out of sequence work, over stacking of trades, lack of materials, etc.

Figure 2. Leonard's Raw Data and Corresponding Regression Lines for Mechanical and Electrical Work (Leonard 1988)



The study notes: "In appropriate cases experiencing greater than 10% to 15% in change orders, these models can be used to estimate productivity losses of labour at micro level [5]."

Leonard study shows that mechanical and electrical work are more negatively impacted than civil and architectural work as change order man-hours increase. Leonard notes that the difference is due to "the level of skill required performing the work, complexity of the work, and the interdependency of the work activities [6]."

Quantitative Impacts of Project Change - Ibbs and Allen (1995)

In 1995, Ibbs and Allen, working under CII, studied 104 projects from 35different companies (15 contractors and 20 owners) representing both disputed and undisputed projects, foreign and domestic work, industrial, commercial and heavy civil work, and various delivery systems. These were rather large projects than those studied by Leonard and the median value of the projects was $44 million [7].

Ibbs and Allen published Figure 3 showing the relationship between the construction productivity ratio and construction change. However, as compared to Leonard study, they did not make a distinction between the project data points on the basis of type of project (architectural/civil or mechanical/electrical) nor was any distinction made for other major causes.

The Ibbs and Allen (1995) study presented a significantly more optimistic estimate of loss of productivity than the Leonard study.

It should be noted that there may be a significant difference between the presentation of Ibbs and Allen (1995) and Leonard (1988) in terms of the measurement of the "percent change orders." The Ibbs and Allen document states:

"The "percent change order" is defined as the number of work-hours expended on authorized changes that originated during the construction phase divided by the total work-hours expended for construction."

Quantifying the Cumulative Impact of Change Orders for Electrical and Mechanical Contractors - Hanna (1999)

In 1999, Hanna published two studies on the impact of change orders on productivity for mechanical construction and electrical construction. The studies were base on the information obtained from mechanical and electrical contractors working on 61 projects. Costs of mechanical projects range from $0.61 to $13.6 million and electrical works is described in terms of hours from 1,100 to 106,000 hours [8].

These studies found that percent change, calculated as the change order hours divided by the estimated base contract hours, was more significant than the "percent change" determined by Leonard (change order hours divided by actual base contract hours). The calculation of LOP was based on a multi-variable empirical formula including the following additional factors:

For mechanical construction:

- Impact classification (subjective evaluation)
- Change order hours / estimated base hours
- Number of changes (total)
- Weighted timing factor for timing of change orders

For electrical construction:

- The number of years experience of the project manager
- The estimate of change orders as a percentage of the original estimate (expressed in logarithmic units); and
- The estimate of change orders expressed in logarithmic units.

Considering the difference in the way the percentage change is measured and the many other variables involved in the calculation, the results of Hanna's studies cannot be compared with Leonard's data.

