



Coping with Extras

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On most, if not all, construction projects there will be changes to scope, time, cost and/or quality of the work. The ability to come to an agreement on the pricing of these changes will frequently dictate the relative success of the project, in this context narrowly defined as concluding the project without third party intervention. Obviously, in the broader context, success means completing the project on budget and on time. Too frequently considerable additional costs are incurred after the project is completed as parties try to settle outstanding matters. Often the problem is rooted in the pricing of changes during construction.

Generally, the difficulty in agreeing on the pricing of changes is twofold:

- lack of trust among project participants; and
- unwillingness to recognize the influence that changes have on labour productivity.

Mistrust appears to be the common denominator between the beliefs of the various project participants:

- contractors like changes;
- contractors make money on changes;
- productivity impact (if it exists) can be quantified on individual changes; and
- contractors make money on the mark-up in change orders.

Naturally, most contractors disagree with the above statements while most owners and design consultants are convinced of their veracity. With these preconceived notions, the owners and design consultants approach negotiations on the pricing of the changes convinced that the contractor is trying to make all its profit on the project with that one change, whereas the contractor takes the position that the owner and design consultants refuse to acknowledge proper compensation for the change.

A further complication is often brought about by the driving need to focus on completing the project while ignoring all commercial problems. This need invariably results in leaving the quantification of many changes to the end of the project. By that time, the contractor has incurred financing costs, which are seldom considered compensable. Meanwhile, the owner, whose project is now over budget, does not wish to advance further payment. Problems left to the end of the project are generally prob-

lems that are bigger and more difficult to resolve.

The discussion that follows deals with the different perspectives that exist among the project participants and some potential means of addressing the problem. Discussion is presented under the following headings:

- impact on productivity;
- reasons for qualifying changes;
- mark-up on changes; and
- pricing of changes.

IMPACT ON PRODUCTIVITY

This section deals with the impact of changes on contract work and concludes that:

- changes have an impact on productivity; and
- the impact on productivity can not be readily quantified.

It is not suggested that a single change or even a few early changes will impact productivity, but rather "several changes" particularly those in the latter stages of the project will affect the cost of the contract work by decreasing productivity thereby increasing unit cost on the project. A quantum definition of "several" is expressly not provided. A number of different factors, such as timing in the project, complexity, number of trades involved and lead time between the issuance of the change and the execution of the work can affect productivity as explained in the subsequent discussion. Consequently, it is inappropriate to pick one criterion such as number and/or value of changes as a basis for determining when there is a measurable impact on productivity.

On most projects where there are changes, a discrepancy between total hours worked and the total hours paid for contract and extra work hours is frequently observed. Total hours worked are often significantly greater than hours paid. The obvious question is why? There are a myriad of factors which can contribute to the total number of hours worked. Keeping it simple and focusing solely on the contrasting opinions of project participants, two divergent opinions exist:

- contractor problems (includes under-estimate); or
- impact of changes on productivity.

Often both of these come into play. Contractors are clearly not entitled to compensation for their own problems. At the same time, all

would agree with the general principle that contractors should be compensated for the total cost of changes introduced into the project. The problem is the determination of that "total cost" and exacerbated by the fact that some owners remain sceptical and refuse to accept that numerous changes affect productivity. This refusal on the part of the owners seemingly ignores the considerable research on the subject.

Out of a number of studies on the subject of changes and their impact on productivity, the following four are most frequently referred to:

1. Leonard, C. A. (1987) "The Effect of Change Orders on Productivity" Revay Report Volume 6. No. 2 August 1987¹
2. Ibbs, C. W. and Allen W. E. (1995) "Quantitative Impacts of Project Change." Source Document 108 Construction Industry Institute, University of Texas at Austin Texas
3. Hanna, Awad S., Russel, Jeffery S., Gotzian, Timothy W. and Nordheim, Erik V. (1999) "Impact of Change Orders on Labour Efficiency for Mechanical Construction" Journal of Construction Engineering and Management May/June 1999
4. Hanna, Awad S., Russel, Jeffery S., Nordheim, Erik V. and Bruggink, Matthew J. (1999) "Impact of Change Orders on Labour Efficiency for Electrical Construction" Journal of Construction Engineering and Management July/August 1999

All four studies have one common conclusion – that is numerous changes will impact productivity. A conclusion perhaps best described by Construction Industry Institute's (CII) publication 43-2 titled "Quantitative Effects of Project Change"; (summarizing the above referenced source document from CII) which states:

"The research concludes that a significant correlation exists between the proportional amount of change on a project and labour productivity, both in design engineering and construction. The decline in overall productivity due to an environment of excessive change can alter the cost/benefit evaluation of

¹ This article is available from any Revay office in PDF file format.

