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Improving Labor Projections

November 13, 2014

Table of Contents

List of Tables

List of Figures

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Abstract

In the construction industry most can recall the frustration of under-estimating losses on an active project that isn't going well. In the Western world, where burdened labor rates are high, the most common cause of job losses are labor overruns. Recognizing, if not accepting, that a project is going to lose money, one projects labor costs-to-compete only to have these projections fall short. Misplaced optimism and faulty projection techniques (today's project management software is of little help), are the primary causes of this failing. This article suggests ways to improve labor cost projections. Labor projections should be based on timely productivity results. If one's current labor projections are based on the estimate less spent costs, read this and other articles dealing with the measuring of productivity. If one's current labor projections are based on a function of to-date earned hours and to-date productivity, this article suggests a methodology paradigm shift will improve results.

Introduction

Upper management pays little ongoing attention to profitable construction projects. It intervenes, however, when construction jobs are losing money. If the loss is self-inflicted, management may instigate a change in personnel. If external impacts have caused the downturn, management will increase due diligence and possibly initiate a claim. Regardless of the cause, internal or external, a projected loss is a call to action.

Typically, bad jobs are subject to loss creep; the first report of a possible loss is too optimistic and it is followed by a roller coaster of hope and more failure. Too often, management is bewildered by how prospects for a job, that appeared to be salvageable, decayed and eventually crashed and burned. The barriers to making accurate projections are psychological – one rationalizes that things will improve, nobody likes to deliver bad news – and systemic; one does not know how to make accurate projections.

Early detection is the key to turning a job around. In the Western world, labor is typically the largest risk on a construction project. Accurate projection of labor costs is essential to early detection. This narrative will suggest technical modifications to our crystal balls.

This paper's focus is the construction industry. It is not intended as a primer on the concept of earned man-hours, productivity calculations or the measured mile. For references purposes, in the construction industry:

1. productivity (Prod.), expressed as a percent, is the quotient when one divides the earned man-hours by the actual man-hours (typically used in Canada); and
2. performance factor (P.F.), the inverse of productivity, is the quotient when one divides the actual man-hours by the earned man-hours (typically used in the U.S.)

The Typical Problem

Assume a contractor routinely monitors its productivity with the following results.

To-date Productivity Results				
Week	Prod.	P.F.	Actual	Earned
20	111%	0.90	100,000	111,000
21	108%	0.93	105,000	113,500
22	105%	0.95	110,000	116,000
23	103%	0.97	115,000	118,500
24	101%	0.99	120,000	121,000
25	99%	1.01	125,000	123,500

Table 1, Typical to-date results

Up to week 20, to-date productivity results are good (above 100% productivity, below 1.0 P.F.) but starting in week 21, productivity has begun to degrade. Week 25 shows a to-date loss of 1,500 man-hours. Although the project is not complete, based simply on the to-date results, a novice project manager will report a projected loss of 1,500 man-hours or $150,000 (assume $100/hr including all burdens, indirect labour, and associated job expenses.) This projection ignores continuing productivity losses.

Assume that to complete the job another 20,000 direct man-hours remain to be earned.

Typical projections, including those by leading cost-control software, recognize that the current loss of 1,500 man-hours is likely to get worse because the to-date productivity is only 99% (P.F. of 1.01). Accordingly, another 1% loss of the 20,000 man-hours-to-come is added for a total loss projection of 3,500 man-hours (1,500 to-date + 2,000 to-come) or $350,000. This projection, the most common in the industry, although more insightful – it includes an allowance for ongoing productivity losses – is also inadequate. In this example, upper management is unlikely to intervene because the additional loss is not catastrophic.

A closer look at the period (weekly results) paints a different picture.

Period Results				
Week2	Prod.	P.F.	Actual	Earned
20				
21	50%	2.0	5,000	2,500
22	50%	2.0	5,000	2,500
23	50%	2.0	5,000	2,500
24	50%	2.0	5,000	2,500
25	50%	2.0	5,000	2,500
			25,000	12,500

Table 2, Typical period results

Recall from the to-date data that on week 20, the earned man-hours exceeded the actual man-hours by 11,000, the job was doing well. By week 25, the earned man-hours were 1,500 less than the actual man-hours. From week 20 onwards, each week, the job experienced a loss of 2,500 man-hours, a total of 12,500 man-hours over the five weeks; $1,250,000 lost. The average productivity for the subject five weeks is 50% (12,500 / 25,000,) a P.F. of 2.0.

