

Mastering
Complex Projects

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Developing and Delivering Complex Projects using Quantitative Risk Analysis

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Presentation Outline

- Monte Carlo & Australia's poor project performance
- QRA: An emerging project management tool
- What keep SRA & CRA apart
- Scepticism toward MCM
- Importance of Schedule to QRA
- True Integrated Cost & Schedule Risk Analysis (IRA)
- Comparison with Serial SRA to IRA
- Examples of use of IRA

Addressing Australia's Poor Project Record

- IPA (2009): 74% of completed large projects they assessed had been failures, mainly due to poor front-end planning
- PwC (2012): ~90% of project failures due to management
- Focus here on use of MCM to improve project development and delivery:
 - Review history & use of MCM
 - Identifies IRA as best available tool, compares with SRA to CRA
 - Examples given of use of IRA
 - Challenges to overcome for best practice QRA to prevail

History & use of Monte Carlo Method (MCM)

- Developed from the Manhattan Project in WWII
- First applied to schedules (PERT) by RAND Corp in 1963
- MCM applied to Capex Discounted Cash Flows in 1964
- World Bank applied MCM to 3 projects in 1970
- Spreadsheet add-on tools @Risk & Crystal Ball released in 1987; used for Cost Risk Analyses (CRAs)
- Schedule Risk Analysis (SRA) tools mostly spreadsheet types linked to MS Project or built into CPM tools such as Pertmaster, now known as Oracle's Primavera Risk Analysis (PRA)
- Wide (not universal) acceptance of necessity for project SRAs &/or CRAs – Quantitative Risk Analyses (QRAs) before and during project execution

PROJECT QRA: EMERGING TOOL

Increasing Use of Monte Carlo Method for
Projects without Consensus on Methodology
and with Scepticism from Some



Separation of Cost & Schedule Risk Analyses

- Despite the acceptance that “time is money” in projects, there is resistance to integrating cost and schedule risk analyses.

Here's why:

- CRAs done by estimators and cost controllers (quantity surveyors & cost engineers) using @Risk or Crystal Ball
- SRAs done by planners & schedulers (tend to be design & construction engineers) using PRA or @Risk for Project or other tools
- SRA tools that can handle costs are not as easy to use for costs as for schedule
- Even where same practitioners perform both SRA & CRA, they tend to use different simulation tools due to evolved specialisations

Scepticism about Monte Carlo Method

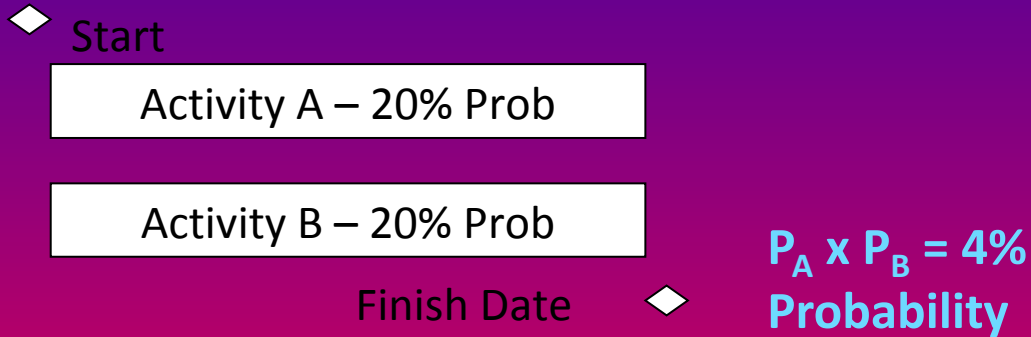
- Significant doubt about QRA value due to hearsay or experience of poor / misleading use in projects
- Believed to be due to multiple factors:
 - Lack of published evidence project QRA is helpful
 - Immaturity of Project QRA discipline resulting in wide range of offered capabilities and disillusionment
 - Lack of understanding and inability to specify QRA
 - Misuse of QRA to produce the desired results

Importance of Schedule to Rigour of Analysis

- SRA modelling of key milestones depends on how well the schedule model represents the project:
 - Represents project scope and strategy
 - Allows for inherent uncertainty of task durations (e.g., the daily trip to work)
 - Allows for complexity of project schedule logic: Merge Bias Effect (next slide)
 - Allows for risk events
 - Allows for weather uncertainty

Merge Bias Effect

- If we have two identical strings of activities and resources to do them, each with a 20% probability of being finished by the target finish date, what is the probability of both being finished by that date?



