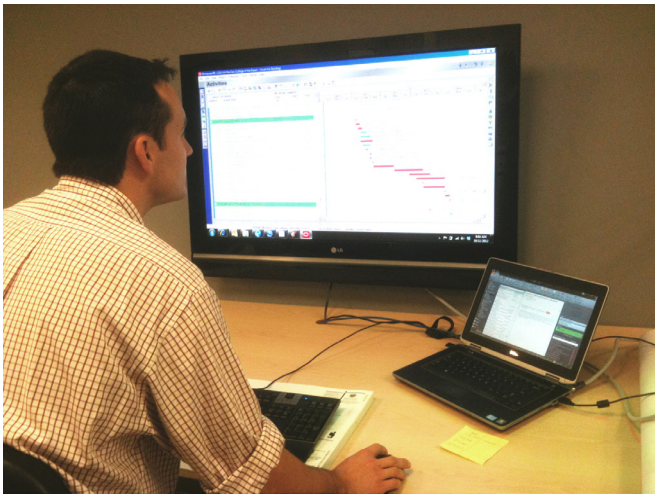


White Paper

SCHEDULE RISK ANALYSIS

CRITICAL PATH METHOD (CPM) SCHEDULING'S CRYSTAL BALL

April 2013

SCHEDULE RISK ANALYSIS

CPM Scheduling's Crystal Ball

In construction, every aspect of the building process is associated with time, calculating the finite number of hours to achieve project completion.

- Equipment and labor are typically quoted as cost over time.
- Progress rates are the quantity of materials installed over time.
- General condition costs or the costs just to be on a project are also tied to time.

Most project issues are just the symptom with time being the real cause or culprit. Thus, closely watching a project's time is one of the most beneficial best-practices in attaining a successful project. Therefore, managing risk is a matter of managing time.

SRA allows the project team to gain insight as to the potential risks within a project schedule

However, it is not just enough to have a Critical Path Method (CPM) schedule that is regularly updated and monitored on a project. The schedule can be utilized for a deeper level of analysis to help manage and facilitate a successful project. As a value added process, Gilbane uses Schedule Risk Analysis (SRA) to gain this expanded perspective into the CPM schedule. SRA can assess the health of a schedule, identify potential trouble spots, and reveal project driving activities (which may not necessarily be on the critical path). All of this new information can then be employed to mitigate risk, improve the schedule, and avoid pitfalls giving a project increased odds of success.

Every project has a degree of uncertainty. A CPM schedule will attempt to factor in some of the known uncertainty, but is unable to mathematically demonstrate. Through SRA, uncertainty can be appropriately assigned to a CPM schedule and the probabilistic completion date range can be determined. The SRA calculation also identifies the activities that affect the completion date most or the activities that have the highest probability of driving the schedule.

Most projects also have various known Risk Events that have a certain probability of affecting the project. These known risk events can be modeled into the schedule along with their probability of occurring, creating an even more realistic completion date range. Risk Events can also be modeled as they occur in time.

The ability to model uncertainty and risk events into the schedule, provides an added confidence in the project plan while identifying the need for further planning, refinement andor the ability to perform relevant risk mitigation.

Risk Event Explained: A risk event potentially impacts the project schedule, such as not approving a mockup thus haulting the installation. The probability of the event can be estimated and the alternate sequence determined should the risk event occur, which is then factored into the analysis.

Schedule Risk Analysis Explained in Depth

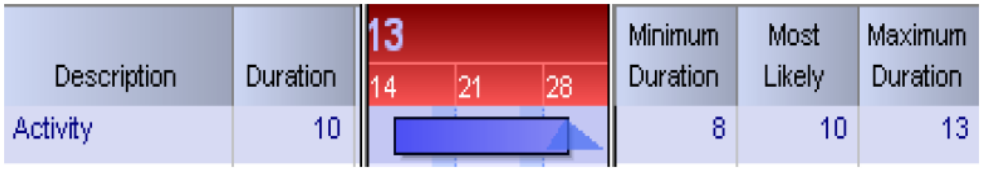
Schedule Risk Analysis is based upon statistics and probability. As mentioned above, on any construction project there is an amount of uncertainty due to unforeseen conditions, weather impacts, labor and material impacts, and so forth. SRA attempts to model these uncertainties in a quantifiable and computable manner that provides analytic metrics for a project team to prioritize and focus on those project activities that will effect the completion date of a project.

