

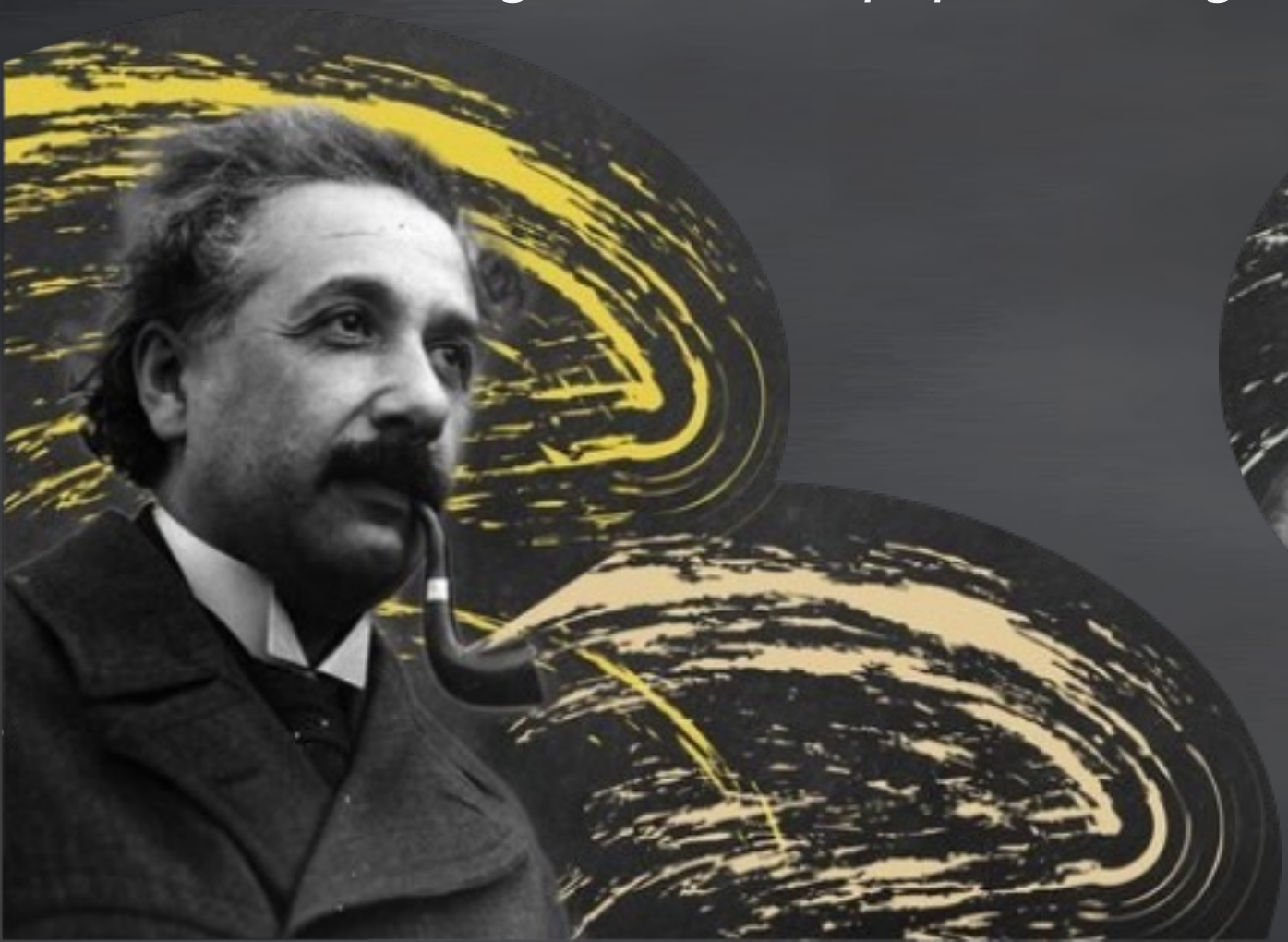
NetPoint + GPM
CONFERENCE
May 11 & 12, 2023

Safe Float

Float *Adjusted* for Uncertainty

Gui Ponce de Leon, PhD, PE, PMP
Vivek Puri, PhD, PMP

Learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop questioning.





– Albert Einstein

MEET THE PRESENTER

Dr. Gui Ponce de Leon PE, PMP

Dr. Ponce de Leon is recognized as one of our nation's foremost planning/scheduling experts. His broad professional experience includes executive and senior roles as investor's developer, program manager, construction manager, EPC contractor lead scheduler, and consultant. He continually pioneers innovations in project scheduling and is the lead inventor in graphical path method (GPM) algorithms and protocols. Dr. Ponce de Leon holds 9 US patents featuring various aspects of GPM.



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MEET THE PRESENTER

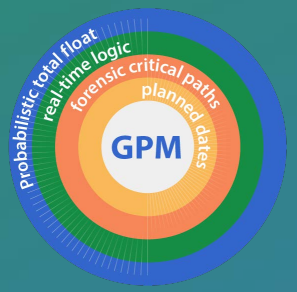
Dr. Vivek Puri PMP

Dr. Vivek Puri has significant experience planning and executing projects in both construction and in information technology. Dr. Puri is a leader in PMA's 12-person Innovation Team; his last decade of work involves research and development and high-level programming relating to NetPoint, NetRisk, and Project Summit, PMA's newest GPM innovation. His doctoral work at Purdue involved simulation applications for construction planning.

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AGENDA

Project Completion Predictability



Safe Float—The GPM Solution

Takeaways

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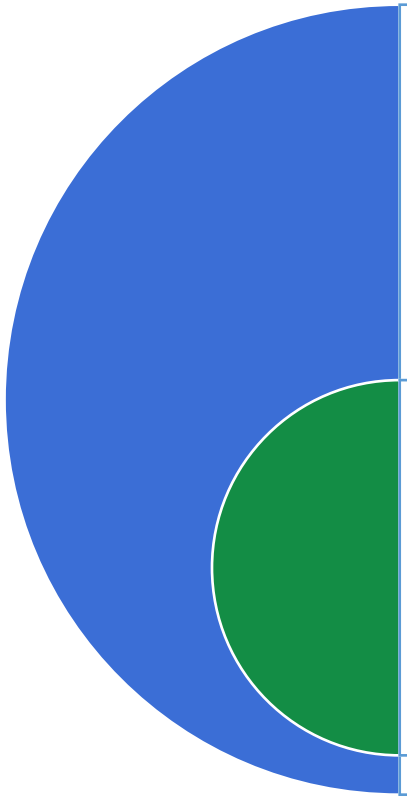
Float Risk Assessment and *Safe Float*

Total float is a key concept in scheduling and schedulers rely on it, day in and day out, even though total float is based on a deterministic schedule without considering uncertainty and risk. To overcome this limitation, at PMA, we are developing a body of knowledge that we call *float risk assessment/FRA*. In FRA, firstly, schedule leeway is calculated with respect to a completion date of realistic likelihood because *float use* is modeled. Secondly, *safe float* values are calculated that take into account all duration uncertainty and risk remaining in the schedule.



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Total Float



Definition: amount of time an activity may be extended/delayed from its early dates ***without causing*** the project to be delayed beyond the required completion date

Disclaimer: No guarantees are implied; projects are innately risky and total float is based on a deterministic schedule without accounting for duration uncertainty and risk

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Project Completion Predictability

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Proliferation of Late Projects

ReNewCANADA

Most construction projects are over budget and late: survey

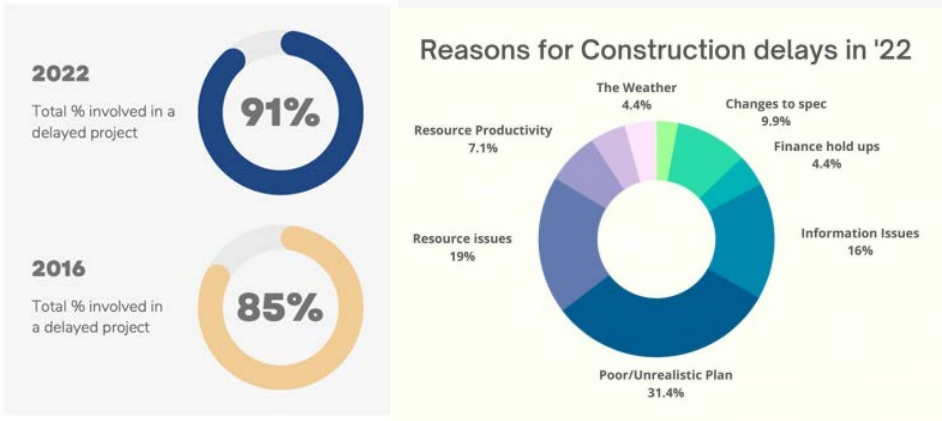
A new survey finds budget and schedule overruns are the norm for more than three-quarters of construction projects, and the adoption of technology can impact performance positively for owners in North America.

The top technologies identified as priority for future adoption were:

- Data centralization technologies (42%)
- Predictive analytics for cost modelling (36%)
- Building Information Modeling (BIM) (32%)
- Digital twin (31%)
- Green building/construction (30%)

CORNERSTONE PROJECTS LTD

Delays in the construction industry: our 2022 survey results and how they compare to 2016



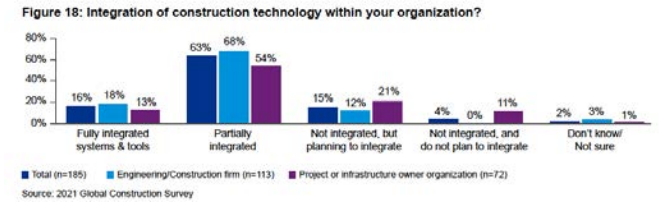
KPMG

2021 Global Construction Survey

Turning point or business as usual?

No turning back: An industry ready to transcend





New Civil Engineer

Delays to large-scale construction projects more than double since start of pandemic

Delays to large-scale construction projects have more than doubled during the COVID-19 pandemic, according to new data released today by nPlan.

Research by machine learning startup nPlan found that the median delay for projects completed before the pandemic was approximately 100 days, while pandemic-era projects have a median delay of more than 200 days.

PlanRadar

Managing construction projects: 9 out of 10 do not finish construction projects in time

In a study by the *Journal of Construction Engineering*, 28% of contractors reported that construction delays were very frequent, 61% regarded delays as fairly frequent and only 11% indicated that they were infrequent. If your business wants to improve time management during the construction process, a combination of the following techniques can help.

