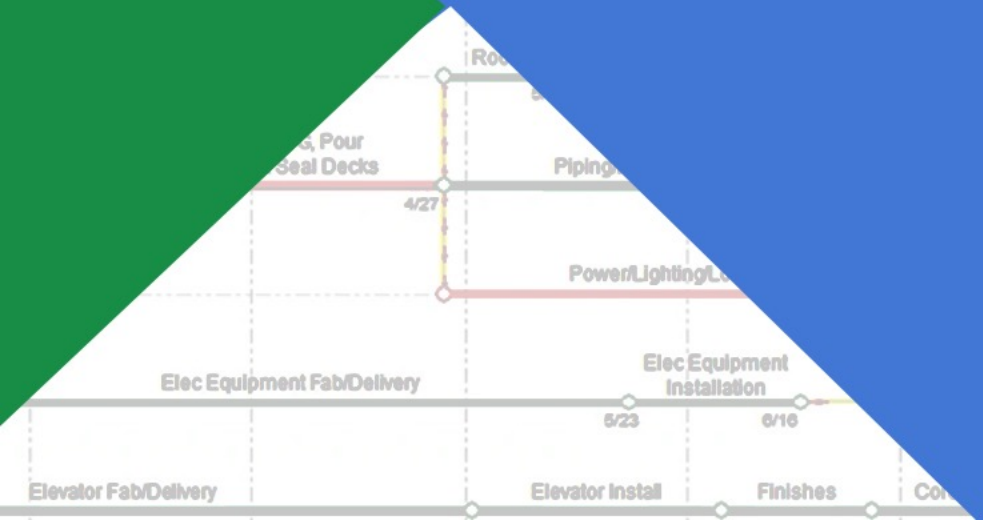


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PMA's Quantitative Risk Innovation Explained

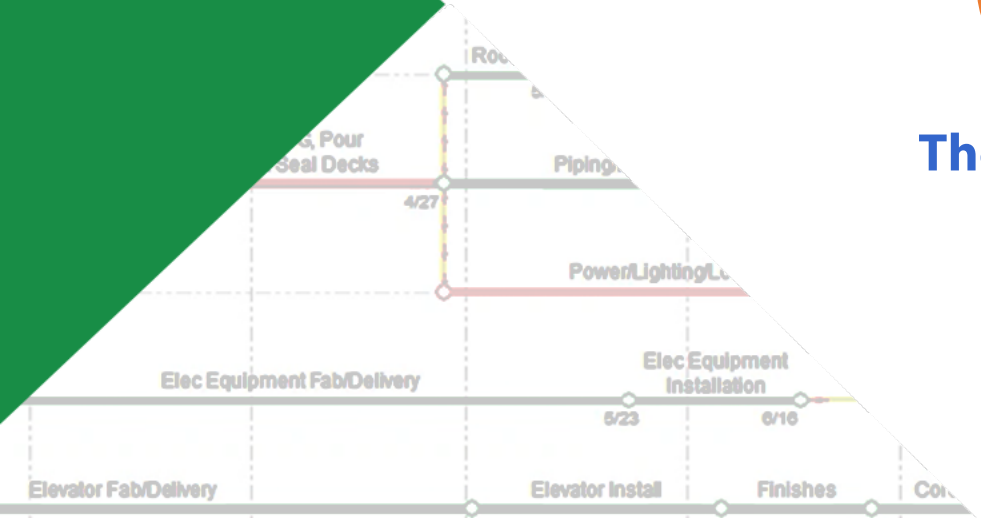


Presented by:
Tim Mather & Dr. Vivek Puri



Agenda

- GPM Explained
- PMA's Innovation
- What is Monte Carlo?
- The Algorithms
- Why Use Schedule Simulation?
- Modeling Start Dates



MEET THE PRESENTER

Tim Mather

As COO of PMA Technologies, Tim is responsible for the overall growth of PMA Technologies. Tim is a PMP, PMI-ACP, CCMP, and LPEC with extensive project management, software development, and marketing experience. Tim earned his bachelor's degree from Michigan State University and completed postgraduate study of project management strategy at the University of Chicago.