Hard Constraint: The day an activity has been manually pinned in the scheduling software. Constraints can severely bias/skew a schedule.

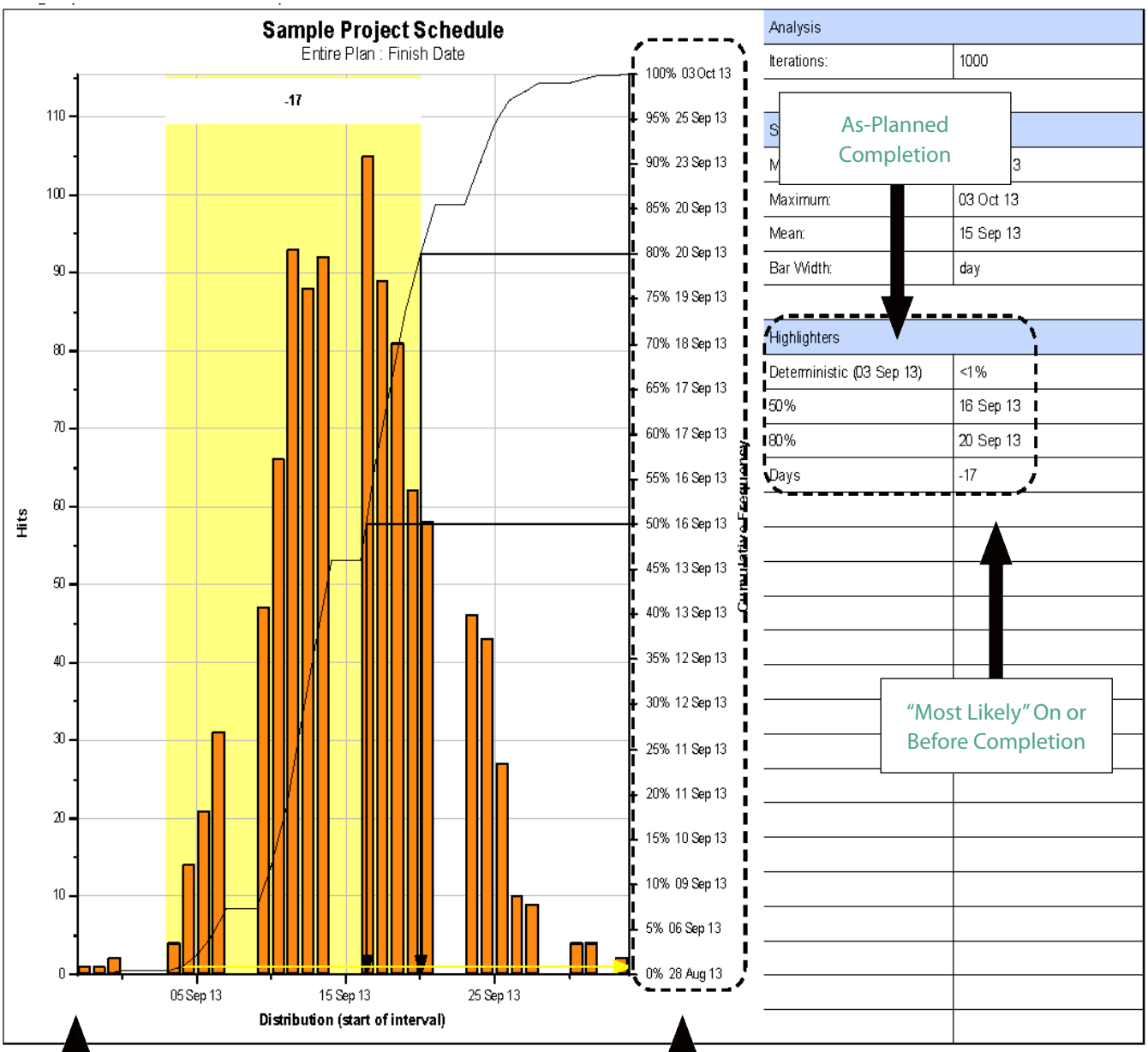
The first step in performing an SRA is to validate and assess the health of the CPM schedule. The schedule must realistically represent the project, be logically tied together with relationships, and be free of hard constraints.

