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CPM, PERT & Schedule Risk Analysis in Construction

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Introduction

- Program Risk Management System
- System Safety Analysis
- Uncertainty Quantification
- Objective: Quantification / Presentation of Time required to achieve a business objective
- Techniques for Schedule Analysis in Construction
  - CPM (CPA), PERT, Monte Carlo Simulation Method
- Construction Feasibility Management Case Study

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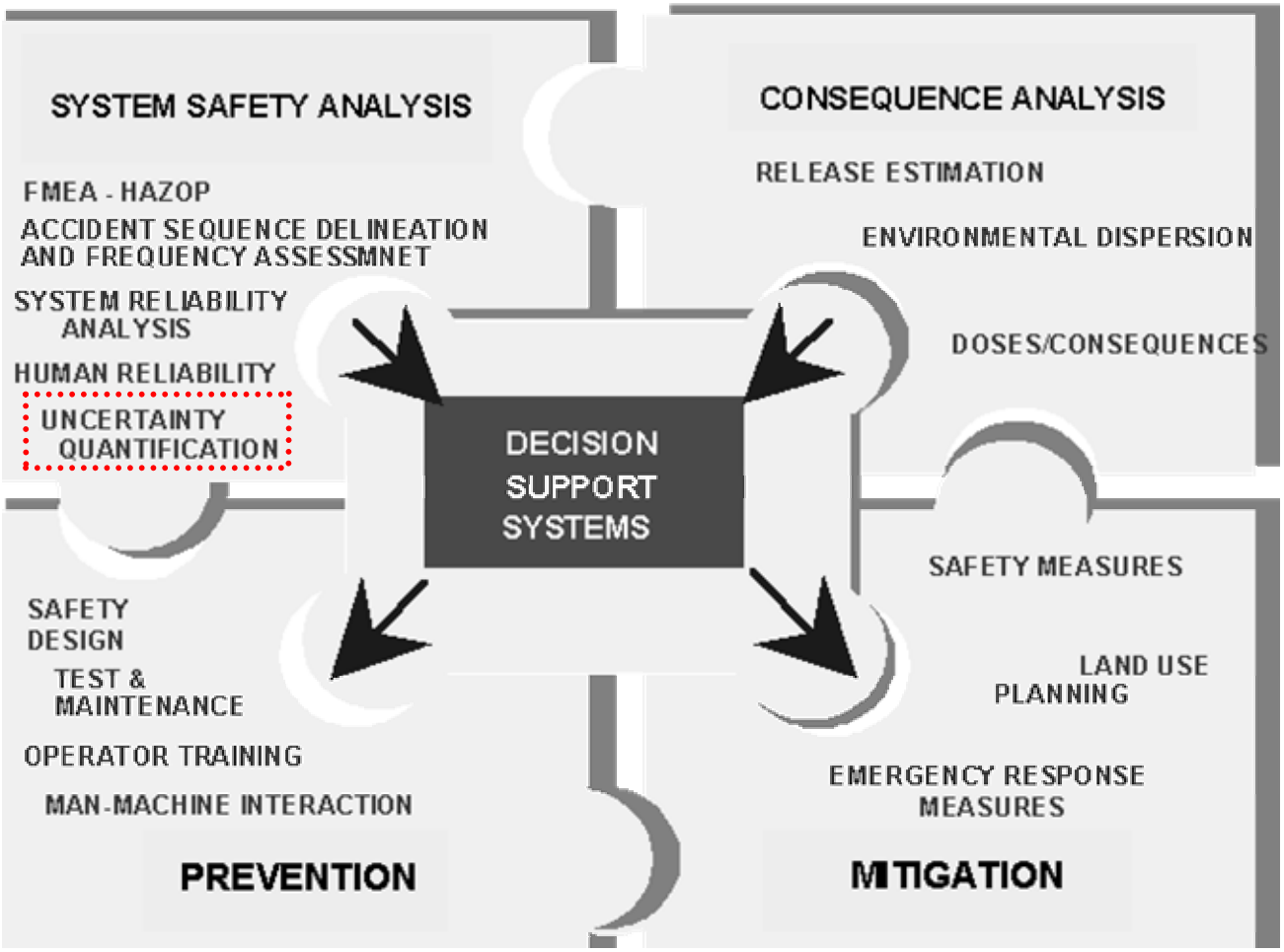
Program Risk Management System



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System Safety Analysis

- FMEA: Failure Modes and Effects Analysis is a methodology for analyzing potential reliability problems early in the development cycle when it is easier to take actions to overcome these issues, thereby enhancing reliability through design.
- Accident Frequency Assessment
- System Reliability Analysis
- Human Reliability
- ***Uncertainty Quantification***

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Uncertainty Analysis Approaches

- Decision Trees
- Linear Programming
- Line of Balance
- PERT
- ***Monte Carlo Simulation Method***

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Monte Carlo Simulation Advantages

- Examine more than one Critical Path (CPM)
- Accurate
  - Overall Duration Distribution
  - Confidence Interval (Accuracy Range)
- Opportunity for Sensitivity Analysis
- Varied Activity Distribution Types – Not just Beta
- Schedule logic can include branching: Probabilistic and Conditional
- If resources loaded, analysis integrates schedule and cost.