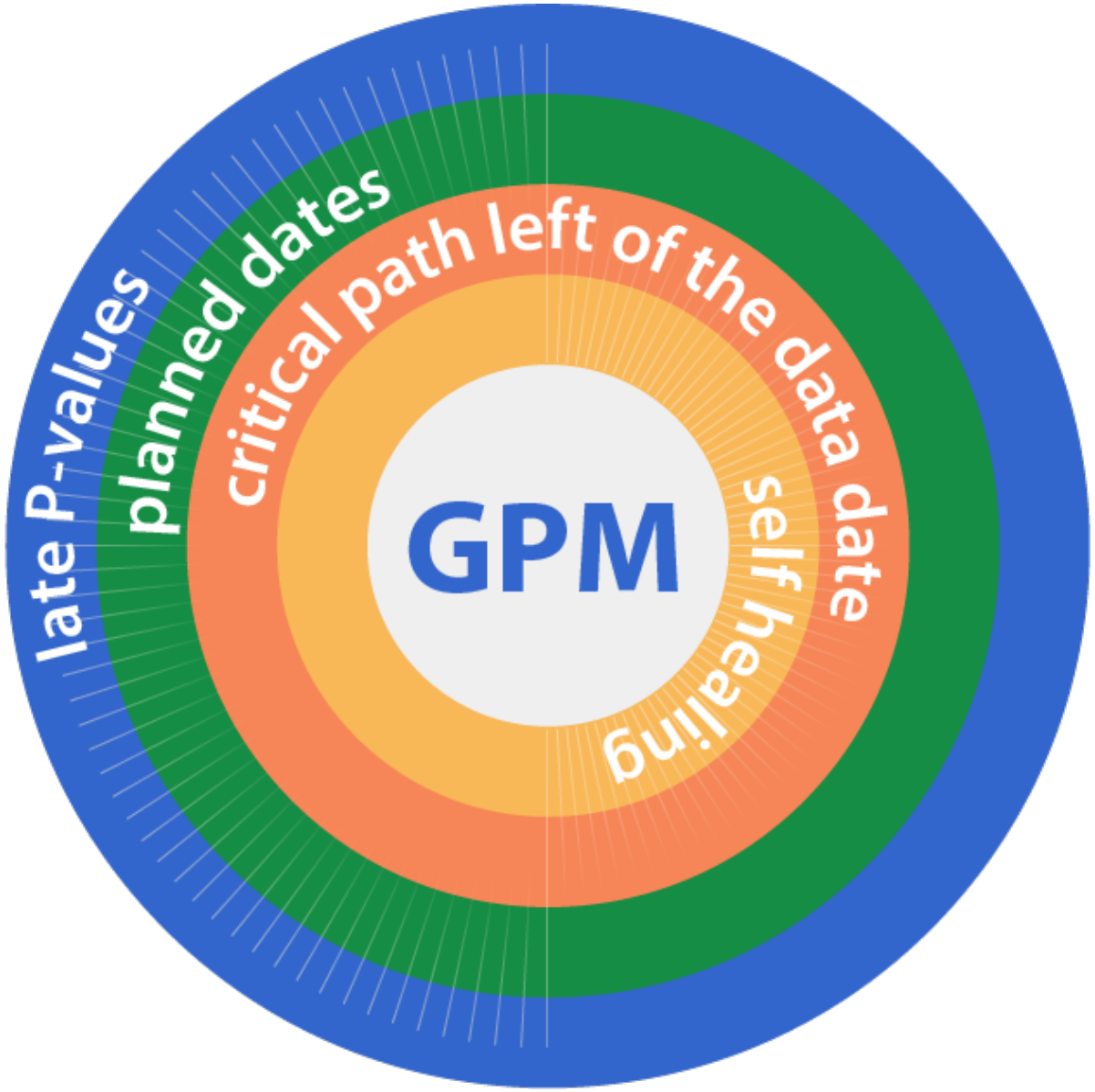


MEET THE PRESENTER

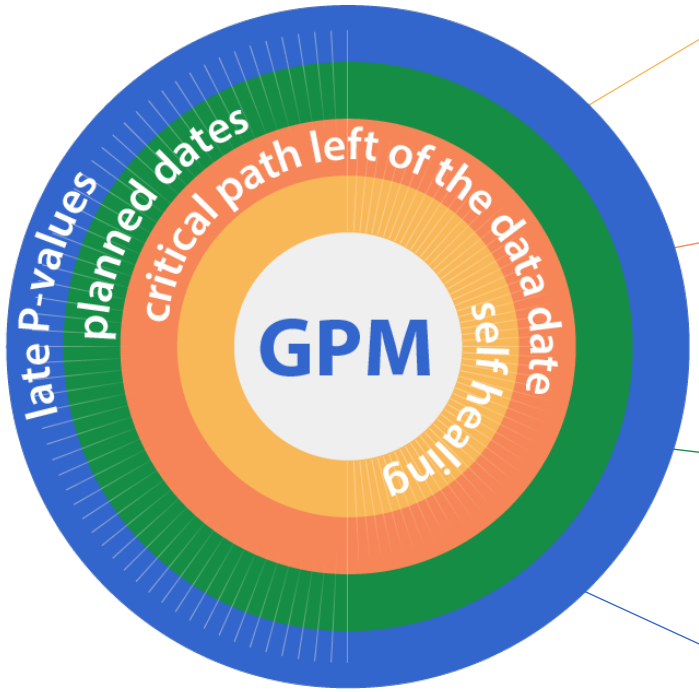
Dr. Vivek Puri

Dr. Vivek Puri has significant experience planning and executing projects in both construction and information technology areas. Dr. Puri's recent work involves research and development relating to NetPoint, NetRisk, and Schedule MD. Three innovative tools were developed in-house by PMA. His doctoral work was in the area of simulation applications for construction planning.




late P-values
planned dates
critical path left of the data date
self healing
GPM

The Essence of GPM



self-healing

The schedule updates instantly ***while moving the mouse.*** Unrivaled for interactive planning sessions, collaboration, what-ifs, etc.

critical path left of the data date

Total floats and critical path/s ***continue on left of the data date*** for forensic delay analysis

planned dates

Flexibility to ***place activities freely*** instead of using constraints and breaking float continuity

late P-values

See the effect of float-use on completion distributions. ***Mitigate the risk of float-use*** with "safe float" thresholds

The GPM Difference

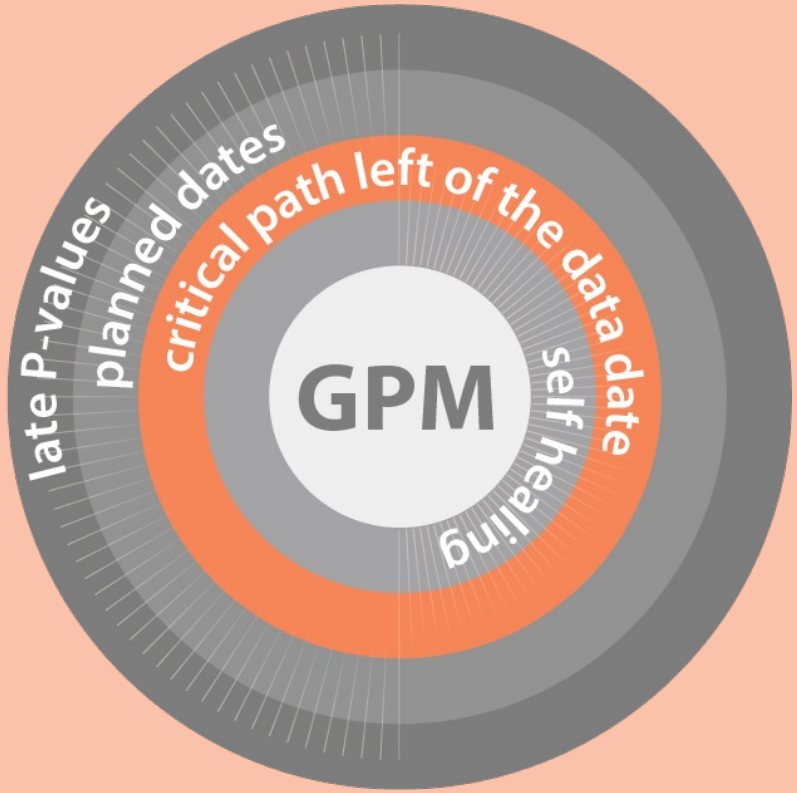
GPM	CPM
self-healing — The schedule updates instantly ***while moving the mouse.*** Unrivaled for interactive planning sessions, collaboration, what-ifs, etc.	***Batch forward/backward pass*** scheduling algorithm requires F9 or letting go of the mouse to see updates
critical path left of the data date — Total floats and critical path/s ***continue on left of the data date*** for forensic delay analysis	Total floats and critical path/s ***do not exist left of the data date***
planned dates — Flexibility to ***place activities freely*** instead of using constraints and breaking float continuity	Must use no-earlier-than start dates which ***reduce float continuity***
late P-values — See the effect of float-use on completion distributions. ***Mitigate the risk of float-use*** with "safe float" thresholds	Activities simulated on ***early dates only*** with ***no insight*** into how float-use affects p values

Self-healing



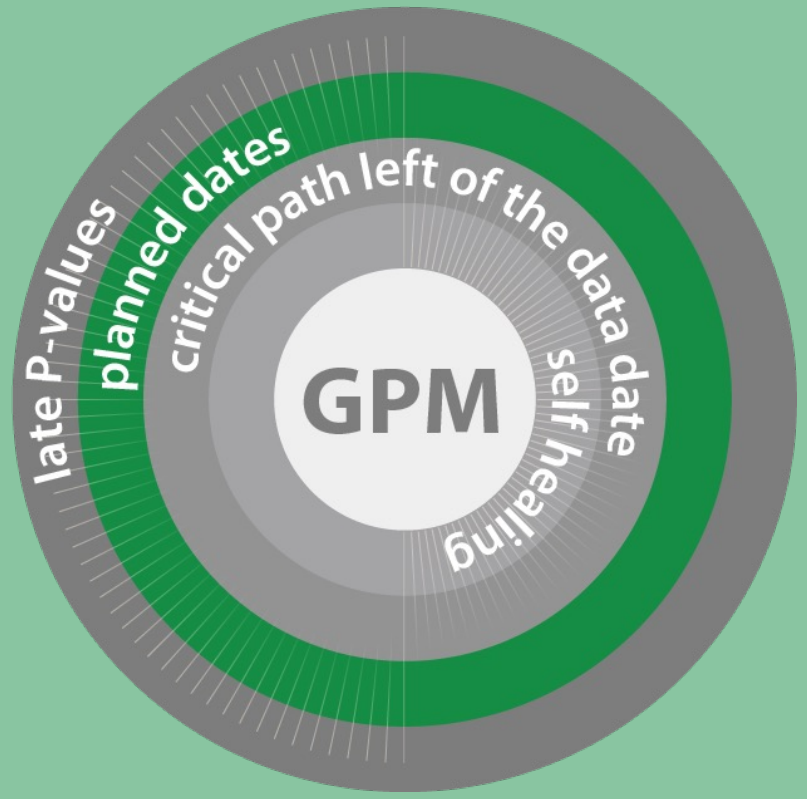
What	The schedule updates instantly while moving the mouse.
Why	Unrivaled for interactive planning sessions, collaboration, what-ifs, etc.
How	Patented as part of the GPM algorithm.