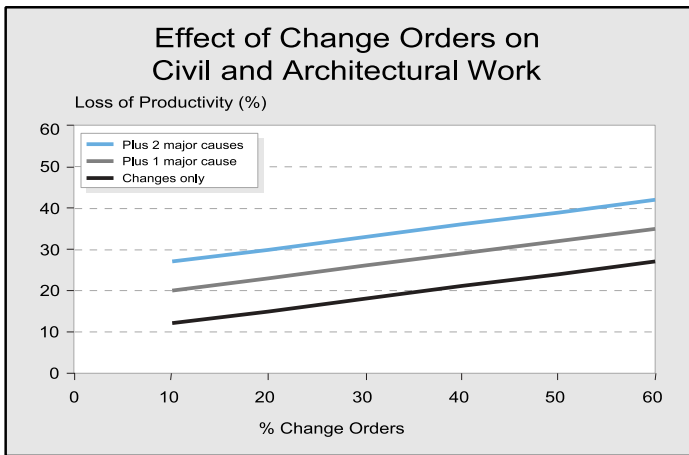


Figure 1

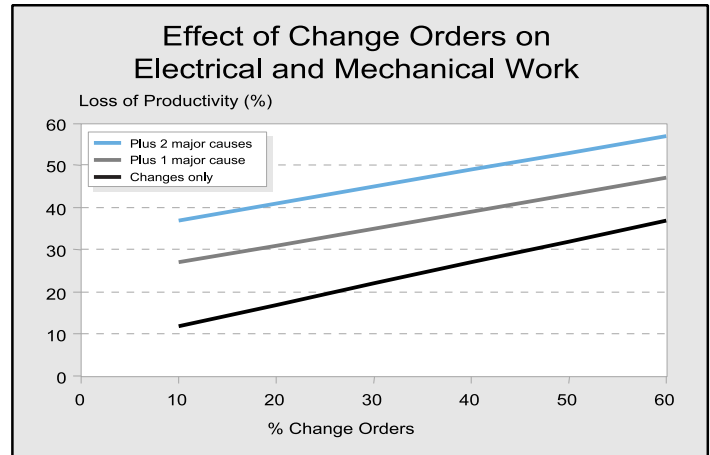


Figure 2

potential change and should be taken in account in project decision making.”
 A brief discussion on each of the above studies is presented below.

Leonard C. A. (1987) “*The Effect of Change Orders on Productivity*”

This study was based on 90 construction disputes that had been evaluated by our firm. The research was conducted by Charles Leonard for his Master’s Thesis in construction management at Concordia University. The study indicated a high degree of correlation between percentage of change order hours to contract hours and the loss of productivity as depicted in the Leonard curves presented as Figures 1 & 2.

Other authors dealing with the Leonard curves have specified two fundamental areas of criticism.

- The study did not address the timing of the changes, i.e., when they were issued during the project life.
- The research for the study was based on troubled projects that had reached the dispute stage.

Notwithstanding the validity of these criticisms, during the past 15 years Revay personnel have found a reasonable correlation between the Leonard study and other projects. Nevertheless, it should be noted that one cannot blindly apply any general study to a specific project and expect a high degree of correlation.

Ibbs, C. W. and Allen W. E. (1995) “*Quantitative Impacts of Project Change*”

This CII study was based on information on 104 projects from 35 different companies (15 contractors volunteered 60 projects and 20 owners volunteered 44 projects). The median project size was \$44 million and the average was \$80 million. The projects included lump sum, unit price and reimbursable contract forms, engineering and construction services, design-bid-build and design-build. One of the results of that study is provided in Figure 3 which suggests that changes have a lesser effect on productivity than suggested in Charles Leonard’s research.

The authors of the next two articles criticized the low correlation depicted in the CII study. They were also concerned with the assumption underlying the CII study that the ratio between the installed material cost and the installed total cost is an indication of the size of a change when late changes are

implemented into a project. This is a valid concern.

Hanna Awad S., Russel Jeffery S., Gotzion Timothy W. and Nordheim Erik V. (1999) “*Impact of Change Orders on Labour Efficiency for Mechanical Construction*”

This study was based on information obtained from 26 mechanical contractors who provided data on 61 projects. The average project size was \$1,940,000, ranging from \$61,000 to \$13,600,000. This study found that percentage change calculated as change order hours divided by estimated base hours was more significant than the percentage of actual change hours as determined by Leonard. In addition, the study concluded that the timing of the change was significant, i.e., the impact of changes on productivity varies depending on when the change was issued in the project life.

