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A Performance-Based Solution to Avoid Schedule Failure on Construction Projects

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1. PROJECT SUCCESS IS POSSIBLE

Is there such a thing as project success in the construction industry? And if there is, if the project succeeds, is it likely or even possible that all the parties to a contract will believe that their interests were also served? Or are the interests of the contractor, owner and designer different from, perhaps in opposition to, those of the project? This article describes a strategy and a system which is dramatically improving project outcomes by convincing the parties that their own best interests are served by making project performance the priority.

2. THE FAILURE OF THE STATUS QUO

Those who have been involved in the construction industry for the past couple of decades will find familiar the following account of how projects often perform. The parties sign a contract – which is an agreement – to meet certain time, cost and other objectives. This seems promising enough; there is at least, or so it would seem, a basis for the belief that there is common purpose since the parties are contractually bound to common objectives. This optimism might even seem well founded to an outsider observing the early harmonious days on a construction project but, too often, the parties are simply "playing their cards close", feeling the other side out for weaknesses. On troubled projects, each side soon has a sense that things are falling apart. They come to know that the time and cost objectives will likely not be achieved, and their behaviours are adapted to a possible legal showdown.

Gradually, the behaviour becomes more confrontational, sometimes culminating in a total breakdown in the collaborative exchange of information essential to problem solving, and without which progress is impossible on construction projects. The individual advocacy strategy has the parties retreating into their respective camps, which only serves to exacerbate the delay and disruption. Nobody is sure how much delay there really is because the construction schedules are deficient, but since time is money, sooner or later the job will be visited by the delay claim, so frequent in construction projects.

In such an environment, it should not be surprising that performance is suffering. Indeed, recent studies bear this out, as for example one by the US Bureau of Statistics which concluded that "construction is the only industry decreasing in productivity since 1964, others have increased by 200%"[1] . And according to the *Economist* magazine, there is "30% waste in the construction industry"[2] . A Revay sampling[3] of 25 (electrical and mechanical) mandates revealed that there was a 100% increase in actual labour hours versus planned (2.2 million hours versus 1.1 million), and that only 30% of this was accounted for by change orders, leaving 70% of the over-run as attributable to performance problems.

There is waste not only in terms of dollars and time, but also of human potential, especially for those who are dragged from their constructive lives into the cycle of failed negotiations, followed by litigation. The waste of resources must be counted an economic failure at the very least.

3. PROBLEMS WITH SCHEDULES

The absence of meaningful schedules is a primary cause of project failure. Too often, the schedules produced for construction projects are deficient as instruments for planning and control. The original plan is seldom validated and it is likely that no-one knows if it was ever possible to achieve it. Schedule updates can become administrative formalities rarely reflecting, let alone dictating, short and long term planning. And if the schedule does not reflect the original scope correctly, then it can hardly be expected to be used to manage changes, even though the contract prescribes this function.

3.1 CPM SCHEDULES IN NAME ONLY

One of the reasons for deficient schedules is the failure to comply with best practices in creating a Critical Path Method schedule. Some examples of poor practice are: missing or erroneous logic; excessive leads and lags; misuse of software features such as constraints, automatic resource

levelling, and calendars; unexamined use of the out-of-sequence logic options[4], etc. Such problems were documented memorably in an article[5], written over ten years ago now, in which leading industry schedule experts expressed their dismay that schedules were "badly flawed". As was pointed out then, they looked good but lacked "mathematical coherence or common sense", with the result of "confusion, delayed projects, and lawsuits"[6].

A decade later, there is no real sign of improvement. At a recent international industry conference the question being debated was: "Should an alternative to CPM schedules be sought since there appears to be no success in producing them at an acceptable level of quality?" Such frustration is understandable, but this really would be throwing the baby out with the bath water. To the extent that schedules are bad as result of deficiencies in software expertise and/or an understanding of CPM best practices, this can readily be cured, where there is the will, with education and training.

3.2. SCHEDULE FAILURE FROM START TO FINISH

That the creation of meaningful schedules is often not a priority becomes evident early on in the life of a project. To take a typical example on a Design-Bid-Build project, consider the owner who goes to tender with a schedule completion date that has not been validated for feasibility. There may be patent impossibilities that minor effort in the direction of validation would have detected.

The contractor's behaviour is influenced by the bidding environment and commercial realities. It is usually estimating multiple projects at once. There is only a limited time to prepare the bid which, after all, it prepares for free. The bid documents will likely be changed numerous times during the bidding period by way of addenda, so keeping up with the scope is a job in itself. An estimator is dedicated to costing and is not a scheduling expert, but there may be, in the best of cases, some effort to validate the time duration in calculating indirect costs. But often the time period stipulated in which to complete is not questioned at all.

Many design consultants qualify their contracts with the owner to exclude schedule review, so in these cases it is a contractually mandated fact, not an opinion, that schedule review is not happening. No wonder the baseline schedule and the monthly updates that follow, are quickly disposed of: they can mean little in terms of time performance. That pre-purchased equipment delivery delay caused by the owner becomes the only schedule issue because, absent proper schedule review, the owner's side doesn't discover the significant problems with the contractor's schedule. Or, less nefarious, but no less problematic, the contractor discovers the problem so late that nothing at all can to be done about it.