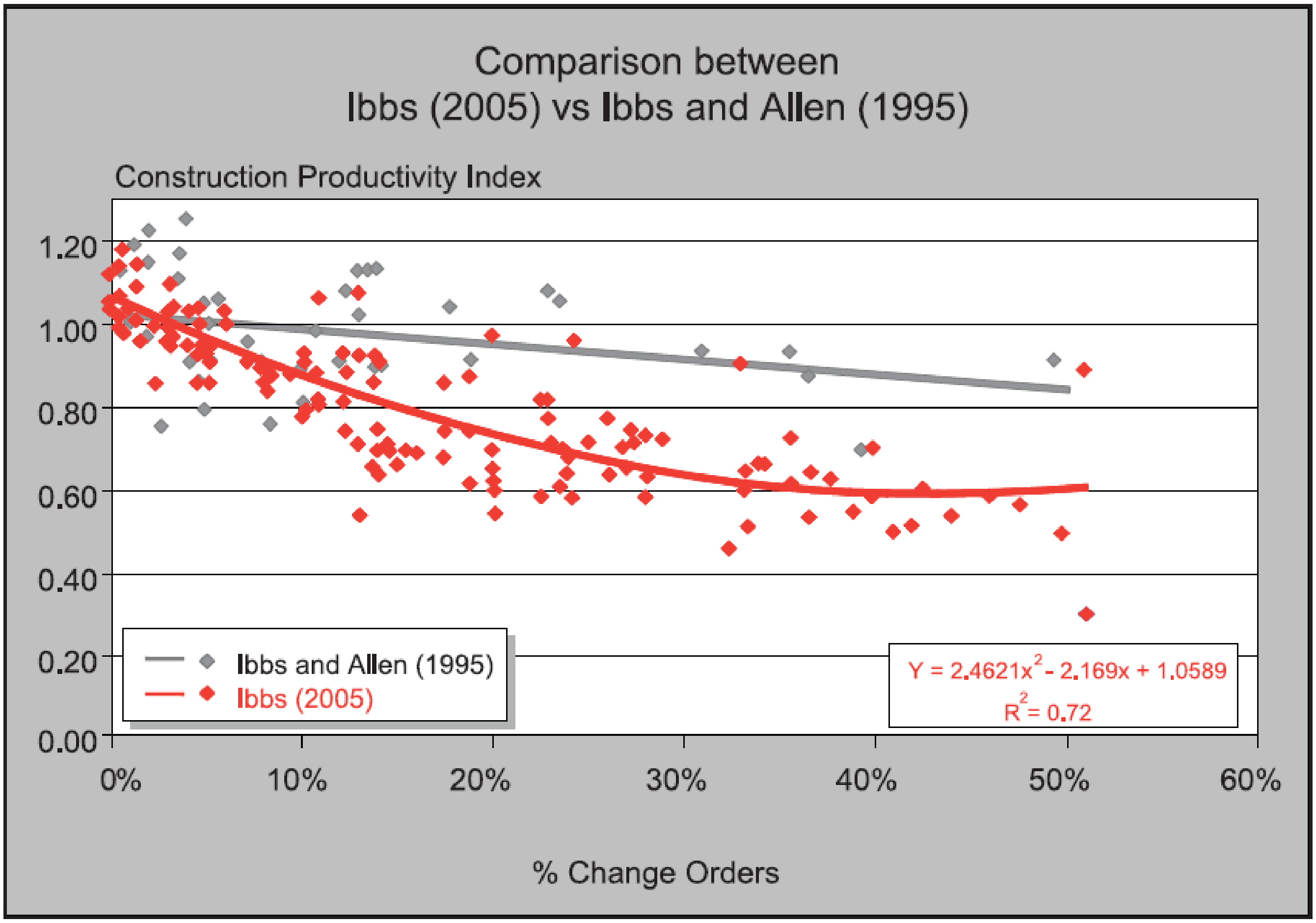
Impact of Change's Timing on Labour Productivity - Ibbs (2005)

In 2005, Ibbs published which was based on the data collected over nine years and included those in the previous study in 1995. A total of 162 disputed and non-disputed projects were studied from 93 companies including contractors, owners, project managers and design firms. The projects were classified as follows: 35% heavy/highway; 16% commercial; and 49% industrial. The projects were evenly split between: 45% public sector; 55% private sector; and two-thirds were delivered using the traditional method of design/bid/build. The project costs ranges from $3.9 million to $14.5 billion [9].

However, Ibbs did not classify the type of projects as Leonard or Hanna in terms of civil/architectural or mechanical/electrical. Ibbs stated that this distinction was unnecessary because this variable did not make a significant difference in the impact of the change.

