2.0 QUANTIFICATION OF DAMAGES/CLAIMS

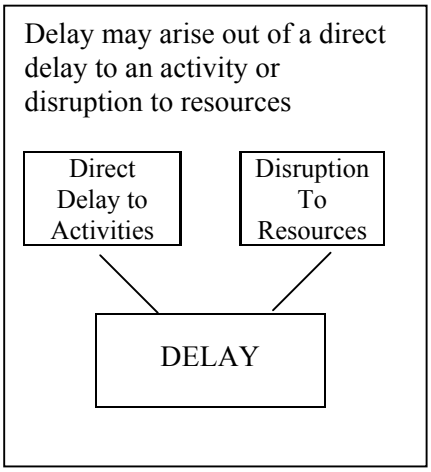
In the following pages we will develop and suggest ways in which the two major elements, CAUSE and EFFECT of quantifying a claim, can be identified and presented. Claims will be evaluated as either SIMPLE or COMPLEX.

For the purposes of this discussion the following definitions shall apply:

Definitions

Activity
An element of work on the project as is usually established for scheduling purposes, i.e. CPM activity.

Cause
The link between the event and the resultant increased time or money that we would not have incurred but for the event.



Delay
The time during which part or all of the project has been extended or not performed due to an event. Delay may arise out of a direct delay to an activity or disruption to our resources.

Disruption
Extended duration and/or loss of productivity of the planned utilization of resources due to the event. It may or may not result in an extended time of performance for the project.

Effect
The actual cost and/or time attributable to each element of increased work, delay, inefficiency, etc. identified as being caused by the event.

Event
An event is an occurrence, which can be of varying duration, resulting from an issue. (An issue can have multiple events. An event can have one issue and an event and issue can be one and the same, i.e., changed condition.)

Issue
An issue is the source problem or cause of an event or a category or classification of events occurring as a result of such source problem or cause.

Remedy
Contract or legal right, i.e. changed condition, changes, breach of warranty. (An issue can have multiple remedies. A changed condition may result in a contract right to additional time and money if there is a changed condition clause in the contract. If not, there may be a legal right under the principle of implied warranty of suitability of plans and specifications.)

A resource will usually perform work on a series of activities in succession.

Resource
A crew or machine performing a particular element of work, i.e., forming crew, rebar crew, dragline. A resource will usually perform work on a series of activities in succession, i.e., form pier 1, form pier 2, form pier 3, etc. The sequence of performance of such activities may or may not be dictated by physical or contractual restrictions or precedent ties.

Simple Claims

Simple claims consist of new activities and direct changes to existing activities.

SUMMARY: The simple claim consists of a single event occurring over a reasonably defined period of time involving known resources and no impact. Simple claims consist of new activities and direct changes to existing activities. Simple claims comprise the majority of the change orders and claims that our company experiences on a regular basis.

CAUSE

Simple claims usually are the direct result of a written change order, a written directive, and/or a constructive change. Usually they involve a change to the contract plans and specifications, and have negligible impact on the unchanged work. Entitlement and the total cost and/or time may be disputed but the cause of such costs and/or time, if any, are reasonably recognizable as being directly attributable to the event in question.

EFFECT

The costs and time attributable to the simple claim event include but are not limited to:

1. Labor
2. Materials
3. Equipment
4. Estimator's time to estimate costs
5. Scheduler's time to update schedule
6. Additional engineering
7. Additional purchasing
8. Additional supervision
9. Additional overhead

10. Bond and insurance

11. Time required to perform the new or changed activity

The Analysis Should Also Include:

a. The effect of the increase time to perform additional or changed work on the total schedule.

b. Resources required to perform additional work.

c. Other activities affected by the event.

The result of the analysis of additional time and resources required for a simple claim are noted and rights to claim for any increased costs (impact) resulting therefrom are reserved. The additional time and resources noted are then used in the analysis of disruption and delay in complex claims.

The Analysis:

- *Use normal estimating methods if forward priced.*
- *Use actual production costs if priced after-the-fact.*

The analysis of the direct costs is performed by normal estimating methods if forward priced. ***Note*: Realistic costs involving actual project production rates where available or production rates from similar jobs as a second choice should be used. Inflated and unrealistic production rates could lead to a false claim charge being filed against us**. If the claim is being priced after-the-fact, actual production costs should be used.

Difficulty often occurs when we are required to separate changed work costs from unchanged work where the two types of work are closely integrated. Thought should be given to the method and manner of tracking such costs prior to performing the work. Realize that if disputed they will be audited.

SETTLEMENT

In the past, a simple claim was often resolved whether we had detailed support from actual records or not. The negotiating parties were able to visualize the various components of the claim. They then weighed the merits of

all claim elements discussed in the previous sections as well as their "feeling" for the value of the increased costs and arrived at a negotiated settlement. The amount of that settlement often did not even closely resemble the presented costs, whether they were estimated or determined from actual audited records.

The fact that there is often a wide variance between presented costs, and the settled claim is a contributing factor to the normal construction person's reluctance to spend the additional time and money necessary to keep and maintain detailed cost, time and resource records of all claim related events. Recently we have found that the amount of recovery on our claims has been significantly discounted or completely denied because we have not been able to produce detailed records of the costs actually incurred by us as a result of the claimed event. This has been the case, even where the other contracting party has admitted entitlement.

Complex Claims

SUMMARY: Complex claims consist of one or more events that significantly effect (impact) the unchanged work. While a simple claim involves the analysis of the effect of an event on an activity, the complex claim involves the analysis of the effect of the event on the resources committed to perform the whole work.

Complex claims are subject to greater scrutiny and dispute, and unusually involve significant sums of money.

Complex claims are not encountered as frequently on our projects as simple claims. When they do occur, however, they are subject to greater scrutiny and dispute and usually involve significant sums of money. Some contracts preclude or attempt to limit the collection of impact-related monies by contractors. The standard federal government contract provides for the payment of such costs, as do many other standard contracts. Even where contracts attempt to preclude or limit the recovery of such costs, many arguments or legal theories may allow us to overcome certain contract provisions. Under all circumstances and/or contract language, **two factors must be well developed if we are to obtain the compensation to which we are entitled**:

Complex Claims are difficult to visualize.

1. **The basis for our entitlement must be well established in the preceding sections of the claim**.

2. **The facts demonstrating causation and effect must be well documented and proven in this section of the claim**.

Complex claims measure increased resource costs.

The more complex and interwoven the issues and claim events are on a project, the poorer the job most of us seem to do in preparing for and presenting our quantification of the claim. We most often fail to prove that the additional costs and/or time are attributable to the event and that the costs and/or time would not have occurred but for the event. We also fail to prove what these increased costs are. We just seem to instinctively know that it must have cost something and expect others to understand our views.

If we were to learn from our recent experience, we would establish the firm rule that all complex claims must have detailed cost and time records. However, the lofty goal faces two obstacles. First, it is often difficult, and in

some cases not practical, to analyze in detail each and every item of increased cost. Second, a complex claim usually arises out of the compound effect of many simple claims.

Individually, simple claims have relatively little impact. But together, they have significant impact.

Simple claims are easy to visualize and, by themselves, have relatively little impact on the total job. Together, they may have significant impact. Each simple claim utilizes our resources and the time float available. At some point, the available resources and time float are gone, resulting in severe impact to the project. We now have a complex delay and impact claim that most probably snuck up on us for which we have few or no records.

Complex claims can arise out of simple claims. They often arise out of the compound effect of multiple claims. They occur as a result of changed conditions, defective plans and specifications, changes in Owner-furnished or Owner-warranted services or obligations.

Complex claims involve the measurement of the increased cost and time incurred as a result of an event on the contractor's plan for performing the work as a whole.

In seeking to quantify our increased costs, we must recognize that we are trying to identify and measure the costs that arise out of the disruption and delay of our resources as opposed to the increased cost of an activity. Simple claims measure increased activity costs. Complex claims measure increased resource costs. Simple claims usually involve the measurement of the costs of performing new work or the increased cost of performing work as changed from the original plans and specifications. Complex claims involve the measurement of the increased cost and time incurred as a result of an event on the contractor's plan for performing the work as a whole. This simple fact dictates that the contractor must have a plan or one cannot measure the variation or difference from that plan.

IDENTIFYING COMPLEX CLAIMS

One of the foremost problems our company seems to have is the timely identification of a developing complex claim. Most of us can recognize the contributing factors in hindsight analysis. Few of us, however, spend enough time or thought towards identifying the contributing factors before they affect us. I therefore recommend that we stop and consider the basic types of costs and/or time that we

will incur with a complex claim and then attempt to identify the causes.

Complex claims consist of the following basic types of increased costs and time:

1. Direct (see discussion on Simple Claims)
2. Disruption
3. Delay
4. Mitigation
5. Delayed Impact—A combination of any of the above

1. DIRECT

The direct cost and time of complex claims is the simple claim portion for each event of a complex claim (Seethe preceding discussion on simple claims).

2. DISRUPTION

Disruption costs and time are the most difficult elements of a claim to recognize, identify and quantify and are the most disputed.

Disruption costs and time are the most difficult elements of a claim to recognize, identify and quantify and are the most disputed. Disruption includes but is not limited to lost productivity due to:

- Slow down
- Delays
- Acceleration
- Lack of continuity
- Loss of morale
- Learning curve
- Change of sequence
- Change of means and methods
- Change of time of performance (winter)

Recognizing that they occur is the first problem we encounter with respect to disruption costs. The second problem is identifying them when they do. Many factors contribute to lost productivity, but before such lost productivity can be measured, we must recognize just what it is that we are looking for.