3.3. SCHEDULE IMPACT OF CHANGES LEFT UNEXAMINED

Most contracts include a clause requiring the forward pricing of changes, including all direct and indirect costs resulting from the change. If the contemplated change would, if accepted, delay the existing completion date, the cost of this delay is to be included, and often there is a clause requiring that the schedule be used to demonstrate such delay. The sound thinking behind this is that pricing the delay and disruption costs in advance of proceeding with the work enables the owner to make a fully informed choice about whether or not to proceed with the change.

But instead of doing this, many contractors tend to price only the direct cost of a change. Some owners are content to accept this approach since they believe it weakens the contractor's case for delay-cost recovery later, though it would seem a far less risky proposition for an owner to avail himself of the contract provision to obtain contractor pricing of delay costs in advance, and thereby make a fully informed choice before proceeding with the change. But most likely this widespread industry reluctance to follow a contract term which, if followed, might help to avoid contentious delay claims, is born of the shared realization that the schedule which would be used to demonstrate time delay is at times unreliable.

There is often no good reason that these time and cost effects, including impacts[7-8], cannot be estimated contemporaneously and incorporated into an accepted change and schedule forecast. The net result of this failure to incorporate all cost and time effects in changes has been disastrous in terms of producing meaningful schedules. What good is the schedule if it is missing important scope added by way of changes? Furthermore, the money issue is left until later to fight over and distract all parties from completing the work.

In addition to specific contract terms explaining how the time effect of a change is captured, expert guidance is required to incorporate changes into the schedule.

4. A STRATEGY TO CHANGE THE "GAME"

The evident failures of the current system notwithstanding, it nonetheless is the abiding approach to which all have become accustomed. All the players have evolved to survive in, and have adopted strategies around, the business reality they know. So it is reasonable to ask how it can realistically be expected to change. How can the industry be convinced to truly cooperate so as to produce the best outcome for the project and themselves?

To begin with, there should be a clear understanding about what objective(s) cooperation is intended to serve. Cooperation should be part of an overall strategy to maximize performance in accomplishing the time and cost objectives. Such cooperative behaviour is necessary to the success of construction projects, but the parties to construction contracts, at times, defect from a cooperative stance. In so doing, they sacrifice project success for what they perceive to be in their own best interests. Defections from cooperative behaviour adversely impact schedule performance and therefore the project.

Why are the parties tempted not to cooperate in making peak project performance the primary objective? One reason is the perception that peak performance is not only not rewarded, it is not even noticed. As will be discussed later, this is largely because of the absence of accountability. The science of Game Theory, which studies strategic decision making, offers valuable insights into how group behaviour can be altered. In order to change the "Game"[9], each of the parties must believe that their own best strategy is one of cooperation in achieving peak performance. Defection will be deterred if the parties believe it will be exposed, and once exposed it would have a cost to the defector that outweighs the perceived benefits of defection. Game theory does not rely on altruism to change behaviour, but rather a strategy with clear rules about how the resource (in this case most especially time) is to be used; definition of permissible and forbidden actions; a system of penalties for violation of the

rules which is understood by all parties, and; a good system to detect cheating[10]. As will be discussed below, meaningful schedules can be the foundation of such a strategy because they create performance accountability.

An essential change in strategy will require owners, contractors and designers in the construction industry to consider in a serious and objective way how its own decisions will impact the other's behaviour. Thinking strategically involves thinking about how to encourage cooperation from the other side even when the other side does not initially perceive such action as in its own self-interest. If each side chooses to guide its behaviour by the imperative of peak project performance because it believes it is the best choice given its belief about how the other side will behave, a stable environment of cooperation will prevail[11].

5. CURRENT FIXES

In response to project failures, the industry has attempted many solutions. First, there is the eternal search for a contract delivery approach that will magically solve the problem, but none of the delivery methods – not design-bid-build; not design-build; not construction management; nor any of their hybrid – have proven to be the panacea they were promised to be. Early euphoria over Public Private Partnerships seems now to have been premature, at least according to a study out of Britain (the birthplace of the model) which concluded that "taxpayers rarely benefit from public-private partnerships … which are more expensive and no more efficient than Government-procured projects."[12] Nowadays, few would assert with any conviction that *Partnering* has a decisive impact on project outcomes.

This accumulated record of disappointment does not bode well for the industry's latest hope, *Integrated Project Delivery* (IPD), which emphasizes collaboration (during pre-construction as well as construction) along with a commitment to *Building Information Modeling* (BIM) technology, to turn the tide of failure. Still, it is instructive to briefly examine this latest offering with the wisdom of hindsight afforded by prior failures. Here again, there is no doubt that the IPD emphasis on collaboration so as to "integrate" people, systems and practices to optimize project results[13] is important, and indeed this has been understood by the industry as being necessary for a long time. But collaboration and commitment to having project controls is not enough: the parties may collaborate fully and happily[14] but still fail to achieve the project objectives because one or all *perform* badly.

6. PERFORMANCE ACCOUNTABILITY

To avoid failure on construction projects, it is necessary to understand that the reason it persists is that generally there is *not sufficient accountability* for poor performance such as which would cause the parties to alter their behaviour.