Critical path left of the data date



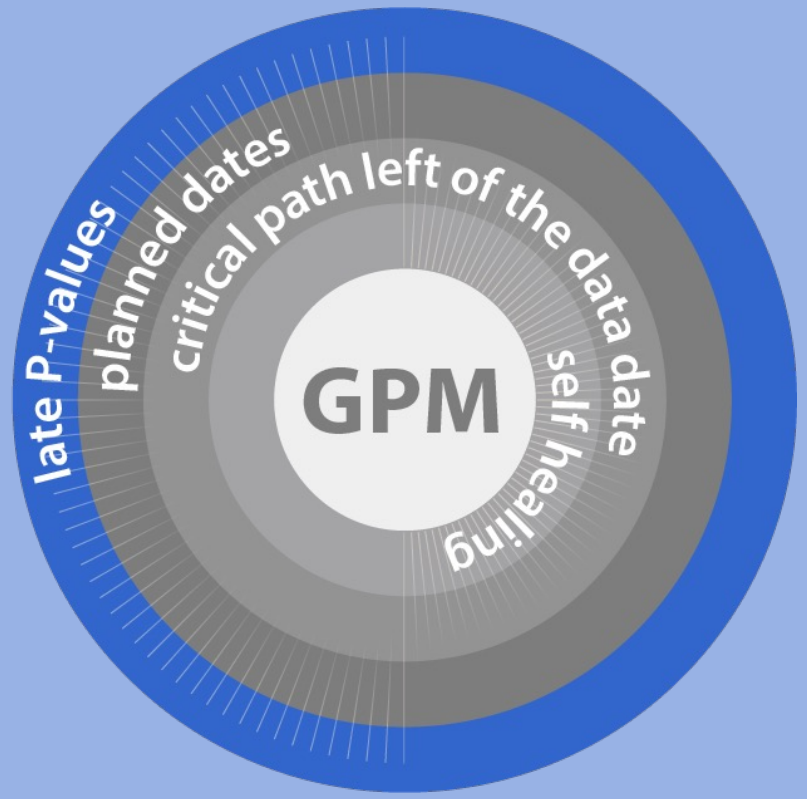
What	Total float and critical paths left of the data date. In my opinion, this is useful to only a minority of planners and schedulers who do delay analysis. Most don't know what they're missing out on.
Why	Key for forensic and delay analysis.
How	Float is calculated based on gaps between activities, not based on early and late dates. There is no forward pass to put activities on early dates and keep them there (aka no early-date bias)

Planned dates



What	Flexibility to place activities freely instead of using constraints to put them there and breaking float continuity.
Why	Indispensable for interactive planning sessions, resource leveling, backwards or pull planning, and planning in general.
How	Float is calculated based on gaps between activities, so there is no forward pass to put activities on early dates and keep them there (aka no early-date bias)

Late P-values



What	See the effect of float-use on completion distributions. *Mitigate the risk of float-use* with “safe float” thresholds
Why	Crucial for a more realistic picture of overall project risk exposure. Use float confidently without risking delays.
How	Float is calculated based on gaps between activities, so there is no forward pass to put activities on early dates and keep them there (aka no early-date bias)

The Role of Intellectual Property in PMA's Future


US011017335B1

(12) **United States Patent**
Ponce de Leon

(10) **Patent No.: US 11,017,335 B1**
(45) **Date of Patent: May 25, 2021**

(54) **GRAPHICAL SCHEDULE RISK ANALYZER**

(71) Applicant: **Gui Ponce de Leon**, Ann Arbor, MI (US)

(72) Inventor: **Gui Ponce de Leon**, Ann Arbor, MI (US)

(73) Assignee: **PMA TECHNOLOGIES, LLC**, Ann Arbor, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1052 days.

(21) Appl. No.: **13/785,853**

(22) Filed: **Mar. 5, 2013**

(51) **Int. Cl.**
G06Q 10/06 (2012.01)

(52) **U.S. Cl.**
CPC . ***G06Q 10/063116*** (2013.01); *G06Q 10/0635* (2013.01); *G06Q 10/06312* (2013.01)

(58) **Field of Classification Search**
CPC G06Q 10/0635; G06Q 10/06312; G06Q 10/063116
USPC 705/7.22
See application file for complete search history.

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(Continued)

Primary Examiner — Timothy Padot
(74) *Attorney, Agent, or Firm* — Carlson, Gaskey & Olds, P.C.

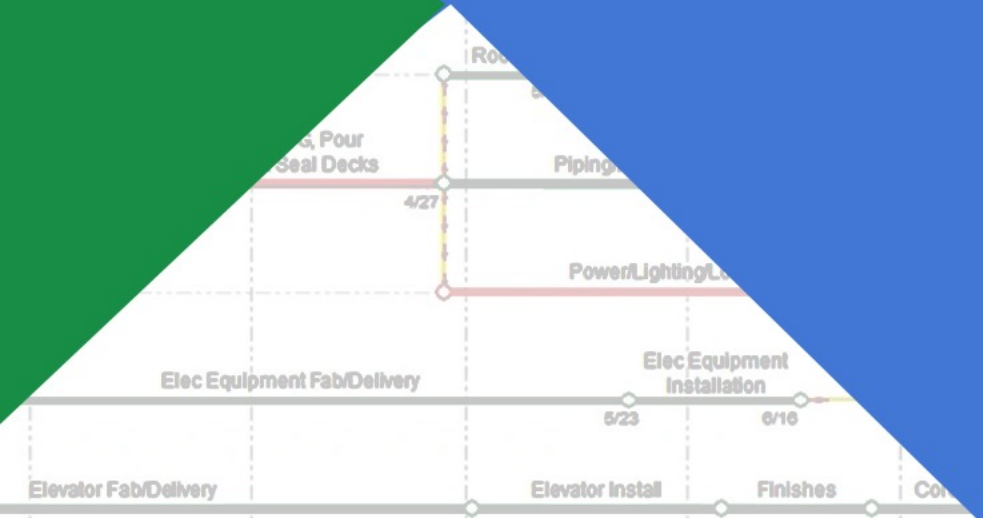
(57) **ABSTRACT**

A computer-implemented simulation method for analyzing schedule risk in a graphical schedule that includes (a) providing a base schedule that has graphical schedule objects including activities that are connected in a logic network by logic ties, the schedule culminating in a completion milestone, (b) sampling from probability distributions representing uncertainties in the durations of the activities to simulate activity durations from start dates to finish dates, (c) modifying the start date of one of the activities as a function of float or drift of the activity, and (d) using the logic ties, the sampled activity durations, and the modified start date to determine an output representing a simulated occurrence of the base schedule culminating in the completion milestone.