Using the contemporaneous productivity (50%), the man-hours to complete are going to double. A more realistic projection for the remaining un-earned 20,000 man-hours is an additional 20,000 man-hours ($2,000,000), a total of 40,000 man-hours to complete the work. As a sanity check, 20,000 man-hours remain to be earned and 40,000 are likely to be spent, the resultant productivity is 50% (20,000 / 40,000), a P.F. of 2.0.

At the start of week 26, the job is a minimum of 8 weeks (20,000 / 2,500) away from completion and the typical project manager has predicted an additional loss over the remaining weeks of only 2,000 man-hours. Instead, with each passing week, another 2,500 man-hours are lost. After only one week, the project manager realizes there is something clearly wrong with his projection. Unaware of the systematic error, however, the embarrassed project manager takes repeated, but inadequate stabs, at new projections. Upper management is assaulted with additional losses every week until the project finishes. Despite any past accomplishments, the project manager appears incompetent.

Projections in Daily Life

Projections are not magic. One routinely make projections, most often regarding our Estimated Time of Arrival (ETA).

- If one is traveling 200 kilometres at a speed of 100 km/hr it will take 2 hours to get to the destination.

  By extension, if at half way along the trip (100 kilometres) 1 hour has elapsed, one can project another hour to arrive.

This is the simplest form of projection, but typically only works when everything is going well.

What if the trip is not proceeding as planned?

- What if there are upfront delays and the first 100 kilometres has taken 2 hours. Depending on the nature of the delay one might project that since the first 100 kilometres took 2 hours, the next 100 kilometres will also take 2 hours.

The performance over the first 100 kilometres is used to project the performance over the last 100 kilometres. Often, however, this is an over-simplification. Consider the treatment of the following two delays.

1. Same trip: **The first 50 kilometres go as planned** (½-hour elapsed), **then there's an accident.**

    a. The accident causes a 1-hour delay in the completion of the next 50 kilometres (total time for the second 50 kilometres is 1½ hours);
    b. The first 100 kilometres takes 2 hours (½ hour + 1½ hours);
    c. The isolated incident is not likely to affect the balance of the trip and so one projects that the next 100 kilometres will take 1 hour, as planned. It would have been wrong to project 2 hours for the second 100 kilometres; **this is not a mistake one tends to make**.

2. Same trip: **The first 50 kilometres go as planned** (½-hour elapsed), **then the weather turns bad.**

    a. Due to the bad weather the next 50 kilometres takes 1½ hours;
    b. The first 100 kilometres has taken 2 hours (½ hour + 1½ hours), twice the plan.
    c. The common mistake is to project 2 hours to complete the next 100 kilometres.
    d. Focus the projection on the recent 50 kilometres. It took 1½ hours to complete 50 kilometres. Assuming the weather is going to stay bad it is likely going to take 3 hours (2 x 1½) to complete the last 100 kilometres. The projection to complete should therefore be 3 hours, not 2 hours. **In this scenario, one typically understates the projection**.

Projections are not trivial, they require knowledge of the recent history, the current conditions and an assessment of the future.

Labor Projections on a Construction Project

Accurate forecasting of the cost to complete (or the cost at completion) is given short shrift on a job that's making money and typically underestimated on a job that's losing money. The following examples will demonstrate the usual pitfalls and suggest methods to improve cost projections. Apply the ETA analogy to labor projections on a construction project.

With the best contemporaneous data at hand, one projects the cost of labor through to the end of the job. The existing data may be payroll records that indicate how many hours have been spent, or it may be a productivity study. The extent and accuracy of the data is crucial to accurate projections. The goal is to accurately determine how many man-hours remain to complete the job.

Starting with the basics, if one only know how many hours have been spent, as with the travel analogy the first stab at a labor projection is to subtract the spent man-hours from the estimate to determine the remaining hours. If the job is going poorly, this method will not yield reliable results. It does not consider the performance to date or any contemporaneous problems affecting productivity.

The next best approach is to complete a fresh re-estimate of the remaining hours but often company resources are allocated to estimating new work. Even if a re-estimate is possible, the estimator typically uses the standard labor units without considering actual site conditions. What assurance does one have that the remaining work will be completed in accordance with the original estimated labor units? Has the workforce performed well to date? Is the labor going to perform as well in the latter stages? Is the remaining scope easier or more difficult? Are there any external impacts that will affect the crew's performance going forward? The window on these unanswered questions is the productivity report.