To accomplish this, we should examine (a) **Crew Productivity**, (b) **Learning Curve**, and (c) **Time, Space and Ordered Sequence**.

(A) CREW PRODUCTIVITY

Typically, a crew is like a machine, each member has his part to perform. For the crew to perform at maximum efficiency, the part each member performs must be optimized relative to the crews function as a whole. When this happens, a balance is achieved that if disrupted will result in lost productivity. For example, studies were conducted on a repetitive operation that had gone through its early learning curve stages (a mature operation). This study revealed that as crew members were added to or subtracted from the crew, the productivity per manhour changed markedly.

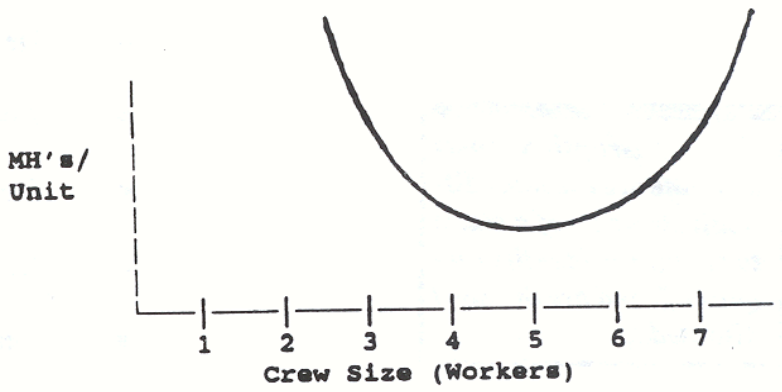


Figure 2-1. **Impact Added Crew Members on Productivity**. Productivity per manhour is markedly changed by adding or subtracting crew members.

Optimum efficiency was achieved at approximately five workers. Such optimum production would vary from crew to crew and be dependent on the foreman and the means and methods chosen. It would depend on the experience that performing the specific type of work. For instance, as each crew learns the capabilities of its individual members and selects the method that produces the best results, it is going through the learning curve process.

The point to be learned from the above graph is that as the balance of the crew is upset, the productivity is affected.

- If we accelerate by adding more people to the curve, productivity per manhour goes down, even though total productivity per crew may go up.

- If people are taken from the crew to work on nonscheduled extra work, productivity per manhour and productivity per crew goes down.

- If individuals within the crew lose their motivation and slack off or slow down, the

productivity of the entire crew drops because the balance of the crew's performance is affected.

- If the foreman is occupied with extra work, or a critical piece of equipment is allocated to extra work, the crew's performance likewise declines. If the foreman is occupied with extra work, or a critical piece of equipment is allocated to extra work, the crew's performance likewise declines.

- If the crew member's individual performance is affected because they are tired due to excessive overtime (i.e., acceleration), the balance of the crew is also affected.

The balance of the crew in the performance of the individual members is a factor that compounds the loss of efficiency of any one or more members.

In other words, the balance of the crew in the performance of the individual members is a factor that compounds the loss of efficiency of any one or more members. For this reason, factors which affect the performance of the individuals can have an enormous and costly effect on a crew's performance. Loss of morale due to excessive changes, and interruptions in the orderly sequence of the work, pulling off equipment and crew members to work on extras, occupying the foreman's time with extra crew operations all can cause this type of productivity loss.

(B) LEARNING CURVE

As we previously stated, a mature operation is one that through experience has developed its method of operation and a rhythm in doing so. When this rhythm is disrupted, that crew must relearn a portion of its learning curve all over again to reestablish its optimum productivity.

Our experience has shown that a successful operation will have a learning curve that appears as follows:

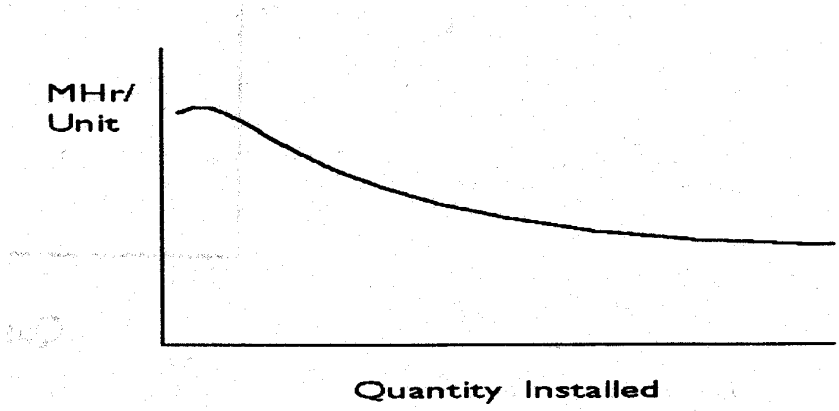


Figure 2-2. **Learning Curve**. Manhour requirements per unit decrease dramatically as operations mature.

If that operation is disrupted by a single event, the learning curve will appear as follows:

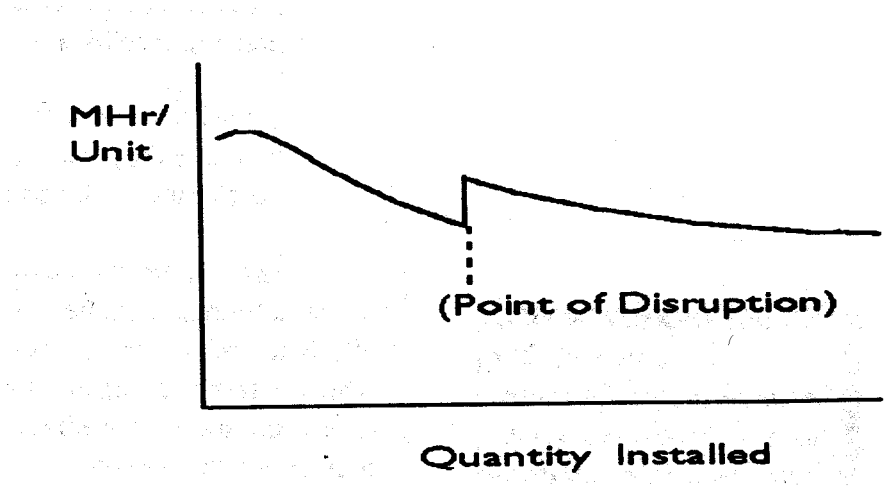


Figure 2-3.

If an operation is continuously disrupted or poorly managed, the learning curve will appear as follows:

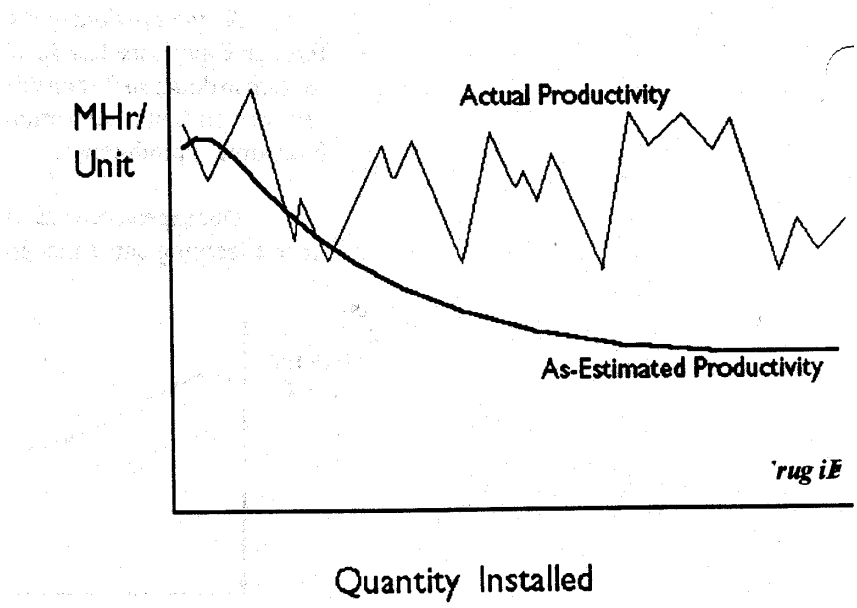


Figure 2-4. **Disruption Impacts**. The smooth curve represented by a well run uninterrupted operation is never achieved under conditions of continuous disruption.

Crew operations or repetitive work that fail to achieve maturity can and often do result in cost and time overruns in the magnitude of 150 to 200% of a mature productivity.

If the orderly sequence of the work is disrupted, causing a crew to jump from one operation to another, that crew will be required to restart its learning curve on each new operation. The crew's rhythm and morale will be disrupted. Its balance will be upset. The more often this occurs, the less likely that that crew will ever achieve the high degree of productivity normally expected in a smooth learning curve situation. Crew operations or repetitive work that fail to achieve maturity can and often do result in cost and time overruns in the magnitude of 150 to 200% of a mature productivity.

(C) TIME, SPACE AND ORDERED SEQUENCE

A crew needs Time, Space and Ordered Sequences in order to optimize its productivity.

- Time is the time space between its activity and the contiguous activities of other crews.

- Space means room in which to work, freedom from outside interference and contiguous activities.