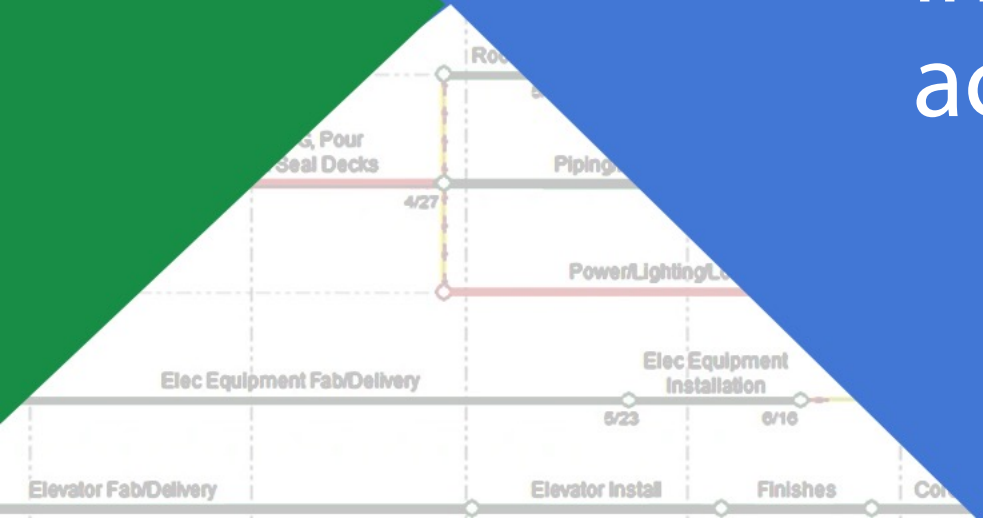
27 Claims, 25 Drawing Sheets



The game-changing insight which must be understood in order to be appreciated.







Type into the chat

How many of us have been involved in a project where every activity started on the early date?

Working Through the Innovation 101



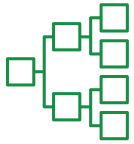
What is modeling science?



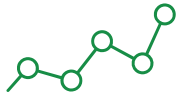
What is simulation?



What is Monte Carlo?



How does the CPM algorithm work?



How does the GPM algorithm work?

Modeling Science Defined

A scientific model is **a physical and/or mathematical and/or conceptual representation of a system of ideas, events, or processes**. Scientists seek to identify and understand patterns in our world by drawing on their scientific knowledge to offer explanations that enable the patterns to be predicted.

Ex. **WEATHER** MODEL | **CLIMATE** MODEL | **SCHEDULE** MODEL

The key to a great model is to accurately represent the system which is being modeled. This is truly a case of garbage in, garbage out.

Simulation Defined



Simulation, in industry, science, and education, is **a research or teaching technique that reproduces actual events and processes under test conditions**. The interaction of these phenomena create new situations, even new rules, which further evolve as the simulation proceeds.

Monte Carlo Explained

Repeated random sampling to obtain numerical results.

The underlying concept is to use randomness to solve problems that might be deterministic in principle but cannot be solved deterministically.

For a schedule simulation, each chosen activity duration is ranged (pessimistic, most likely, and optimistic).

A risk can also be applied to an activity.

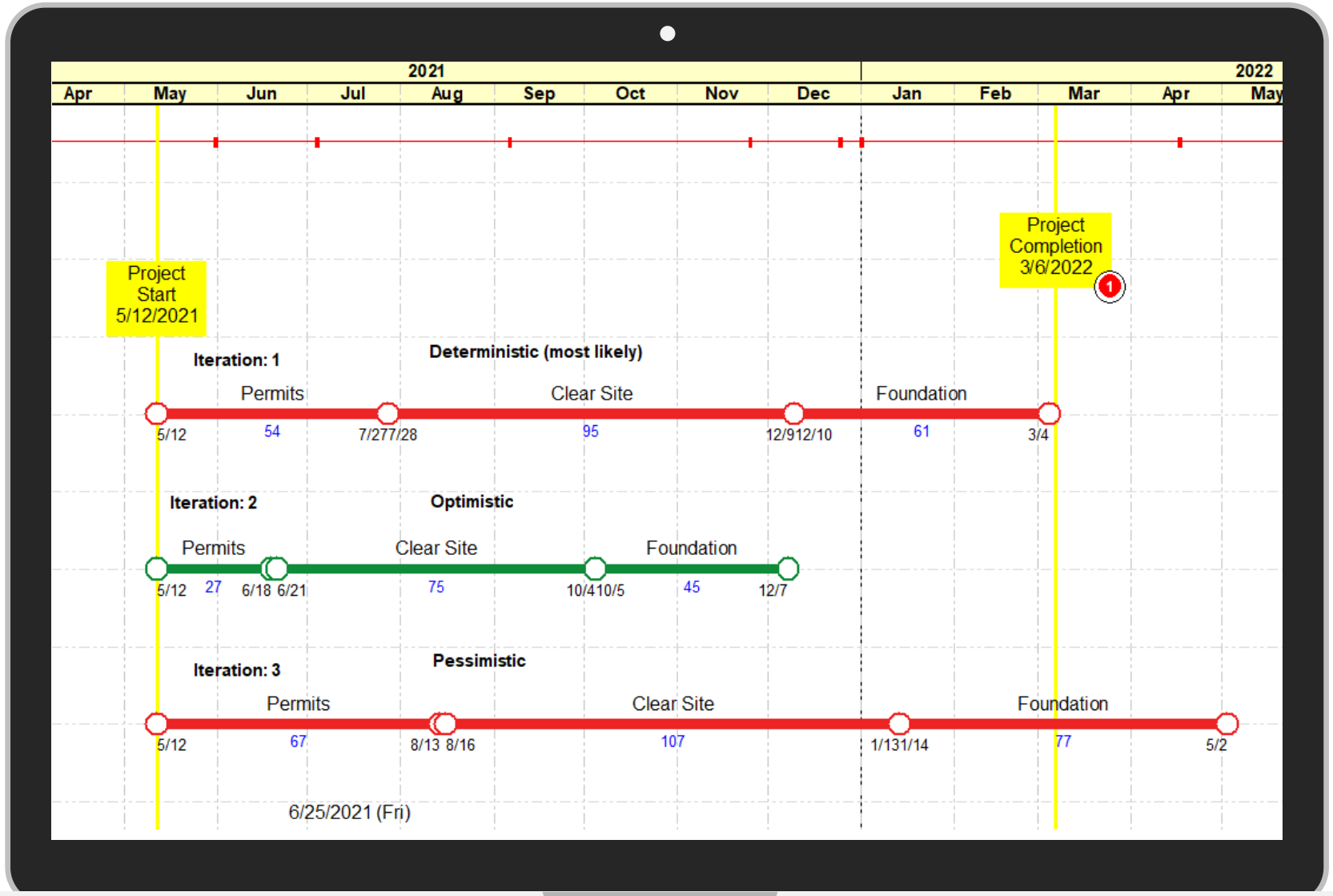
Then the simulation selects a duration within the range for each activity (or applies the risk) and calculates a new schedule based on those durations.

this is called an iteration.

The process of iterations is repeated until the simulation comes to convergence.

Convergence is the point at which the values will not change much regardless of how many more times the simulation is run.