For the purposes of this narrative, assume an estimate of 25,000 direct man-hours and 20,000 man-hours have been spent (without including supervision or indirect labor).

Example of a Basic Labor Projection

Original Estimate:	25,000
Spent man-hours:	20,000
Remaining hours to complete	5,000
Man-hours at completion	**25,000**

Like the basic travel projection, there is no historical or contemporaneous analysis of productivity.

If there is an independent re-estimate of man-hours to complete, the re-estimate may identify scope increases that were not included in the estimate or factors that apply to the remaining scope. Re-estimates, however, tend to be optimistic. Without a directive to depart from the original labor units, the estimator does not want to be the bearer of bad news.

Labor Projection Based on Historical Productivity Adjustment (productivity to-date)

Using the same basic data, assume that labor performance to-date is below the estimate, 20,000 man-hours have been spent and 18,000 man-hours have been earned. The productivity is therefore 90% (18,000/20,000) or, stated differently, the to-date performance factor (the inverse of productivity) is 1.11 (20,000/18,000).

Original Estimate:	25,000
Earned man-hours based on productivity report (72% Complete)	18,000
Remaining hours to complete	7,000

Barring a turnaround, it is likely that poor productivity will continue to plague the remaining work. For each earned man-hour remaining, 1.11 man-hours will be spent.

Add: man-hours to account for the productivity factor (7,000 x 1.11 – 7,000)	770
The projected man-hours to complete are therefore:	7,770
Check (7,000 / 7,770 = 90%)	
Add: the spent man-hours:	20,000
Total man-hours projected at completion (2,770 man-hours over budget):	**27,770**

With the application of a to-date productivity factor, a project that looked as if it would complete on estimate is now showing a loss (**2,770 man-hours over budget**).

Bad news is difficult to accept but given that the bulk of the loss has already been incurred (2,000 man-hours) and the productivity is not catastrophic (going to lose another 770 man-hours), management is unlikely to intervene.

Industry Standard Software

There are many project management/cost control software packages available on the market. The more sophisticated options tie into the accounting system and include productivity analysis, and forecasting. These packages require the user to break down the job into a set of activities and assign an estimated quantity and man-hours to each activity. The ratio of quantity and man-hours is the estimated "production" rate.

Expended labor hours are posted, on a weekly basis, against individual cost codes (one per activity) through the payroll module. Periodically (preferably weekly), site management inputs the quantity installed of each activity. The software then calculates the earned man-hours, productivity (or P.F.), and percent-complete for each activity. The results are typically available in a report that displays Period and To-date results.

The software Forecasting module uses the to-date productivity results to make projections of man-hours at completion and the result described above is the typical product.

The balance of this narrative will demonstrate the inadequacy of this methodology and suggest ways to improve forecasting.

Labor Projections with an Adjustment based on Timely Productivity Analysis

Again, assume that labor performance to-date is less than estimated, 20,000 man-hours have been spent and 18,000 man-hours have been earned. The productivity is therefore 90% (18,000/20,000), the to-date performance factor is 1.11.

The project has been ongoing for 15 weeks with the following weekly productivity results.

	Period				To-Date			
Week	Spent	Earned	Period Productivity	P.F.	Spent	Earned	Productivity	P.F.
1	200	150	75%	1.33	200	150	75%	1.33
2	300	300	100%	1.00	500	450	90%	1.11
3	500	700	140%	0.71	1,000	1,150	115%	0.87
4	1,000	1,200	120%	0.83	2,000	2,350	118%	0.85
5	1,000	1,600	160%	0.63	3,000	3,950	132%	0.76
6	1,500	2,000	133%	0.75	4,500	5,950	132%	0.76
7	1,500	1,800	120%	0.83	6,000	7,750	129%	0.77
8	1,500	1,700	113%	0.88	7,500	9,450	126%	0.79
9	1,500	1,400	93%	1.07	9,000	10,850	121%	0.83
10	1,500	1,100	73%	1.36	10,500	11,950	114%	0.88
11	1,700	1,300	76%	1.31	12,200	13,250	109%	0.92
12	1,800	1,000	56%	1.80	14,000	14,250	102%	0.98
13	2,000	1,300	65%	1.54	16,000	15,550	97%	1.03
14	2,000	1,300	65%	1.54	18,000	16,850	94%	1.07
15	2,000	1,150	58%	1.74	20,000	18,000	90%	1.11