- Ordered Sequence means that each crew must have a logical sequence of similar activities that it can look forward to, plan for, and expeditiously perform at its optimum productivity rate.

A well organized project will plan its crew operations (i.e., the use of its resources) in such a manner that they all have the best Time, Space and Ordered Sequence possible under the conditions known and the assertions made in the contract at the time of bid. This is the Contractor's Plan (see Section III). If there are variations in the contract, assertions which causes the Contractor's Plan to be disrupted, and the contractor can prove that the disruption in his plan is directly related to such variation and there is a remedy, he will be entitled to an adjustment in his contract price and/or time.

FLOAT

Who owns the float? This question has caused substantial argument and worry over how we submit our schedule to not give away the float. If we submit a well thought out plan and not just a schedule, we should not have to worry excessively over float.

The best way to visualize the Time, Space and Time Ordered Sequence is with the linear schedule on a simple paving job.

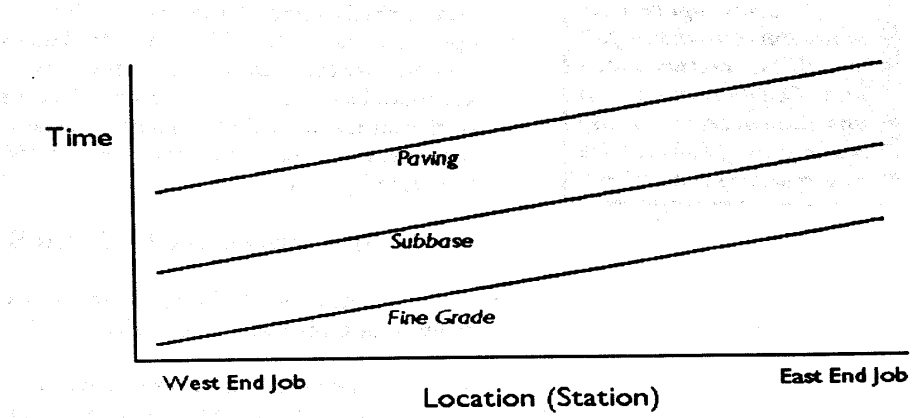


Figure 2-5. **<u>Time, Space and Ordered Sequence</u>.** Is the clear space between the lines float or necessary lead time?

Figure 2-5, for simplicity, shows three crews (resources) producing at approximately the same rate. The duration of the activity at any one point on the job is represented by the vertical thickness of the line at that point. The clear space between the lines would, on a CPM schedule, be denoted as floater, if the is well understood would be designated as "necessary lead time."

In reality, the clear space between the lines is the time and space needed by any operation to effectively and efficiently perform at optimum productivity without interference from contiguous activities. The performance of the grading, subbase and then the paving on a segment of the road and the performance of each of these functions on the next segment of road in succession represents an efficient time ordered sequence of activities and resource utilization. There is no available float shown between the performance of each segment of work for each resource. Each crew's ability to anticipate and plan for the next day's work is high. Production should be high.

The representation of the planned production by the sloped line is an average rate of production. Thought in preparing such a plan should be given to the learning curve process. If that is done these same curves should appear as follows:

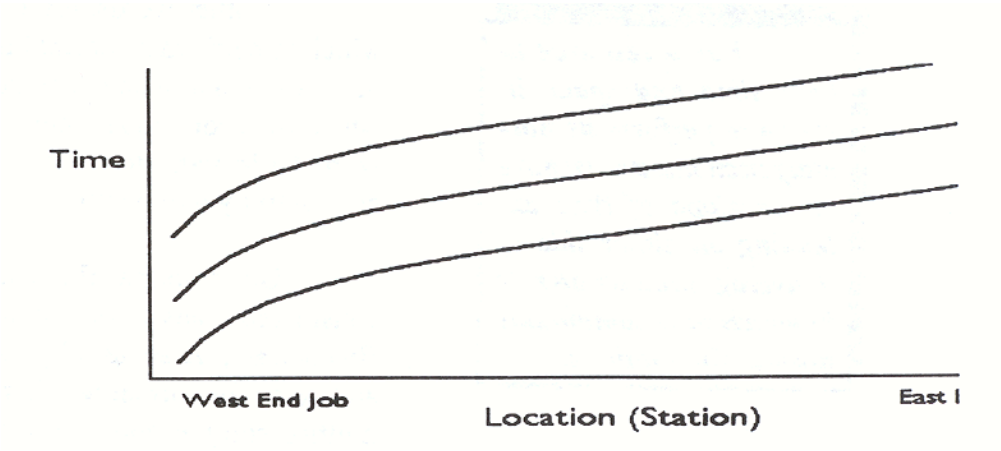


Figure 2-6. **<u>Learning Curve</u>.** The learning curve dictates a large total duration on the project for each resource and longer duration for the early segment of work performed by each resource.

The next factor that must be considered relative to the average, productivity rate are normal variations in the productivity rate due to conditions that the contractor is required to bear the risk of, i.e., Labor and Weather.

As was previously discussed, the absence or addition of a new member will usually impact the daily productivity of a crew by upsetting its balance. Many other factors normally occurring on a project also affect the daily productivity rate. If these factors (normal daily productivity fluctuations) are considered a resource curve of work as actually performed, plotted against the planned productivity would appear as follows:

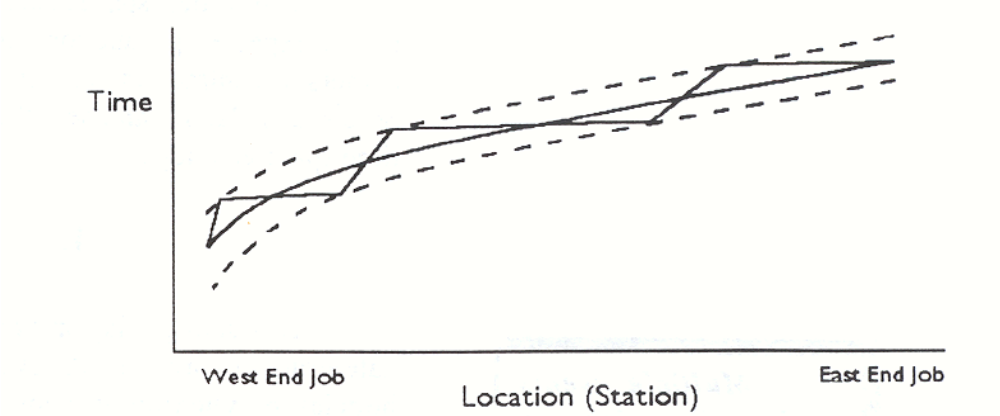


Figure 2-7. **Time Envelope**. To perform normal functions, a resource must have an envelope of time on either side.

For a resource to have time and space in which to perform its normal functions, it must have an envelope of time extending on either side of its average production rate in which to accommodate normal fluctuations.

In other words, for a resource to have time and space in which to perform its normal functions, it must have an envelope of time extending on either side of its average production rate in which to accommodate normal fluctuations. If you are working with a CPM mandated schedule, merely increasing the duration of each activity will be misleading and will not work.

Other normal fluctuations in productivity that must! be considered in any work plan and productivity analysis is Weather. By contract, we are usually required to bear the risk of disruption and delay for normal weather. If weather is fully considered in a multiseason job, the plot of the productivity curve for a single resource may appear as follows:

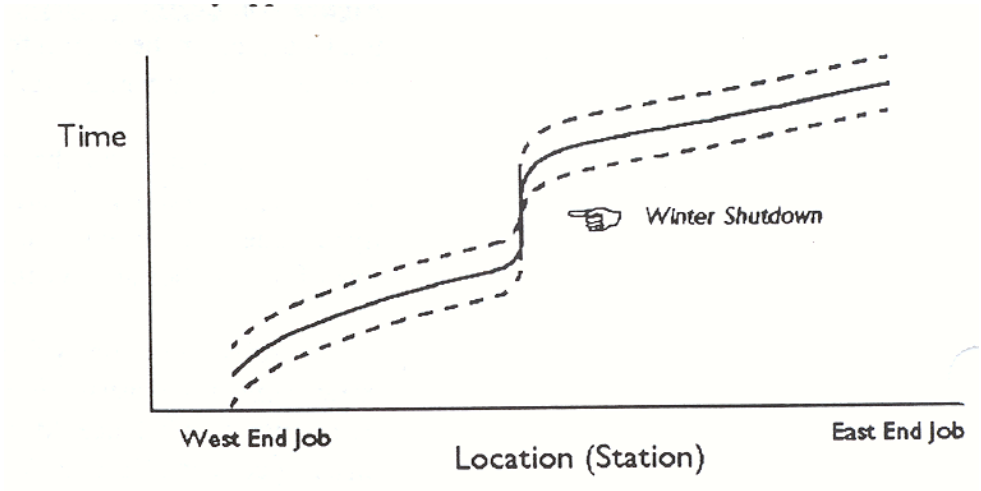


Figure 2-8. **Anticipated Fluctuations**. Weather.

The vertical space in the time space envelope on either side of the expected production rate is not float, even though few owners or contractors understand the concept. The contractor is required to plan for and bear the risk of contingencies within that time space envelope.

3. DELAY

Multiple events result in disruption and delays which can build on each other.