The study developed empirical formulas for impacted and unimpacted projects based on the following factors:

IMPACT = Impact classification

CHGEST = Change order hours/estimated base hours

NUMCHG = Number of changes (total)

WTIMING = Weighted timing factor for timing of change orders

The equation to determine loss of productivity initially requires the determination of the weighted timing factor before applying the calculation. To apply the equation one must read the article. The authors of this article take the position that timing is a significant factor, both as regards to:

- progress of the project (percentage complete); and

- lead time – interval from notification to implementation of the change

Although the authors make reference to both factors, they only consider the first one in their calculation. No explanation is provided for exclusion of the lead time.

Hanna Awad S., Russel Jeffery S., Nordheim Erik V. and Bruggink Matthew J. (1999) “*Impact of Change Orders on Labour Efficiency for Electrical Construction*”

The same authors studied electrical construction and found different variables that affect labour productivity for electrical projects with significant change.

- the number of years experience of the project manager has;
- 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.

Data for the study came from 61 electrical projects with project sizes ranging from 1,100 to 106,000 hours. The average size was approximately 18,000 hours.

It is difficult to accept the notion that all project managers improve in exactly the same fashion during their career. How often has one heard the expression one year’s experience 20 times, i.e., no significant improvement in 20 years. In truth, job experience is like wine. Some wines get better with age while others simply get older with no appreciable improvement.

Conclusions on studies

It is extremely unlikely that any one study will satisfy all critics on any given construction project. There are simply too many variables affecting productivity. Equally, a number of variables pertaining to the changes themselves can contribute to the impact changes have on a project, such as:

- progress of the project (percentage complete);
- lead time — interval from notification to implementation of the change;
- frequency and size;
- efficiency of the project team to cope; and
- number of trades/subcontractors affected.

In addition to the above, the type of change can have varying affects. Changes that are initiated on the field resulting from interferences or systems simply not fitting in the space provided will impact the morale of the crew considerably more than changes that do

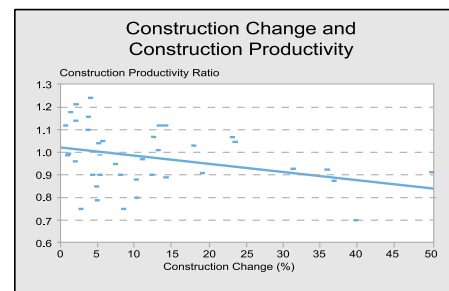


Figure 3

not require resequencing or remobilization.

Despite the weaknesses as pointed out, the results of these studies should not be ignored. Every day we experience the impact of change and/or interferences. How often on a normal working day have we wondered what we have accomplished because the majority of the day was spent answering phone calls or inquiries from subordinates and/or supervisors. And how often have we been surprised at what can be achieved over a weekend or after hours when all the "changes/interferences" have gone home.

Continuing the analogy, consider how difficult it would be to determine the impact of each and every phone call or question/interruption which causes some deviation from the planned tasks of the day. Interruptions and/or deviations from the planned sequence of work cause inefficiency regardless of where they occur.

The inescapable conclusion can only be that "numerous" changes can and do affect productivity. Equally, it is not only impractical but also impossible to determine the impact of each change as it occurs. If they want to see the impact priced on each change, owners must consider accepting one of the above studies as a basis for that payment as there is no other means, short of simply guessing, to arrive at a number.

REASONS FOR QUALIFYING CHANGES

This section deals with the contractor's need to address the potential impact of changes on productivity and duration. It must be stressed that the following comments are general in nature and specific contract language can have a bearing on them. As a common provision, general comments cannot be applied without first ascertaining if the specific contract language or the particulars of the work distinguish that project. Equally, Notice Provisions and their significant potential impact on the ability to pursue a claim for additional cost must be taken into account.

Productivity

When discussing productivity, qualifying change orders refers to the phrase more and more contractors are putting on their change order quotations reserving their right to quantify the impact of changes at a later time. An example of such a qualifier would be:

"The price quoted is only for the direct cost of the change. We reserve the right to seek compensation for the impact on contract work and/or the cumulative effect of changes when these costs (if any) can be quantified."

Contractors use this kind of qualification for a simple and obvious reason; without it, contractors lose their right to discuss (entitlement) the cumulative impact of changes on productivity, should it occur.