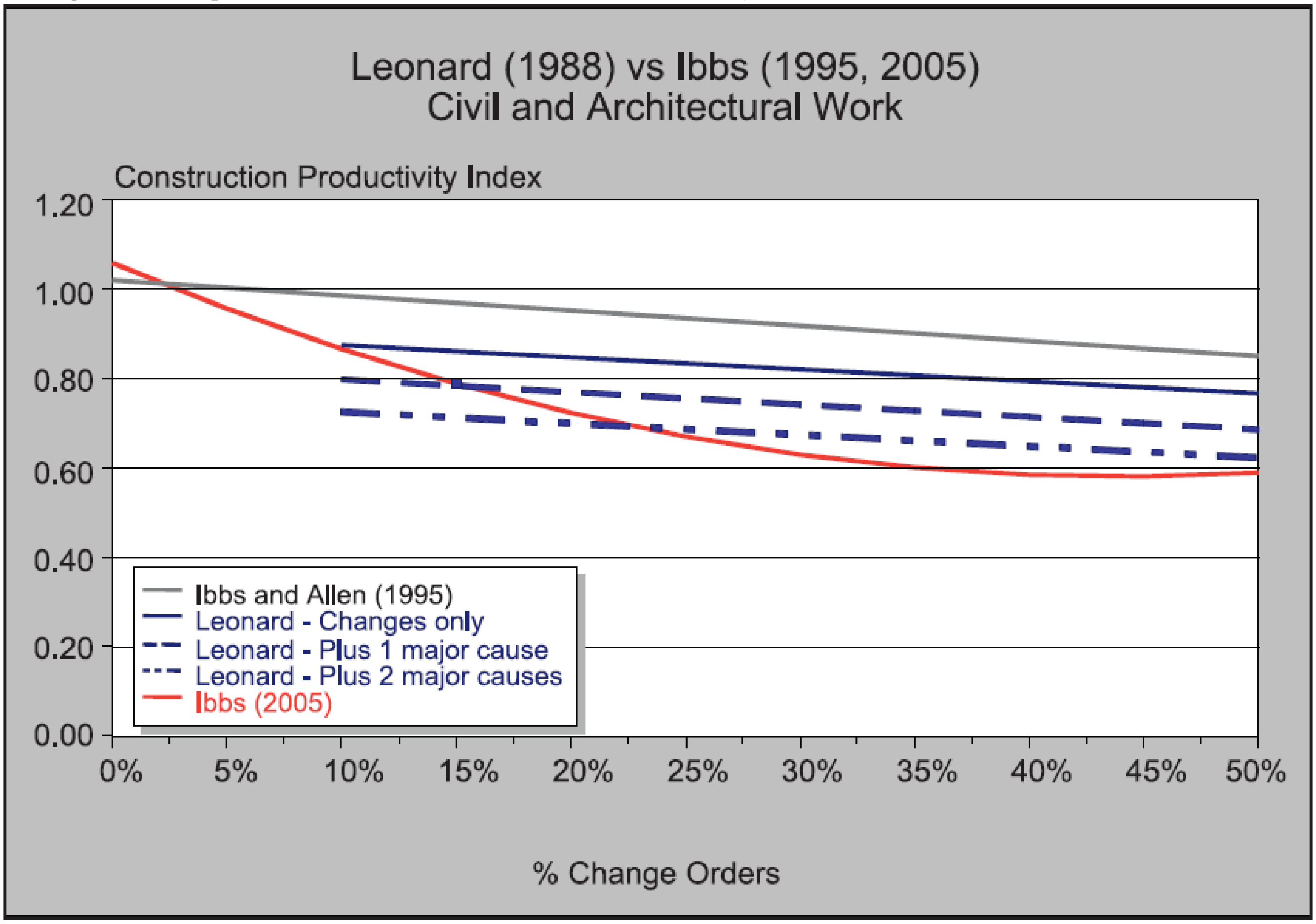
A comparison was prepared by the Revay and Associated Limited (RAL) of the two Ibbs studies in Figure 3 which shows a dramatic difference between the 1995 and 2005 results [10].