Next, a level of uncertainty is assigned to each activity in the schedule. This can be done on an activity-by-activity basis or in blanket assumption fashion.

Example: An uncertainty of +/-25% was assigned to each activity in blanket assumption fashion, thus each activity now has a minimum and maximum duration. For a 10-day activity, this means that the minimum duration is 8 days and the maximum duration is 13 days, as can be seen in the example below.



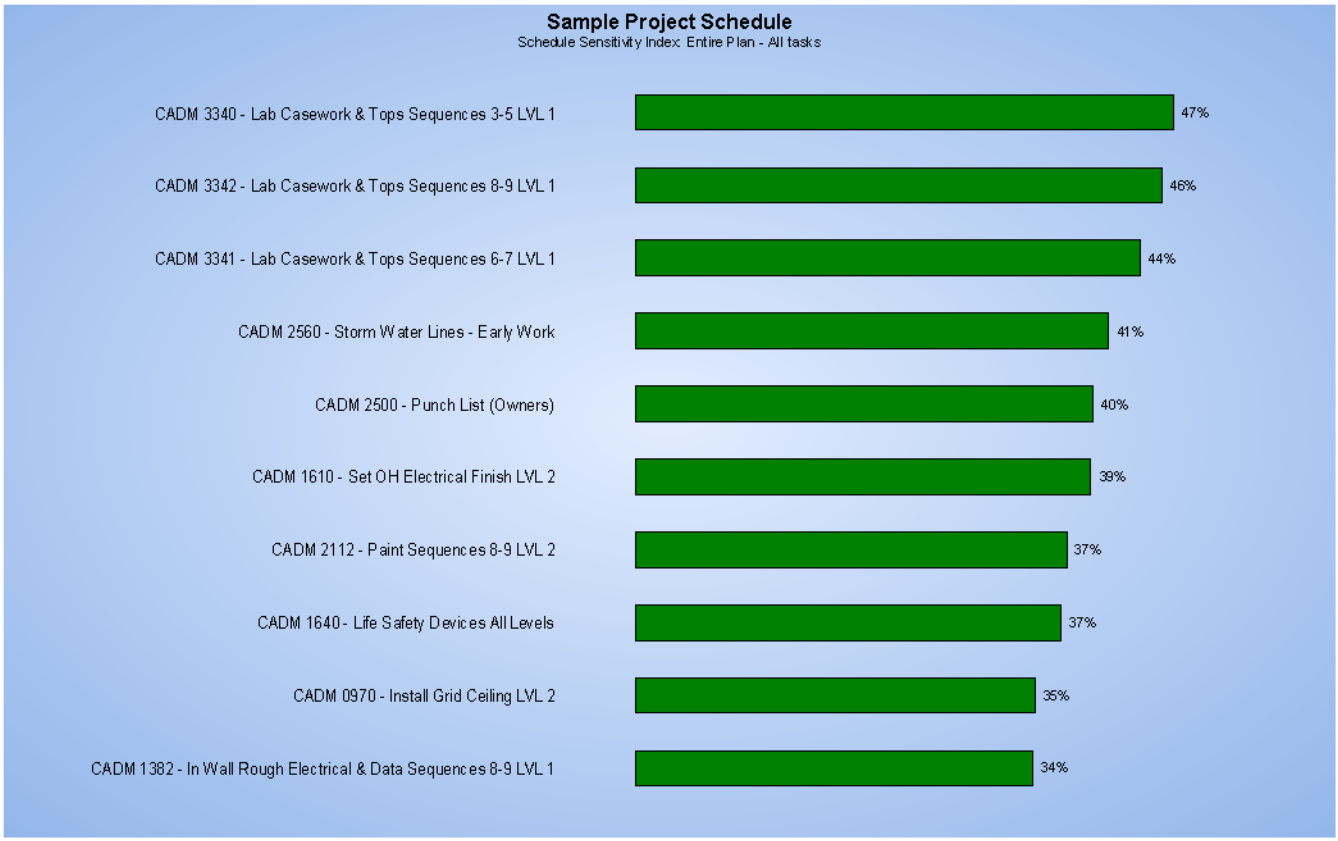
After the uncertainty has been assigned, the system runs an SRA calculation called 'Monte Carlo' simulation on the schedule. This involves calculating the schedule multiple times (usually ≥ 1,000) while taking random durations from each activity's duration range distribution for each calculation cycle. Each schedule completion date of these multiple iterations of the schedule is tallied in a distribution graph such as the one pictured on the following page.