The failed fixes described above are not without merit. It is not as though a well-crafted contract which intelligently allocates risk is not beneficial, and certainly the selection of an appropriate contract delivery method can positively influence the outcome. Moreover, the collaborative philosophy embodied in approaches such as partnering is a necessary part of success, and to be sure, technological approaches (so long as they are regarded as means; not ends) have the potential for great benefit. Indeed they all have their place in the pantheon. The problem is that without accountability, it is manifest that *none of them are nearly enough*.

In this regard, time, and what constitutes its abuse, which is indifference to it, is the performance factor which has been neglected to the detriment of project success. There is no reliable knowledge about performance as it impacts time because, as was touched on earlier and will be discussed more later, schedules are so often deficient, as such, there is no accountability in terms of the responsible use of time, which determines success in a fundamental way.

Despite widespread opinion to the contrary, the parties absolutely *could* know the truth about what happened on the project with a reasonable level of certainty. Accountability, as demanded by a system of project planning and controls, with meaningful schedules as the centrepiece, and peak performance understood as the means to the objective, is absolutely possible, but has not been the norm in the industry.

7. THE SOLUTION: A PERFORMANCE-BASED SYSTEM

In order for construction projects to succeed, the individual advocacy approach must be replaced by a *Performance-Based System* in which peak performance becomes the objective to which all parties commit in order to achieve the time, cost and scope goals required by contract.

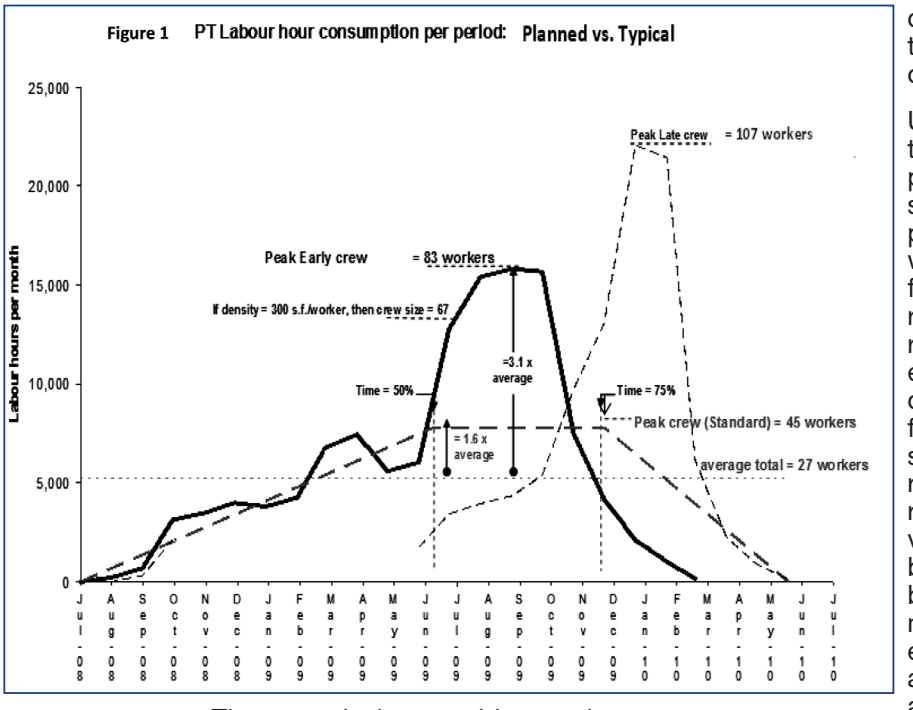
Performance is the elephant in all of the rooms in which solutions to the failure of construction projects are discussed. Any project manager who is dedicated to making a project succeed will tell you that time really *is* "of the essence"[15] in succeeding on a construction project. It is the resource that must be respected in order to achieve the agreed time and cost objectives.

In a *Performance-Based-System* (PBS), what matters centrally is time, because the judicious use of it increases the probability of finishing on time, thereby avoiding claims, and cost overruns. How the parties perform will determine whether time is used efficiently or not, and there must be mechanisms to establish accountability for the use of time. The performance of participants in effectively and efficiently using time is measured and evaluated. The indiscriminate or cavalier use of time to the detriment of project performance is discouraged. Behaviour of all participants is dictated by the priority of attaining peak performance, which is understood to be the determinant of project success.

In a PBS, the parties become focused on what is in the interest of the project. In this environment, if the contractor is not resourcing the job as it promised and progress is falling behind, or if the Consultant's dilatory review of a shop drawings is consuming large amounts of schedule float, or if the owner is putting work on hold or introducing discretionary changes at a critical time, such negative performance is detected, analyzed to determine its impact, and the responsible party held to account.

Knowing who the best-performing contractors are is extremely important to owners in a PBS because it is understood that such contractors are the most valuable resource that an owner can have. They are coveted for their problem-solving ability because there will almost always be problems (such as design errors and omissions) which the contractor is not responsible for but nonetheless imperil project performance. Astute owners realize that resourceful contractors, by their exceptional performance, may even find solutions that mitigate the performance failures of the owner and its consultants.

A PBS commits to the objective measurement of performance of all parties because, as has become axiomatic in project management, one cannot manage what is not measured. Collaboration in this system is a dedicated effort to serve the project interests as told by the schedule truth. There may be arguments, but instead of being based on self-serving positions, it is over reasonable differences of opinion about what will best serve the project. What *is* valued is expertise, experience, and behaviour that conduces to peak performance which will benefit the project.