PROCORE

78% of Corporate and Public Real Estate Owners Over Budget in Construction Projects: IDC Survey

Survey Reveals How Technology Adoption Positively Impacts Performance

Most Construction Projects Are Over Budget and Delivered Late

The survey revealed that 75% of owners went over planned budgets on their projects and 77% were late

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Total Float Predicates that Handicap Schedules



The schedule finish date—the predicate for total float—is *achievable*



A delay within total float does not delay project completion, ergo is "*safe*"

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1. Schedule Finish Dates Are Rarely Achievable

Deterministic Schedule Completion Date P-Values, CPM Monte Carlo Simulation			
Project Name	SRA Date	Deterministic Completion Date (DCD)	DCD P-value
Expressway - 2018	3/6/2018	8/30/2028	<1%
Expressway - 2022	2/10/2022	12/24/2029	<1%
Drive to I-595 - 2018	5/8/2018	4/30/2029	<1%
2016 Segments 1A, 1B, & 5	5/11/2016	1/11/2027	<1%
- 2016 Segments 2, 3, & 5	5/11/2016	3/3/2028	<1%
- Update 2017	10/2/2017	12/12/2031	<1%
- Update 2020	9/28/2020	12/23/2035	<1%
- Update 2021	10/5/2021	10/22/2035	2%
301 to CR 33 - 2019	1/8/2019	1/7/2025	4%
528 - 2017	10/30/2017	2/5/2029	5%
a Project - 2016	4/5/2016	2/16/2022	5%
Project - Update 2017	1/9/2018	1/31/2023	9%
Project - Update 2018	9/18/2018	11/30/2022	12%
s Interchange 2022	3/29/2022	10/23/2030	13%
chobee Rd - 2018	12/4/2018	3/31/2028	13%
hobee Rd - 2021	3/16/2021	1/5/2032	14%
826	6/2/2016	2/4/2028	14%
Palmetto	5/26/2015	3/2/2027	16%
TBNext - 2018	5/22/2018	7/4/2024	19%
- TBNext - 2019	5/14/2019	6/26/2024	23%
from Rd - 2021	9/21/2021	12/9/2026	39%
Widen 417 to 434 - 2022	7/14/2022	12/18/2028	53%
	8/9/2022	10/4/2029	57%

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Worse Yet, CPM Simulations *Overrate* P-Values



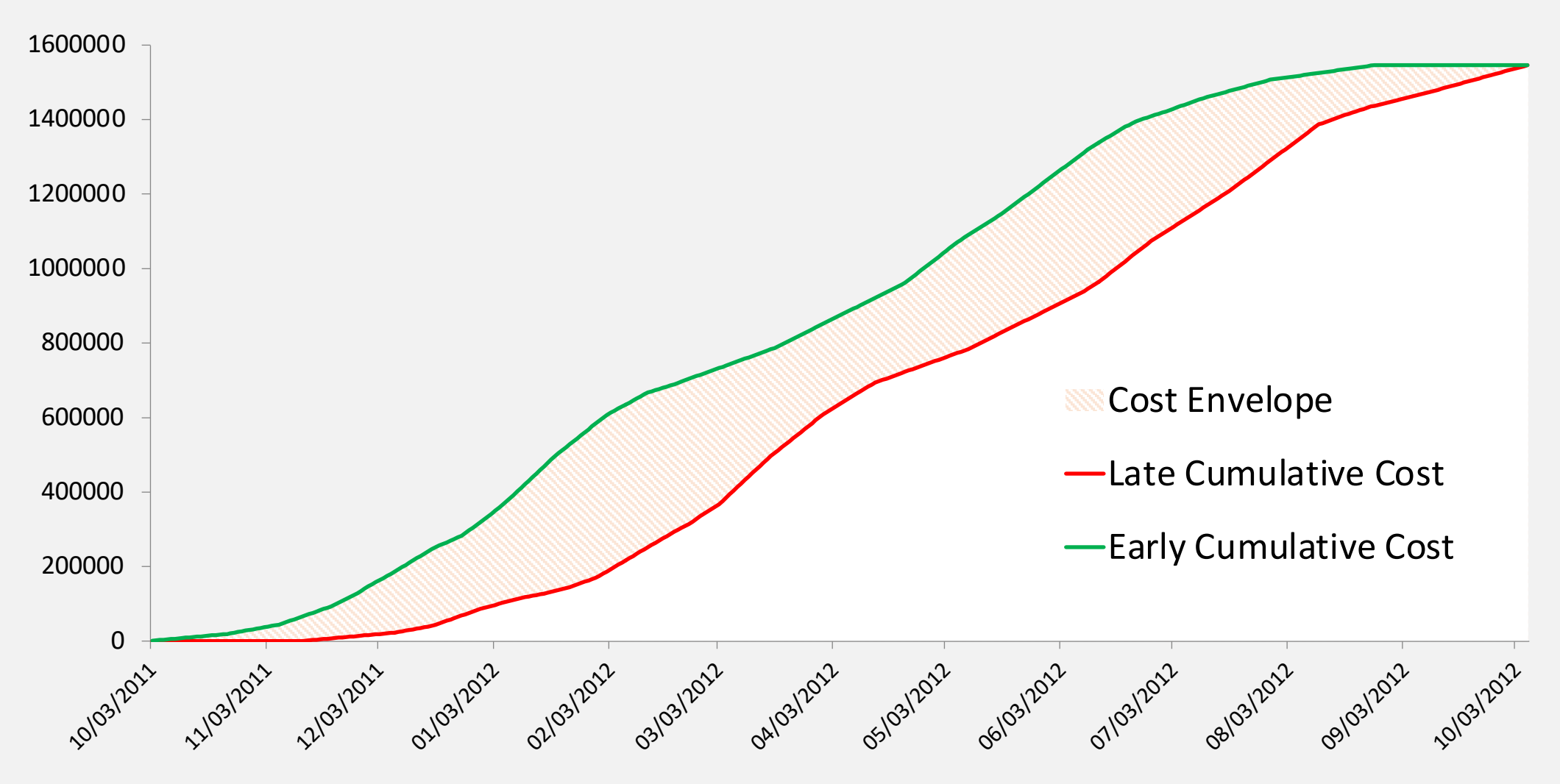
CPM SRA faces the conundrum of predicting, *without modeling* total float use in any iteration, the likelihood of occurrence for the range of project completion dates



Absent total-float-use modeling in CPM simulation, project completion date P-values schedulers routinely rely on decisively overestimate the likelihood of project completion

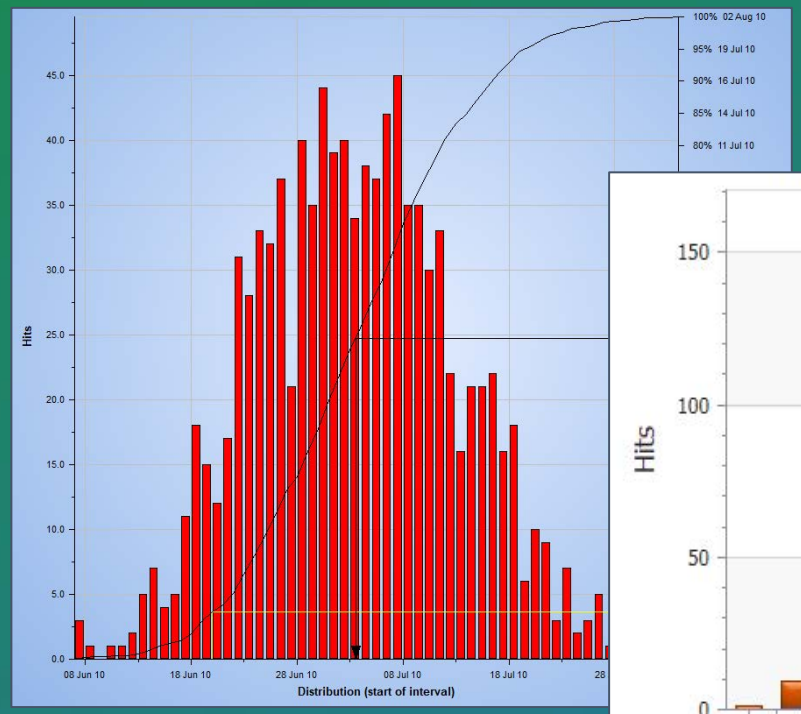
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Float Use Is Commonly Modeled in CPM Conventional (Deterministic) Scheduling…