Visual of Monte Carlo



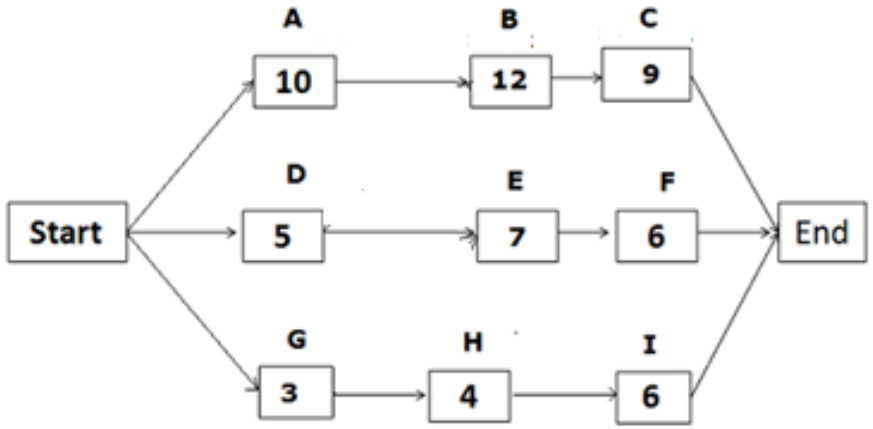
CPM Algorithm Explained

Forward Pass ES + duration

Backward Pass LS – duration

Float LF - LS

Critical Path = longest path / lowest float



FORWARD PASS

ES 0 A	EF 10	ES 10 B	EF 22	ES 22 C	EF 31
EF 0	LF 10	EF 10	LF 22	EF 22	LF 31

BACKWARD PASS

ES 0 D	EF 5	ES 5 E	EF 12	ES 12 F	EF 18
EF 13	LF 18	EF 18	LF 25	EF 25	LF 31

ES 0 G	EF 3	ES 3 H	EF 7	ES 7 I	EF 13
EF 18	LF 21	EF 21	LF 25	EF 25	LF 31

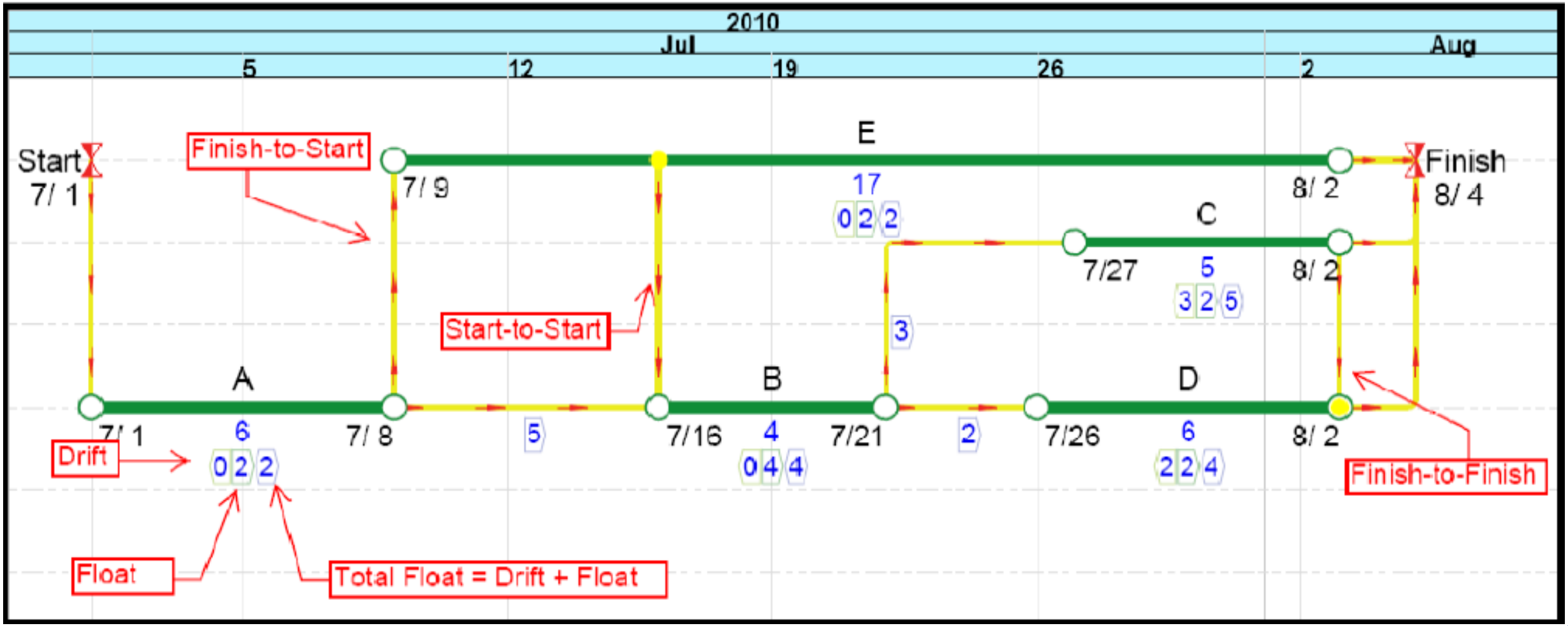
GPM Algorithm Explained



In GPM, float is calculated as **Float I = min [Float J + Gap I,J]**, for all J Activities that are successors to Activity I. **Drift I = min [Drift H + Gap H,I]**, for all H Activities that are predecessors to Activity I.