Figure 3. Comparison of the Ibbs 1995 and 2005 Data and Trend Lines



As shown, the 2005 data indicate that changes had a more significant impact on productivity than the Ibbs and Allen (1995) study by as much as 20% more. Considering the remarkable difference between the 2005 and 1995 data and trend lines, RAL also made a comparison of Leonard study to the new trend line established by Ibbs in 1995 and 2005 [11]. Assuming for that values of "percent change orders" can be equated between the two methods.

Figure 4. Comparison of the Leonard (civil and architectural) Data Trend Lines with Ibbs 1995 and 2005.



From Figure 4, it is apparent that the Leonard curves fall below the Ibbs and Allen (1995) but above the Ibbs (2005). It would appear that the Leonard curves are more conservative than the Ibbs (2005) curve. The "changes plus one major cause" line of the Leonard mechanical analysis is similar to the Ibbs (2005) results when the number of changes falls within the 20-50% range and even underestimates the impact of changes relative to the Ibbs (2005) analysis at least when comparing the "changes only" lines.

Legal Aspects

Courts and boards acknowledge the theory of the cumulative impact of changes but they generally deny recovery to contractors seeking such claims for several reasons.

Cumulative impact claims usually fail because of the following: (1) failure to reserve the rights to claim; (2) flawed damages methodology; and (3) lack of causation. Usually, a client's defense to a cumulative impact claim is to demonstrate that in execution of multiple change orders, the contractor agreed to the price of the changes and thereby waived its rights to seek any further compensation. For example, the change order form may contain the following language:

"This change includes all costs associated with the scope of work associated with this change, including all direct, indirect, and impact costs on the unchanged work such as loss of productivity, ripple effect, and acceleration [12]."

To avoid this legal issue, the contractor must always reserve its rights to claim for cumulative impacts as soon as the problem becomes apparent. Also, courts and boards reject contractor's quantum calculations for either using the wrong methodology or using the correct methodology wrongly. These mistakes can be rectified by using a qualified expert who employs the correct methodology to calculate contractor's damages.

In most cases, cumulative impact claims are denied because the contractor fails to show the relationship between the various owner-caused changes and the contractor's loss of productivity. Courts are in agreement that the quantity of changes alone does not establish a claim's validity, but that a combination of the quantity and the total cost of the change orders compared to the base contract may be more indicative that a cumulative impact has occurred [13].

Each claim must be analyzed on a case to case basis and on its own facts, giving fair consideration to the magnitude and quality of the changes ordered and their cumulative effect upon the project as a whole. Hence, there is no accepted formula to determine the quantity and magnitude of changes that constitutes a recoverable cumulative impact claim, nor is there any set standard for proving how two or more change orders synergistically impacted other basic work. Courts and boards seem to look at the facts and circumstances of each case independently, and, by their own admission, make a subjective decision as to the merit of the claim [14].

Facts Required Supporting a Cumulative Impact Claim

Numerous questions arise on each project that experiences cumulative impact and the answers to those questions will also vary on a case by case basis. For example,

- How many changes over what period of time have to occur before a cumulative impact is experienced?
- What order of magnitude has to occur within a given change to determine if it is part of cumulative impact?
- How soon can the impact be measured or does a contractor have to wait until the end of the project to look back to determine what happened?
- Can there be a waiver of cumulative impacts by executing change orders as the work progresses?
- If there is a cumulative impact, what is the measure of damages?

This and other questions makes this notion of cumulative impact difficult to identify and equally difficult to measure [15].

Selecting a Methodology

A contractor seeking equitable compensation on its cost overrun has several claim methodologies from which to choose. Several variables must be considered into the selection process, including:

- The detail and the reliability of the contractor's cost and man-hour records. Certain methodologies can be utilized only if this detail exists.
- The detail in contemporaneous project documentation. These records, demonstrating the cause of the problems and the effect on the contractor's productivity, are important to all methodologies. The use of detailed quantum calculations, contemporaneous documentation must be detailed as well.
- The stage of the claim's process. Certain methodologies are useful in negotiations, but are ineffective in court.
- The size of the contractor's cost overrun. The cost to prepare the damages analysis must be weighed against the size of the potential recovery.
- The extent contractor-caused problems and the ability to separate those costs. It is problematic in most methodologies if contractor-caused problems cannot be identified and accurately priced.