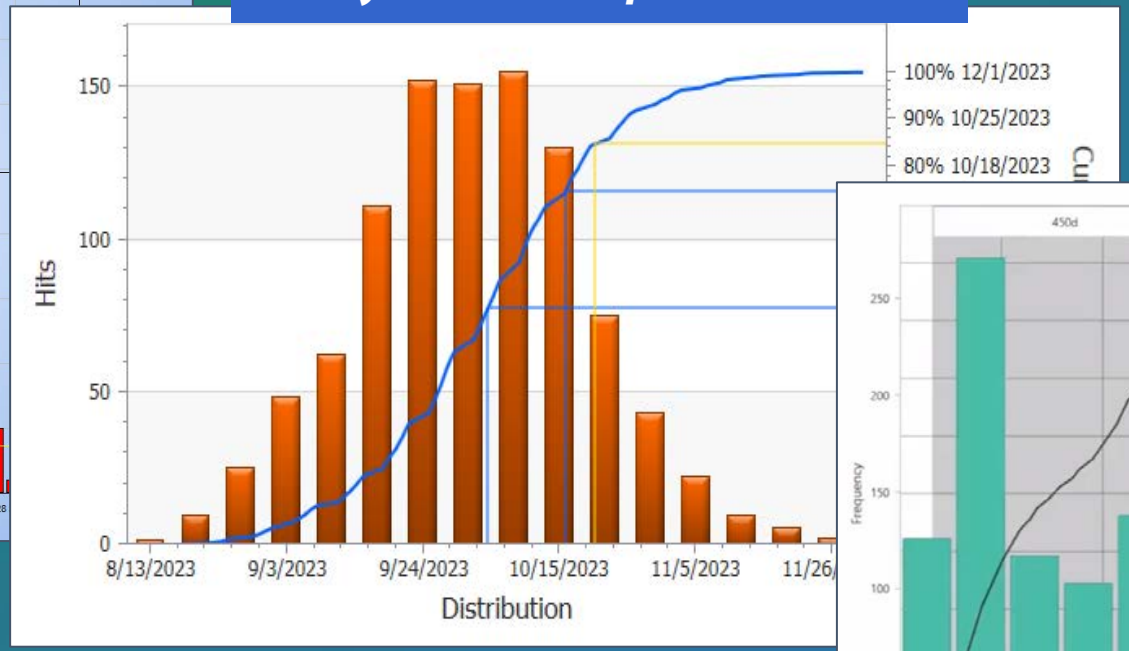


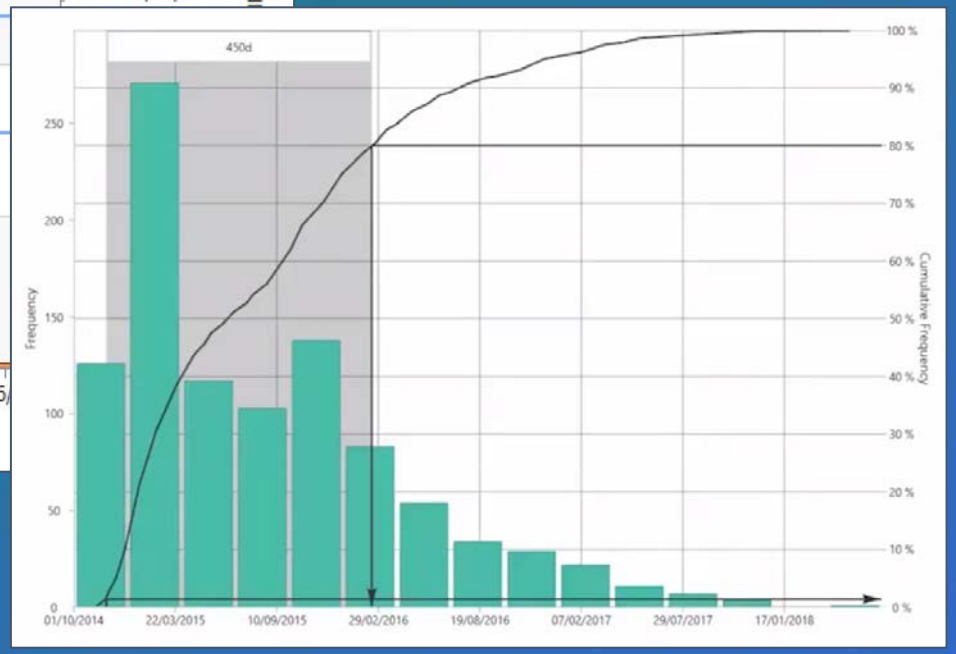
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…but *NOT* in CPM Schedule Risk Analysis!!



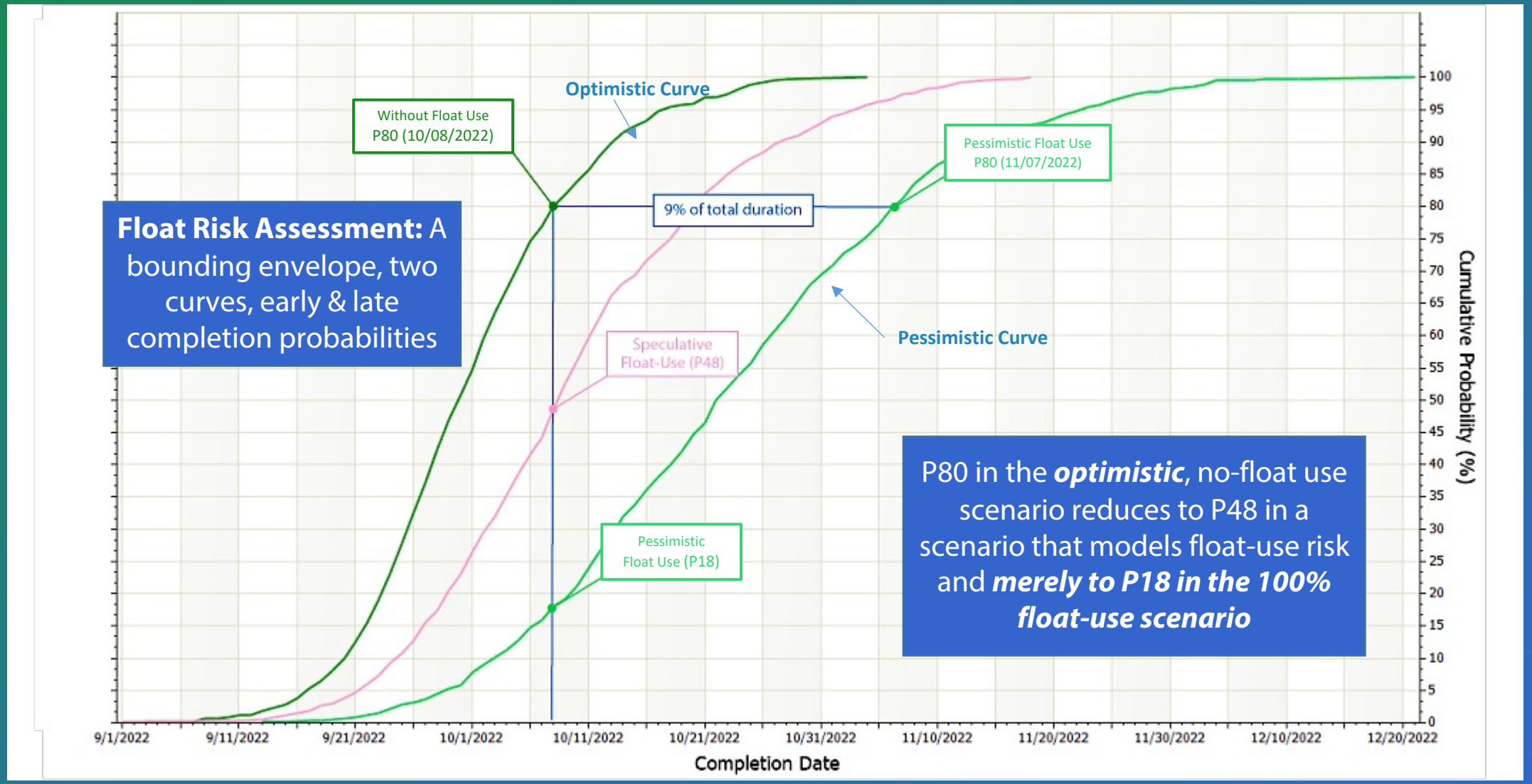
Only one curve, no envelope!
***Early* or *late* completion curve?**





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Float Risk Assessment Impact on P-Value *Curves*



Float Risk Assessment: A bounding envelope, two curves, early & late completion probabilities

P80 in the ***optimistic***, no-float use scenario reduces to P48 in a scenario that models float-use risk and ***merely to P18 in the 100% float-use scenario***

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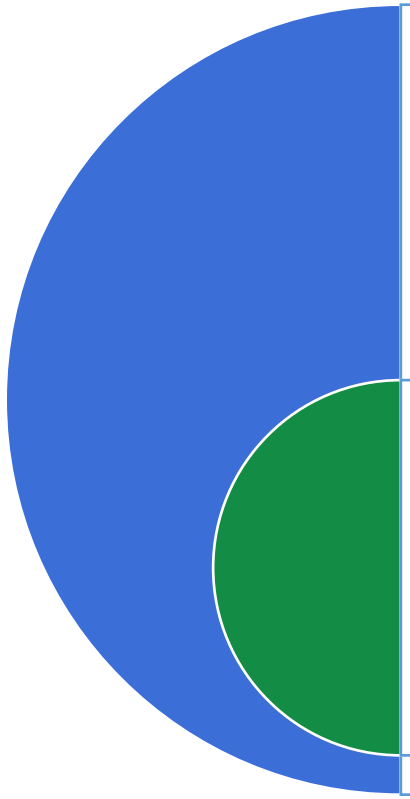
How Reliable, Really, Is Total Float?

Premise—activity durations are inherently uncertain

- Total float is a lagging indicator when making decisions pertaining to pacing
  - Total float can turn out to be a lot less should the activity paced take longer
- Total float treats every network path equally regardless of uncertainty
  - 50% use of total float may impact completion and 110% use may not
- Total float DOES NOT represent the same flexibility throughout the project
  - 5 days of total float at the start are not equivalent to 5 days at the end

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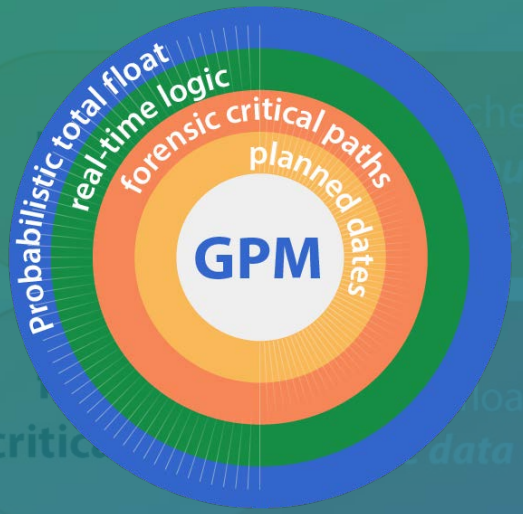
Float Risk Assessment Impact on Total Float



Rather than simulating a schedule *and reverting* to total floats when managing the schedule, why not distill a measure of total float otherwise discernible from the schedule risk assessment?