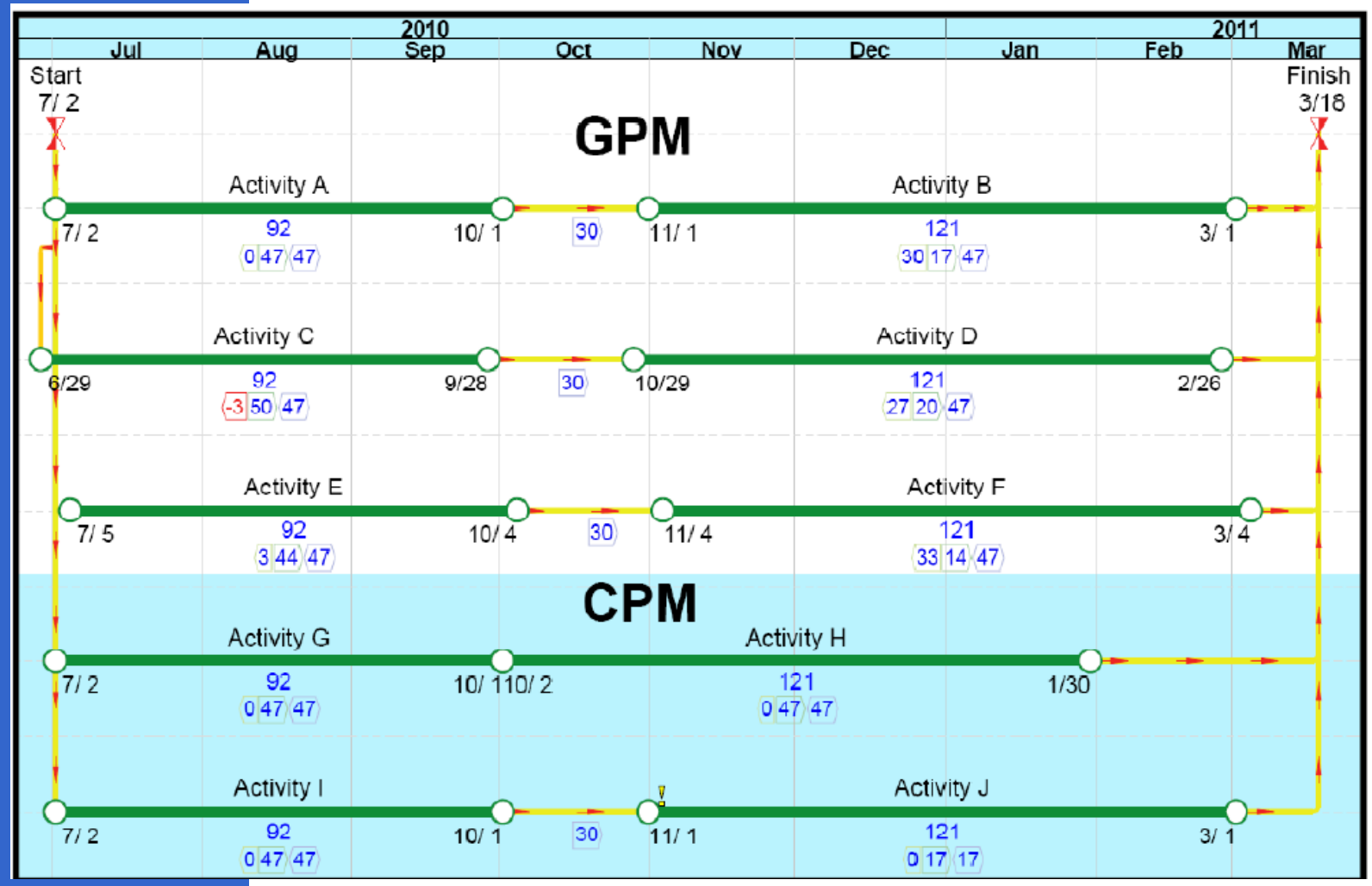
Total Float I = Drift I + Float I

LDM Graphic of GPM Explained



Networks in GPM & CPM

Remember, this is the model to be used in a simulation.
The most important aspect of the model is that it accurately reflects real-world conditions.



Why Perform Schedule Simulation?

We are trying to predict the probability of project completion.

This simulation produces a predicted project end date for each iteration.

Over thousands of iterations a pattern will emerge. When the pattern stabilizes, the simulation has come to convergence and the probability end dates can be charted (P dates). P dates are expressed in the percentage probability of meeting that date based on the simulation.

Many large capital projects require a certain P value (P80 for instance would predict an 80 percent chance of project completion by a certain date) before the project will be authorized.

A board of directors uses the Monte Carlo results to inform their decision about committing capital to a project.

The more accurate the simulation results, the better informed the decision makers will be. That is why our innovation is so important. CPM is overly optimistic and gives the decision makers bad information.

The CPM Optimism Bias in Simulation

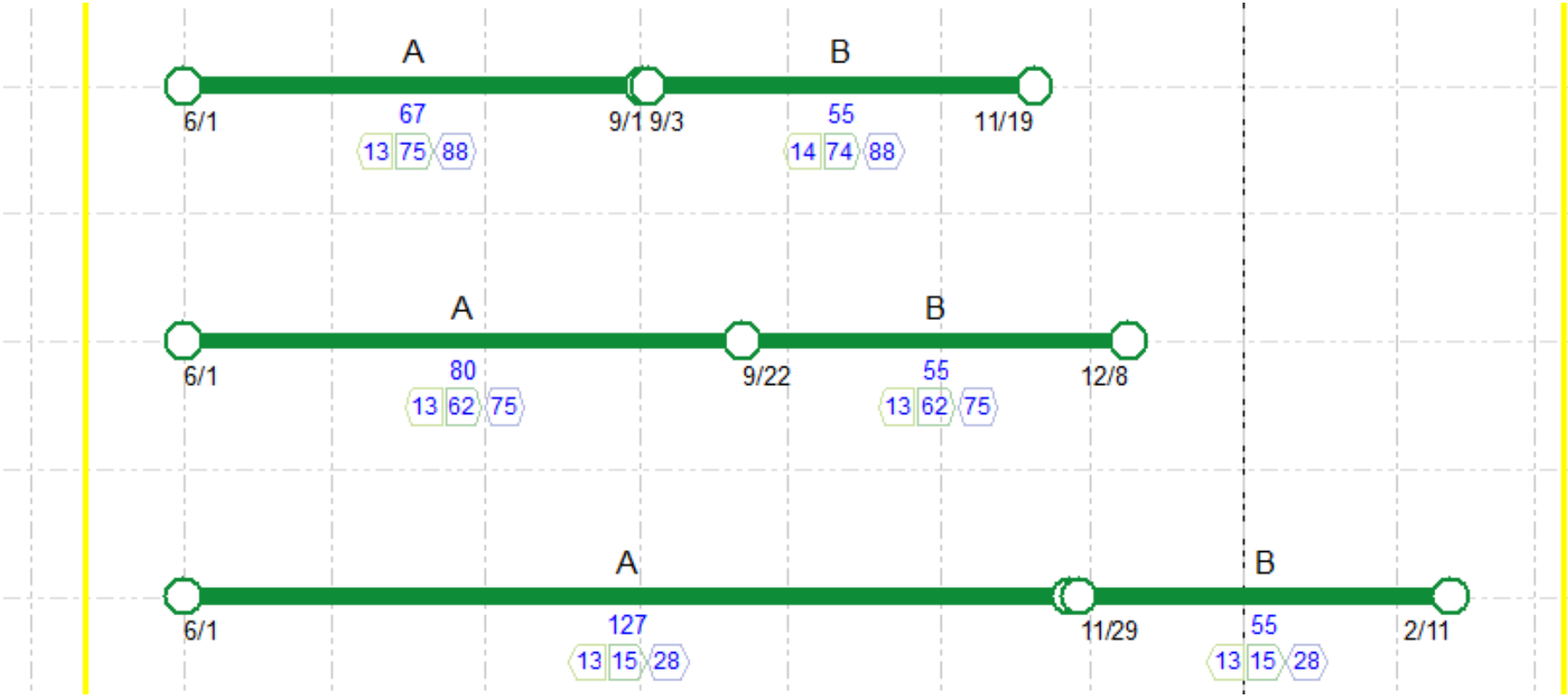
Every CPM-based Monte Carlo simulation is based on a deterministic schedule model in which every activity starts on the early date.

As we apply the Monte Carlo simulation to this model, each iteration will also start with every activity on the early date.

The CPM forward and backward pass is a bulk operation which is insensible to intermediate changes to the network as the iteration progresses through the network.

How GPM Improves Both the Schedule Model and the Simulation

The GPM algorithm steps through the network one activity at a time; this means that the float in activity B will be adjusted after the duration of activity A has been sampled in an iteration.

