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How Artificial Intelligence & the Digitization of Knowledge is Driving Contractor Efficiency

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The Need for Better Forecasting

- We assume project execution is at fault
- Poor productivity is not root cause
- What if our plan is the root cause?
- We have just one chance at execution
yet many chances at planning...

”

*It's not project execution
that fails us, it's our
unrealistic expectation of
success driven by overly
optimistic planning*

Planning Using Traditional Critical Path Method

- Invented in 1956
 - Dupont/Remington, UNIVAC
- Basic premise
 - Input durations & sequence
 - Output dates & float (wiggle)
- 60 years later - same algorithm
 - 15 lines of computer code
- Shortcomings
 - Generates 'best' not 'most-likely' case
 - Inputs highly arbitrary



A Change in Planning Philosophy

Plan For Achievable

- *Plan backwards* - build forecast against a target completion NOT a given start date
- *Path of Construction (PoC)* - link Engineering to Procurement to Construction
- Contingency vs. margin erosion

Leverage Historical Expertise

- *Human Intelligence* - consensus driven so as to eliminate silo planning
- *Augmented Intelligence* – reversal of human-computer interaction
- *Risk Intelligence* – avoid same mistakes twice

$$[PI] = [AI+HI+RI]$$

Full Lifecycle Planning



~~Plan the work then work the plan~~

“Better plan the plan so we can better work the work”

Bid Planning

- Old Way
 - Contingency fixed %
 - Margin % of contingency
 - Unknown confidence
- Post Digital Transformation
 - Contingency based on history
 - Margin adjusted based on competitive requirements
 - Bid carries confidence factor



Building a Deliverable-Based Forecast

- Costs/durations mimic the product of quantities & productivity rates
- Quantity take-offs from 2D/3D drawings
- Durations derived from marriage of quantities & productivity rates

Package	Output	QOM	Quantity/QOM	Hours/Day/Wk/Mth	\$/QOM
Wall Preparation Workmanship	1	sqm	4	Days	\$15,000.00
Concrete Workmanship	12	Cubic Yards	1	Days	\$9,000.00
Concrete Pour 4000 x 100mm x 100mm	1	Cubic Yards	3	Hours	\$30.00
Concrete Pour (general) Workmanship	8	Cubic Yards	1	Days	\$20,000.00
Concrete Pour (cellar) Workmanship	8	Cubic Yards	1	Days	\$15,000.00
Concrete Workmanship	1	sqm	4	Days	\$40,000.00
Early Works Workmanship	1	Area	1	Days	\$2,000.00

Rate Estimation
Package Output: 12 QOM: 1 Rate: 30

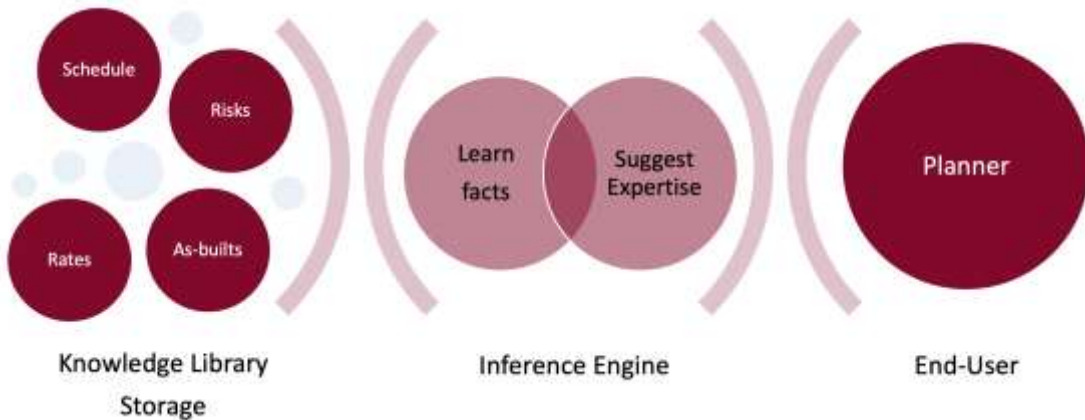
Output: 12 QOM: 1 Rate: 30

How many Cubic Yards? 120
How many Days? 12

120 Cubic Yards of Concrete to pour @ 1 day will take 12 Days and cost \$108,000

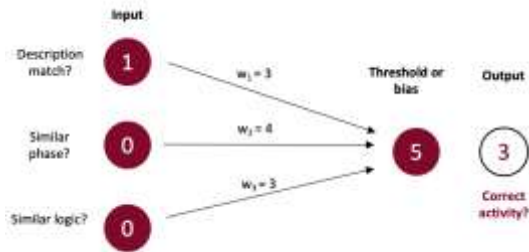
Productivity Rate Estimation
Rate: 30
Total Cost: \$108,000

