Trending and Forecasting

Presented by
Jake Ortego, PE, CCE, CCA
Trending and Forecasting

1. Schedule
2. Costs
3. Changes
4. General Conditions
THE PROJECT WILL NOT GO OVERBUDGET
THE PROJECT WILL MEET THE SCHEDULE

Two very common phrases that are:
• Typically unrealistic
• Easy to say at the beginning and hard to understand at the end
• Perceived as unquantifiable to forecast

WOULD YOU RATHER HAVE A SHORT SCHEDULE AND
LOW BUDGET OR THE RIGHT SCHEDULE AND RIGHT
BUDGET?
What is Trending and Forecasting?

- Typical construction reports are only historical
- Trends can be created from this data
- The trends can be used to forecast the project outcome
- These forecasts are based on the idea of the project behaving in the future as it has to date
1: Schedule Forecasting

- The schedule performance is one of the most useful tools in understanding how well a project is performing.
- Some federal government and “mega” projects used earned value techniques to forecast the schedule performance.
- Very few contractors, owner’s reps, and design firms understand this method.
- Most contractors simply try to recalibrate their schedule on a regular basis to reflect what they think will happen.
Project Curves

• Theoretical project costs follow an S Curve Distribution
• The standard model is based on a traditional bell curve using either a standard deviation approach or a sine function
More accurate models for cash flow can be made if the contractor accounts for:

- General conditions
- Major tasks on the schedule
- Expected expenditures by each major sub rather than as a whole
- Excluding multipliers such as fee and insurance

Having a reasonable model in the beginning can greatly increase the usefulness of trending the project costs.
Consider a project with this planned expenditure:
At the 50% completion point, the expenditures are:

Notes:
- Unit per month are $
- Project duration is a % of the total duration
- Duration months can be used instead of duration %
At closer inspection, the lag is 15 percentage points

- This example is using % for duration
- If it were a 10 month project, the lag would be 1.5 months
There are several possible forecasts that can be used:

- The remaining project can be condensed to meet the planned completion date.
- The remaining expenditures can follow the original curve for the remainder of the project.
- A Schedule Performance Index ("SPI") can be used to predict the new project duration.

\[
Estimated\ Duration = \frac{Planned\ Duration}{\frac{Actual\ Cost\ to\ Date}{Planned\ Cost\ to\ Date}}
\]
The resulting curves look like this:

Notes:
- The curves are cumulative
- The Bars are per duration cycle
- These curves can be calculated or drawn by hand
Trending and Forecasting

Or simplified for clarity

End Points for this example:
• Original = 100%
• Follow Curve = 110%
• SPI = 120%

Q: Which one is right?

To meet the original Schedule, the next several period spend rate must be close to 150% more than the max spend for any given period to date.

To meet the original Schedule, the next several period spend rate must be close to 120% more than the max spend for any given period to date.

A “Schedule Performance Indicator” equation maintains a historic spend rate.

Project duration will increase by 20%
A: There is not enough to accurately know – Rather, each creates a discussion point

• Meeting the original schedule date requires completing more work than the plan shows, when to date, this has not been achieved
• Matching the remaining curve implies that the limits to date have been overcome for the rest of the project
• Using the SPI implies a minimum acceptance that the project cannot recover and that the performance will continue to follow the trend to date

With this type of forecast, each possibility can be explored with the contractor.
Important Considerations

- Using costs to forecast schedule requires comparing the correct values.
- Changes to the contract can greatly skew the value. They either need to be accounted for or considered separately.
- A well thought out, sequenced, and realistic schedule (or schedule update) will most likely be more accurate than trend curves.
- A trend and forecast is not a crystal ball. It only represents possibilities based on history.
2. Costs

- Costs are often not forecasted for fixed fee or GMP contracts
- Forecasting and trending costs are good for:
  - **Cost-Plus or T&M projects**
  - Validating the project schedule
  - Understanding the financial health of the contractor on the project
Cost Performance Indicator ("CPI")

\[
CPI = \frac{\text{Budgeted Value of Work to Date}}{\text{Actual Value of Work to Date}}
\]

- CPI > 1 means under budget
- CPI < 1 means over budget
- Can be used to predict performance with T&M or Cost-Plus tasks
Example:

- A project is 40% physically complete with a budget of $1M. The actual costs to date are $500K.
  
  \[ CPI = \frac{40\% \times $1M = $400K}{$500K} = 0.8 \]

- This implies that the total project will cost more given the current performance.

  \[ \text{Estimate at completion} = \frac{\text{Budget}}{\text{CPI}} = \frac{$1M}{0.8} = $1.25M \]

- Major unforeseen events should not be included in the CPI calculation but should be added to the forecast at the end.
Alternate Consideration 1

• Contractor believes that they can deliver at the original budget.

\[
\text{Required Remaining CPI} = \frac{\text{Planned Value of Remaining Work}}{\text{Remaining Budget}} = \frac{60\% \times \$1M}{\$400K} = 1.5
\]

• In other words, the contractor believes they can deliver another $600K in work for $400K.