And let's call that measure of total float *safe float* because it considers all possible activity duration scenarios and is calculated relative to a targeted completion date of *known likelihood* (P-value)

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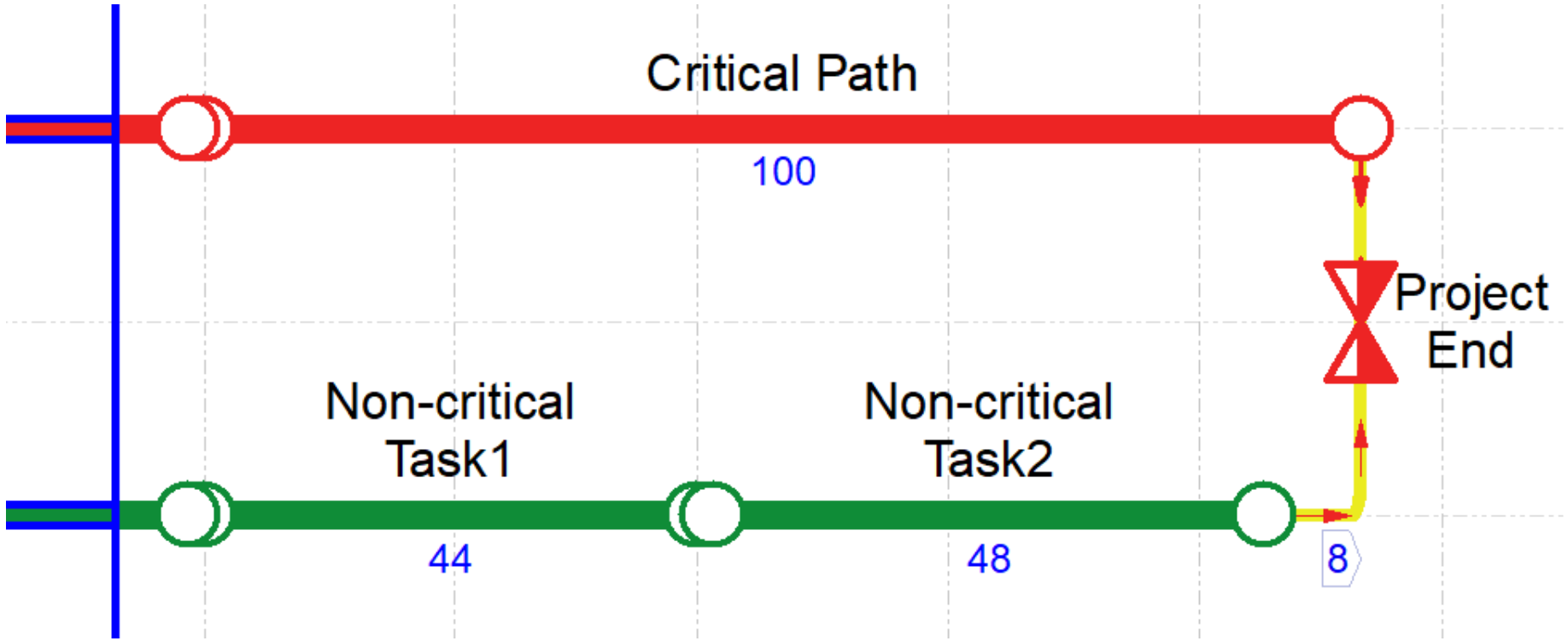


Safe Float—The GPM Solution

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Will you delay?

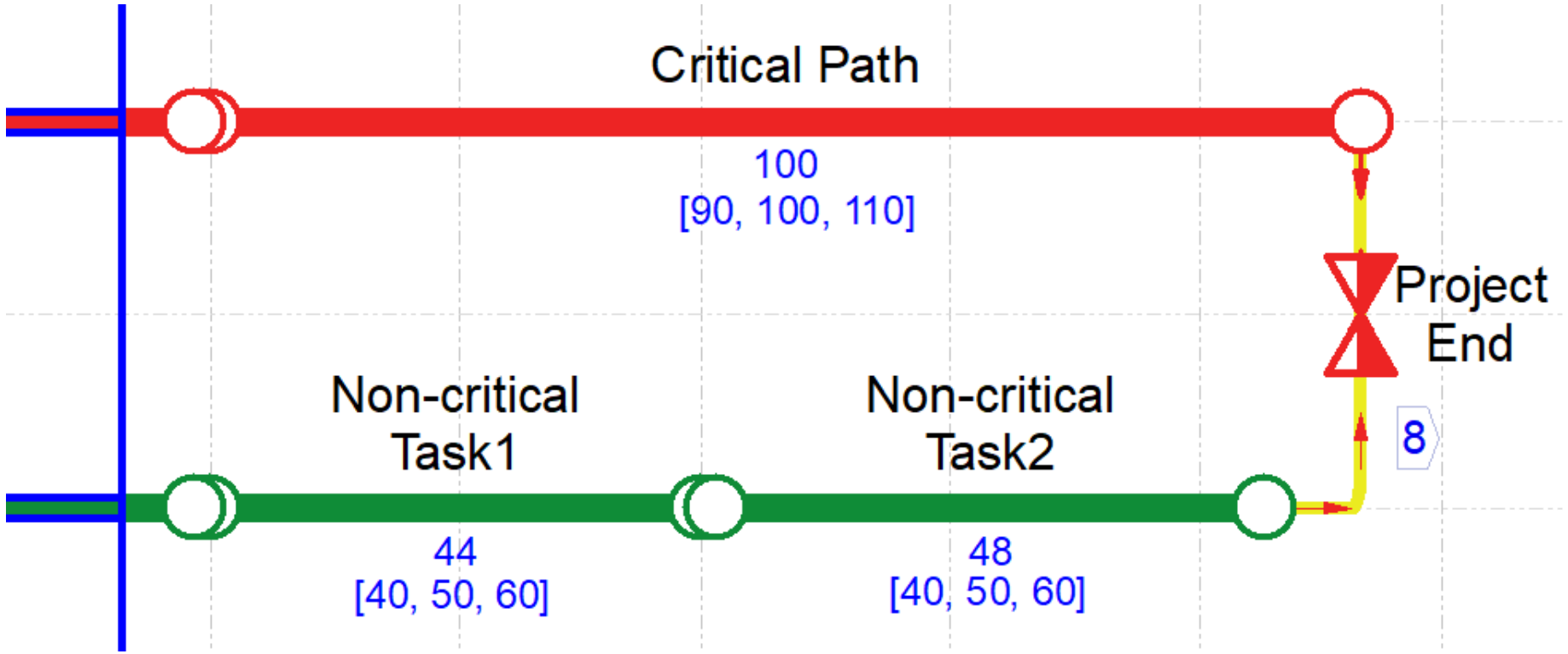
To manage resources and maintain progress on the critical path, will you delay start of “Non-critical Task1” by 7 days?



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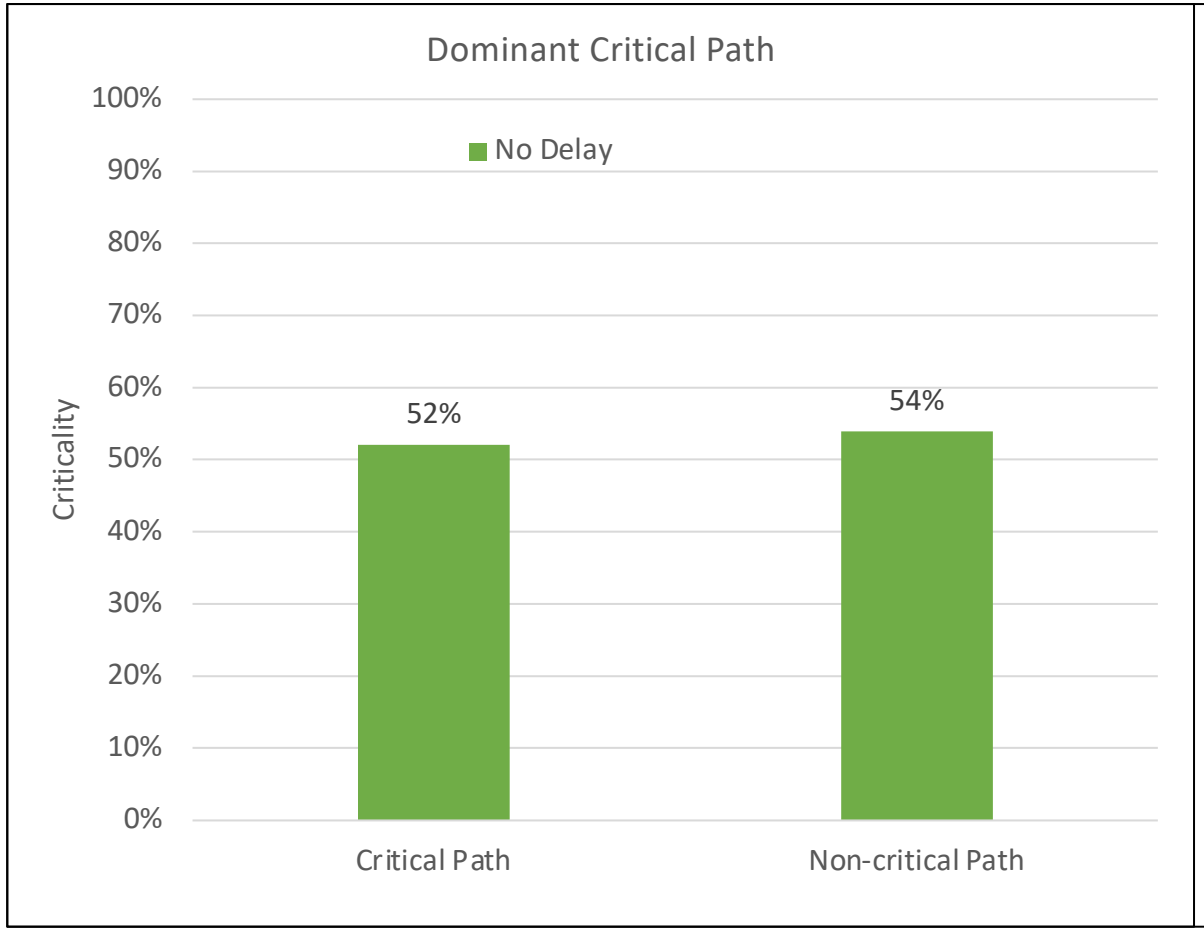
Will you delay?