- This is known as Merge Bias Effect (MBE) and it is reason why it is so hard to finish a project on time when many strings of activities converge into finish and delays have occurred. Probability falls geometrically.
- It is also why it is important to model complex projects with detailed schedules. Summary schedules reduce MBE, falsely increase optimism.

Success using SRA on detailed schedules

- Australian LNG Train Completion to RFSU
 - 5 months from planned startup (RFSU), schedule slipping each week
 - 2,700 tasks converted to hourly schedule
 - Duration ranges from superintendents
 - Several SRA iterations, correcting startup logic
 - 3rd produced P50 within 3 days of actual
- Middle East LNG Train Completion
 - 4 months from planned RFSU, slipping sched
 - Construction not connected to commissioning, used pressure testing systems dates to link
 - 1,000 task sched modified with SRA iterations
 - Commissioning logic changes resulted in P50 within 1 day of actual RFSU
- Oil Refinery Enhancement Project
 - 4 mths into 18 mths EPC project , owner required SRA of key milestones
 - First milestone was “95% Engg Complete”
 - After ranging of ~700 task sched by EPC Contractor Proj Mgr & Chief Planner, Planned & SRA dates for 95% Engg were: Plnd: 16Sep; P50: 26Oct; P90: 5Nov
 - Proj Director rejected results stating he was negotiating with EPC Contractor to bring 95% Engg Complete MS forward by 2 weeks
 - Subsequently actual 95% Engg was 5Nov
 - 2 further engagements on project resulted, during procurement and construction

INTEGRATED COST & SCHEDULE RISK ANALYSIS

What is Integrated Cost & Schedule Risk Analysis (IRA) and How does it compare with Serial SRA to CRA (SRA2CRA)?