Table 3 – Sample productivity data: Period and To-Date

Graphically:

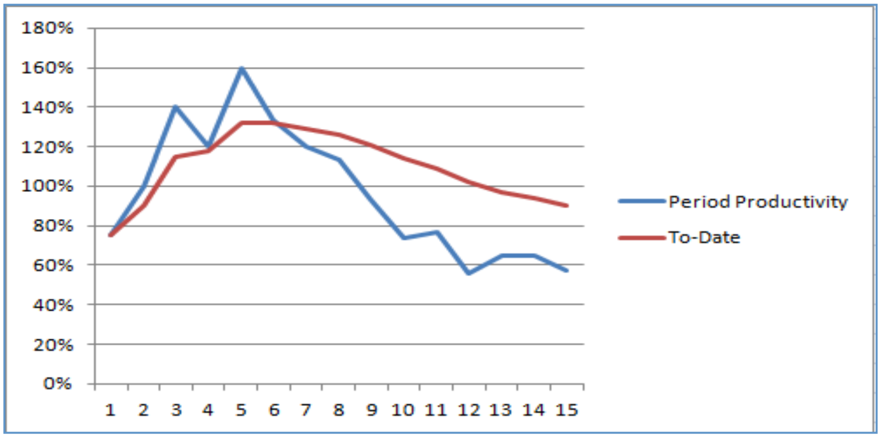

Figure 1 – Period and To-Date Productivity Graph

Although the to-date productivity shows 90% (performance factor of 1.11) the period productivity (blue) is declining at a faster pace. Productivity at the beginning of the job was good but since week nine, something has begun to negatively affect production. This contemporaneous result should have a greater bearing on the projection than early results.

Current productivity may be declining for many reasons; the work may be more difficult, the weather may be worse, or there may be external impacts such as excessive changes, acceleration, restricted access, trade stacking, congestion . . .

5-week Rolling Productivity Weighted Average

Depending on how site supervision takes credit for quantity installed, the earned man-hours, and therefore the productivity measurement in any given week, may be lower or higher than the true measure. If the bulk of a task is complete but for a few odds and ends, one usually takes full credit. Assume there are ten rooms to paint. One room is painted though the drop cloths are still on the floor and the furniture hasn't been replaced. Take credit for the complete painting of one room and this week's performance will appear better than it should. Conversely, if one doesn't take credit, then this week's performance will appear worse than it should. In subsequent weeks when the deficiencies are completed without any credit for earned man-hours, the performance will appear worse than it should. This week's good performance may assure a poor performance calculation next week simply because of this type of unavoidable misallocation. The result is "spiky" weekly data.

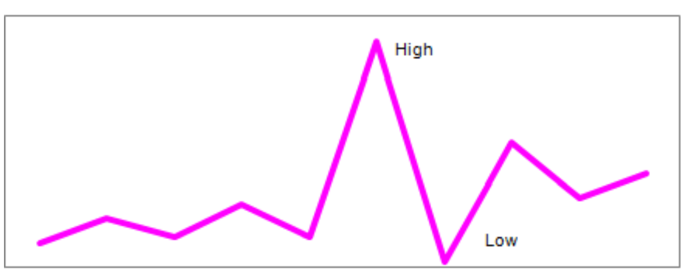

Figure 2 – Spiky data

“Rules-of-Credit” attempt to mitigate this problem. For example, a completed 100-foot run of pipe may be worth 1,000 earned man-hours of which 5% is material handling, 35% is fabrication, 15% is pipe hangers, 10% is rigging, 25% is fit-up and welding out of the field joints, 5% is quality assurance, and % is a hydrotest. The technician identifies the status of each of the rules-of-credit components in order to determine the overall percent complete for the pipe run. Even rules-of-credit can be deceiving, however, because on a given job they are applied universally. It is too complicated to have rules-of-credit for each pipe run. The rules-of-credit for a 50-foot straight run of pipe are applied the same as the rules-of-credit for 50 feet of pipe around a pumping station (a more complex configuration). Both scenarios will typically earn the same man-hours although the spent man-hours may differ significantly. Rigging, supports, and deficiency variability add to the ambiguity.