Evaluating delay on a project is like solving an indeterminate structures problem. An event can directly cause an activity to be delayed. When this happens, resources will be diverted and thus disrupted. Disruption causes delays in other activities and further disruption, which, in turn, causes further delay. This phenomenon is often referred to as the ripple effect. A single event results in disruption and delays which damper out with time. Multiple events result in disruption and delays which can build on each other.

When we discussed disruption and the learning curve, we noted the effect of a single event on resource productivity.

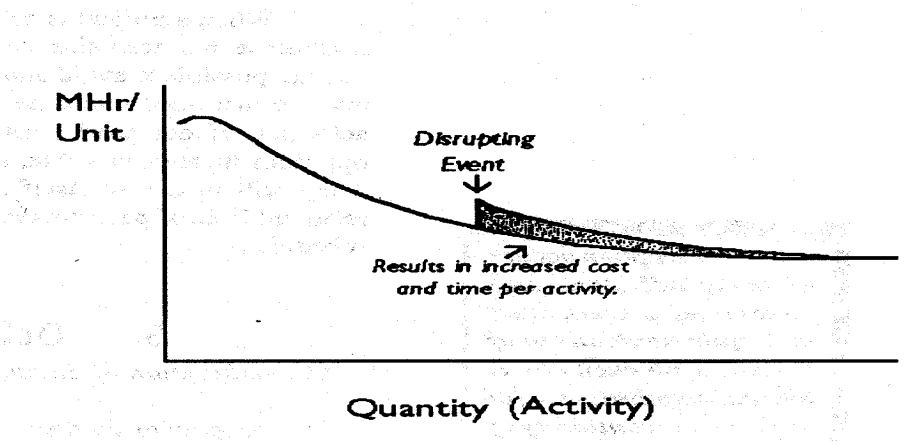


Figure 2-9. <u>Demonstrating Disruptive Events</u>. The effect of a single event on resource productivity.

From the above learning curve example, we can see that the single event affects activities 5 through 9. These activities not only cost more on a MH/Unit basis, but, if our crew size is constant, will take longer to perform. This translates into an extended duration for each of these activities. When the extended duration of the affected activities is inserted in the CPM calculation, other resources may be delayed and, as a result, disrupted and so on.

If any of the activities affected are on the critical path, the entire project will be delayed. If not, then the only effect will be the increased time and cost the allotted resources are required to be on the project and the direct costs of the event itself. In summary, we should be entitled to compensation for the increased time our resources are on the project and any extension of the project itself. Once the delay attributable to each activity can be determined, whether a result of a direct delay to that activity or a result of disruption to the activity's resources, then such delay should be inserted into the CPM analysis to determine the total effect on the project.

4. MITIGATION

When a project is delayed, the contractor is obligated to reschedule his activities and resources in the most optimum manner possible to avoid unnecessary increased costs. This could involve increased overtime, additional crews, and rescheduled activities. If our work

was originally scheduled in the most optimum manner possible, such efforts to mitigate the cost of delay will in and of itself cost additional money, even if the resultant time of performance is the same or less than originally scheduled.

5. DELAYED IMPACT

(A combination of direct, disruption, delay or mitigation)

Disruption occurs when the individual components of a crew, men and equipment fall out of balance with each other, lose their motivation, and/or lose their continuity of effort.

As previously discussed, disruption is the reduction in a resources productivity due to an event. Disruption occurs when the individual components of a crew, men and equipment fall out of balance with each other, lose their motivation, and/or lose their continuity of effort. Disruption will usually occur when the time, space and time ordered sequence plan for projects resource are changed by virtue of an event. The occurrence of an event and the loss in productivity due to that event are often days and sometimes months apart.

Case Study Model:

For example, let's assume we have a series of footings to excavate, form and pour. In order to accomplish this work, we need an excavating crew, a forming crew and a concrete crew.

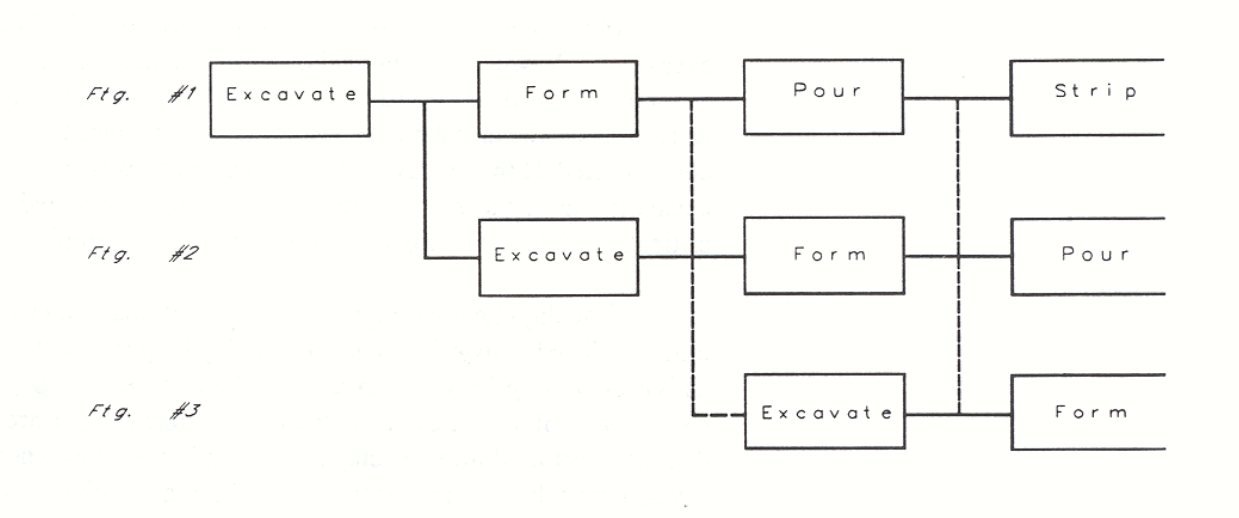


Figure 2-10. **<u>CPM Format</u>**. Sequence is demonstrated, but time space is absent.

If we plot our resource utilization curves in linear schedule format, we may have something that appears as follows.

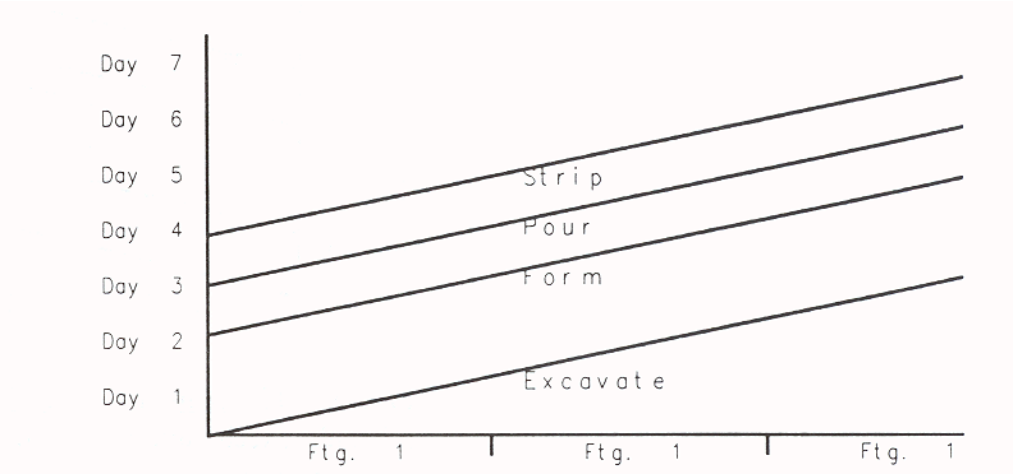


Figure 2-11. **<u>Linear Schedule Format</u>**. Time and space envelope is shown clearly.

In our planning, we recognize that the conditions under which we will be setting our formwork will cause that operation to experience greater delays as a result of rain and the ensuing wet conditions than will the other three activities. Therefore, in our allowance for weather, we will allow a greater time space between excavate and pour to accommodate greater fluctuations in our projected average productivity rate.

If the owner now directs us to perform one day's extra excavation elsewhere for which he issues a change order paying us for the excavation crew for that day, he will consider that he has fully paid us. Usually we will also consider ourselves to be fully compensated. If that excavation crew, however, was intended to excavate Ftg. 2 but since none of the footings happened to be critical, no delay was allowed and no impact registered.

Two days later we experience rain of normal intensity and duration. The formwork is delayed one day longer than the other activities waiting for the excavation to be pumped and dry. The entire series of activities downstream from form Ftg. 1 are now disrupted by the additional delay in forming Ftg. 1. The owner will say that the delay in question was due to normal weather of which we are required to bear the entire risk.