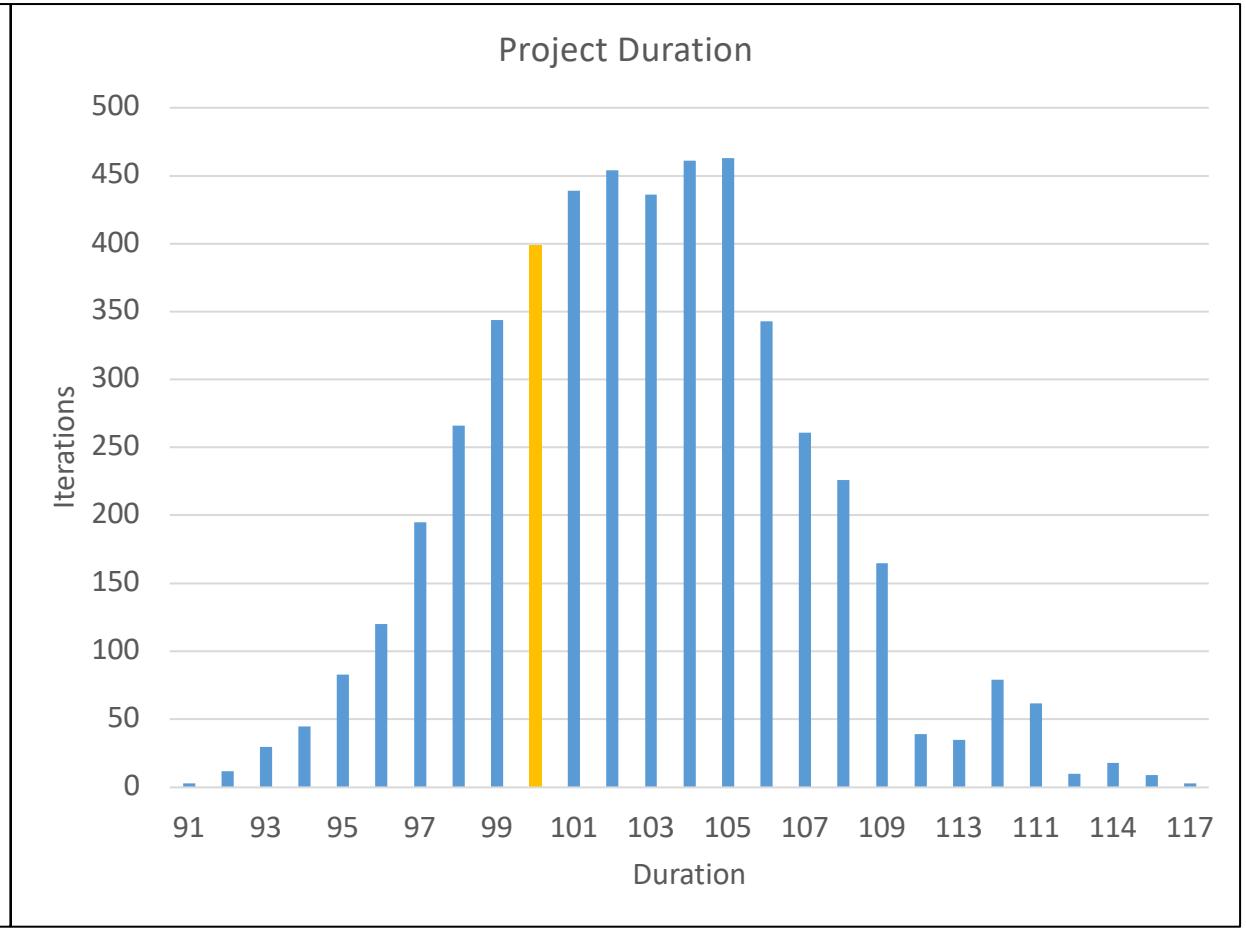
When the task durations are uncertain, how likely are you to delay “Non-critical Task1” by 7 days?



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Statistically speaking…

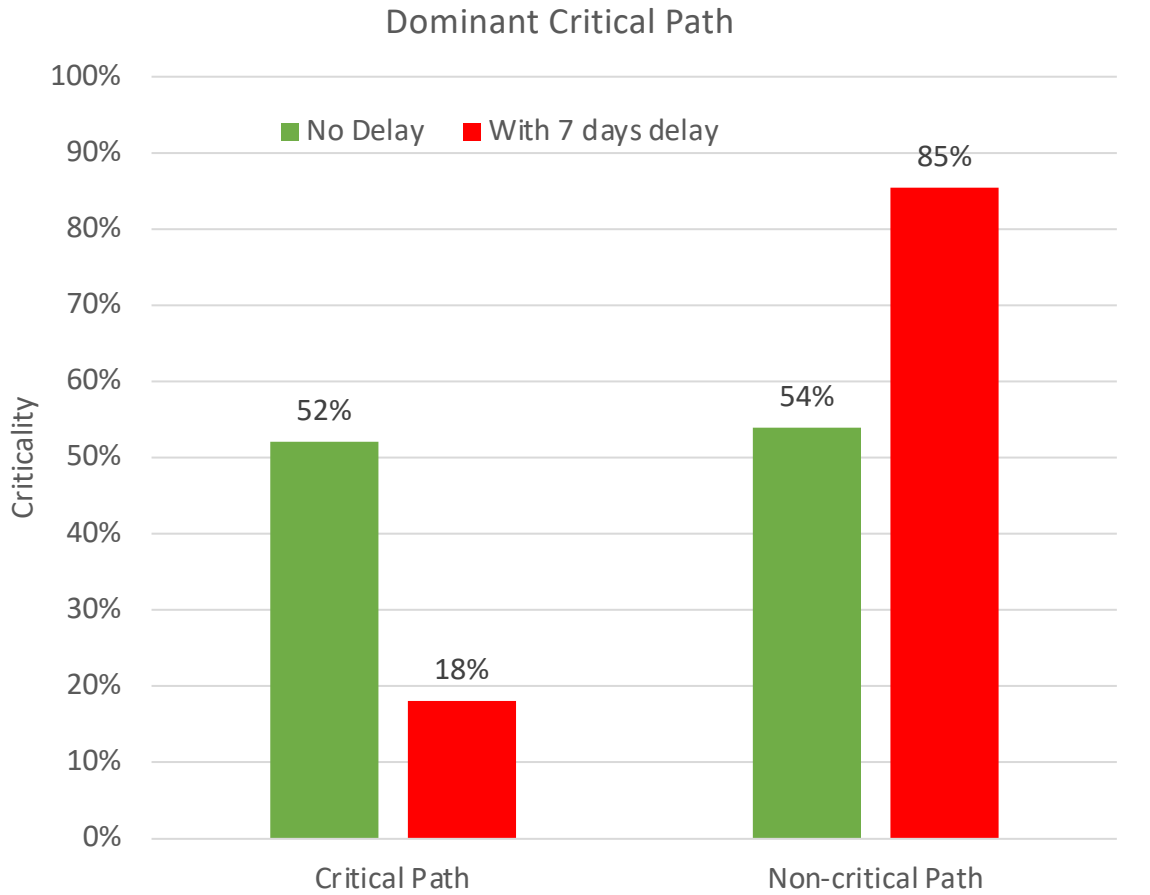


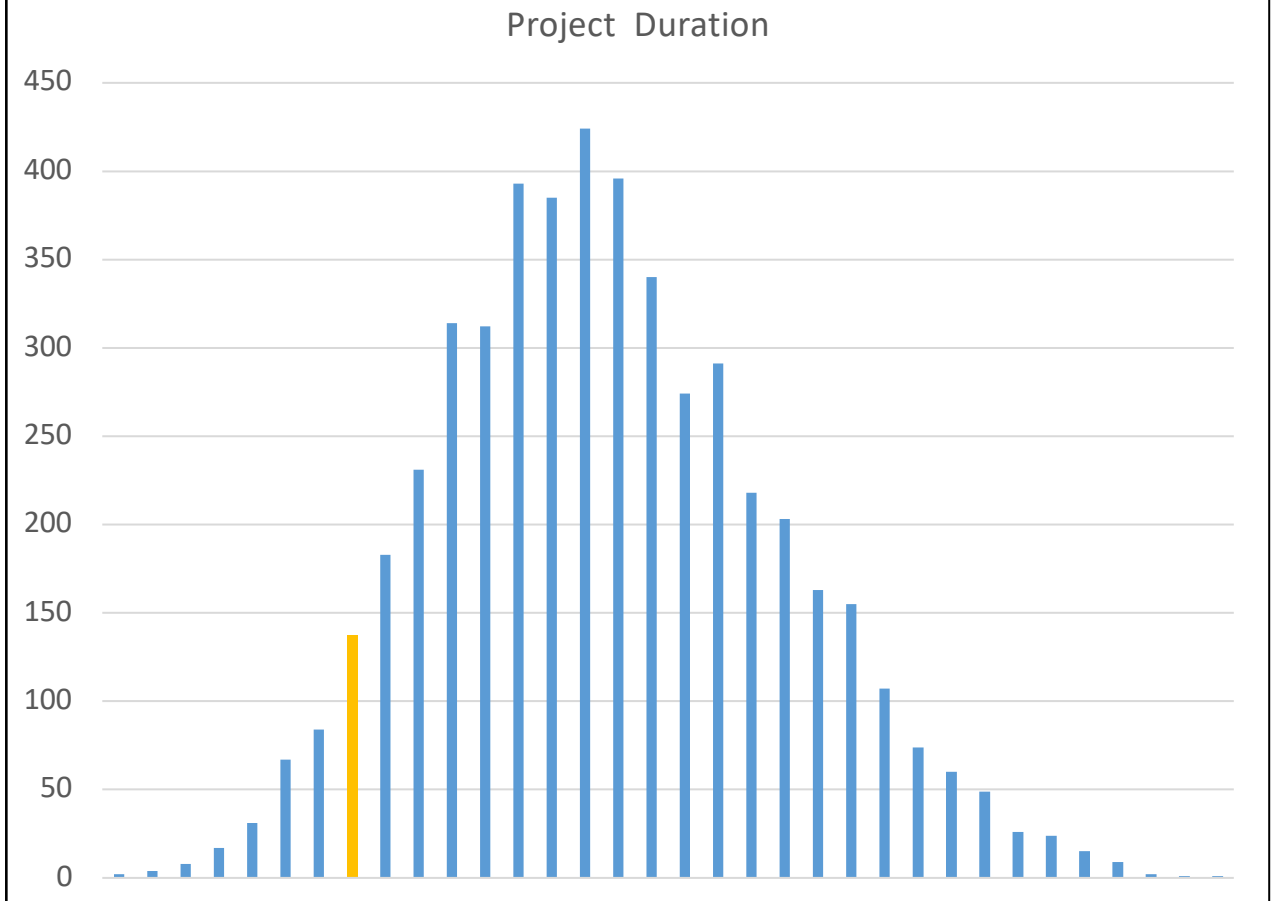


Likelihood of completion by deterministic Project End Date is 30%.

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With delay to Non-critical Task1…





Likelihood of completion by deterministic Project End Date is 8%.