8. SCHEDULE MEASURES TIME PERFORMANCE

The project schedule should tell the truth about time: past, present and future. If it does, then it is the vitally important tool at the heart of an effective project management planning and control approach, and which is essentially this: a feasible plan is created to which all buy-in; actual progress is measured against this plan to identify off-trends, and corrections made to bring the schedule back on course if possible; and reliable forecasts to complete are produced so that delay can be avoided or mitigated. If the schedule tells the truth it also provides the means to evaluate performance and enforce accountability.

9. CONNECTING TIME AND RESOURCES

Not just any schedule – certainly not such as those to which the industry is accustomed-will do to measure project performance. Cost, labour, material and equipment resources, must be loaded into the network of activities to form a logic-driven mathematical model called the Integrated *Time-Resource*[16] *Critical Path Method schedule*[17] .

The loading of resources is essential because in order to gain real performance transparency, it is necessary to know the resource assumptions on which the time assumptions are based.

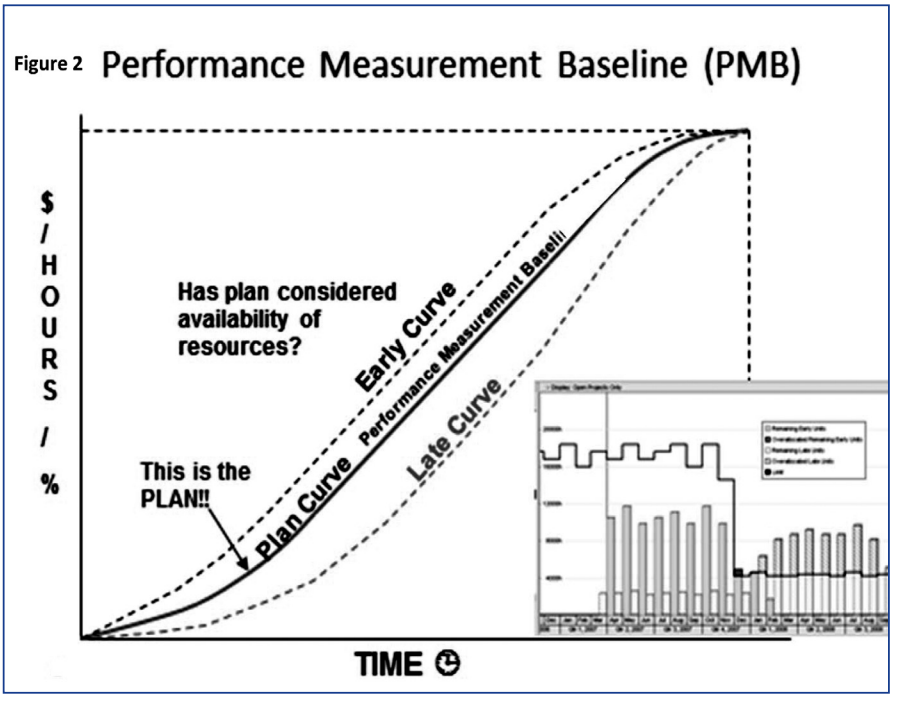
Time analysis provides only one analytical dimension – the full perspective requires the story told by resources, and then by qualitative information such as provided by a schedule Narrative and Delphi[18] sessions. The analyst searching for a complete understanding of schedule performance might ask questions such as the following: "How much of the concrete was placed versus the plan (per-period and cumulatively), and how many actual labour hours went into concrete placement, formwork and rebar installation? Are variances in time related to variances in planned resources, or reduced productivity, or delayed decisions, or something else?" These performance questions should be answered in the contractor's Narrative which is a centrally important communication tool because what the schedule model is showing may have various interpretations. For example, comparison of planned to actual concrete placement shows that this work is way behind plan, but why? Analysis of earned and actual hours shows that productivity is actually higher than planned, but actual hours are far fewer than planned as of this date. The fact that the actual rebar labour hours have declined steadily over the past few months may explain the commensurate drop in production of formwork (and concrete placement) over the same period, but is rebar performance the problem? Perhaps there is no work for the rebar contractor because the formwork contractor is not working quickly enough in advance. If so, why not? Perhaps the formwork has been delayed by an owner change that is now completed, or the formwork contractor sent a crew to another job to "put out a fire".

Ultimately, the contractor is the performing party, and so it is in the best position to know whether it can perform the work in the required time, but it is reasonable and necessary to have the owner buy in to the feasibility of the schedule, which requires disclosure of resources. This is vitally important because schedule will be the primary instrument against which to evaluate performance and enforce accountability. Still, contractors are reluctant to even load dollars into a schedule, so a word needs to be said about why the loading of *all* resources is so important.

The need to load *labour* resources is especially important to understand because labour performance is, in most cases, a controllable factor which will likely determine the outcome. If made available, the feasibility of the labour plan might be tested against standardized performance patterns (see Figure 1).