Another attempt at tackling the problem is to increase commodity breakdowns by size, type, and zone; the sheer number of tasks then often becomes too complex for job site management. For example, all instrument cable may be grouped as one activity regardless of size; this approximation can be forgiven because of the similarities in unit estimates. Having an activity for each size of cable would be a timekeeping nightmare and the number of miscoded spent man-hours alone would reduce the credibility of the data.

Alternatively, one can adjust for the spikiness by calculating a five-week-running, weighted, average and a to-date curve. Presumably, during that 5-week period the drop cloths are picked up and the furniture rearranged while the painting of other rooms continue. Assume after five weeks that four rooms are totally complete (including deficiencies) and a fifth room has been painted but the drop cloths remain. Now when one claims five rooms painted, the margin of error is reduced.

The 5-week sum of the spent man-hours is used in conjunction with the 5-week sum of the earned man-hours to calculate the productivity or the performance factor. These calculations are weighted averages of all period results for individual activities.

	Period				5-week Averages			
Week	Spent	Earned	Productivity	P.F.	Spent	Earned	Productivity	P.F.
1	200	150	75%	1.33	200	150	75%	1.33
2	300	300	100%	1.00	500	450	90%	1.11
3	500	700	140%	0.71	1,000	1,150	115%	0.87
4	1,000	1,200	120%	0.83	2,000	2,350	118%	0.85
5	1,000	1,600	160%	0.63	3,000	3,950	132%	0.76
6	1,500	2,000	133%	0.75	4,300	5,800	135%	0.74
7	1,500	1,800	120%	0.83	5,500	7,300	133%	0.75
8	1,500	1,700	113%	0.88	6,500	8,300	128%	0.78
9	1,500	1,400	93%	1.07	7,000	8,500	121%	0.82
10	1,500	1,100	73%	1.36	7,500	8,000	107%	0.94
11	1,700	1,300	76%	1.31	7,700	7,300	95%	1.05
12	1,800	1,000	56%	1.80	8,000	6,500	81%	1.23
13	2,000	1,300	65%	1.54	8,500	6,100	72%	1.39
14	2,000	1,300	65%	1.54	9,000	6,000	67%	1.50
15	2,000	1,150	58%	1.74	9,500	6,050	64%	1.57

Table 4 – Sample productivity data: Period and 5-week Weighted Average

The 5-week rolling average is less erratic (spiky) than the weekly, a smoother curve:

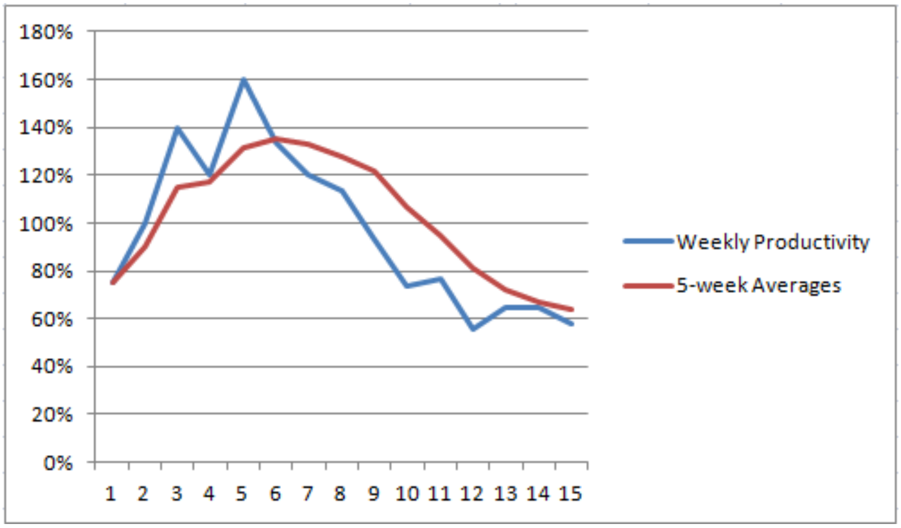

Figure 3 – Period and 5-week Average Productivity Graph

The 5-week running average is also a better indicator of the contemporaneous productivity and a better indicator of the trend than the to-date figure. The 5-week average excludes the bias of the early productivity results.