1. The bars on the graph represent the number of times that result was encountered in the simulation.
2. Probabilities are then derived from the graph distribution to determine 'most likely' e.g. 80% of the results show the project finishing ON or BEFORE 20SEP13.
3. The range between the 'Most Likely' and the current As-Planned completion date can also be calculated, which in the example above is 17 calendar days.

After the SRA distribution has been created, the driver activities can be determined via the Tornado graph as shown below.

1. The Lab Casework and Tops activities have the highest influence percentage on the completion date of the project.
2. This information can then be evaluated by the project team as to how to best keep the Lab Casework and Tops activities on schedule whether it is by close lead time monitoring, accelerated installation, or re-sequencing of construction activities to allow an earlier start.



SRA in Action

Arizona State University Polytechnic Sun Devil Recreation Center
Mesa Arizona

Gilbane used SRA on the **Arizona State University Polytechnic Sun Devil Recreation Center**, a 61,495 square foot sports and recreation facility, due to the compressed construction timeframe and the project team wanting to know if the scheduled completion date was still a reality. The SRA on the schedule improved the quality of the schedule by tightening up of the loose ends, some re-sequencing to reflect actual field conditions, and general schedule cleanup. The SRA results showed an 80% probability that the project would indeed complete on time and that the activities in the sequence through the ceiling installation were to be the most influential schedule drivers. After the SRA, the project team was able to place their focus and attention on the top schedule driver. The project was successfully completed on time.

As a third-party, Gilbane was contracted to perform an SRA on an **office / laboratory building for a confidential client.** The SRA revealed many gaps in the project schedule, which led to numerous recommendations to assist the general contractor to improve and clean up the project schedule. The SRA results showed that the As-Planned completion date had a <1% probability of being achieved, with an 80% probability that project completion would occur 16 days later. The schedule drivers were shown to be the curtain wall activities. The contractor then took this information and revised the entire curtain wall sequence to better fit into the overall project, which ultimately increased the As-Planned completion probability by 30%.

As a value-added service, SRA allows the project team to gain insight into the potential risks within a project schedule, which permits the team to take proactive measures to mitigate these risks. Additionally, running an SRA periodically throughout the life of a project further aids in risk identification as project conditions change or evolve.

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About the Author

Steve started his 23-year career at the end of a shovel and has performed in all aspects of field construction. He is a contributing member of Gilbane's Scheduling Peer Group and provides schedule management training through Gilbane University. Steve has managed scheduling across both preconstruction and construction phases for well over 80 projects representing all delivery methods which involved phasing, fast-track and pull scheduling to manage field performance efficiencies. He has led the scheduling for higher education, K-12, civic, criminal justice, public assembly, healthcare, life sciences and infrastructure projects from $2M - $250M. Furthermore, he helped introduce one of Gilbane's powerful scheduling services – Schedule Risk Analysis.