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Monte Carlo Simulation Outputs

- **Tabular Statistical Data**
  - Activity listings showing:
    - Start & Finish Date Ranges
    - Duration Ranges
    - Number of times and/or percent Critical
    - Criticality Distribution Profile
    - Major Critical Path reports
    - Three point estimates typically mark out the range of outcomes from the 5th to the 95th percentiles. If estimates are accurate, then only 5% of the activities or risk events should fall beyond the pessimistic points.

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Feasibility Management Case Study

- Case Study:
  - ***Building Engineering Services Feasibility Studies on various Telephone Exchanges*** included:
    - Identify non-compliance with client's Fire Safety Manual
    - Identify non-compliance with client's standards
    - Identify available capacity
    - Identify Critical Elements in services
    - Increase system reliability and availability

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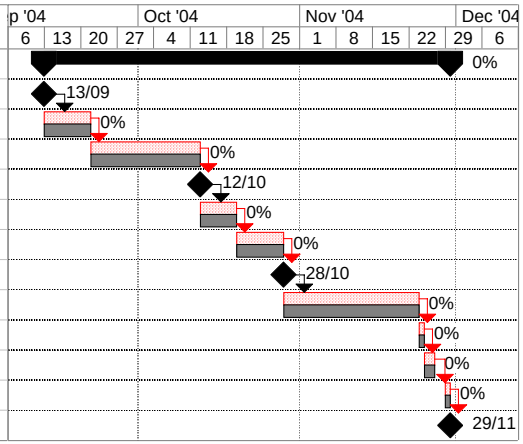
CPM and PERT Methods

- CPM: Likely task Durations
- PERT: Optimistic, Likely and Pessimistic Durations

ID	Task Name	Baseline Start	Baseline Finish	Min	Likely	Max	PERT
1	**Telephone Exchange Feasibility**	**Mon 13/09/04**	**Mon 29/11/04**	29 days	56 days	98 days	58 days
2	Project Released	Mon 13/09/04	Mon 13/09/04	0 days	0 days	0 days	0 days
3	Develop Feasibility PDP	Mon 13/09/04	Tue 21/09/04	2 days	7 days	20 days	8 days
4	Prepare Feasibility RFT	Wed 22/09/04	Tue 12/10/04	4 days	15 days	30 days	16 days
5	Feasibility RFT Issued	Tue 12/10/04	Tue 12/10/04	0 days	0 days	0 days	0 days
6	Feasibility RFT Period	Wed 13/10/04	Tue 19/10/04	5 days	5 days	10 days	6 days
7	Tender Review / Stakeholder Review	Wed 20/10/04	Thu 28/10/04	5 days	7 days	10 days	7 days
8	Feasibility RFT Award	Thu 28/10/04	Thu 28/10/04	0 days	0 days	0 days	0 days
9	Site Inspection	Fri 29/10/04	Tue 23/11/04	10 days	18 days	20 days	17 days
10	Stakeholder Brief of Key Findings	Wed 24/11/04	Wed 24/11/04	1 day	1 day	3 days	1 day
11	Complete Report	Thu 25/11/04	Fri 26/11/04	1 day	2 days	4 days	2 days
12	Issue Final Report	Mon 29/11/04	Mon 29/11/04	1 day	1 day	1 day	1 day
13	Practical Completion Date (PC)	Mon 29/11/04	Mon 29/11/04	0 days	0 days	0 days	0 days



- Schedule MSP layout based on CPM & PERT

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Schedule Risk Analysis Methodology

- Definition of Project Identifications
- Risk Definition
- Create CPM and/or PERT Output
- Uncertainty Estimation
- Schedule Risk Analysis Performance
  (Monte Carlo Simulation)
- Sensitivity Risk Analysis Performance
- Assumptions Re-consideration