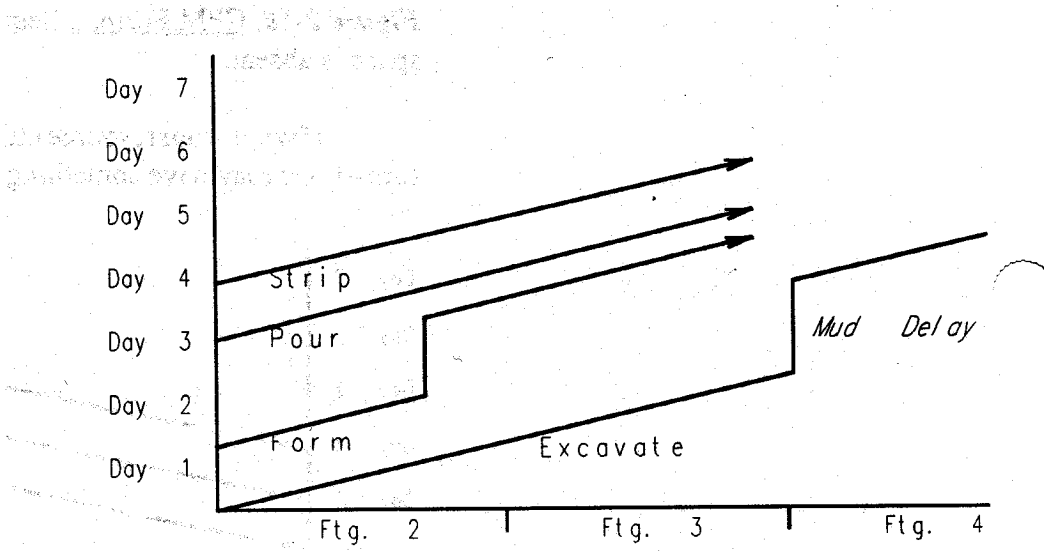


Figure 9-12. <u>Demonstrating Disruption's Impact</u>. The linear scheduling technique easily demonstrates events' impact on time/space envelope.

The net result is that the operation of pour and strip are now each delayed by one day. That delay is the direct result of the earlier expropriation of the excavation crew to do extra work. Of the three operations (resources) -- form, pour and strip -- each experienced a disruption. The extra work occupied the time of the excavation crew and we were appropriately paid for our direct costs. The forming

concrete and stripping crews each had to find something else to do out of sequence with little notice. The use of their time is at best less than efficient and, in some cases, may be virtually nonproductive.

Let's examine what we were not paid for.

All Crews

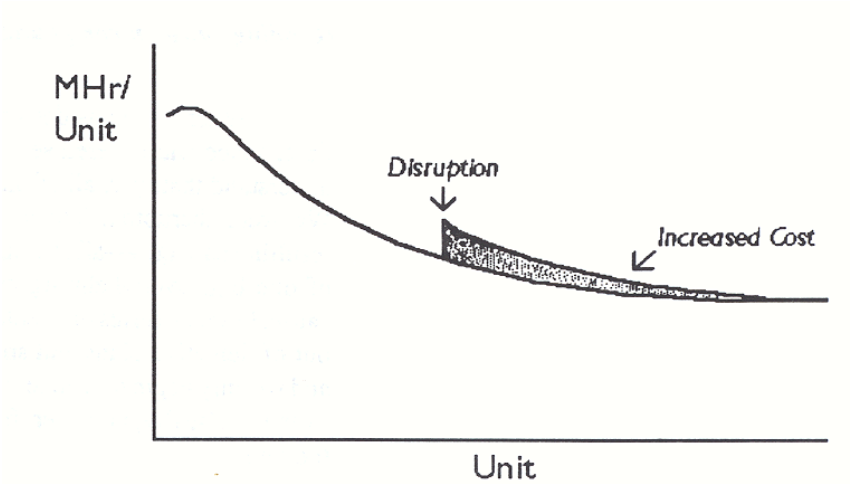


Figure 2-13. Disruption's Impact on Productivity. Due to interruption of maturity cycle, productivity gains are postponed and costs increase.

Forming Crew, Concrete Crew and Stripping Crew

- Performance of out-of-sequence activity with no advanced planning at substantially reduced efficiency.

- Loss of rhythm.

Supervision and Support Staff

- Increased demands as supervisory and engineering and staff time to accommodate out-of-sequence activities.

If any of the three affected resources have activities on the critical path or if their envelopes of time space encroach on the time space of other resources that they had previously not, then the affect of the single event of extra work is further compounded.

CAUSE
(Finding cause in compounding event)

When we consider crew productivity, learning curves, time, space and ordered sequence, and delayed impact, we can understand that, yes, all of the factors discussed happened to us. We were disrupted. We were delayed and we mitigated the resulting damages all at great expense. If all of this was the result of one big, overwhelming event, we can usually pinpoint the cause. Often, a series of events affect us similar to those that arise out of defective plans and specifications or changed conditions and we only begin to realize it when our costs start to significantly overrun. Usually, however, from a claim standpoint, that is often too late.

If we are conscious of what causes disruption to our resource utilization, as previously discussed, we are more apt to be alert to the compounding effect each event will have on the succeeding work. Each of the factors discussed should be considered when reviewing simple claims and Owner-responsible events for which we may not even be making a claim.

Of the four types of costs and time, the direct costs attributable to the simple claim portion of the claim are the only element of costs that are measured against the original contract documents.

Of the four types of costs and time, the direct costs attributable to the simple claim portion of the claim are the only element of costs that are measured against the original contract documents. All other types of cost and all differences in time are normally measured against the Contractor's plan of performance. More often than not, when we fail to recognize that we are experiencing the adverse effect of disruption, delay and/or mitigation, we fail to do so because we do not have an up-to-date plan for performing the work at hand.

IF WE DO NOT KNOW WHERE WE ARE SUPPOSED TO BE (OUR PLAN), IT'S VERY DIFFICULT TO DETERMINE THAT WE ARE NOT THERE AND EVEN MORE DIFFICULT TO DETERMINE WHY WE ARE NOT THERE (CAUSE) OR HOW MUCH OUR NOT BEING THERE WILL COST (EFFECT).

Identifying the cause of disruption, delay or mitigation at the time the event or events occur is extremely important to us if we are to preserve our rights and keep track of the ensuing costs. The best way I know of to accomplish this task is to establish the instruments of plan, contract and means and methods discussed early in this book and the seminar. Establish a clear picture as to where in the project we are supposed to be, monitor the progress and continually ask why are we not there (if we are not). This process will usually provide us with the answers (the cause) in sufficient time to do something about it, even if that something is only keeping track of the costs for claim settlement purposes.

DETERMINING EFFECT

(Sometimes simple, often impossible)

If the instruments for managing a job are in place, and the cause of our deviation from plan or contract are identified, the next problem becomes that of identifying and proving costs. Direct costs are reasonably simple, delay costs for a defined duration, and delay to a specific activity are also relatively simple. Disruption costs and resultant delays and mitigation costs are not as simple.

What Research says About Disruption Costs

The fact that productivity will be effected when a well planned operation is disrupted/interrupted is well understood. The question is, how much?

The fact that productivity will be effected when a well planned operation is disrupted/interrupted is well understood. The question is, how much? A study done by the Construction Industry Institute at a refinery on accounts such as structural steel, concrete and above ground piping showed the following:

- Less than 10 interruptions per week was considered normal and given a Productivity Index (PI) of 1.0
- 10 to 20 changes per week, PI = 0.937
- 10 to 20 changes per week, PI = 0.937
- Over 20 changes per week, PI = 0.573
- No time was included for the direct time of the change itself.

The Construction Industry Institute study concluded that the calculation of productivity loss caused by one or more interruptions or changes is an inexact process. However, it must be acknowledged that there is an effect and it can be significant. Logic dictates that the effect will be a function of numerous factors, such as:

- Worker concentration and planning required to perform the work. A pipefitter trying to align two pipe spools will be much more affected by an interruption than a concrete finisher.

- Whether work is labor-or machine-intensive. Earthmoving and similar equipment return to normal productivity quickly.

- The total number of interruptions. Frequency and demotivation are closely related.

- The elapsed time since the last interruption. The longer the period of time since the last interruption, the greater the potential for productivity to return to normal.

- The time lapse between the interruption and the time when work can be restarted. The longer the delay, the more reorganization required to get started again.

- Whether interruption was expected or not. Workers tend to plan their work so that personal breaks, lunch breaks, and comparable interruptions occur when they can best be accommodated.

- The source of the interruption. If an adversary causes the interruption, the effect will probably be more adverse than if the interruption is from a friendly source.

- Whether worker agrees with the change or need for the interruption. If the worker does not endorse the need, the effects can be

expected to be more negative than if the worker supports it.

Since we normally do not have the benefit of a production study for each disruption claim, how do we measure and separate the increased cost of the disruption from the costs that we would have incurred but for the disruption?

The Courts and Construction Delay Claims

Bramble and Callahan's book, "CONSTRUCTION DELAY CLAIMS," John Wiley & Sons, New York 1987, uses three cases to illustrate the courts' position on the measurement of such damages.

SUMMARY: These three cases illustrate the success and failure of comparisons of actual costs and adjustments to estimates in recovering lost productivity costs in delay claims. In two of them, the contractor successfully recovered most, if not all, of its lost productivity claim. The third claim was not based on a reasonable calculation and was denied by the court.

CASE #1

In *General Insurance Co. of America v. Hercules Construction*, Hercules contracted with the May Company to construct a parking garage adjacent to the Famour-Baff Department Store (owned by the May Company) in St. Louis, Missouri, on November 29, 1961. Hercules was required to give a performance bond to the May Company which required completion of the parking structure on August 8, 1962. Hercules signed a subcontract with Press-Crete on November 29, 1961, whereby Press-Crete agreed to supply Hercules with custom precast concrete components, which were to comprise a substantial portion of the parking structure. Hercules required a performance bond from Press-Crete on which General Insurance Company was surety, to guarantee compliance by Press-Crete with its subcontract.