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Combined Influence Problem

Gong & Rowings, 1995

- Joint influence of *float use* and the *uncertainty* of non-critical activities on project completion date

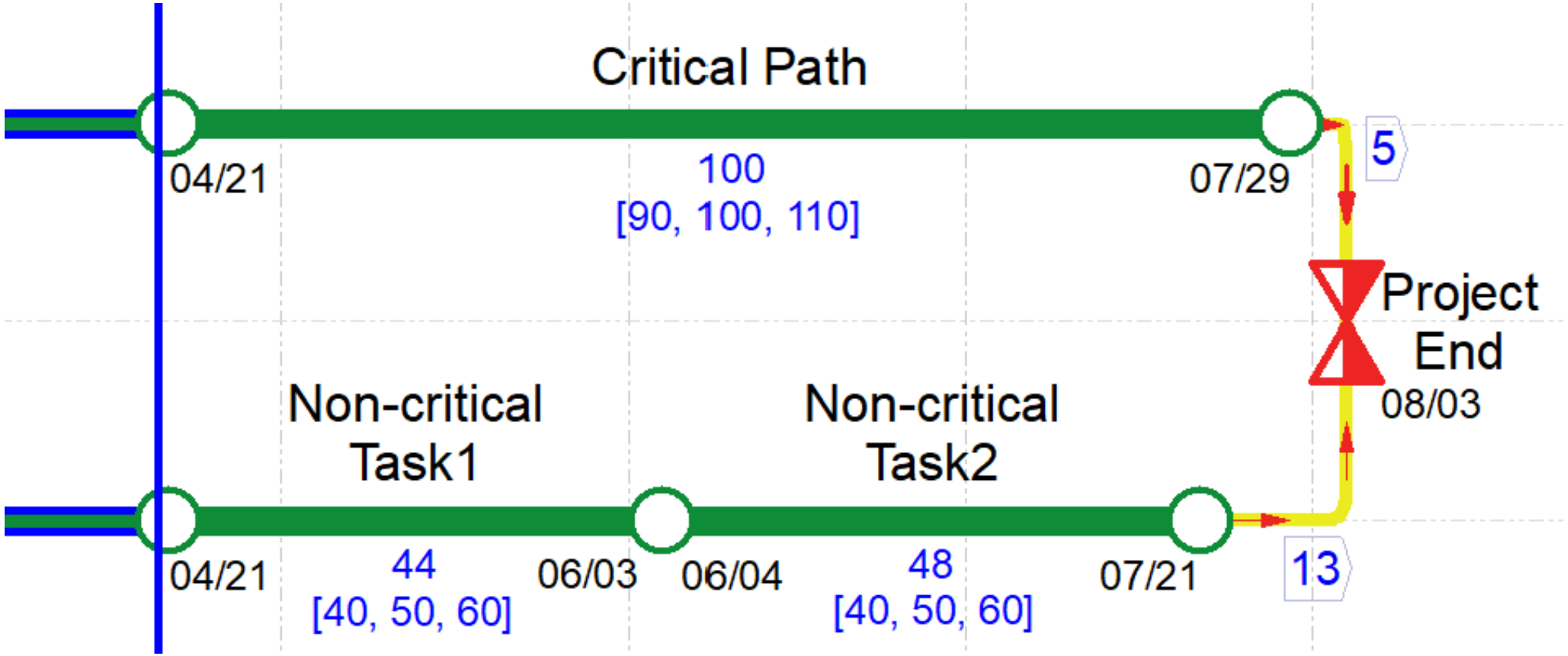
Conclusions

- Conventional solution gives optimistic estimates of project duration and float available to non-critical activities
- Safe range of float use considering duration uncertainty and risk can eliminate or reduce the risk of schedule overrun
- Safe float use can depend on project manager's risk appetite

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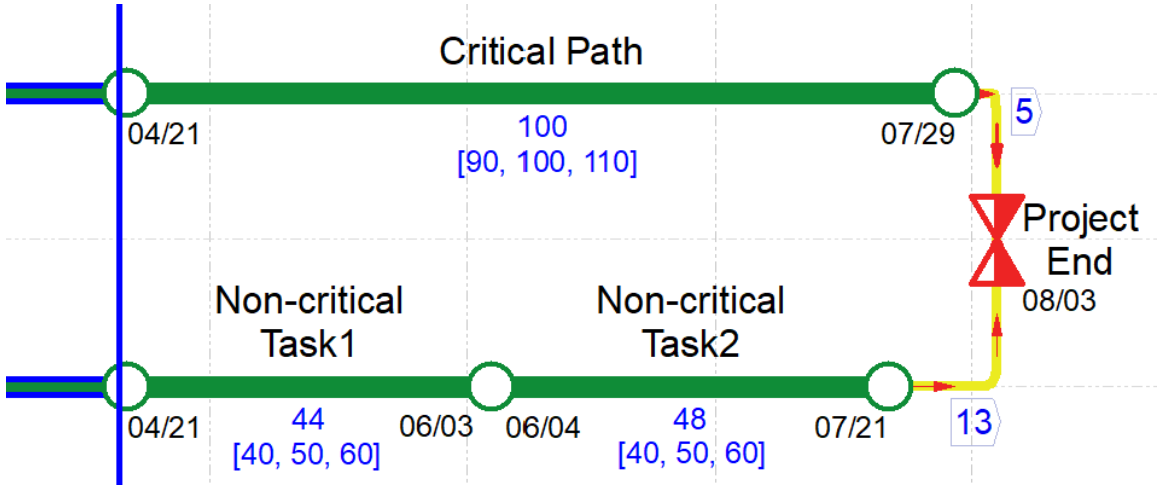
Safe Start Date & Safe Float Use – Theoretical Approach

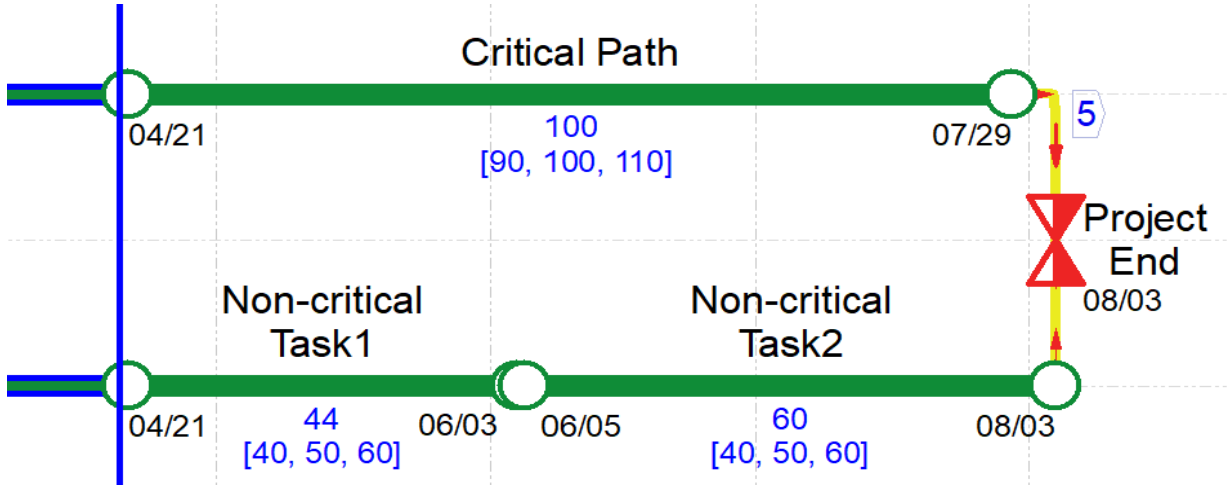
Required Project Completion Date is **August 3**.



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Safe Start Date & Safe Float Use – Theoretical Approach



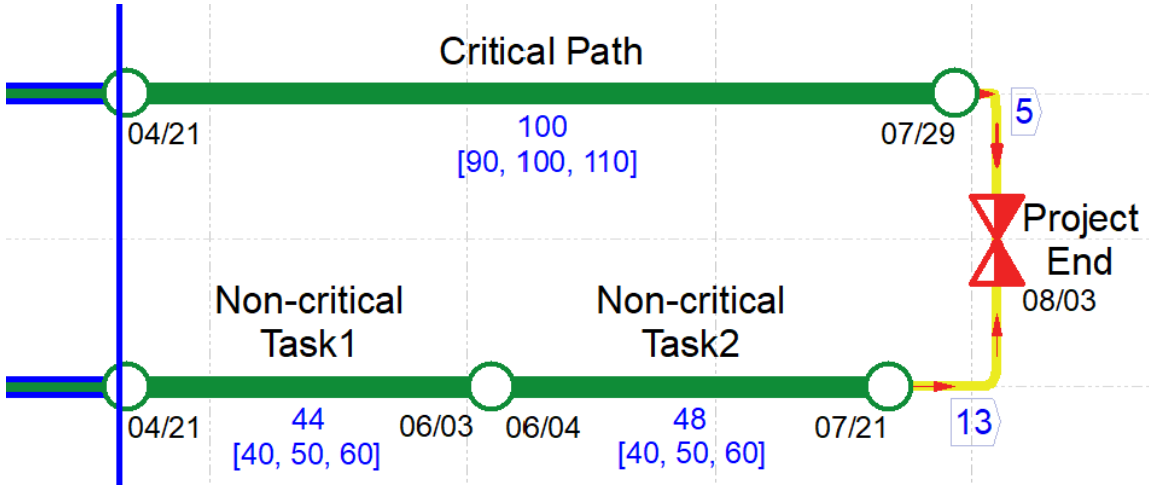


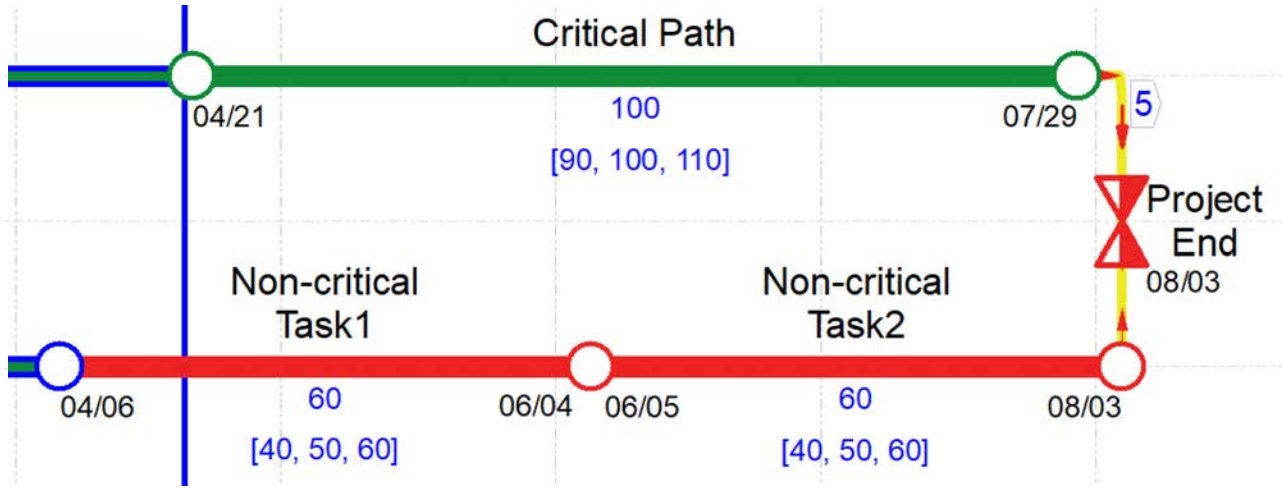
For Non-Critical Task2

- Early Start Date: **Jun 4**
- Late Start Date: Jun 17 (Jun 4 + 13 days of total float)
- Safe Start Date: **June 5** (Aug 3 - pessimistic duration)
- Safe Float Use: **1 day** (from 06/04 to 06/05)