There is much resistance to labour loading. For example, a contractor may assert that it is unnecessary because if one of his sub-trades falls behind, it will be apparent in the delayed start and finish dates shown in the schedule and, once noticed, the contractor will simply demand corrective action by his sub-contractor. But what if the circumstances are such that there are plausible alternative justifications for falling behind in time? What if, for example, the trade asserts that the delay is explained by the increased inspection regime lately required by the Owner which is adversely impacting productivity? What can be known about the veracity of this contention if no analysis was done to determine the feasibility of the baseline production and productivity assumptions, or the crew sizes and number based upon them? A *Performance-Based-System* demands to know such information so that the real reasons for performance problems are known, timely solutions can be found, and results improved.

10. A SOLID FOUNDATION: THE PERFORMANCE MEASUREMENT BASELINE



The *Integrated Time-Resource CPM Schedule*, properly prepared, generates a cumulative curve which becomes the performance target for the project, or in Earned Value terminology, the *Performance Measurement Baseline* (PMB) (Figure 2). It is important to understand that since all resources have been loaded, the schedule generates not only time information, but all the earned value, production and productivity information required to establish a baseline against which progress will be evaluated. Since schedules are typically not resource loaded at all, not even with dollars, the divide between time and cost is structurally imposed, and this gives rise to flawed analytical practice. A good example of this is found in the frequently adopted contractor approach to providing cash flow curves, which is to either base the curve on a theoretical S-curve, or to manually calculate monthly expenditures without any connection to the schedule[19]. Contractors often aver that "time is money", but in this practice of disconnecting schedule from cost, they ignore their own hard-learned wisdom, and decide to ensure this inter-connection will not be respected.

The resource loaded schedule plan (or PMB) will generate a cumulative curve (in dollars, labour hours, or percentage complete) that has been fully validated. Along the way to developing the PMB, the contractor will have gone through an exercise in which it first develops a constructible plan in time, which it then evaluates for feasibility given the availability of resources. Figure 2 depicts the different cumulative curves which result from such a process. The "Early Curve" is constructible, but has not accounted for the real-world limits of resource availability. Once the subcontractors have verified the number of crews, the number of workers in each of those crews, and the quantity of work, so that durations can be checked, the PMB which is generated may be less optimistic than the Early curve, but represents a practical and feasible plan. The PMB must reflect resource availability and the durations and logic should be adjusted accordingly[20].

A mistake frequently made in evaluating schedule feasibility is to ignore the "Late Curve". Deficiencies in logic and schedule impossibilities are often revealed in anomalous Late Curve profiles. If the activity is delayed until the late date (see Figure 1), are the resources that would be required, often very considerable, realistically available and would the physical constraints of the job permit it? Contractors sometimes artificially reduce schedule float , but the exaggeration of available float[21] is also detrimental because it distracts attention from what should be the true planning and risk mitigation imperatives. What is needed to properly evaluate risk is a schedule in which the float of all activities reflects constructible logic and realistic resource levels.

In a PBS, the availability and use of float is very important because there is an understanding that the consumption of float reduces the probability of timely completion. The conventional opinion that progress is within the safe range so long as it is inside the bounds of the Planned and Late curves is viewed with scepticism. Instead, the planned curve is the target, and any late deviation from it is cause for concern which may require risk management.

This does not mean that float consumption will be totally avoided[22], but rather that time is treated as of the essence from a project performance point of view.

Who Owns the Float?: All Time is Precious in a PBS

Currently, in a system concerned with gaining contractual advantage, a debated question has been: *Who owns the float?* Some contracts have explicit terms asserting the owner's exclusive right to use schedule float, others allow that float is available to whomever uses it first, and still others state that float is not for the exclusive use of any of the parties to the contract.

To get a feeling for how project performance is harmed by owners, contractors and designers obsessed with a legalistic perspective, consider the design consultant who delays the review of a shop drawing with the result that the delivery which had two months of float now falls on the critical path. Now that all of the spare time has been used up, if delivery is delayed by one day the project will be equivalently delayed, and that day of delay is now the contractor's responsibility since, strictly speaking, the consultant-caused delay never fell on the critical path. The design consultant used up all available float, but the contract says whomever gets there first, can use it. What does a system concerned about performance, as opposed to prevailing in a court room, have to say about this? By consuming float, the design consultant has failed to make performance a priority, and thereby jeopardized the time objective.

In a PBS, the answer to the question who owns the float is clear: the project owns it, and each party has a stake in using it responsibly, because the group and the individual derive maximum economic benefit where time is not wasted.

Once it is understood that float consumption is a performance risk, the critical path is no longer the exclusive focus in discussions about schedule effects. There is an understanding that near-critical paths (that is, those with some limited amount of float) may even be higher risk than the critical path(s) at any given time, and so effective

schedule analysis must examine these sub paths and float consumption in general. The statistical finding that *Float Path Convergence*[23], resulting from float consumption, increases the probability of late completion is of much more interest to persons committed to a PBS than the latest legal decision on float ownership.

11. THE POWER OF SCHEDULE USING A TRIANGULATED APPROACH

Even a meaningful CPM schedule is only a mathematical representation of reality, and has the limitations of any such model. It takes experience and expertise to properly analyze and interpret the schedule. What works best is what we call a *Triangulated Schedule Analysis* approach, so-called because multiple methods and information sources, analytical approaches, and perspectives are evaluated to close in on the truth in the way that one perspective may not reveal. If two or more of the approaches point to the same conclusion, the probability of risk is high, warranting management efforts to avoid or mitigate.