Press-Crete's subcontract specifically called attention to the completion date for the entire project of August 1, 1962, and that completion of the project was contingent upon adherence to the schedule for Press-Crete's work. Delivery of the precast was scheduled to start January 2, 1962, and be completed April 15, 1962. Delivery was to be in the sequence directed by the Hercules superintendent.

Hercules claimed Press-Crete breached the subcontract. Hercules showed first delivery of precast was not made until February 12, 1962, or one month later than the date called for in the subcontract. Final delivery of precast was not made until September 1, 1962, about four and one-half months after the date called for in the subcontract. The precast components were not delivered in the proper sequence, and until about May 6, 1962, approximately 25 percent of the components delivered were miscast or defectively engineered. Hercules did not complete the parking structure until October 8, 1962, two months late.

Hercules claimed damages due to Press-Crete's breach incurred in an attempt to complete the structure as close as possible to the contract completion date. Efficient precast erection depends upon receipt of components properly fabricated, engineered, and delivered in the planned erection sequence. Hercules' evidence showed that from the time Press-Crete began delivering the precast until May 7, Hercules' productivity suffered, but after May 7,

the workmanship and sequence of delivery showed a marked improvement.

Using the period when Press-Crete had experienced difficulties in delivery of precast, February 12 until May 6, Hercules computed the average manhour cost (at base wage rates) and the average equipment cost per piece required for erection. These figures were then contrasted with comparable figures for the period following May 6 when the precast components were delivered in substantially proper sequence with minimal fabrication deficiencies. The difference per piece in what it cost Hercules in base wages and equipment was then multiplied by the number of pieces erected in the February 12 to May 6 period to determine the amount of Hercules' damages.

The court gave Hercules a verdict in its favor for all of the claimed $21,900. General Insurance Company appealed, claiming the Hercules theory for measure of damages for delay was incorrect under the law. General Insurance claimed Hercules proved damages in a manner so unsupported by logical basis in fact and at such variance with accepted law that the damages awarded could not stand.

The Hercules court pointed out the general rule for measure of damage in case of a breach of contract is the amount that compensates the inured party for the loss which a fulfillment of the contract would have prevented or the breach of it has entailed.

The Hercules court pointed out the general rule for measure of damage in case of a breach of contract is the amount that compensates the injured party for the loss which a fulfillment of the contract would have prevented or the breach of it has entailed. The test of damage calculations is reasonableness of the methods used. Comparing costs before and after breach of contract is designed to afford a reasonable basis on which to evaluate the damage caused by the defaulting party.

Case #1 Finding

The court held Hercules' method of computing damages certainly not unreasonable as a matter of law. The court also held Hercules' evidence could not be deemed to have such an illogical basis in fact that submission of this evidence was in error.

CASE #2

In *Natkin & Go. v. George A. Fuller Co.*, the contractor's method of calculating lost productivity claims was similarly accepted. Natkin and Western Electric entered into a contract under which Natkin was to perform the mechanical portion of the construction of Western Electric's Shreveport manufacturing plant. The Natkin contract was later assigned by Western Electric to George A. Fuller Company as general contractor. Natkin's contract was for a fixed price of $2,979,261 and was to be performed between July 1966 and July 1967. Nine milestone dates for completion of certain areas of work were designated.

The contract provided that a critical path method (CPM) schedule would be followed by all parties throughout the job. The general contractor was to be responsible for preparing the logic diagram, updating it, and providing computer printouts as required. On January 6, 1967, and for the rest of the job, Fuller and Western Electric abandoned the CPM because Fuller could not keep up with it, and because Western Electric would not accept the later completion date it indicated. By failing to permit the later completion dates which the CPM indicated, Natkin's work was accelerated. Fuller and Western Electric failed to recognize time extension requests and insisted on meeting original completion dates.

Natkin was due time extensions because Western Electric furnished equipment and vendor drawings late; contract drawings were not completed until the spring of 1967, after 75 percent of the original contract time had been used. Moreover, Western Electric and Fuller adversely affected job morale and caused delay through harassment by taking daily head counts of Natkin labor, delaying the Natkin workforce, and giving the job a cost-plus appearance, as well as talking to Natkin's field men on

a daily basis, further slowing the work. As a result, Natkin labor believed the job was a cost-plus job and developed the attitude that their slowdown did not cost Natkin anything.

The productivity of Natkin labor began to deteriorate in late 1966 and throughout the rest of the job in 1967 due to the acts of Fuller and Western Electric and their refusal to grant an extension of time. As a result, Natkin sued both Fuller and Western Electric to recover its damages.

On November 25, 1966, Western Electric, Fuller, and Natkin had agreed that Natkin's work was 43 percent complete. Natkin's accounting system had also indicated that its work budget was 43 percent expended on November 25, 1966. However, one year later, Natkin was only 44-1/2 percent complete with the work.

Costs for performing Natkin's work prior to November 25, 1966 were 0.181 manhours for each standard piping unit compared to 0.20 manhours after November 25, 1966. Natkin's costs for each standard piping unit was greater due to Fuller and Western Electric's refusal to grant valid time extension requests, acceleration, and design errors. Natkin calculated it was due $1,(~42,136 for defendant's acts based on the difference between the standard piping unit costs prior to and subsequent to November 25, 1966.

Case #2 Finding

The court awarded Natkin $715,567 for its lost productivity claim. The court stated that comparing actual damages before and after the point in time defendant's failures caused damage to plaintiff was a reasonable method for computation of damages. The court also said Natkin's evidence of manhour cost for a standard piping unit before November 25, 1996, with the cost after that date was a logical basis for computing Natkin's damages. The lost productivity claim had a reasonable basis for its computation and was thus successful.

Other courts have commented that a comparison of costs both before and after a disruption to contractor's productivity is the accepted method of presenting lost productivity claims.

CASE #3

However, in *E.C. Ernst, Ina v. Koppers Co.*, the contractor's method was not reasonable and thus failed. In June of 1973, Koppers entered into an agreement with Jones and Laughlin to design, engineer, and construct on a turn-key basis a coke oven battery and related facilities at Aliquippa, Pennsylvania, to produce coke for use in the steel-making process. The coke oven battery was to be functional by June 17, 1975.

At the time of the Jones and Laughlin/Koppers agreement, Koppers was constructing a coke oven battery of similar concept for Inland Steel in Indiana. Koppers' specifications for the project were developed in April and May of 1973 and were based on Koppers' own expertise, Jones and Laughlin input, the know how they developed from handling problems as they arose at the Inland site, and from experience gained from an experimental plant operating in Irontown, Ohio.

Koppers' engineering department developed plans and specifications for the work to be subcontracted, including the installation of electrical materials. On

January 11, 1974, an electrical bid package containing specifications, drawings, equipment lists, arrangement and single line drawings, flow diagrams, instructions to bidders, and other materials was issued to prospective bidders.

Koppers separated the electrical work into various work areas, such as wet coal handling, preheat, and the like. When the initial package was issued, drawings and other information were not yet available for all work areas, and the bidders were asked to submit quotes on each of the areas as completed. On April 25, 1974, Ernst made a bid on the electrical work of $3,356,800. A subcontract resulted based on a purchase order issued by Koppers to Ernst on June 4, 1974.

Meanwhile, substantial changes were made to the original design drawings. In order to qualify for an investment tax credit, Jones and Laughlin demanded that the facility be operative by January 1, 1976. To meet this deadline, Koppers and its subcontractors were required to complete the project which had been expanded 70 percent in scope in a time frame expanded only 27 percent. A crash program was necessary to complete the job. However, the engineering department of Koppers was 15.7 weeks late in developing final drawings, causing further time reductions.

The crash program resulted in delays to Ernst caused by trade interferences, both from other trades, the so-called stacking of trades, and from being forced to work in a stop-and-go fashion on work beyond the scope of the subcontract.

Ernst sued Koppers for the cost overrun due to lost productivity which Koppers had caused. In its damage calculations, Ernst employed a variation of the total cost method. Ernst began with the estimated productive electrical journeyman-hours. The estimated electrical journeyman-hours were calculated by averaging three estimates prepared by Ernst at the time of the bid. Ernst then subtracted the total number of estimated manhours from the total actual manhours experienced on the project. Ernst claimed these hours were the impact of the changes, delays, and interferences incurred by Ernst. The resultant figure, however, covered a three-year period from 1974 to 1976. Ernst had paid different wage rates for those years.

To allocate the number of delay hours to each year, Ernst calculated the percentage of drawing revisions submitted in each year in question since the extraordinary number of drawing revisions submitted by Koppers to plaintiff was a primary cause for delay. Ernst then multiplied the total manhour figures by each percentage to arrive at delay manhours per year. Finally, Ernst multiplied the number of manhours calculated each year by the relevant wage rate to come up with its damage figure.

The Ernst court stated that it was obvious to it that hypothetical allocation of unpaid journeyman hours of drawing revisions received per year was invalid.

The court rejected Ernst's damage calculation. The Ernst court stated that it was obvious to it that hypothetical allocation of unpaid journeyman hours on the basis of the number of drawing revisions received per year was invalid. Not all drawing revisions required work by Ernst, and all revisions requiring rework would not cause an equal amount of work. The more revisions there were in one year, the more compressed the work would become in the next year. The effect of drawing revisions was not felt until subsequent years. However, Ernst's damage calculation method assumed that the effect of drawing revisions was generated in the year the drawing revision was submitted. The court concluded that Ernst's calculation based on an artificial method of allocation was not a proper substitute for a calculation based on historical expenditure of labor.