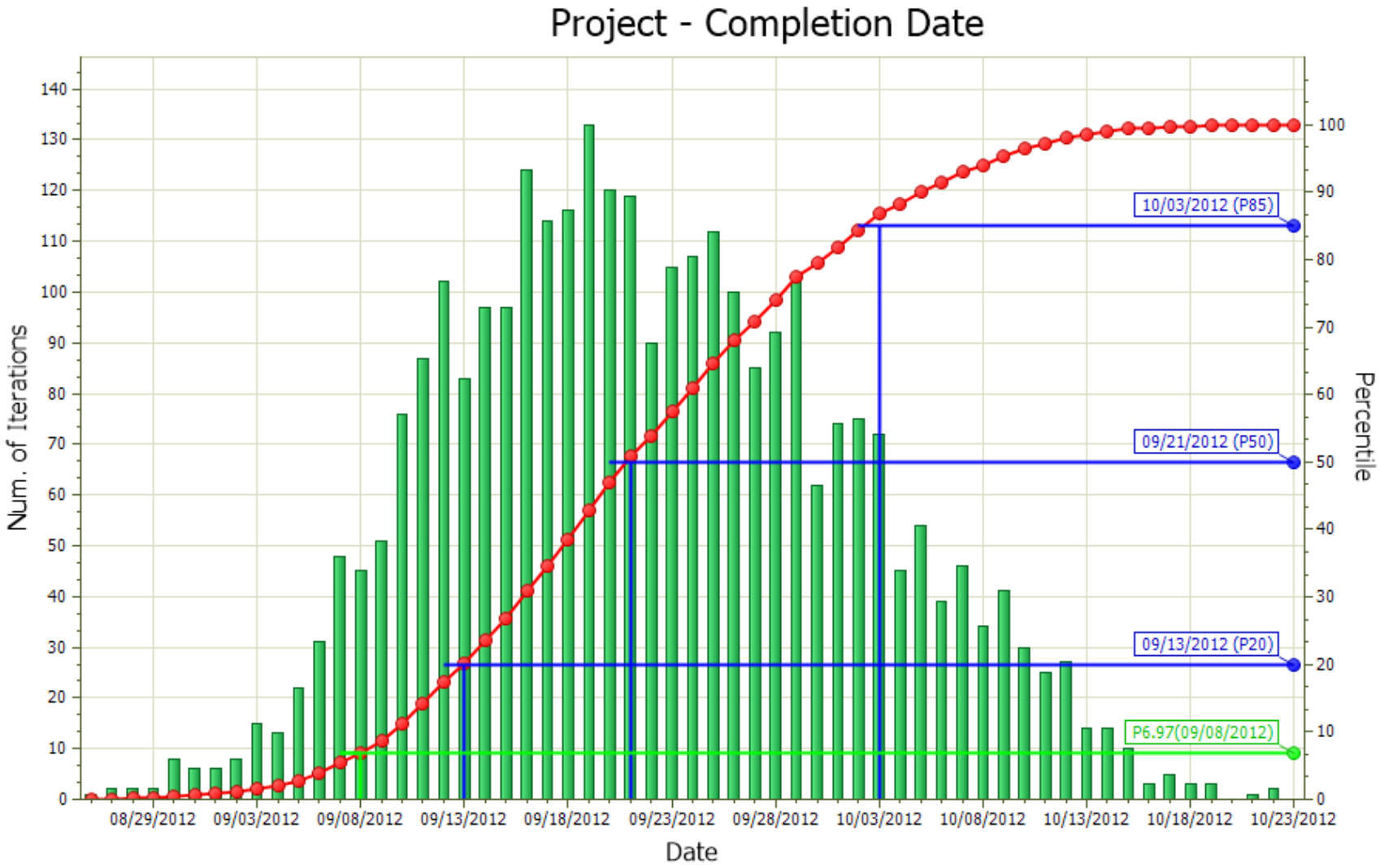


Floating and Pacing

In a GPM Monte Carlo simulation, activities can react to what has occurred earlier in their float chain. This means that the schedule model can more closely approximate what happens in a real-world project. GPM can model decision making based on progress on a chain during the simulation.

All Early Dates

CPM Simulation Project Completion Risk Distribution *Lower Bound*



Ready for Commissioning

- Required by 10/03/12
- Schedule deliberately anticipates completing early on 09/08/12
- 342-day as-planned duration, which results in 24-day early completion, reserves 7% contingency
- In CPM simulation, the required completion date of 10/03/12 is P85 in the early completion risk curve

What About Start Date Variability?

01

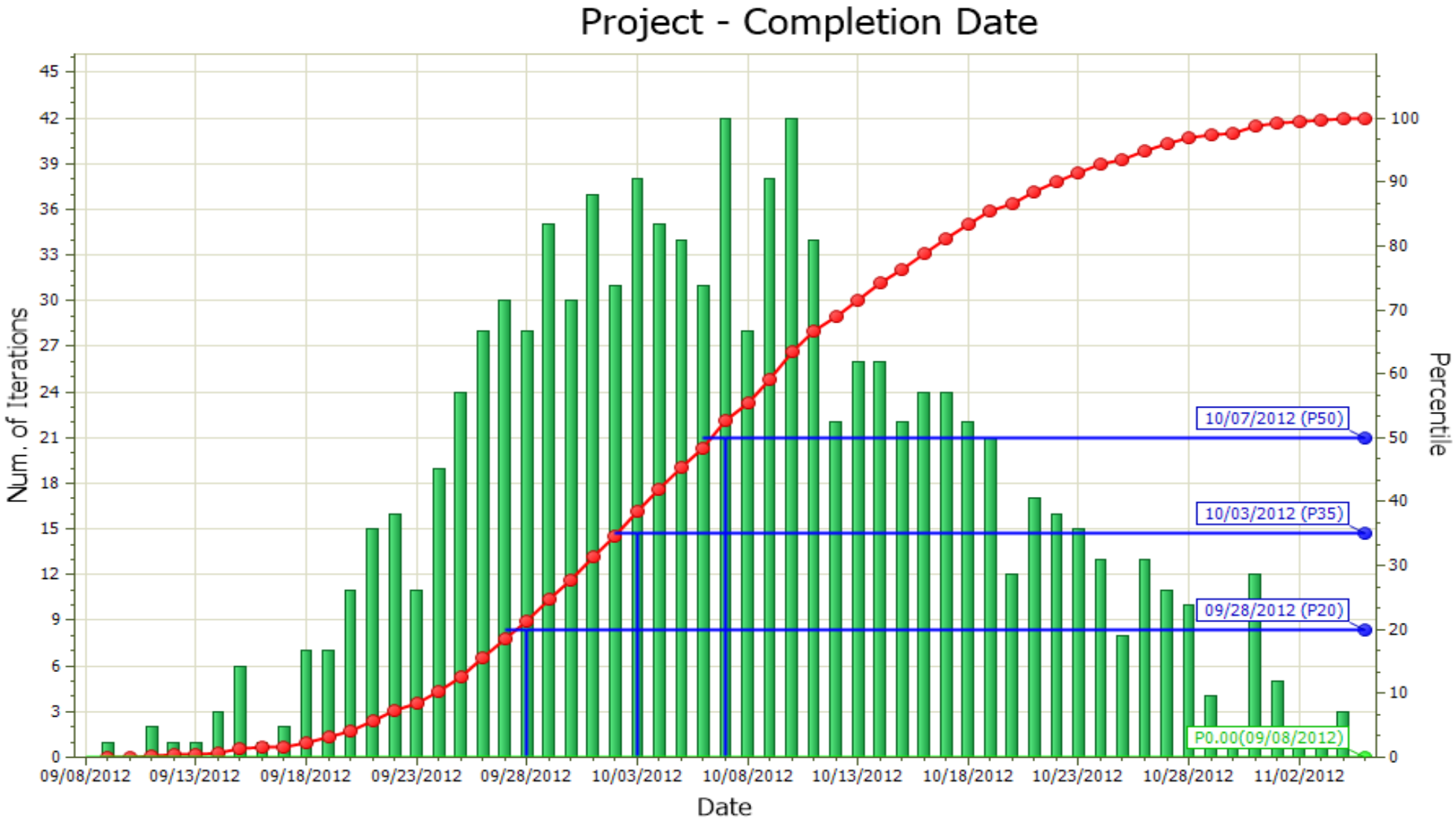
If any project as-built schedule is analyzed, it becomes quite apparent that activities in many instances are not started on their early dates; in other words, total float was actually used for a myriad of reasons