Needless to say some owners take exception to such a qualifier because they want to know the full price of the change at the time it is issued. Some owners insist on its exclusion. While this is an understandable position, it is unfortunately inequitable. The qualifier preserves the contractor's right to seek compensation for the full cost of the change. In reality, owners have several alternatives:

- control the frequency and magnitude of change by ensuring that the engineering is near complete as construction starts;
- pay for the impact of changes on each individual change; and/or
- accept the qualification and be prepared to discuss the cumulative impact of changes at the end of the project or at interim stages of the project.

One could of course argue that owners have a fourth alternative, which is to refuse any changes with qualifications. This approach is not viable if an owner wishes to properly compensate the contractor and avoid protracted disputes. Logically since the owner ultimately controls the frequency, timing and magnitude of the changes issued on a project (by virtue of the front end work the owner performs prior to the start of construction), it should bear the consequences of that decision.

Duration

On most requests for quotations, the contractor is asked to identify the impact of the proposed change on the project schedule. This is obviously a well founded request. Unfortunately, it is usually made without knowing when the change is actually going to be approved, thereby making it impossible to identify potential impact.

Contractors, being an ingenious group, have solved this dilemma by simply proceeding without approval thereby giving the owner the choice of paying for the change. The other method of dealing with this dilemma is to be silent, thereby losing all rights to discuss delay arising from the change. Obviously, neither of these solutions is appropriate.

It is recommended that contractors adopt one of the following statements on their quotations:

- no effect if authorization to proceed by [date];
- will provide effect on completion of the changed work; and
- identify effect based on a **stated** assumed date of approval.

Contractors, please note that if your quotation states that the proposed change will have, say, a five-day effect on project duration the cost of those five days should be included in the quotation.

For owners, it is recommended that their contracts:

- provide a provision that enables the contractor to proceed under protest. This would avoid forcing a contractor to consider walking off the site; and
- provide a mechanism (such as the change directive in the CCDC 2 Stipulated Price contract) that enables contractors to start work with paperwork in place prior to formal approval.

The legal and bureaucratic need for formal approval before the work begins simply does not comply with the practical need to get the work done promptly and efficiently.

It makes eminent sense to insist on some form of paperwork before a contractor begins executing the change order work. That paperwork need not be a formal change order. Often, owner's representatives are restricted by their own contracts, which dictate that change order work cannot commence until formal approval is obtained.

They then find themselves encouraging contractors to ignore their contract, hardly an enviable position for either party.

MARK-UP ON CHANGES

This section will address the question of what constitutes an appropriate mark-up. Several different types of mark-ups are seen in contracts; some suggest 10% for overhead and profit while others will separate the two items indicating 10% and 5% for overhead and profit respectively. In order to determine what is appropriate, a review of the costs that are intended to be covered by the mark-up on change orders is essential. These costs are presented under the following headings:

1. Change order preparation
 - Estimating
 - Purchasing
 - Clerical
 - Administration
 - Coordination
 - Sub-trades
 - Consultants
 - Site
2. Project overheads
 - Field supervision/coordination
 - Temporary facilities
 - Administration/clerical
 - Meetings
 - Correspondence
 - Bonding
 - Extended warranty
 - Cost control
3. Home office overheads
 - Utilities
 - Building cost and taxes
 - Payroll
 - Computers
 - Administration/clerical
 - Management
 - Financing
 - Insurance
 - Business development

These cost categories are general in nature. Specific cost allocations will frequently depend on the size and nature of the work and more particularly the cost control coding system used by the contractor.

On a \$5,000 change order involving a number of trades (subcontractors) it is unlikely that the 10% mark-up (\$500) will cover the above costs. On the other hand, these costs on a change which only involves the addition of one more mechanical or electrical component with, say a value of \$25,000, will be more than adequately compensated by the 10% mark-up (\$2,500).

The Saskatoon General contractors Association in their document "*Recommended Procedures to Effect Change Orders to Construction Contracts*" advocates a sliding scale for overhead mark-up. This approach at least recognizes the problem and offers a valid proposal. One could do a more detailed evaluation by addressing the labour and material component. The effort, however, might not justify the potential cost of arriving at and administering an agreed-to formula.

Some owners are likely saying, "Who cares"? The contractor plans for certain overhead on a project. If a few changes are introduced without any apparent effect on the contractor's overhead, is the contractor getting paid twice for the same overhead, i.e., once as part of the contract price and

once through the mark-up on changes? This line of argument can be extended to deal with the cost of extended duration. If a project experiences a 20% increase in scope and duration, does the overhead paid through the change orders compensate the contractor for the extended duration costs incurred?