Space does not permit a detailed discussion of the Triangulated method, but in summary it fully integrates the CPM schedule with Earned Value approaches customized for construction, on-site monitoring, schedule modelling, Delphi sessions, probabilistic and other analytical tools we have developed.

The power of Triangulated analysis is that it brings performance questions to the fore. It can expose schedule performance problems long before they become irreversible. Where meaningful baseline and schedule updates are available, and such analysis is applied, there is the opportunity to apply the project management approach as it was always intended: plan, implement, monitor and respond to off trends. Analysis which is made possible by meaningful schedules provides actionable intelligence to manage risk.

11.1 CUSTOMIZING EARNED VALUE FOR CONSTRUCTION

Earned Value analysis is an essential part of evaluating schedule performance, but it must be customized to reflect the unique characteristics of construction. Evaluating performance requires an understanding of the interdependency amongst accomplishment (what is earned), efficiency (productivity) and effort (input). It is beyond the scope of this article to discuss the interconnection of these factors, which we have found can be mathematically expressed in a unified formula that defines and enables more accurate forecasting of schedule performance. In a PBS, the goal at all times is to avoid negative Schedule Variance, because this reflects lagging accomplishment which increases time risk. Performance thresholds of variances in efficiency and effort are evaluated based on their respective contributions to the any such negative Schedule Variance.

12. WHAT IS NEEDED TO MAKE SUCCESS HAPPEN?

Buyers of construction are in the best position to effect change. Their commitment to a performance based approach is an essential first step, but even where there is the will, the way is not easily found. A strategy to "change the game" was discussed above to help overcome the impediments to change.

The earlier the performance emphasis is introduced the better, so involvement in pre-design, design, tendering, and award can greatly benefit the outcomes. Performance information, as well as knowledge gained about the causes of success and failure feed into the system to improve current and future performance. Some of the keys to success are discussed below.

12.1 PROJECT SUCCESS ADVOCATE – CHAMPION OF PERFORMANCE

Implementing a *Performance-Based-System* requires experience, expertise and a diligent champion and leader of the performance approach. Typically, an owner, contractor, or designer will not have such an individual available in-house (though in time a performance program will develop many such people). We call this person a *Project Advocate* because, irrespective of who this person works for, the interests of the project are the priority.

An example of a typical lump sum project[24] helps to illustrate how the approach can be implemented to transform outcomes. In this case, the end date was extremely important to the owner, and a performance based approach was adopted during the preconstruction phase to create the opportunity for optimal performance. The owner committed to an expert schedule analysis to validate the feasibility of the desired date, and it was determined to be a very high-risk schedule as quantified in the Monte Carlo[25] simulations. The schedule specifications were highly detailed in order to ensure that a fully resource loaded CPM schedule including material quantities, labour hours, crew assumptions, etc. were unambiguously required. Early on, with all of the actual performance data (required by contract) reported, deficits were observed in labour hour supply combined with less work accomplishment than planned. Despite these negative indicators, the schedule updates submitted by the contractor showed timely completion, but examination revealed that this could only happen if future activities were completed according to daily production rates that had not thus far been achieved. Based on the analysis, there was no reason to believe this would happen –certainly the contractor offered none. Applying the Triangulated method, various analytical approaches, including P6 modelling, earned value forecasting, productivity curve analysis, and on-site monitoring were used to evaluate the situation. They all pointed to delay of several months unless labour was increased.

No credible rationale for continued faith in the schedule forecast was provided by the contractor, who insisted that feasibility be taken on faith. The contractor's project manager strenuously denied there was a problem. Even the design consultant urged the owner not to question the contractor.

Still, the *Project Advocate's* primary role is to use meaningful schedules to champion performance, and all the data suggested a serious problem that needed attention to avoid becoming fatal. There was enormous resistance to the suggestion there was even a problem, but at each construction meeting performance questions were posed: Why was the original plan to resource the job not being followed? How could the current low rates of production versus that plan not bring the completion date into serious doubt?

Ultimately, the contractor agreed that a substantial increase in labour was required to avoid a very considerable delay, and increased its work force. The project was completed on time. It turned out that the contractor had never had crew sizes this large on a site before and had held off in fear that its efficiency would decline. As it turned out, as the site data also showed, efficiency did not decline. The contractor, eventually (armed with a

high performance evaluation score for turning the job around), went on to do more work with the same owner. *This is project success!* The disaster this job might have become was averted by an unwavering commitment to the implementation of a *Performance Based System*.

12.2 IMPROVING SCHEDULES

Improving the quality of construction schedules will involve changes such as the following:

- More effort during pre-construction phase to establishing feasibility of stipulated completion date and other milestones.

- Commitment to meaningful schedules starts at the senior management level, and is communicated as a corporate priority throughout the organization.

- Advocate dedicated to implementation[26] .

- Improved Schedule Practice: There are two inter-connected problems here: firstly, there is not generally an understanding of best practices in creating resource-loaded CPM schedules, and; secondly, the scheduling software is so feature-rich that there are a multitude of traps and pitfalls which all but the most experienced schedulers will fall into. To fix this, industry best-practice standards in scheduling must be further developed, along with more and better training, but until then, expert help is needed to get schedules where they need to be.