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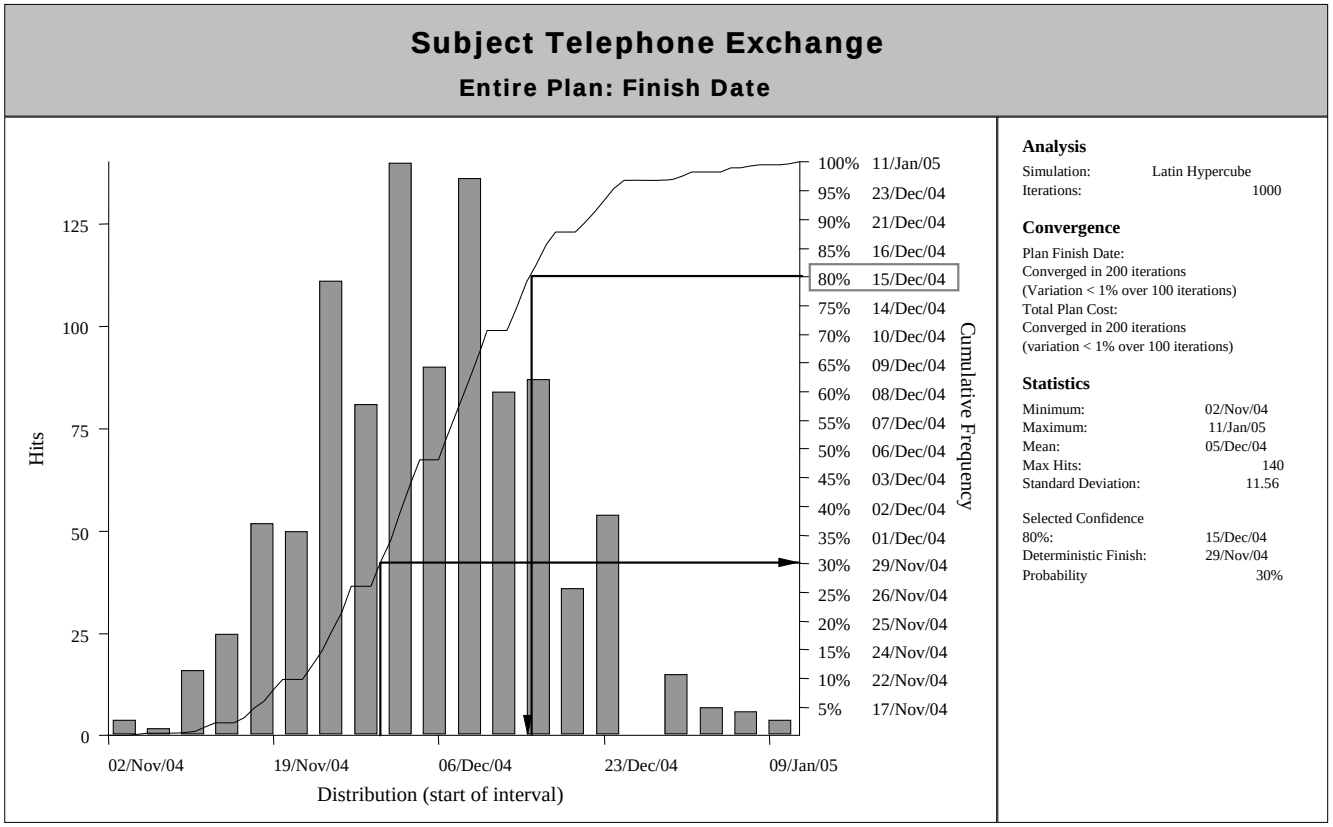
Outputs



Analysis

Simulation: Latin Hypercube
Iterations: 1000

Convergence

Plan Finish Date:
Converged in 200 iterations
(Variation < 1% over 100 iterations)
Total Plan Cost:
Converged in 200 iterations
(variation < 1% over 100 iterations)

Statistics

Minimum:	02/Nov/04
Maximum:	11/Jan/05
Mean:	05/Dec/04
Max Hits:	140
Standard Deviation:	11.56

Selected Confidence

80%:	15/Dec/04
Deterministic Finish:	29/Nov/04
Probability	30%

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Conclusion / Suggestions

- We reached 140 Max Hits when Std Deviation was 11.56 and Min and Max PPC Dates were 02/Nov/04 and 11/Jan/05 respectively.
- Deterministic Finish Probability for PPC is just 30%.
- PERT Finish Probability for PPC is about 35%.
- Schedule Risk Analysis suggests the 80% probability for PPC Date.
- Output illustrates the probability of different PPC Dates.
- Project modeled with Triangle Distribution. Beta Pert Distribution can be considered for future analysis.
- Analyze similar to Cost Risk Analysis.
- Duration Sensitivity Risk Analysis should support the data.
- Further study into the Confidence Levels is required.

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More Risks ... More Achievements
Less Risks ... More Safety

Answer : Risk Management.