In some methodologies, all loss of productivity costs, including the cumulative impact of changes, is incorporated into the total claimed costs. Costs associated with the basis of each issue, such as the cumulative impacts or acceleration, are not segregated. These methodologies include the total cost method, the modified total cost method, jury verdict and the measured mile [16].

Total Cost Method

The total cost method involves a simple claim calculation based upon the assumption that all costs overruns are the result of the owner's actions. The contractor claims the difference between the costs expended and the costs it was paid, and adds applicable overhead and profit.

This method is frowned upon with disfavor from the courts and other legislative bodies and should be applied only in cases, where no more satisfactory method is available. Many courts and boards have applied strict standard to its use. As a guideline, the contractor must show:

1. The impracticality of proving actual losses directly;
2. The reasonableness of its bid;
3. The reasonableness of its actual costs; and
4. Its lack of responsibility for the added costs.

Thus, the total cost method should only be used when costs and field records are not sufficiently detailed to allow calculation by any other methodologies. Moreover, it must be shown that the contractor did not contribute to any delay in the schedule.

Modified Total Cost Method

The modified total cost method involves calculating the contractor's cost overrun and subtracting out any costs associated with the contractor's bid error or performance problems. The calculation method assumes that the owner is responsible for all the cost overruns, except those costs specifically identified and deducted for being contractor-caused overruns. This methodology has had some success in court but the contractor must still prove the impracticality of proving actual losses directly and similar to the condition set by the courts in proving damages under the total cost method.

Jury Verdict Method

If there is no way that a contractor can calculate its damages with any certainty, it leaves the calculation to the hands of the court by way of the jury verdict method. This methodology is typically employed when there is clear proof that the contractor was injured, but there is no reliable method determining damages. With this approach, courts may award damages even if costs cannot be documented.

Measured Mile Method

"The most widely accepted method of calculating lost labor productivity is known throughout the industry as the "Measured Mile" calculation. This calculation compares identical activities in the impacted and non-impacted sections of the project in order to ascertain the loss of productivity resulting from the impact of the known set of events. The Measured Mile calculation is favored because it considers only the actual effect of the alleged impact and thereby eliminates disputes over the validity of cost estimates, or factors that may have impacted productivity due to no fault of the owner [17].

Demonstrating Cause and Effect

When projects are impacted with a huge amount of changes, the site supervisors spend their time coordinating the changed work and finding the most productive work for their crews in an attempt to be on budget and on schedule. They have less time to document the impacts to their work and fill out the daily timesheet of their resource allocation. Without these records, the contractor will find it difficult to recover on any cost overruns.

The contractor should also track the change orders in separate cost accounts, apart from the cost codes for the original scope of work. As one commentator noted, "the use of effective cost-accounting methods and the maintenance of appropriate cost records can minimize many of the proof problems inherently associated with construction claims [18]."

Once the contractor becomes aware that a multitude of changes are impacting its productivity, the impacts are foreseeable, it is essential that the contractor notify the owner of its findings and that the contractor reserves its rights to claim such impacts on any subsequent change orders.

The following suggestions, depending on the detail of the project record, provide several ideas on linking excessive changes with a loss of productivity [19]:

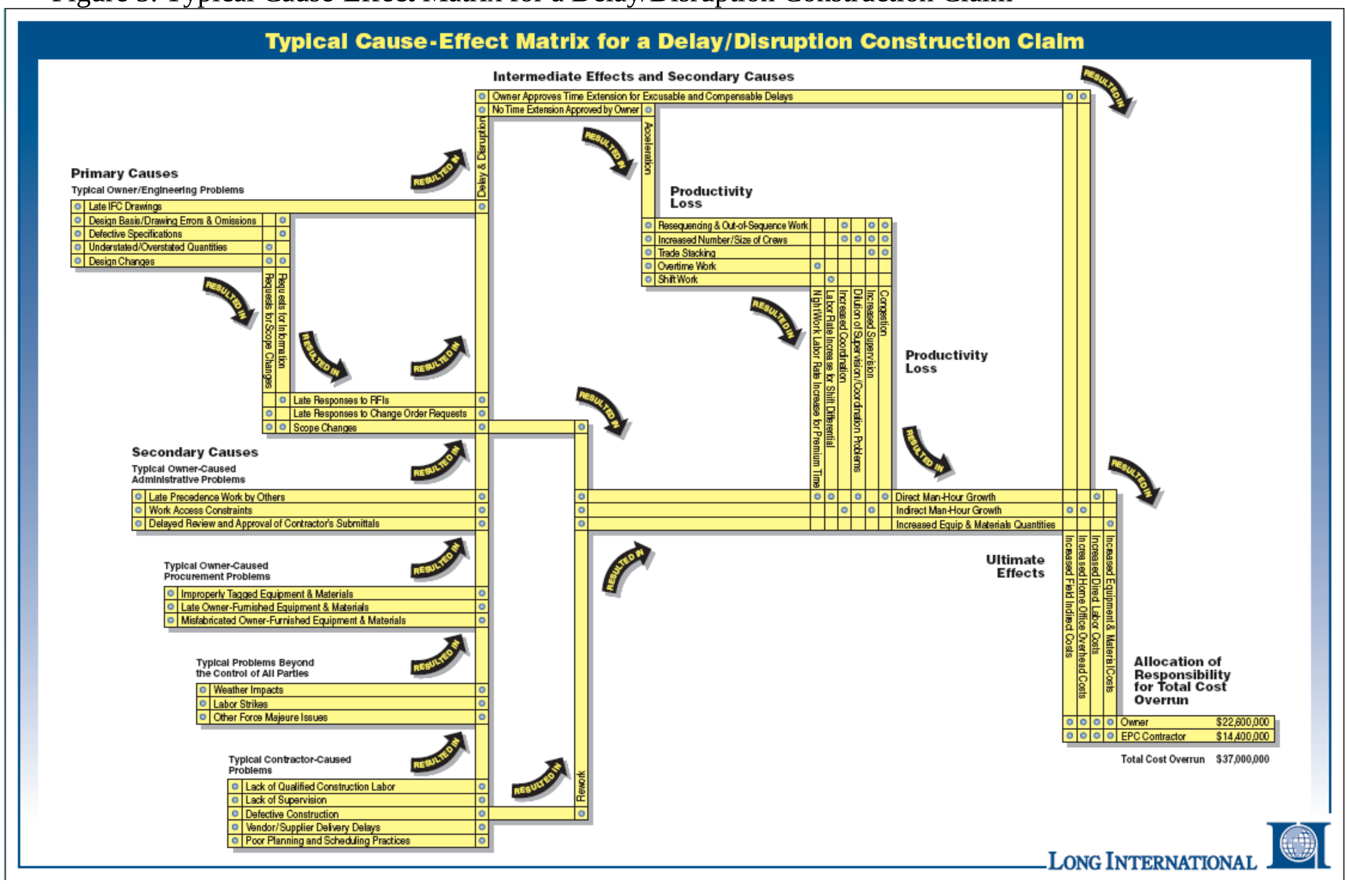
- Prepare a cause-effect matrix for entire project;
- Track the impact on an activity or crew;

- Show how the site environment changed from plan; and
- Present the factual story with graphics.

The Cause-Effect Matrix

The basis of any cause-and-effect linkage in any claim is the cause-effect matrix. One can graphically trace the effects to the contractor's work. As multiple causes and their resultant effects are added, the matrix ultimately gets much more complicated. Long International has prepares a typical cause-effect matrix for a highly impacted project as shown in Figure 5 [20]. Primary and secondary causes, including contractor-caused problems are shown to have a multiple and duplicative effects, the end result being the cost overrun.