Case #3 Finding

The Ernst court stated that it was incumbent on Ernst to show that the nature and extent of various delays for which damages are claimed and to connect them to some act of commission or omission on the defendant's part. Some basis for allocation must be present in the evidence of the case. If a plaintiff is unable to segregate delays and damages caused by the defendant from delays and damages attributed to other factors, no damages may be awarded. Although the Court of Appeals subsequently remanded the case, Ernst did not recover its lost productivity damages until the damages were recalculated by the district court using a more reasonable formula.

Thus, calculation of lost productivity claims which are not based on reasonable or historical data most likely fail. Artificial means to allocate or calculate lost productivity claims are usually not accepted by courts.

Conclusions From Case Law

From these cases and other cases on the subject, it becomes clear that proof of entitlement, followed by an unsupported allocation of damages, will not usually be sufficient to produce satisfactory results.

If we accept the fact that the measure of disruption is the difference between the cost and time of performing undisrupted work versus the cost and time of performing disrupted work how do we handle the situation where the undisrupted work was in the early stages of the project are high learning curve costs and the disrupted portion was later in the project where we should have been making excellent costs. In those situations and other situations that make before and after comparisons impossible or unreliable, we need to resort to other reasonable methods of analysis. The total costs or modified total costs method is acceptable where more precise methods are impossible. The courts generally require, however, that before total cost method is used that the contractor demonstrate that:

1. There is no other way of estimating damages;

2. That no underbid or errors in the bid took place;

3. That inefficiency by the party submitting the claim can be distinguished from the costs of delay due to improper acts of others; and

4. That the actual costs incurred by the contractor are reasonable.

This method of proof consists of assuming that all the problems are the Owner's and that the Contractor could have performed the work for his original estimated costs if not interfered with by the Owner. The modified total cost method attempts to make adjustments for Contractor bidding errors and inefficiencies in performing the work. **COMPLETE RELIANCE ON THE TOTAL COST APPROACH IS DANGEROUS. IT IS USUALLY UNSUCCESSFUL.**

Failure to maintain adequate cost records during the project is an unacceptable excuse rejected by the courts. There is also a tendency by the courts to expect the larger, more sophisticated companies to maintain such records and, as a result, are not as lenient with large companies as they are with small father/son organizations. Also, if damages are awarded, they are usually significantly less than would be available through other more acceptable means because of the inherent doubt in the total or modified total cost method.

Recommendation

My recommendation is that if the before and after comparison is impossible for reasons other than our failure to keep accurate cost records, we should first try to use the modified total cost method on an item by item basis. In such an approach we would show the probable cause of our cost overruns by event and explain the manner in which such events would disrupt or delay our work. We would also show that our original estimate for that work was reasonable and that a reasonable learning curve for uninterrupted work of that type would produce the estimated costs notwithstanding early startup inefficiencies.

This can best be done with historical records of similar but uninterrupted activities and some expert testimony.

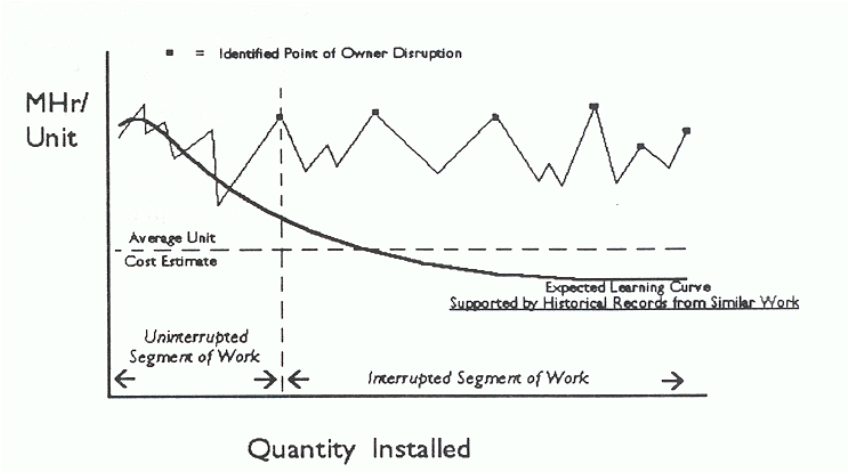


Figure 2-14. <u>Continuous Interruption Measured Against Expected Productivity</u>. This figure should provide us with an early warning of any problems.

The more specific we can get in identifying the cause and effect of each event, the more likely we are to prove the quantification portion of our claim.

The problem we will usually face here is that we probably do not have the historical records to support the learning curve. (An argument for keeping such records in the future.) We will also be in trouble if our schedule durations do not reflect the variations in the production rate as depicted by our learning curve. The argument being that the learning curve is not a significant factor on this type of work, as evidenced by our own schedule. The Owner would then attempt to show by our early start-up difficulty that we were merely unorganized and inefficient in our performance and the Owner-caused events had no effect on our total costs. Our plan of execution would not produce the estimated results. In other words, the more specific we can get in identifying the cause and effect of each event, the more likely we are to prove the quantification portion of our claim. Also, the more likely we are to collect greater portion of our claim.

Mitigation Costs

Mitigation costs are the costs incurred when we re-sequence our activities to accommodate prior and projected changes in production rates or delays. These costs are as much a part of the total claim as are the direct, disruption and delay costs.

The main point here is that these costs, like disruption and delay, are measured from our original plan for performing the work. They cannot be effectively identified or measured after the work is complete, but must be quantified at the time of the delaying event. This is most effectively done by what is called a Time Impact Analysis which compares and measures the cost and time difference in the plan for performing the work before the delay to the plan for performing the work after the delay.

2.1 QUANTIFICATION OF COSTS DUE TO CHANGE

This example presents a method for quantifying the effect of a change on the cost of an operation using a simple reinforced concrete retaining wall.

Let's assume that the intended operation includes placing rebar cages and reusable steel forms position with a mobile crane prior to concreting.

The schedule of unit prices in the contract provides for mobilization; most of the supervision and overheads have been included in this. Mobilization of the crane and the cost of manufacturing the formwork is included in the concreting operation.

The costs associated with the operation can be calculated and grouped as follows:

1. Method Related Costs (M)

All costs related to the establishment of the planned method. This will include costs for loading, transporting, leveling and setting out the plant and equipment, manufacturing of formwork and all other costs expendable as a lump sum in order to provide the intended resources. After it has been incurred, d sunk cost and therefore not recoverable.

In our example these are:

Mobilization of the crane	$2,000
Manufacturing of the formwork	$6,000
Total	$8,000

2. Costs Related to Activity Duration (A)

These costs include all those items directly related to the duration of an activity and will include such as direct labor, plant costs, and equipment hire.

In our example these are:

Crane hire	$ 900/day
Labor	$1,500/day
Total	$2,400/day

3. Quantity Related Costs (Q)

These include all of the material and other expendables directly proportional to the quantity of work done.

In our example, these are:

Concrete	$ 65/cu yd
Steel	$100/cu yd
Miscellaneous	$ 30/cu yd
Total	$195/cu yd

4. Other Project Information

If the planned activity duration (a) is 15 days, and the planned volume of concrete (q) is 400 cubic yards, then the total price for the work can be calculated as follows:

$$P = M + A \times a + Q \times q$$

In our case this works out as follows:

$$P = 8000 + 2400 \times 15 + 195 \times 400$$

$$= 8000 + 36{,}000 + 78{,}000 = 122{,}000$$

The unit rate is then:

$$\frac{\$122{,}000}{400\ yd^3} = S\ 305 / cu\ yd$$

This breakdown can be used to quantify changes to the activity cost. Changes which cause the y to go critical and extend the project duration require a study of related supervision and overhead, an entirely different matter.

Consider the following scenarios:

(1) The owner wants to add 2 feet to the height of the wall to keep black-footed ferrets from wandering onto the project. This change will add 50 cubic yards of concrete to the wall. The effect is an increase of two days in the duration of the activity.

The impact of this change of costs can be calculated:

I. Method Related Costs
II. Activity Duration Costs
III. Quantity Related Costs

Total Cost ($)
Unit Cost

(2) The owner wishes to add 4 feet to the original height of the wall to keep small children from wandering onto the jobsite. This will add 100 cubic yards of concrete. The effect is an increase of five days in the duration of the activity.

The costs of this change are:

I. Method Related Costs
II. Activity Duration Costs
III. Quantity Related Costs

Total Cost ($)
Unit Cost ($/cu yd)

(3) The owner instructs the contractor to accelerate work so that the addition of the extra 100 cubic yards will not increase the activity duration beyond two days.

Extra resources (another crane) will have to be mobilized at a cost of $3000. Activity duration will increase by two days.

The costs of this change are:

I. Method Related Costs
II. Activity Duration Costs
III. Quantity Related Costs
IV. Extra Resources

Total Cost ($)
Unit Cost ($/cu yd)

(4) Unfortunately, this interference has caused productivity levels to drop and learning curves to be adversely effected. When the activity was finished, the work had taken three days to complete. The resulting costs for the activity:

I. Method Related Costs
II. Activity Duration Costs
III. Quantity Related Costs
V. Extra Resources

Total Cost ($)
Unit Cost ($/cu yd)

(5) Let's consider the original situation, but due to owner interference (a late design change) a productivity loss of 40% is experienced. This caused a change of six days in the activity duration. The effect on the activity cost is now:

I. Method Related Costs
II. Activity Duration Costs
III. Quantity Related Costs

Total Cost ($)

Unit Cost ($/cu yd)

Extension of Time Analysis on Blue Route Section 600.