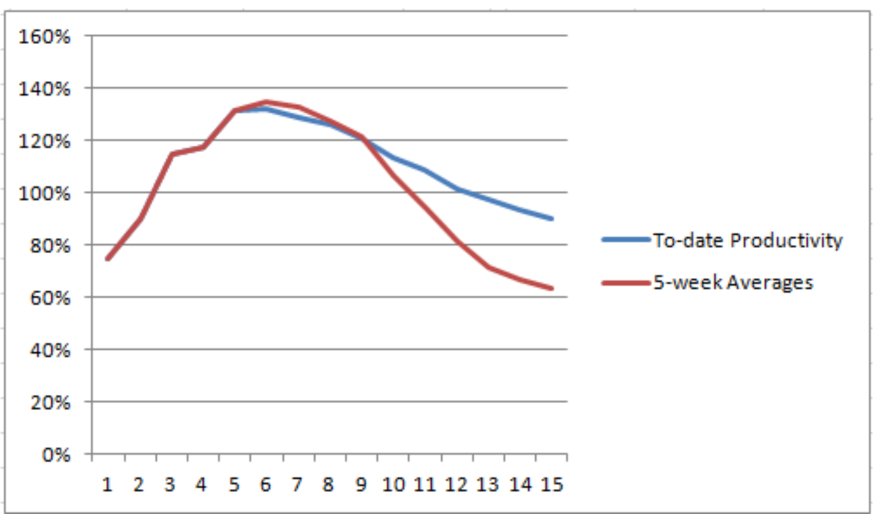

Figure 4 – To-date and 5-week Average Productivity Graph

Using the man-hour sums from week 11 to week 15, the 5-week weighted average at the end of week fifteen is 64% (P.F. 1.57).

Barring a turnaround, it is likely that the poor 5-week productivity average (64% and performance factor of 1.57) will possibly continue for the duration of the job.

Original Estimate:	25,000
Earned man-hours (72% Complete)	18,000
Remaining hours to complete	7,000
Add: man-hours to account for the productivity factor (7,000 x 1.57 – 7,000)	3,990
The projected man-hours to complete are therefore:	10,990
Check (7,000 / 10,990 = 64%)	
Add: the spent man-hours:	20,000
Total man-hours at completion (**5,990 man-hours over budget**):	**30,990**

Had the analysis stopped with the reliance on the to-date productivity, the project would have looked like it was only going to lose an additional 770 man-hours (total of 2,770) due to productivity losses. Instead extrapolations based on the 5-week rolling average indicate that the job will lose an additional 3,990 man-hours (total of 5,990) due to productivity losses.

Impact Period Productivity

A project that appears to be in trouble will likely receive more than casual attention from management. The best way to manage cost projections at this juncture may be to establish a new benchmark (cut-off date) from when the project began to go off the rails. From this cut-off date, track the to-date term results and 5-week rolling averages as if the job was just starting.

The productivity evaluation would now focus on the following term data 1) the measured mile from week one to eight and 2) the impact period from week nine to completion. The first week of Term data is a reflection of the Period data for week nine.

	To Date (Term data)				5-week Averages			
Week	Spent	Earned	Productivity	P.F.	Spent	Earned	Productivity	P.F.
1								
2								
3								
4								
5								
6								
7								
8			**126%**	**0.79**				
9	1,500	1,400	93%	1.07	1,500	1,400	93%	1.07
10	3,000	2,500	83%	1.20	3,000	2,500	83%	1.20
11	4,700	3,800	81%	1.24	4,700	3,800	81%	1.24
12	6,500	4,800	74%	1.35	6,500	4,800	74%	1.35
13	8,500	6,100	72%	1.39	8,500	6,100	72%	1.39
14	10,500	7,400	70%	1.42	9,000	6,000	67%	1.50
15	12,500	8,550	68%	1.46	9,500	6,050	64%	1.57

Table 5 – Sample productivity data: Impact Period

Focusing on the term data, the productivity during the first eight weeks (measured mile period) is 126% (better than estimated) and the term productivity measure for the impact period is 68%, a P.F. of 1.46. It is clear that the job took a turn for the worse starting on week nine, and barring a turnaround, will likely experience further productivity slippage.

Original Estimate:	25,000
Earned man-hours (72% Complete)	18,000
Remaining hours to complete	7,000
Add: man-hours to account for the productivity factor (7,000 x 1.46 – 7,000)	3,220
The projected man-hours to complete are therefore:	10,220
Check (7,000 / 10,220 = 68%)	
Add: the spent man-hours:	20,000
Total man-hours at completion (**5,220 man-hours over budget**):	**30,220**

This projection happens to be slightly better than the 30,990 man-hours projected using the 5-week running average of the 15th week. To be conservative, it would be wise to continue tracking both measurements and use the worst of the two.