Figure 5. Typical Cause-Effect Matrix for a Delay/Disruption Construction Claim



Showing these relationships graphically, in addition to a narrative containing relevant excerpts from contemporaneous documents, provides the contractor, owner, the arbitration panel or court a clearer picture of all the impacts on the project.

Tracking Impacts by Activity or Crew

It is important to explain the impacts caused to one activity or group of activities in the claim document. After the impact is established, one may be able to show the "ripple," or the impacted activities negative effect on the other activities. From the project schedules, one could then determine which activities ran concurrently with this activity, and which activities were its logical successors.

Site Environment Changes

It is important that the contractor note all the changes to the site environment in the daily reports. Assuming there is no such record, below are a few examples of analyses that might be performed to demonstrate this proof:

- Out-of-sequence work: One could review the causes of this sequence change from the as-planned and as-built schedules and show a detailed list of activities that were impacted due to changes. Using the same comparison, one could review concurrent activities in the planned schedule versus those in the as-built schedule.

- Demotivation of Work Force: From cost records, one could calculate the absenteeism and turnover rates on the project and compare them with other similar projects that were not as severely impacted by changes. If the increased absenteeism and turnover occurred during the same period as did the owner-caused impacts, the cause-effect relationship may be justified.
- Loss in Learning Curve: One could make a comparison between the planned peak manpower and the actual peak manpower and show that the timing of additional forces corresponded to the timing of change order work.

Present the Factual Story with Graphics

When one reads a claim document or attends settlement meetings or mediations – the focus is on graphics. Hundreds of pages of narrative can be effectively summarized in one graphic. Including interesting and factual graphics in a claim submittal grabs the reader's attention and focuses that attention on one's argument.

Defenses to Cumulative Impact Claims

To prevail on a cumulative impact claims, one must generally show:

- the existence of a cumulative impact caused by the excessive and frequent changes;
- that the cumulative impact of the excessive changes affected the work;
- that the cumulative impact of the excessive changes increased the cost of performance; and
- that the impact was not foreseeable when the change orders were priced.

Failure to meet any one element may prevent recovery. It is very important to reserve the rights to pursue impact costs on future changes. If the client will not allow reservations, then the contractor should ask to cost the impacts that may occur since they have to waive them. Most clients will deny such a request but fairness suggests that the contractor should be permitted to reserve rights for future impacts it does not even know about or be allowed to price them in the present change order [21].

Conclusion

Cumulative impact claim is best studied by evaluating causes and effects specific to a particular project and, when possible, performing differential analysis between normal and impacted periods of the work [22]. Industry studies alone are of limited use.

In the preparation of the cumulative claim document, much of the proof needs to be documented during the project, through daily reports and detailed cost records. Keeping such records should be a required procedure for documentation on all projects because the contractor may not always know whether significant changes to its original scope may result to disruptions and productivity loss.

If available, contractors should attempt to use a measured mile approach to quantify lost of productivity. This approach provides more reliability than a total cost or modified total cost approach because this method compares the productivity of an impacted period with the productivity of an unimpacted period. This method of quantifying a lost productivity claim is often successful and is accepted by court and other legislative bodies.

However, a contractor will not always be able to rely on a measured mile approach. If a project never experiences an unimpacted period, the contractor may not be able to rely on the measure mile approach. In that case, the contractor may choose to rely on an industry study to quantify lost of productivity claims. Industry studies while not a substitute for a more project-specific measurement of lost productivity provides a significantly stronger quantification of lost productivity than reliance upon either total cost or modified total cost approach.

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AKNOWLEDGEMENT

Special thanks to Robert Law Brown who has introduced me and guided me through this subject and to Ahmed Hassan Abdallah and Maria Joane Mimay who has read and reviewed this paper.

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