- Improved Schedule Specifications: Contract documents often don't even have a dedicated schedule specification, and even where there is one, it is closer to being a Performance (end result) specification than a (descriptive) Procedure type. Since schedule practice is poor, and best-practice standards for construction schedules are scarce, what is needed is clear, concise and complete definition in the specifications of what a CPM constructed according to best practice would look like.

- Contract terms to enforce compliance.

- Specify a dollar amount to be carried for scheduling.

- Pre-bid meeting to highlight schedule expectations.

- Specify how schedule is to be used to forward price delay and impact.

12.3 WEB COMMUNICATIONS: ACCOUNTABILITY AND COLLABORATION

The idea behind *Online Collaboration and Project Management* (OCPM) is to use a web-based platform to create communications structures and automated procedures to manage the administration of a construction contract. The potential benefit of these systems in a PBS is much greater efficiency and accountability. Documents are stored and controlled in a shared and centralized environment, creating a unified structure. Furthermore, the history and status of all of the typical work flows is real-time and transparent, which encourages accountability.

OCPM *can* be an invaluable resource which enhances performance. However, on many projects, the platform is used mainly, or only, as a document storage place, and the great potential benefit is not realized. The system which we have developed to manage work flows such as contract changes, Requests-for-Information, shop drawings, etc, was based on extensive experience in contract administration and managing such work flows on construction projects. It has now been successfully used on over $1.5 billion of construction, by numerous different contractors and on different types of construction. Keys to the success of this system is: ease of use, exclusivity of use, strict adherence to documented procedures, and early training and support.

12.4 PERFORMANCE-BASED DISPUTE RESOLUTION

The first problem with conventional dispute resolution approaches (on unfinished projects) is that the focus is on the dispute. The next problem is that it is entirely concerned with the past. In what we call "*Performance Based Dispute Resolution*", the emphasis is completely changed so that the primary question that must be answered is: "When will the project be completed?"

Of course, to answer this question, one needs a meaningful schedule, and because this is often not available, it must be developed. At the same time, assuming the schedule exercise is successful, the contractor has a claim that must be addressed. During a pre-defined period (say 6-8 weeks), off-the-record negotiations take place in which two tracks are simultaneously followed: the claim is assembled and reviewed and a feasible schedule-to-complete is created.

The parties are introduced to the idea that performance still matters even though it has not been a shared objective up to now. After all, the job is not finished, so there is an opportunity to mitigate the looming disaster with good performance, and this will benefit all[27]. From this day forward, it is agreed, the design consultant will be available on site as much as is needed and the contractor will formulate a feasible schedule plan taking into account all known issues. Answering the questions that prevent finalizing the schedule is a top priority, and weekly workshop meetings are held to monitor progress in developing the schedule. By the end of the process, the schedule that is produced provides a realistic forecast to complete, so that all delay cost can be quantified and reasonably evaluated, and, most importantly in terms of project success, there is a schedule that can be used to plan and complete the remaining work.

This approach has proven so successful that projects which were at or near standstill are transformed into efficiently functioning construction projects, claims are settled, and completion is achieved earlier than it would otherwise have been in the absence of a performance imperative.

12.5 PERFORMANCE EVALUATION

Contractor Performance Evaluation systems have been found to improve overall construction program delivery, performance on current projects, and the ability to identify high quality contractors. In the best systems there is objective scoring, numerical scores are supported with a rationale, and scoring is done on a regular basis. Not only is there a project-specific benefit, but lessons-learned are fed into the system to avoid future performance problems.

However, the experience of most people in the construction industry with contractor performance evaluations is of a one page report issued at the end of the project. Categories such as schedule management, supervision, quality of work, safety and environmental compliance, will be listed and scored according to a loosely defined numeric or alphabetical scale. There are usually no established criteria for the scoring and so it is highly subjective. This approach is rightly dismissed as having little value.

What is needed instead is a system that reveals the full performance story in all its complexity. This type of evaluation, though it is called a *Contractor* Performance Evaluation, digs deeply into the reasons for the

performance score, and thereby identifies problems on the designer and owner side as well. The fact that the latest progress schedule shows late completion may not justify a poor score for the contractor because the contractor has dramatically mitigated problems caused by others. In fact, because such problem-solving contractors are the key to project success, the test of a good performance evaluation system is whether it identifies such contractors. Furthermore, evaluation should be more than a number: it should be supported by qualitative criteria, which is accomplished by creating a narrative to explain the numerical score. Causes are examined so that lessons can be learned. A construction program can perform better immediately, and continuously improve, when there is objective measurement such as this.

13. CONCLUSION

The question posed at the beginning of this article was whether there is such a thing as project success. For those who have been fortunate enough to be a part of a *Performance Based System*, the answer is an emphatic "yes"! Based on our experience in successfully implementing such systems, it makes the most economic sense for each of the participants because it maximizes the return for the individual *and* the group. No party can do better by defecting from cooperation. The return on the investment dwarfs the costs. It is practical and will transform the industry if embraced.

Crucially, schedules matter in a PBS because they measure time performance, and if they are meaningful they can be the instrument to demand accountability. Armed with such schedules, the project advocate, who holds the project's interests as paramount, can demand accountability from all sides in the service of peak performance.