The IRA Process - 1

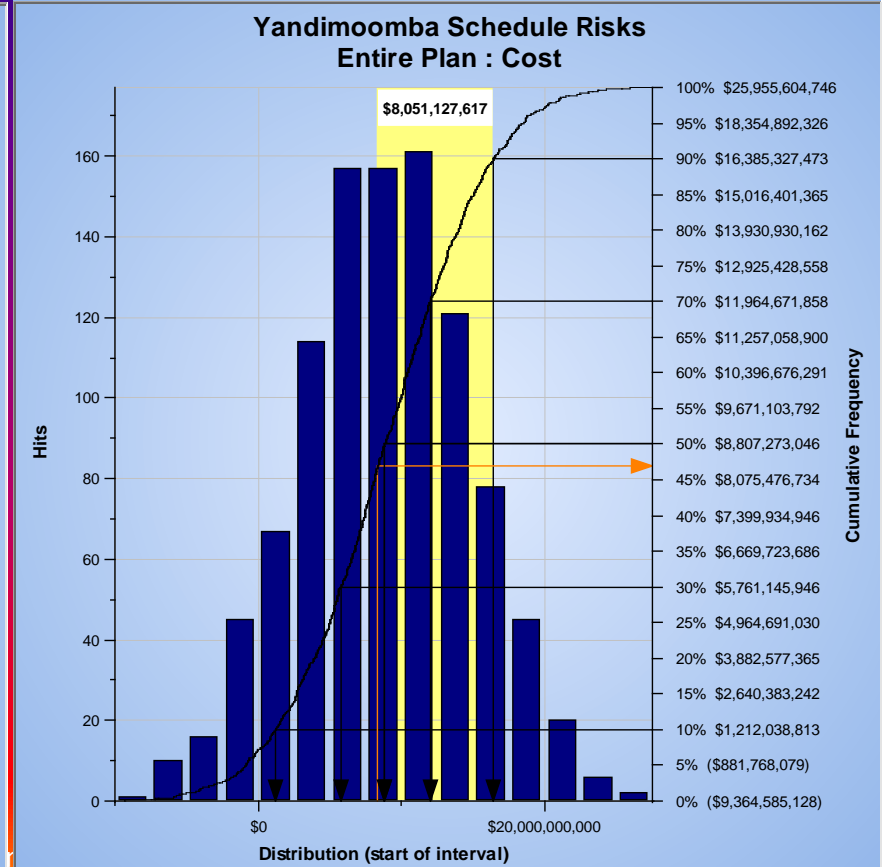
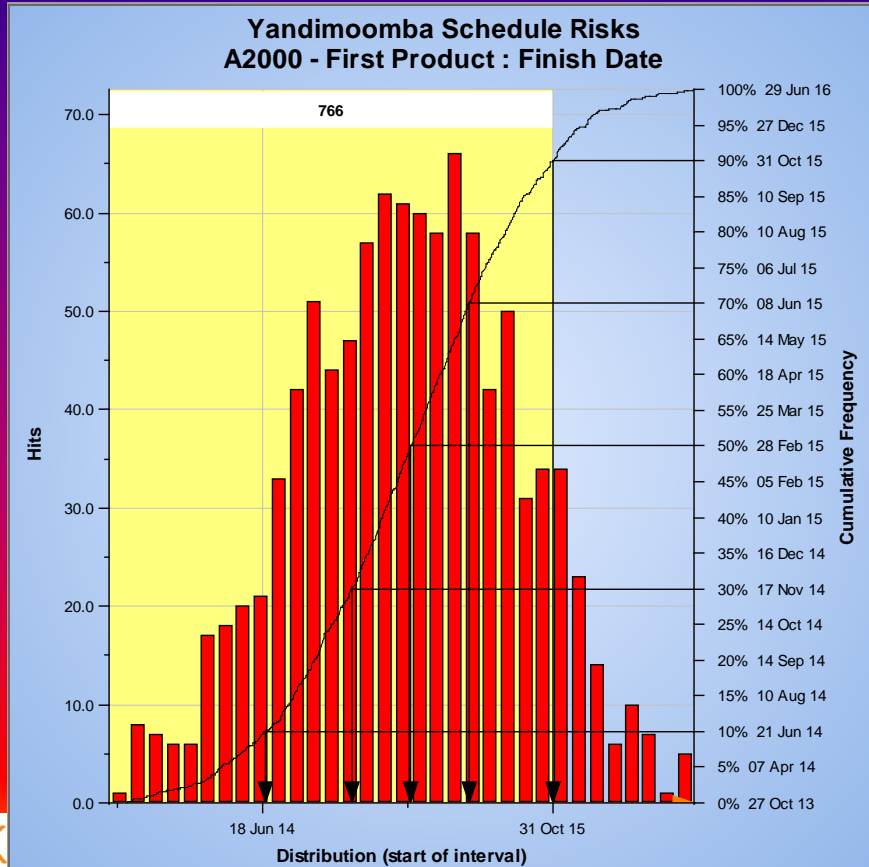
- Schedule representing project scope & strategy and detailed enough to show various alternate critical paths
- Estimate overlaid on schedule in form of a series of hammock tasks loaded with summations of cost items with similar risk profiles, carefully split into time-dependent ('variable') and time-independent ('fixed') costs
- Task durations and line item costs are ranged with project team
- Cost & time impact risk events from Project Risk Register and risk factors from ranging workshops mapped into IRA model
- Probabilistic weather calendars added from weather records