Augmented Intelligence Using an Expert System

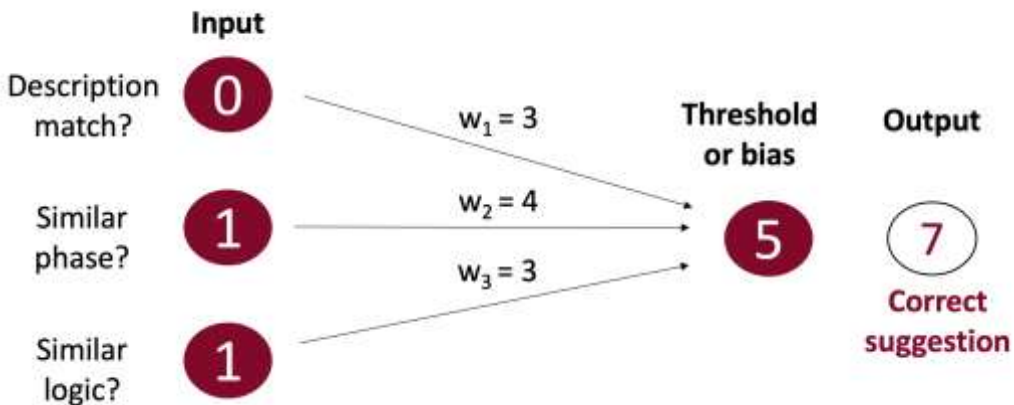


Planning Neural Network

- Objective: suggest suitable cost/duration based on historical performance
- 3 characteristics
 - x_1 does the description match?
 - x_2 is it similar phase?
 - x_3 Is there similar logic?
- Apply importance through weightings
 - Description match $w_1 = 3$
 - Similar phase $w_2 = 4$
 - Similar logic $w_3 = 3$



Machine Learning

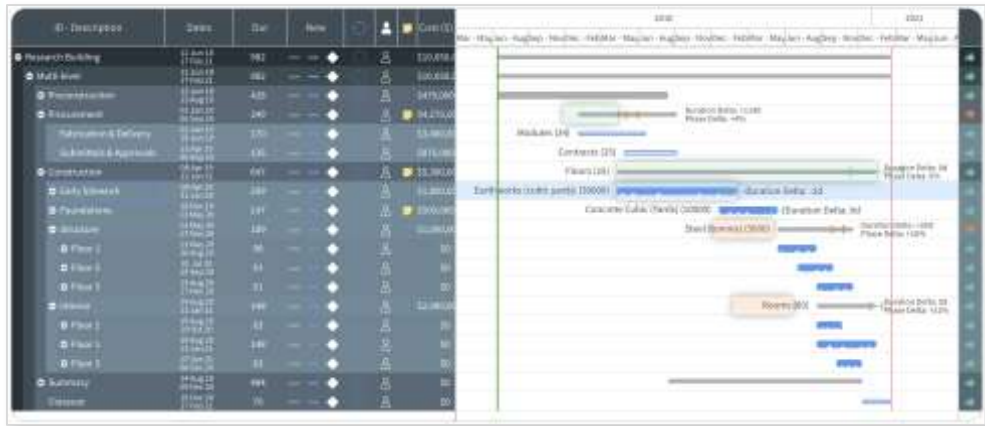


Multiple Suggestions Based on Match



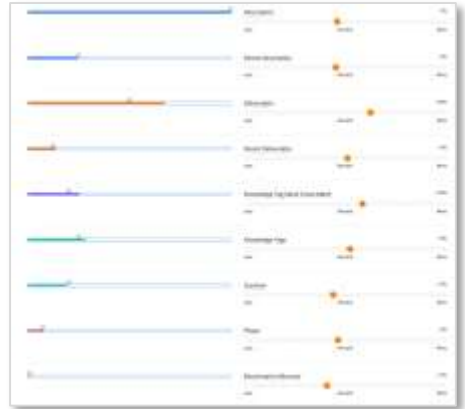
- Don't assume engine can provide the **best** suggestion
- Multiple suggestions based on degree of match

AI-Based Forecasting Critique



Automatically Gets Smarter

- Inference engine
- The 'brain' that mines knowledge
- Multiple attributes pinpointing context
- Algorithm adjusts automatically
- Self learning based on adoption



Incorporating Expert Opinion Through Human Intelligence (HI)

Objective

- Incorporate team expertise
- Validate proposed bid

Process

- Canvas team members
- Simple voting interface
- Consolidate inputs

Result

- Consensus-based bid



- Duration buy-in
- Capture risks
- Request changes
- Challenge quantities

Driving Confidence Through Risk Intelligence (RI)