• The performance would have to increase by 87% from what has been done to date.
Contractor believes that they can deliver the rest of the project at the planned cost rate.

\[
\text{Estimate at completion} = \text{Actual to Date} + \text{Budgeted Remaining} \\
EAC = \$500K + (60\% \times \$1M) = \$500K + \$600K = \$1.1M
\]

• In other words, the contractor believes they can deliver another $600K in work for $500K.

• This scenario requires a CPI of 1.2 to complete, meaning that the contractor would have to perform 50% (1.2./0.8) better for the rest of the project.
Using Charts to Validate the Alternatives

- The project performance to date may help validate the alternatives.
- Consider the following chart - %Complete roughly equates to time.

- This example shows both higher and lower monthly costs than planned.
- Could be an indication of finite issues at certain moments in the project.
- This performance could validate the possibility of improved performance.
Extrapolating the alternatives

This performance shows that it may be possible to recover some of the performance to date
Using Charts to Validate the Alternatives

- Consider the following chart - %Complete roughly equates to time
- In this example, the contract costs are consistently higher
- This performance could imply that the contract is unlikely to improve on performance
Extrapolating the alternatives

This performance shows that it is less likely to recover some of the performance to date
3: Changes

- Although changes are nearly impossible to predict prior to a project, they can follow trends during the project.
- Systemic events are not usually confined to one moment in time.
- This includes when a significant amount of changes occur due to:
  - Design flaws
  - Undefined or poorly defined scope
  - Owner changing scope
  - Unforeseen conditions – Particularly for renovation and remediation projects
Example Changes on a Project at 50% |

- Cumulative moving average shows the rate of change between each month
- When the curve slopes UP, the average value of changes is GREATER than the previous period
- When the curve slopes DOWN, the average value of changes is LESS than the previous period
Using The Cumulative Moving Average ("CMA")

- A CMA curve may be erratic in the early stages of the project, but generally starts to smooth out by 30%
- A CMA curve rarely has large spikes or dips after 50%
- This means that the curve will continue in the general slope direction for the next several periods after the forecast date
- CMA curves for changes usually taper off towards the end of the project
Example of Trend Analysis

- By forecasting the period values, you can model the CMA curve for the rest of the project.
- The monthly values are only used to model the CMA and cumulative curves and should not be used to predict the actual values expected per month.
- For comparison, a straight line was inserted using the average changes at the 50% mark.
Comparison to Actual Outcome
This example uses real values from a project

- The model forecasts were created independently of the known results
- The forecasted monthly value was fairly accurate
Considerations

- Finite changes should be removed from the analysis to make a CMA change curve more accurate. This includes:
  - Major scope changes that modify the entire nature of the project
  - Major natural isolated events such as tornados, hurricanes, earthquakes, etc
  - Large delays on the project due to the owner
What does this trend tell you?

- To believe that changes will stop or drastically drop in the next period is short sited
- The trend gives the project team a sense of what may happen if things continue as they have to date
- A trend showing higher costs than planned may be used as a warning that the current approach is not working as expected
- A downward or positive trend can validate that the management of changes is under control
Beyond Change Costs

- This method can be applied to trend
  - Number of changes per period
    - This can be used to determine $/change to validate possible trends
  - RFIs per period
    - This can be used to determine average number of changes resulting per RFI and average cost resulting per RFI to validate possible trends
  - Labor Hours
    - This can be used to validate how much effort a contractor is using and if it is possible to increase the volume of labor to influence the schedule
4: General Conditions ("GC")

- GCs do not follow the typical construction S curve
- They have a slight taper upward at the beginning and then are usually straight until near the end of the project
- A similar model to the change trend can be used
- The analysis should exclude finite events such as permits, major purchases, or major rental events such as cranes unless they are on the project for the duration
- The analysis should exclude multipliers such as OHP, insurances, sureties, and tax
What does GC trending show?

- Trending and forecasting GCs can be used to determine how much effort the contractor is using to manage the project against the plan.
- GC overruns could mean that the:
  - GCs were undervalued – possible impact to project cost
  - The contractor has an inflated staff – possible impact to the project cost
  - The contractor is incurring more costs due to external factors such as owner driven changes or poor design
What does GC trending show?

• Lower GCs could mean:
  ▫ The contractor does not have enough staff – possible schedule impact
  ▫ The GCs were overinflated in the contractor budget
  ▫ The contractor has replaced higher end staff with lower end staff
  ▫ The contractor is being more efficient than planned (Less pessimistic)
Example – Fixed GCs

- Forecasted value higher than the fixed value:
  - Contractor at risk for losing money
  - Contractor may understaff the project to save
  - Changes could be impacting the contractor

- Forecasted value lower than the fixed value:
  - Contractor will make a greater profit than planned
  - Contractor is managing changes within the budget. This can be used by the owner to refute claims for additional general conditions due to changes.
Example Curve Analysis

- Note that the monthly forecast is modeled to keep a relatively smooth CMA curve.
Example Curve Analysis Compared with Actuals

- The forecast came in slightly higher than the actuals
- The forecast was closer than just using a straight line average
Summary of Training

• Trending can be a valuable tool for predicting possible outcomes of the project
• Forecasting from trends provides a view of what could happen if the project continues as it has to date
• Finite events are hard to predict. Costs and schedules do tend to follow trends.
QUESTIONS?