Let us take a closer look at these issues:

1. *Does a contractor get paid twice if the change has no apparent effect on overhead?*

The answer is no. Even if a contractor does not increase its overhead (adding resources and/or overtime), dealing with changes takes away from the management of the contract work which will likely cost the contractor more than what is recovered in the mark-ups.

2. *Does mark-up on changes offset extended duration costs?*

The answer is perhaps. The mark-up on a couple of large scope changes that simply increase duration by virtue of the increase in scope of work could offset some extended duration costs. On the other hand, the mark-up on numerous changes which increase duration as a result of disruption, delay and inefficiencies will not offset any extended duration costs.

As a final comment, those owners who advocate covering everything under the sun within the mark-up are adding fuel to the fire.

To contractors, I offer the following true story. A few years ago, I was at a site on a phone call with the project manager to head office. The job was in trouble and we were trying to get a junior engineer to assist in the administration of changes. As head office was denying this request because overhead costs had surpassed the budgeted amount, the General Foreman walked in and placed a call to the local union hall seeking an additional 25 pipefitters. Despite the fact that labour costs had exceeded budget, the pipefitters were on site in short order. When dealing with overhead costs, how often do contractors save pennies and waste (labour) dollars by inadequately managing resources?

PRICING OF CHANGES

On some construction sites, the work starts with a certain level of mistrust which is further exacerbated by contractors attempting to claim all potential costs by inflating the direct cost of changes. To alleviate this situation, contractors should identify the various

cost components of a change. As stated above, contractors should address the questions of productivity, duration and mark-up and should also ensure that they address the General Condition costs, such as:

- supervision;
- temporary facilities;
- field support;
- temporary utilities;
- construction equipment;
- special conditions (e.g. winter); and
- estimating.

This last item is interesting and raises the question of the costs that should be claimed on unapproved changes. Estimating is particularly important on tenant improvements where change order pricing is frequently considered to be a form of shopping. If contractors are asked to do extra work beyond that stipulated in the contract it seems fair that they should be compensated.

There are a number of published books/documents that deal in more detail with this subject. Two good sources are:

1. "Contractor's Guide to Change Orders" Andrew M. Civitello Jr., Prentice-Hall - ISBN 0-13171588-7
2. Canadian Construction Document # 16 "Guidelines for determining the costs associated with performing changes in the work"

The obvious intent of the foregoing is for contractors to better present and quantify their change order quotations. The objective is to reduce the mistrust and apparent inflation in change order pricing that currently exists on some construction sites.

CONCLUSIONS

From the above discussion, it is obvious that there are a number of potential situations where contractors can miss out on recovering all the monies due from changes. To offset this situation, some contractors inflate their quotations considerably in order to pick up any unknown or potential costs. There are, of course, those contractors who simply inflate their prices "just because". In both cases, the general perception is that contractors are inspired merely by a desire for gain. To counteract that perception, contractors must improve their pricing of changes.

There is little question that the pricing of change orders is a complicated matter. In addition to correctly pricing the direct cost of the work, the impact on productivity, effect on duration, the appropriate mark-ups and

all potential general condition costs that might be affected should be taken into consideration. The problem is frequently exacerbated by the conflict between stated contractual procedures and the practical need to complete the work on time. The net result is frequently mistrust and frustration, which can often lead to protracted disputes.

Some of that mistrust and frustration might be reduced if owners:

- accept that numerous changes will affect productivity i.e. cost of the contract work;
- control the impact on productivity and the resultant compensation by more front-end work and not by refusing to accept qualified change orders;
- either accept that productivity influence cannot be priced on each individual change order or agree to some formula for compensation prior to the start of work;
- consider a sliding scale on mark-ups;
- avoid the potential trap of trying to include everything under "mark-up"; and
- develop a contractual procedure for administering changes that doesn't conflict with the practical need of getting the project completed.

To assist the process, contractors must initially recognize that, arguably for valid reasons, many owners and design consultants are of the opinion that many contractors inflate their prices when they quote on change orders. That will change only when contractors price changes more fairly. In addition contractors must:

- address the impact on productivity and time;
- deal with and identify all general condition cost;
- not inflate prices simply because it is easier than identifying and quantifying all real costs; and
- consider spending more money on overhead costs in order to improve management of labour, contract administration, scheduling and the pricing of change orders.

It is contended that if some of the above suggestions are adopted there will be more trust and less argument (cost) upon project completion. Time will tell.

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