Fine Tuning

Continuing with the example, weekly productivity may not yet have hit bottom. End-of-job syndrome (slowdown), deficiencies, partial occupancy . . . may come into play. Based on a graphic extrapolation of the above 5-week data, a productivity of 55% (see graph) is conceivable – a performance factor of 1.82.

Graphically,

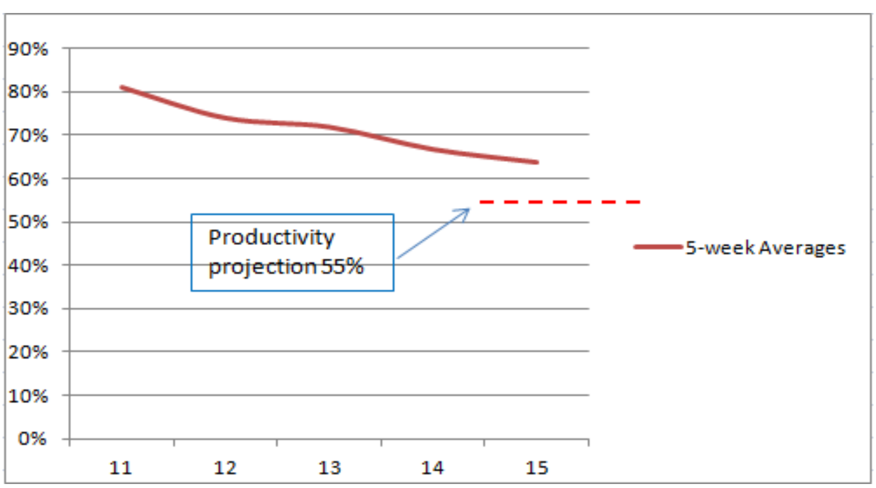

Figure 5 – Impact Period Productivity Graph

Original Estimate:	25,000
Earned man-hours (72% Complete)	18,000
Remaining hours to complete	7,000
Add: man-hours to account for the productivity factor (7,000 x 1.82 – 7,000)	5,740
The projected man-hours to complete are therefore:	12,740
Check (7,000 / 12,740 = 55%)	
Add: the spent man-hours:	20,000
Total man-hours at completion (**7,740 man-hours over budget**):	**32,740**

This projection is an additional 1,750 man-hours higher than previously calculated. Instead of the 770 man-hour productivity losses to-come calculated by industry norms, the job is expected to lose an additional 5,740 man-hours (total of 7,740) due to productivity losses. Upper management will definitely intervene and any number of potential remedies will be applied.

This methodology, albeit the most dire, may provide the most accurate projection. Whether or not to go this extra step needs to be evaluated on a case-by-case basis.

Summary of Various Projection Methodologies

The result of the various methodologies is summarized below.

	Man-hours at Completion	
Basic Projection	25,000	as estimated
Projection based on To-date results	27,700	2,700 - 11% loss
Projection based on latest 5-week average	30,990	5,990 - 24% loss
Projection based on Impact Period	30,220	5,220 - 21% loss
Projection based on a graphic extrapolation	32,740	7,740 - 31% loss

Table 6 – Summary of Projection Results

Depending on the projection technique used, the man-hours at completion worsen with the sophistication of the technique. Assuming the job completes at 31,000 man-hours, it comes down to a choice; would it have been better to project 32,000 man-hours and share the relief of having saved 1,000 man-hours or 25,000 and suffered, week after week, as the results showed the weekly projections to be flawed.

In this author's forty years of construction experience, fifteen of which have been as a consultant, the second methodology, assuming the contractor produces a productivity report, is the one primarily used; that said, the first, regrettably, is used too often. The author has yet to witness any contractor using the third or fourth methods. Detractors will argue that the fifth method is too pessimistic; the judgment to go beyond the third or fourth methodology is a project-by-project decision.

A job that is losing money is difficult to project – it's hard to know where the bottom is – and manage. Better projections, however, identify a losing position sooner, improve the chances of turning the job around, and allow the contractor to provide earlier Notice of impacts to the client.

Automated Labor Projections

Equations for assessing man-hours to come and lost man-hours are difficult to remember. Having the calculations done by a program improves objectivity and removes a lot of the work.

Ideally, existing cost control software should adopt something akin to the activity-based 5-week rolling average model because there are some precautions that need to be considered when using weighted averages.