The IRA Process - 2

- Essential schedule and cost correlation added to the model
- Initial analysis performed, producing for key milestones and cost summaries:
 - Probabilistic Date Distributions
 - Simultaneous Probabilistic Cost Distributions
 - Sensitivity Drivers for milestones and costs
- Results workshopped with project team, model changed
- Re-analyse, confirm results and drivers with team or re-revise
- Quantitative Exclusion Analysis (QEA) to produce accurate drivers
- Prepare Final Report

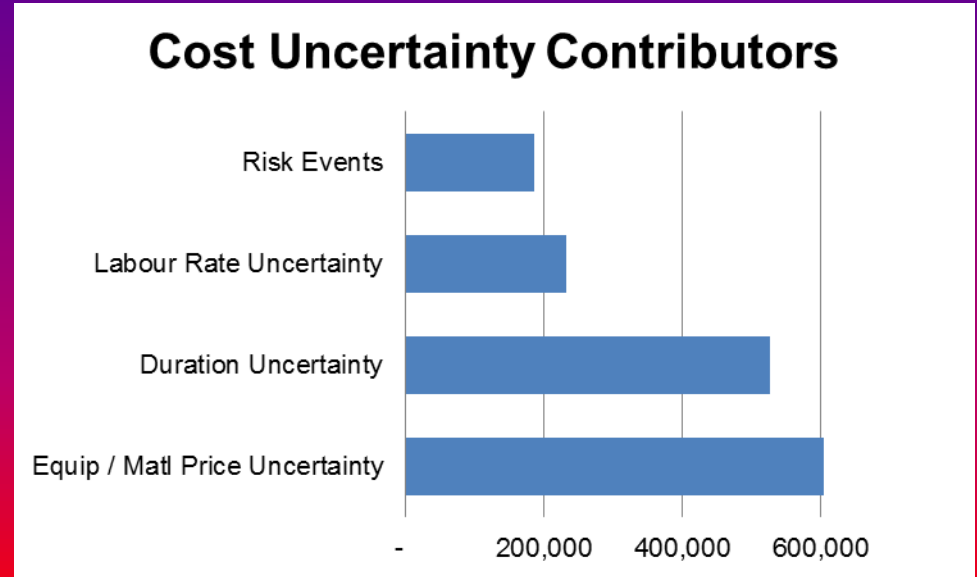
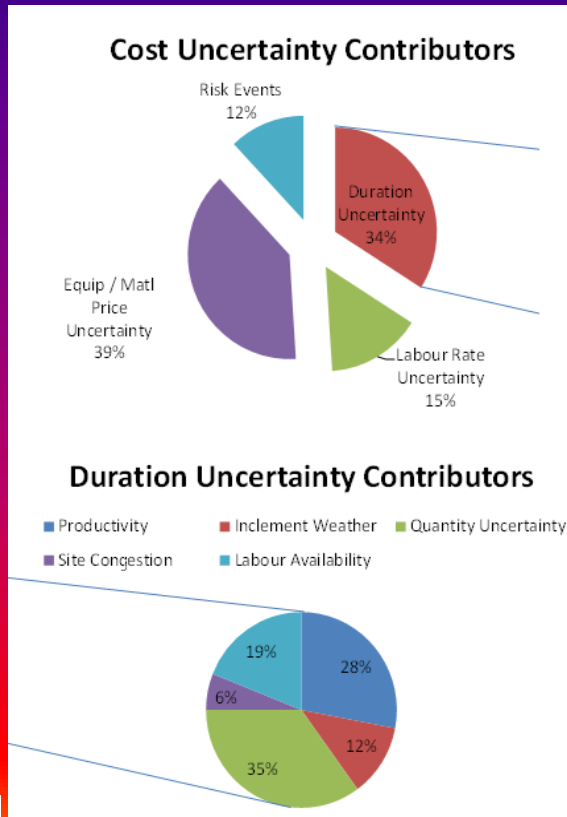
The Benefits of IRA - 1