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Safe Start Date & Safe Float Use – Theoretical Approach



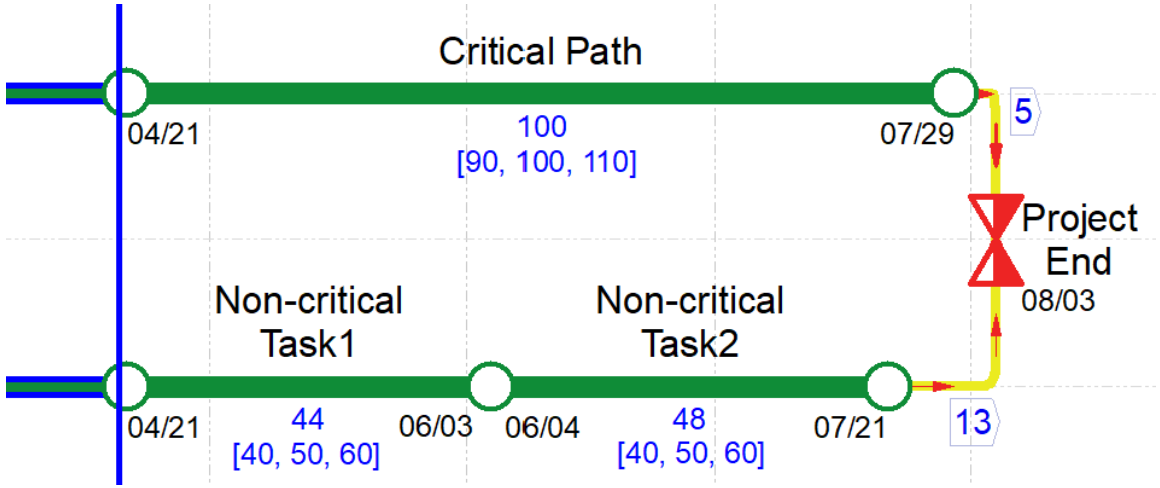


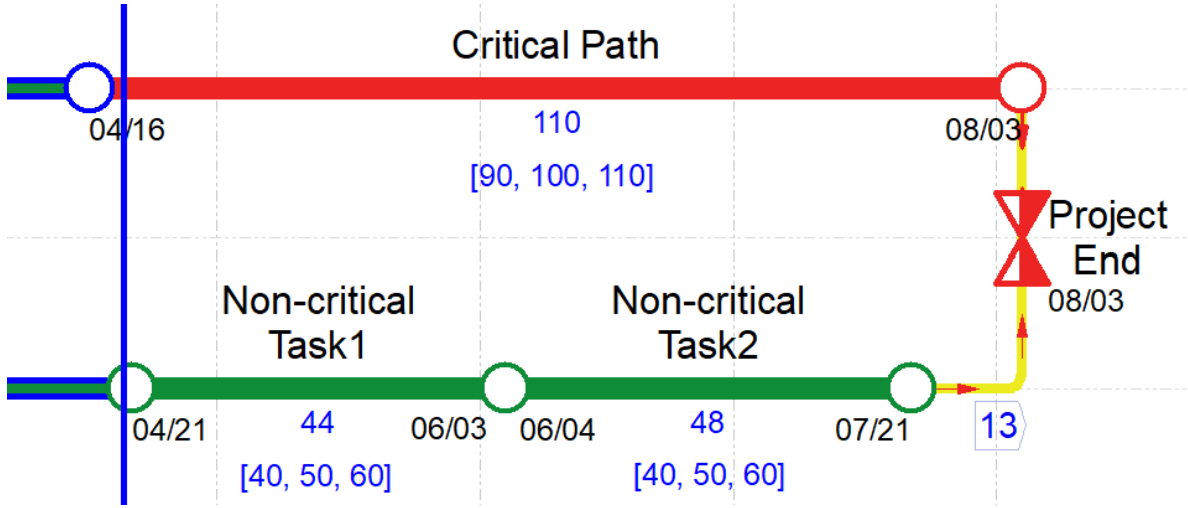
For Non-Critical Task1

- Early Start Date: **April 21**
- Late Start Date: May 4 (Apr 21 + 13)
- Safe Start Date: **April 6** (Aug 3 – 120)
- Safe Float Use: **-15 days** (from 04/06 to 04/21)
- **Any delay will likely delay project end date!**

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Safe Start Date & Safe Float Use – Theoretical Approach





For Critical Path

- Early Start Date: **April 21**
- Late Start Date: April **26**
- Safe Start Date: April 16
- Safe Float Use: -6 days (from 04/16 to 04/21)
- **Any delay will likely delay project end date!**

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GPM Solution—NetRisk

Theoretical Approach

- Calculates ***guaranteed*** safe float
- Leads to strict restrictions on safe float

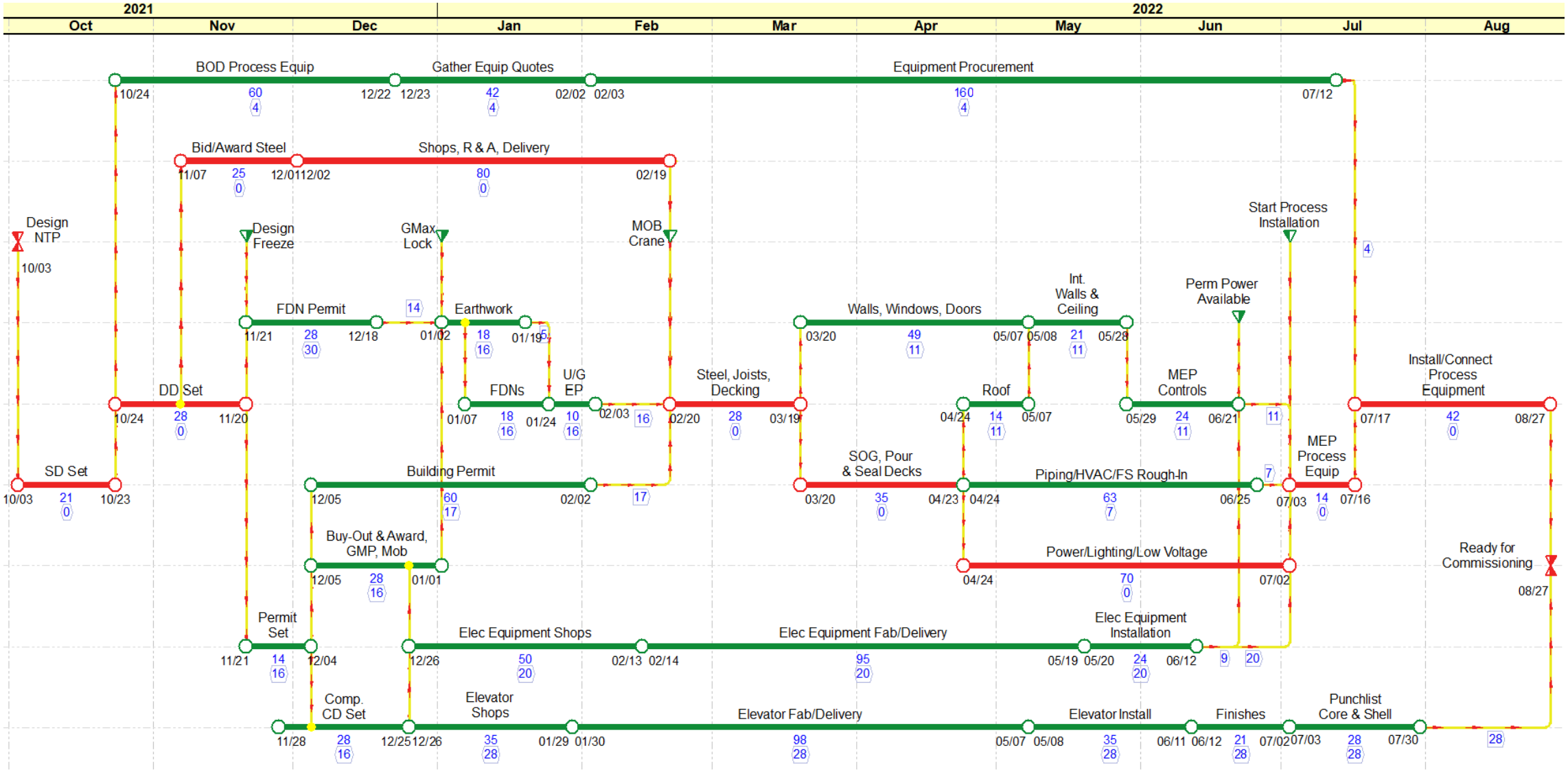
NetRisk–GPM Optimized Approach

- Optimizes to avoid low probabilities
- Considers PM risk appetite
- Uses simulation approach
- Uses risks, correlations, calendars, etc.