The following steps were discussed and agreed in order to perform an "as built but-for" analysis on the activities which comprise the critical path of the Blue Route Section 600 contract.

1. The critical path for the contract is thought to run through the chain of activities needed to construct bridges 904 and 900. The first step is thus to sort these activities from the original as planned schedule and store them in a specially named file - say EXTA 1, the raw as planned data file.

We must accept that this is an approximation as one should do an as built and "but for" analysis of all the activities on the job. Sorting and using the activities from 904 and 900 will be much simpler and will yield the same results if this is indeed the critical path and if there are no impacts from other parts of the job. Impacts from other parts of the network can cause two things to happen:

- There may be gaps in the bar chart you develop in step 4.1 due to activities or constraints outside the selected set of activities.

- The but for "collapsing" operation (see 6.1) may not proceed as far as it would if the full network were used due to concurrent contractor delays in other areas.

The best bet is to acknowledge these shortcomings in the analysis and that no other path would produce a longer as built or "but for" period. You will have to defend this statement and may have to stand by to analyze another path to back this up. Analyzing a rationally chosen portion of the net makes the whole thing workable in the first instance and certainly is a good start.

You will also have to acknowledge that the analysis is being done at a time when there remains work to do on the presumes longest paths. It is thus not a full and final analysis and there may be changes due to further changes (owner and contractor imposed) in the uncompleted or future work.

2. The next step is to review the as planned network comprised of these activities and remedy it for any errors and omissions made at the time the as planned network was created. Two things must be borne in mind when doing this:

- You are remedying errors and omissions made at the time the as planned network was created and you cannot (or should not) import any knowledge that you now have. [If, for example, the duration of a forming operation was originally put in as one day when five days is a reasonable estimate, then you must substitute five days even if you now know

that it took you ten days because you really did have problems with productivity in the forming crews.]

- You are doing something of which the owner is inherently suspicious and thus every care must be taken to avoid the impression that you are rigging the as planned schedule for your own benefit given the fact that you are remedying errors and omissions after the fact as the basis for a claim.

The following four steps are necessary:

2.1 Review the calendars and ensure that there are an appropriate number of calendars reflecting appropriate work periods available. If not, set them up and change the calendar codes accordingly. Log what has been done and the reasons why.

2.2 Review all the activities and add any which were left off in error given the original scope of work. This is tricky as you must remember that any changes which came about after the original planning date cannot be included. Log what has been done and the reasons why.

2.3 Review all technical and sequence logic links between the activities and change any links which are unnecessary or erroneous. Add any links which are missing. Log what has been done and the reasons why.

2.4 Review all the durations and change any which are in error. Again, you must use the knowledge available at the time the original planning was done. Log what has been done and the reasons why.

All these changes must be made on file EXTA 1 and their effect must be recorded by creating a new file - say EXTA 2 – which thus contains the "raw as planned data with errors and omissions remedied" file.

3. The next step is to produce an as built bar chart of the section of work covered by the as planned schedule. As the construction is not complete this will comprise two portions:

- The portion reflecting the work which has been done where you will have data which shows what has happened.
- The portion of the work which has not been done where you will have to use the as planned schedule and any new and reasonable knowledge which you now have to reflect the future work.

The following steps are required:

3.1 Insert all as built dates for the activities in file EXTA 2. These will include actual start, actual start and end of any suspensions and actual finish. Any and all sources of data can and must be used including photos,

diaries, time cards and the like. Build a reference file recording where each and every date came from so that you can retrieve and substantiate the source material if necessary.

3.2 Insert any new work activities which were added after the as planned schedule was done at the correct points in the network. Add their as built dates and log the data as set out in 3.1.

The time needed for added activities, if they are on the critical path or if they affect the critical path, must be the subject of a separate claim for extension of time based on the time needed to complete the added work. "But for" can mean "When would we have completed the work 'but for' owner imposed delays" or it can mean "When would we have completed the work 'but for' owner imposed delays and extra work." If you code added work then it is reasonably easy to include them in the but for collapsing operation carried out in 6.1.

3.3 Insert any owner imposed delays that you know of at the correct points in the network. Add the actual dates and log the data sources. Code the owner imposed delay activities so that you can identify them easily in any subsequent operation.

3.4 Insert any other delays that you know of caused by you or any other party at the correct points in the network. Add the actual dates and log the data sources. Code these delay activities so that you can identify them easily in any subsequent operation.

3.5 Review any uncompleted work add your current best knowledge as to the scope of the future work, the sequence logic and the durations. This is effectively an update of the planned schedule for the future work and, again, log what has been done.

3.6 Run a schedule analysis to check for any out of sequence work warnings. Change the logic links which gave rise to the warnings and at the same time check all logic links to make sure that they are as good as you can make them. Plot a logic diagram to check. Log what has been done and the reasons why.

3.7 Update all the calendars to show the actual nonworking days experienced on calendar for the elapsed period.

3.8 Use P3 to draw you an as built bar chart. Save the file - say EXTA 3 – "as the built raw data" file.

4. The next step is to analyze the as built bar chart for any gaps along any of the paths and to find reasons for these gaps. If you have identified all owner imposed delays and all other delays in your as built data then there will be very few gaps. This step therefore acts as a check on the completeness of the data as you will have to show that each day in each path is

accounted for as either a work activity (original or added), a delay of your own making or an owner imposed delay.

The following steps are required:

4.1 Review the bar chart and identify any and all gaps in all paths. Identify these as either data errors, contractor delays or owner imposed delays. Interfaces between the fragnet sorted out in step I may be the cause of some of these gaps and this will have to be looked into.

4.2 Insert activities where necessary to close the gaps and make all the paths continuous. Give the added activities start and stop dates to suit and code them as either owner imposed delays or contractor imposed delays as necessary. Log what has been done and the reasons why.

4.2 Leave all future work unchanged.

4.4 Have P3 produce another out of sequence analysis and bar chart. Check that it is as good as you can get it. Save the file - say EXTA 4 - as the "as built improved data" file.

5. The next step is tricky. It requires that you free the bar chart drawn using the as built data so that it can move within the logic constraints when durations are substituted for the as built data which created the actual start and finish dates.

The following steps are necessary:

5.1 Obtain a print out of all the durations calculated by P3 for all the activities and delays in file EXTA 4.

5.2 Go through all the activities in file EXTA 4 and delete all the actual start and finish dates for all the activities. Substitute an appropriate duration (use the list obtained in 5.1 as a guide) so that P3 now calculates the start and finish dates based on logic and substituted durations. The durations may change from the list obtained in 5.1 due to the effect of the change in calendars. This enables the network to change as durations change for the given activities and logic. Log what has been done and the reasons why.

5.3 Leave all future work unchanged.

5.4 Save the above as a new file - say EXTA 5 - as the "as built duration driven" file.

5.5 Perform a variance analysis between EXTA 4 and EXTA 5 to ensure that the substituted durations produce the same start and finish dates as those which appear in the as built improved data file. This ensures that there has

been no change other than that needed to free the network and permit it to be driven by the substituted durations rather then the actual start and finish dates. Adjust the substituted durations as necessary until the variance analysis shows no difference between EXTA 4 and EXTA 5.

6. This is our last "but for" step. We must now reduce the durations of all the owner imposed delays to zero or some other value which you could reasonably have expected in terms of the contract to show when the activities would have been performed had there been no or only reasonable owner imposed delays. If you are doing a "but for owner imposed delays and extra work" analysis (see 3.2) then you must include extra work activities in this operation.

The following steps are necessary:

6.1 Identify all the owner imposed delays in file EXTA 5 and reduce their durations to zero or some other value which you could reasonably have expected in terms of the contract. Log what has been done and the reasons why.

6.2 Leave all future work unchanged. The total duration of future work may change due to calendar effects. Save this "but for" analysis in a separate file - say EXTA 6 - the "but for" file.

Perform a variance analysis between EXTA 4 and EXTA 6 to show the effect of reducing the owner-imposed delays to zero or the chosen reasonable value. Produce comparative bar charts.

The extension of time that we request is the difference between the as built - EXTA 4 and the as built with owner-imposed delays reduced to zero or an appropriate value - EXTA 6.

7. This analysis is substantially strengthened if it is possible to perform an "as planned impacted analysis" and if the requested extension compares with the results obtained from the "but for analysis."

The required steps are as follows:

7.1 Perform the corrections to the as planned schedule as set out in 2 above

7.2 Add all owner-imposed delays to the as planned with errors and omissions remedied network. The descriptions, durations, dates and locations in the network developed in 3.3 and 4.2 can be used in this step. Store the "as planned" impacted data in a new file - say EXTA 7. Log what has been done and the reasons why.

7.3 Perform a variance analysis between EXTA 2 and EXTA 7 to show the effect of the owner-imposed delays on the as planned schedule. Produce comparative bar charts.

The extension of time that we request is the difference between the as planned - EXTA 2 and the as planned with owner-imposed delays – EXTA 7.