Cautionary Notes

Premature Projections

Current cost-control software calculates projections using to-date productivity results for each individual activity with the exception of activities that have not started or progressed sufficiently; for those activities the software assumes 100% productivity and holds to a projection equal to the activities' revised estimate. The sum of the activity-based projections becomes the projection for the whole job. Consider an example using three activities.

		To-Date				Projection, At-Completion			
Activity	Revised Estimate	Spent	Earned	Productivity	P.F.	Spent	Earned	Productivity	To-date P.F.
1	1,000	500	600	120%	0.83	833	1,000	120%	0.83
2	5,000	3,000	3,000	100%	1.00	5,000	5,000	100%	1.00
3	5,000	4,000	3,000	75%	1.33	6,667	5,000	75%	1.33
Totals	11,000	7,500	6,600	88%	1.14	12,500	11,000	88%	1.14

Table 7 – Sample data, three in-progress activities

For Activity #1, 600 man-hours have been earned to date at a productivity of 120%. When completed, 1,000 man-hours will be earned (equal to the revised estimate) and the at-completion projection is 833 man-hours, the sum of 500 spent man-hours plus 333 (400 to be earned / 1.2 or 400 x 0.83) to-come man-hours. Each activity has its own projection at completion and the sum (12,500) is the projection for the whole job, an overrun of 1,150 man-hours.

As described in the narrative, these to-date projections are often incorrect because they include performance from the beginning of the job, which no longer has any relevance at the end of the job. The enhanced projection suggested in this narrative, by contrast, extrapolates to the entire project the weighted average of contemporaneous (5-week average) productivity results across all activities. Having demonstrated this earlier, the reader is spared the distraction of another proof here.

If, however, the project is less than approximately 50% complete (not a hard and fast rule), the enhanced projection results may be misleading. To illustrate the point, consider the following example with three activities, two of which have not started.

		To-Date				**Projection, At-Completion**			
Activity	Revised Estimate	Spent	Earned	Productivity	P.F.	Spent	Earned	Productivity	To-date P.F.
1	1,000	600	800	133%	0.75	750	1,000	133%	0.75
2	5,000	-				5,000	5,000	100%	1.00
3	5,000	-				5,000	5,000	100%	1.00
Totals	11,000	600	800	133%	0.75	10,750	11,000	102%	0.98

Table 8 – Sample data, One in-progress activity

Activities #2 and #3 have not started; 0 man-hours have been earned. Cost-control software will base projections on the revised estimate (5,000 man-hours for each activity), assuming 100% productivity despite the good performance on Activity #1 (133% or P.F. 0.75).

This is a fair approach because one knows nothing about the productivity of the two activities. The sum of the individual activity projections is 10,750 man-hours, a savings of 250 man-hours.

The enhanced projection suggested in this narrative, however, would use the average productivity across all the activities (assume it happens to be the same as the to-date results, 133%) and project a significant gain of 2,730 man-hours. The enhanced projection results may be misleading because one doesn't have any information regarding activities #2 and #3. If the performance of activity #1 is due to a crackerjack crew that will continue with activities #2 and #3, then it's possible this same performance may carry forward to the other activities. If, however, the performance of activity #1 is due to better-than-expected job conditions, to extrapolate the performance of activity #1 on the other activities will be misleading. The enhanced projection only works well when the majority of activities have started. The weighted average performance across all activities is then a good indicator of how the job will fare.

In summary, reserve the reliance of the enhanced projection projections to jobs that have advanced beyond 50% complete.

Productivity Report Errors

Assume that the productivity report is producing wildly inaccurate results for as few as one significant activity. This can happen for any number of reasons such as miscoding, unanticipated scope change, or unit of measure confusion.

Due to the nature of a weighted average, those wild results may adversely influence the enhanced projection if the activity has significant weighting.

Conclusions

Labor projections on a job that is losing money are difficult and often inaccurate. The tendency is to underestimate the losses while hoping the prognosis will improve. Optimistic but failing projections, week after week, make site management appear incompetent. Better to make a one-time, worst-case projection, take the heat and improve on those results.

Current methods used by job management and cost-control software alike, are systematically inaccurate on mature jobs (more than 50% complete.) Accurate projections ignore the influence of irrelevant early data and rely on contemporaneous productivity results, preferably a 5-week rolling average. In the case of impacted jobs, as an alternative to contemporaneous results, one might also focus on the impact period productivity.

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