02

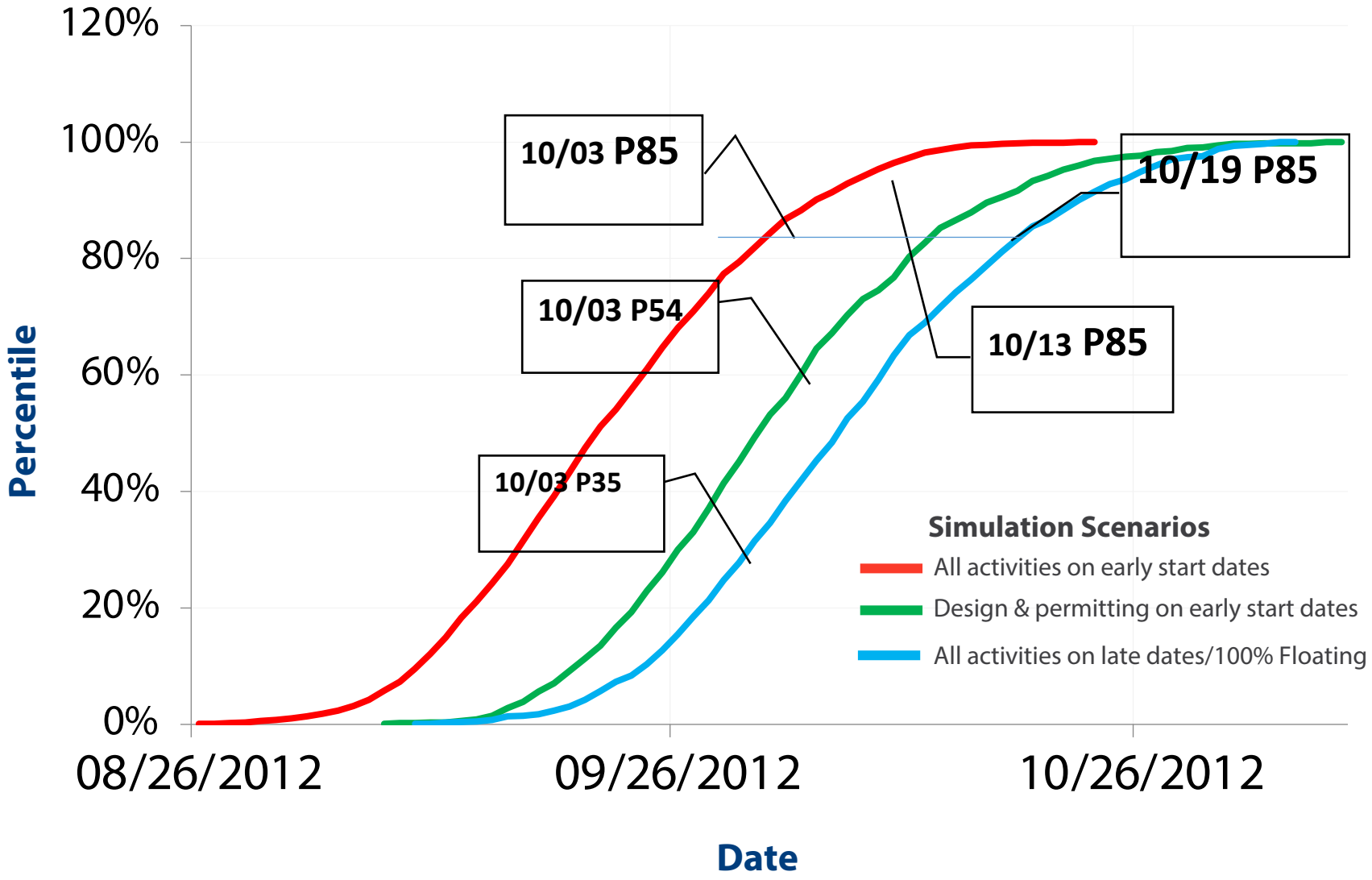
How realistic is the project completion risk distribution when we contemplate the project schedule in simulation occurring thousands of times if, in every iteration, every activity is restricted to start on the early date?

GPM Simulation Models Risk of Late-Start Dates

GPM Project Completion Risk Distribution *Upper Bound*



Bounding Envelope: The Missing Puzzle Piece



A Better Assessment of Completion Risk

- The CPM simulation 85% probability of completing by 10/03/12 is optimistic if floating risk is modeled
- GPM simulation reveals that 10/03/12 more likely falls between P35 and P54
- Reserving schedule contingency over 7% will require replanning for even earlier completion and/or slipping the required completion date

The Recap

- Good models reflect the reality of what they are trying to model.
- Activities within projects don't always start on early dates.
- CPM deterministic schedules start on early dates.
- CPM Monte Carlo simulations always start on early dates.
- CPM simulations have an optimistic bias built in.
- GPM networks are not required to start on early dates.
- GPM Monte Carlo simulations can model later than early date starts based on floating and pacing.
- GPM & NetRisk better represent an accurate simulation of project completion probability.

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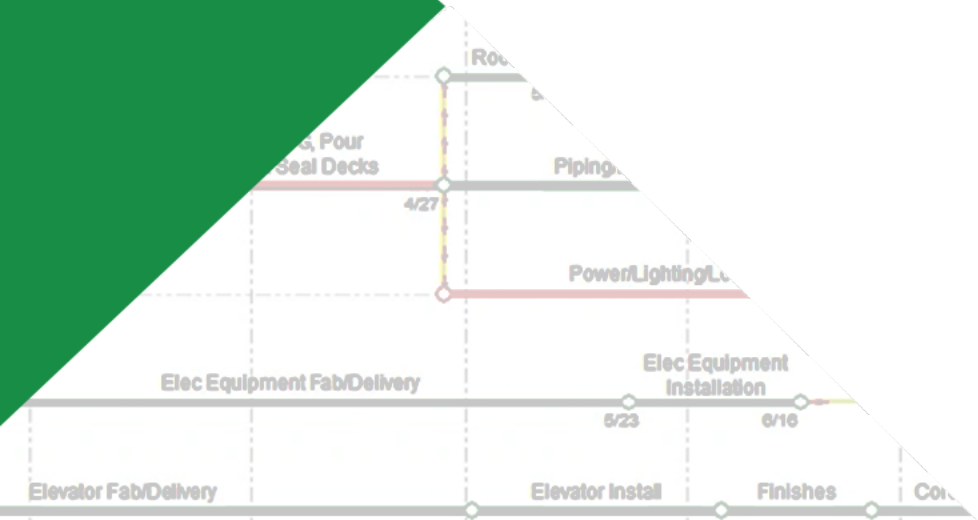
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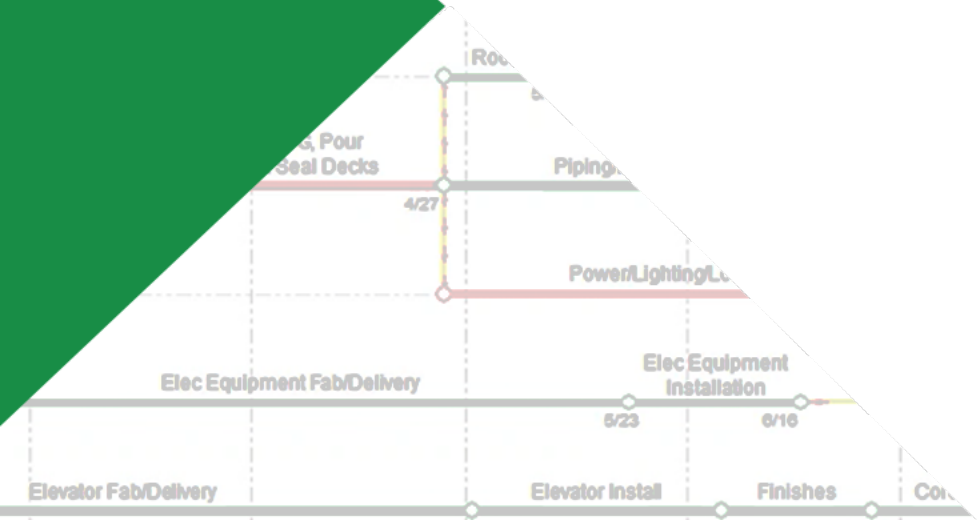
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Demo





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Q & A Time



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Thank You!