- Simultaneous analysis of schedule & cost distributions



The Benefits of IRA - 2

- Combined rankings of delay and cost drivers:



The Challenges of IRA

- IRA has pitfalls that must be avoided to produce reliable results:
 - Schedule & estimate must be aligned (based on same assumptions)
 - Splits of Fixed & Variable costs must be accurate
 - No ‘double-dipping ‘ between duration & cost ranges and risk events
 - Costs must be spread over right groups of tasks to model variable costs
 - Estimate must match schedule for level of breakdown detail
 - Correlation through risk factors, durations & costs must be thorough
- Megaprojects exacerbate difficulty of getting IRA right:
 - Size and complexity of model increases and need for correlation with it
 - QEA becomes more complex, time-consuming and important

What is wrong with Serial SRA to CRA?

- Assumed cost/unit time takes no account of when and where schedule changes occur
 - When – before, during or after peak expenditure rate?
 - Where – delay costs may be real but not delay the finish
 - What, why and how assumptions between schedule and estimate must be aligned to produce valid cost consequences from duration changes
- Serial process cuts off delay cause from cost effect and prevents integrated analysis of drivers of cost

IRA	SRA to CRA
More rigorous if done correctly	Less rigorous
Harder to do correctly	Easier to perform
Can provide key driver information, unifying schedule and cost drivers in one ranking as influences on project cost	Cannot reveal cost consequences of schedule delays – schedule drivers are separate from cost drivers

Examples of Use of IRA

- All of Santos GLNG Project scope was analysed pre-FID from Sep09 to Nov10. SRA in Jan/Feb 2010 had following results:

MILESTONE	PLANNED	P50	P90	ACT/ CURRENT FORECAST
FID	2SEP10	21DEC10	15APR11	JAN11
FIRST LNG CARGO	31JUL14	20MAY15	29SEP15	"2015"

- RIMPL worked with Talisman Energy to produce generic IRAs for O&G Exploration. "Rig Moves" (unrisky) contrast with Drilling (risky)

KUPIO-1 WELL	RIG MOVE (UN-RISKED)		ACT/PLAN	DRILLING (RISKED)		ACT/PLAN	ACTUAL
	PLAN	ACTUAL	%	PLAN	ACTUAL	%	CF FORECAST
TOTAL DAYS	21D	40D	190%	51D	53.8D	105%	P87
TOTAL COST	\$5.79M	\$7.90M	136%	\$16.2M	\$15.4M	95%	P45

MANTA-1 WELL	RIG MOVE (UN-RISKED)		ACT/PLAN	DRILLING (RISKED)		ACT/PLAN
	PLAN	ACTUAL	%	PLAN	ACTUAL	%
TOTAL DAYS	35D	45D	129%	31D	29.5D	95%
TOTAL COST	\$8.23M	\$9.63M	117%	\$10.2M	\$9.7M	95%

Conclusions and Recommendations

- Development & Delivery of complex projects need major improvement
- Improving quality of key assessment tool, QRA would be big step forward
- Most realistic version of QRA shown by this paper to be IRA
- IRA challenging but useful where:
 - SMEs can reach consensus on ranges & risks
 - Sufficient detail defined, eg, PFS or FS/FEED
- Quality of results depends on:
 - Capable experienced practitioners, good tools
 - SMEs/Project team capable & experienced
 - Inputs to analysis technically good & aligned
- IRA has rigorous foundation in Integrated Master Control Schedule
- All IRA inputs viewable and auditable
- Assumptions & exclusions in report
- Use of IRA is scalable: successfully used on small (<\$5m) to very large (>\$15b) projects
- IRA can materially improve probability of success through identification & optimisation of major risk drivers
- Project owners, managers & contractors need to improve their understanding of best practice QRA so can specify use & understand its value

QUESTIONS?

Anyone who wants an electronic copy of the presentation should give me their business card or email me at:
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