In the best of worlds, the industry will decide that a PBS is the preferred approach, but until then, owners most of all, but contractors and even design consultants as well, can decide to change the rules of the game as it is currently played. There should be no underestimating the seismic shift that will be required to move from the entrenched individual advocacy model to a performance based one with meaningful schedules as the centrepiece. Game theory teaches us that strategizing can help individuals to understand the economic interests they share with the group. One strategy, which this article is intended to serve, is to get the word out about the better alternative.

A Performance Based System is the road less traveled, but for those who have journeyed on it with us, it has made all the difference in terms of dramatically improved results.

1 U.S. Dept. of Commerce, Bureau of Labour Statistics.

2 http://www.aia.org/"Integrated Project Delivery: A Guide", 3.

3 Brian Foster, "Monitoring Job-Site Productivity", The Revay Report Volume 19 (May 2000), 4.

4 The "Retained Logic" or "Progress Override" options in Oracle P6 software may, or may not, accurately reflect the plan going forward for work that is proceeding out-of-sequence. To produce meaningful schedules, the schedule must reflect the actual plan, so if the logic must be changed, instead of accepting either of these automated options, then so be it.

5 http://enr.construction.com/features/bizlabor/archives/030526.asp, "Critics Can't Find the Logic in Many of Today's CPM Schedules - Users want software with flexibility, but is it true CPM?", May 26, 2003.

6 Ibid.

7 The subject of how the effect of "Impact" can be captured is not discussed here, but what has not been generally understood, or reflected in schedules, is that "Impact" effects (as opposed to their discrete causes) should be apparent where meaningful schedules are maintained. For a discussion on how productivity impacts might be forecasted in advance for the purpose of forward pricing see "The Effects of Change Orders on Productivity", Charles Leonard Master's Thesis, p. 125.

8 J. Gerard Boyle, "Productivity Claims: Beyond Smoke and Mirrors", American Associations of Cost Engineers International (AACEI), 2007. Presentation based on this article was delivered in the same year at the AACE conference held in Nashville. Included demonstration of impact on road construction project.

9 A strategic Game represents a situation where two or more participants are faced with choices of action, by which each may gain or lose, depending on what others choose to do.

10 Avinash K. Dixit and Barry J. Nalebuff, The Art of Strategy, WW Norton (Sept. 2, 2008), 95.

11 In Game Theory, this is called a Nash Equilibrium.

12 http://www.telegraph.co.uk/finance/newsbysector/constructionandproperty/9196524/UK-taxpayers-rarely-benefit-from-public-private-partnerships-claims-study.html

13 "Integrated Project Delivery: A Guide", The American Institute of Architects.

14 Rosemary O'Leary and Lisa Blomgran Bingham, "A Manager's Guide to Resolving Conflicts in Collaborative Networks", IBM Centre for the The Business of Improving Government. See especially the section entitled "The Paradox of Collaborative Management: Collaboration May Yield Conflict".

15 The words "Time is of the essence" may be familiar to the reader as an explicit term in some contracts. For a legal opinion about what these words mean contractually, the reader should consult with a lawyer, but from a project management point of view, which is the point of this article, time is always of the essence.

16 The term "Time-Resource" is used instead of the more familiar "Time-Cost" because all resources, not just dollars, are important to include so as to make performance transparent.

17 Hereinafter, where reference is made to "meaningful" or "sound" schedules, it should be understood that the schedule is a feasible, fully-resource loaded, CPM schedule produced using scheduling best practices.

18 A technique developed for the Polaris submarine program which allows diverse experts to deal systematically with a complex problem or task. For example, contractor, sub, consultant, and independent expert all debate the merits of the forecast or significance of a delay issue.

19 Even where contractors go to the effort to fully cash load the schedule, they often insist on not using the cash flow produced by the schedule, which is an indication there is a problem with the schedule cash loading.

20 This raises an important CPM best-practices point. Some contractors submit an automatically resource-levelled schedule instead of revising the logic and durations to reflect resource limits. This is the sort of practice that turns the schedule into a "black box" where what is really driving the plan is not clear. A feature such as automatic resource levelling is beneficial in modelling, but assumptions of automated software features must be validated by the scheduler to ensure it corresponds to the actual plan.

21 Float is the amount of time an activity can be delayed or expanded before it impacts the specified completion date

22 On a job of any complexity, work sequences will change, and so will float calculations. As well, the owner usually has the right to introduce changes, which will likely consume float. Finally, in responsibly mitigating schedule delay and efficiently using resources, the contractor will make use of float, reallocating resources to offset events that would otherwise cause delay.

23 In statistics, "Float Path Convergence" refers to the increased probability of delay which occurs when activity paths previously not overlapping are pushed into overlap by float consumption or other delays.

24 This account is a composite of many jobs. Any resemblance to a particular job is coincidental.

25 Computer modeling using a probabilistic, as opposed to a deterministic approach. The great value of it is to give the participants an appreciation for the vulnerability of the completion date to use of float time.

26 J. Gerard Boyle, "Managing Contract Changes", in Construction Law and Risk Management, ed. J. Kent Holland (Vienna, VA, Ardent Publications, 2006). This provides insight into how a project manager can exhibit leadership to advance a performance-based approach.

27 Those familiar with the Interest-Based Negotiation method advocated in the book Getting to Yes may appreciate how performance becomes the unifying interest that facilitates settlement.

* **All above mentioned websites were confirmed operational at the time of this publication.**

* The views expressed in this article are those of the author and may not necessarily reflect the views of the company.

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