- Account for qty growth
- Incorporate external risks
- Calculate contingency

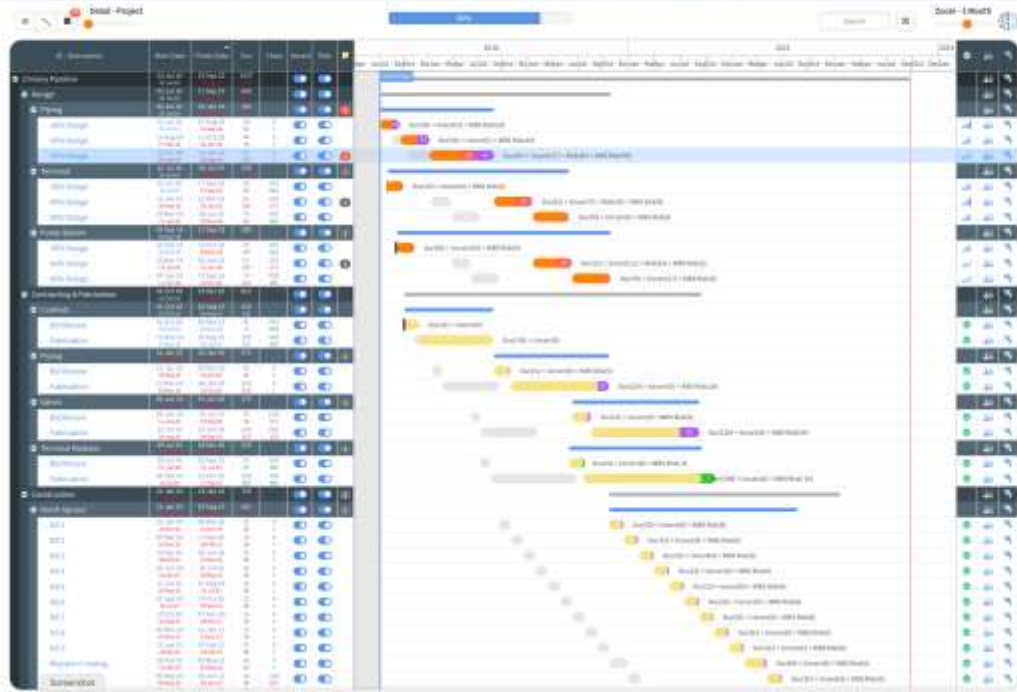
Traditional CPM-based bid



Risk-Adjusted Bid



Risk-adjusted plan as long as CPM model & critical path is different



Business Overview

Currency Type

Base will create a job definition for the user setup.

Layer	Min Sur	Constraint
Submittals	45	
	45	
	45	
	45	

Distribution

Base will apply the beta percentage against the distribution, meaning divided by one to constantly distribute.

Min:

Early:

Mid:

Max:



Min Sur (PTE)

Calculated

Apply to Log

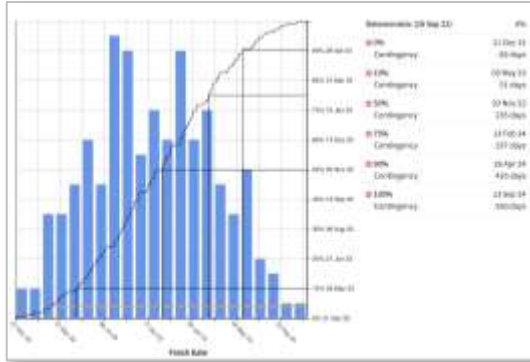
Register



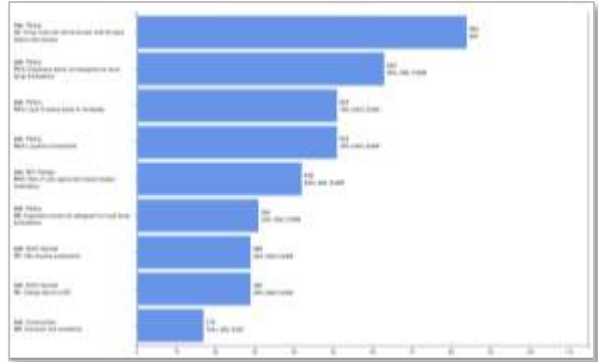
Add Entry

Bid Risk Reporting

What is My Exposure?

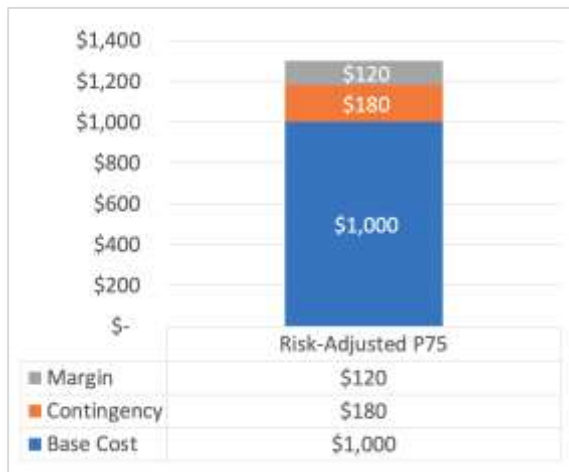


Why so?



Net Result

- Bid required less contingency than originally thought
- 75% certainty of no margin erosion
- Opportunity to reduce total bid price & still maintain margin.



Kiewit's Project Intelligence (PI)

Augmented Intelligence



Leveraging historical performance

Human Intelligence



Domain experts are validating bids

Risk Intelligence



Certainty in forecasts

ALL ENABLED THROUGH
PROJECT DIGITIZATION
RESULTING IN STRONGER
BID COMPETITIVENESS &
BETTER EXECUTION
EFFICIENCY

THANK YOU