	Safe Float (in days)		
Likelihood	Task1	Task2	Critical Path
100%	-16	6	-6
99%	-14	8	-4
95%	-10	9	-3
90%	-10	10	-1
80%	-8	12	0

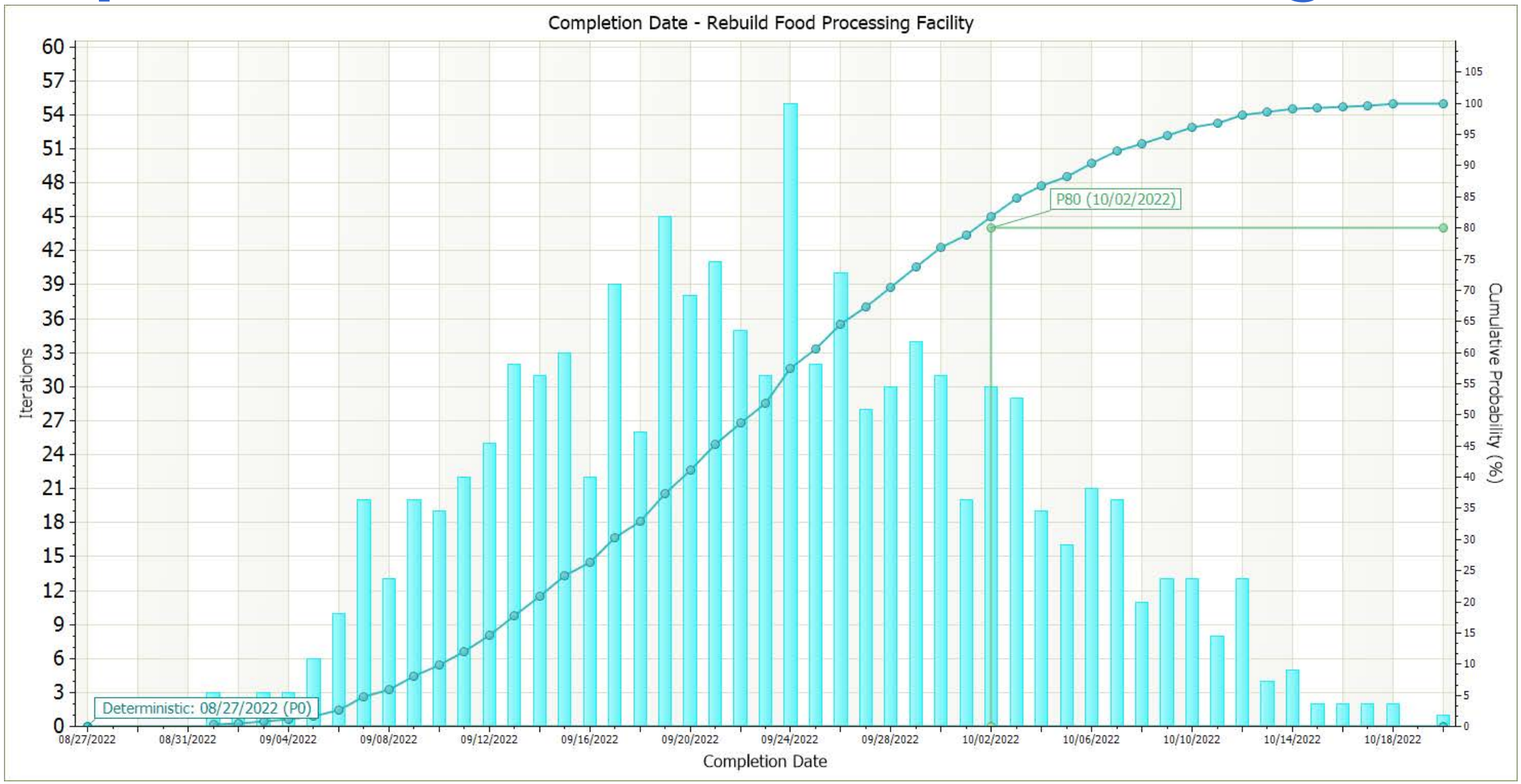
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Case Study – Rebuild Food Processing Facility



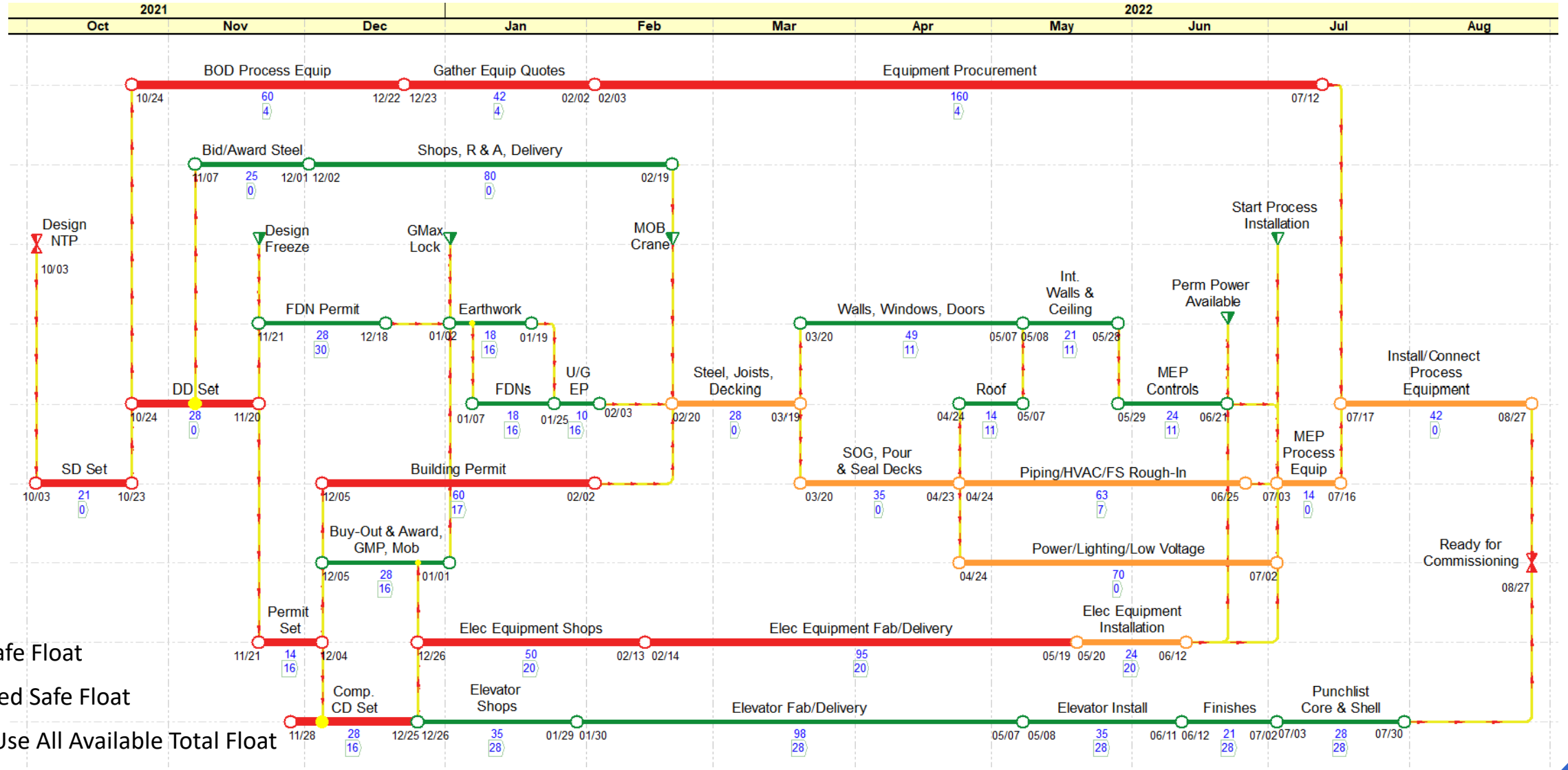
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Completion Date – Rebuild Food Processing Facility



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Safe Float (P80) Overlay



No Safe Float

Limited Safe Float

Can Use All Available Total Float

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Decisions with Safe Float

Due to delays, the project team has used up 15 days of available total float for "Building Permits." Is the project likely to be delayed?

Total Float

- Non-critical
- Deterministic float: 17 days (from Dec 5 start)
- Delay within float thus project is not delayed
- After delay, start date varies due to uncertainty
- Since delay is within available float
  - No mitigation necessary
- BUT, due to 15-day delay,
  - 100% chance to start after Dec 3
  - 100% chance project goes beyond P80 date

Safe Float

- Safe start date is Dec 3
- If start date after delay is earlier
- No delay is likely for project
- If delay within safe start date
  - **~0%** chance project goes beyond P80 date
- If delay is beyond safe start date
  - Project likely delayed/mitigation likely needed

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Decisions with Safe Float

In the base-case schedule, are certain activities starting too late?

Total Float

- Due to schedule contingency (Aug 27 to Oct 2)
  - For every activity, Float > 0
- NO activities starting too late

Safe Float

- If activity start date > safe start date, then activity is starting too late
- For P80 project finish, 8 activities have deterministic start later than safe start date
  - SD Set
  - DD Set
  - BOD Process Equip
  - Permit Set
  - Comp. CD Set
  - Building Permit
  - Elec. Equipment Shops
  - Gather Equip Quotes

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Decisions with Safe Float

To reduce resource profile, how should the project prioritize between fabrication of electrical equipment or elevator?

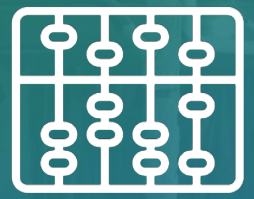
Total Float

- Elec. Equipment Fabrication: 20 days of float
- Elevator Fabrication: 28 days of float
- Delay Elevator Fabrication
- **But**, deterministic float…
  - is based on deterministic duration
  - can be easily manipulated

Safe Float

- Safe float from deterministic start
  - Elec. Equipment Fabrication: 0 days
  - Elevator Fabrication: 14 days
- Task with greater safe float can be delayed
- Delay Elevator Fabrication

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Takeaways

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Safe Float as ***Stochastic*** Equivalent of Total Float

Premise #1

Safe float is a reliable metric because it adjusts total float for uncertainty and risks remaining in all network paths

Premise #2

Negative safe float values in a stochastic schedule undermine the goal of on-time completion just as negative total floats do

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Safe Start—Conventional and Enhanced



Late Start date

- Latest possible start date for an activity without causing the project to finish beyond the ***required*** completion date
- Determined through a forward pass and a backward pass calculation that considers one duration for each activity



Safe Start date

- Latest possible start date for an activity without causing the project to finish beyond the ***targeted P-value*** completion date
- Determined through a simulation that considers duration uncertainty and risk remaining in the schedule when the activity is eligible to start

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Safe Float as a Schedule Control Tool

Safe floats are specific to the network model used in the simulation/float risk assessment

Where a detailed schedule was summarized into a base-case model for the schedule simulation, using **density zooming*™, the underlying detailed schedule can be auto-summarized to the simulation model at will to confirm whether activity actual and projected start dates breach safe start dates

***Density zooming™,** a feature in Project Summit, is real-time navigation on a network schedule on a time-scale canvas, at multiple levels of concordant activity and logic detail, as the time scale is compressed/stretched or as WBS levels of indenture are selected

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About Project Completion Predictability

Because total floats are derived from a forward-pass-calculated, overly optimistic finish date, improving the odds of timely completion requires ample contingency

We leave too much on the table when we simulate a schedule and choose not to assess float-use risk

The combo of total floats and safe floats in scheduling should greatly improve our odds of timely completion

We have much to learn about how to capitalize on safe float principles in deterministic schedules, but the potential project control payoff appears very enticing

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Thank You!

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