Planning and Executing Fast-Track Projects

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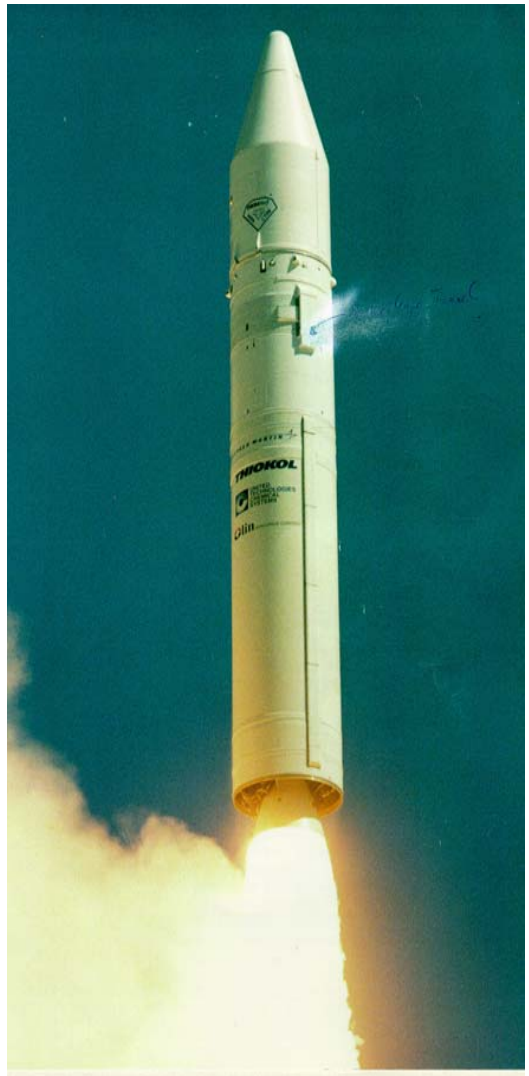
Outline

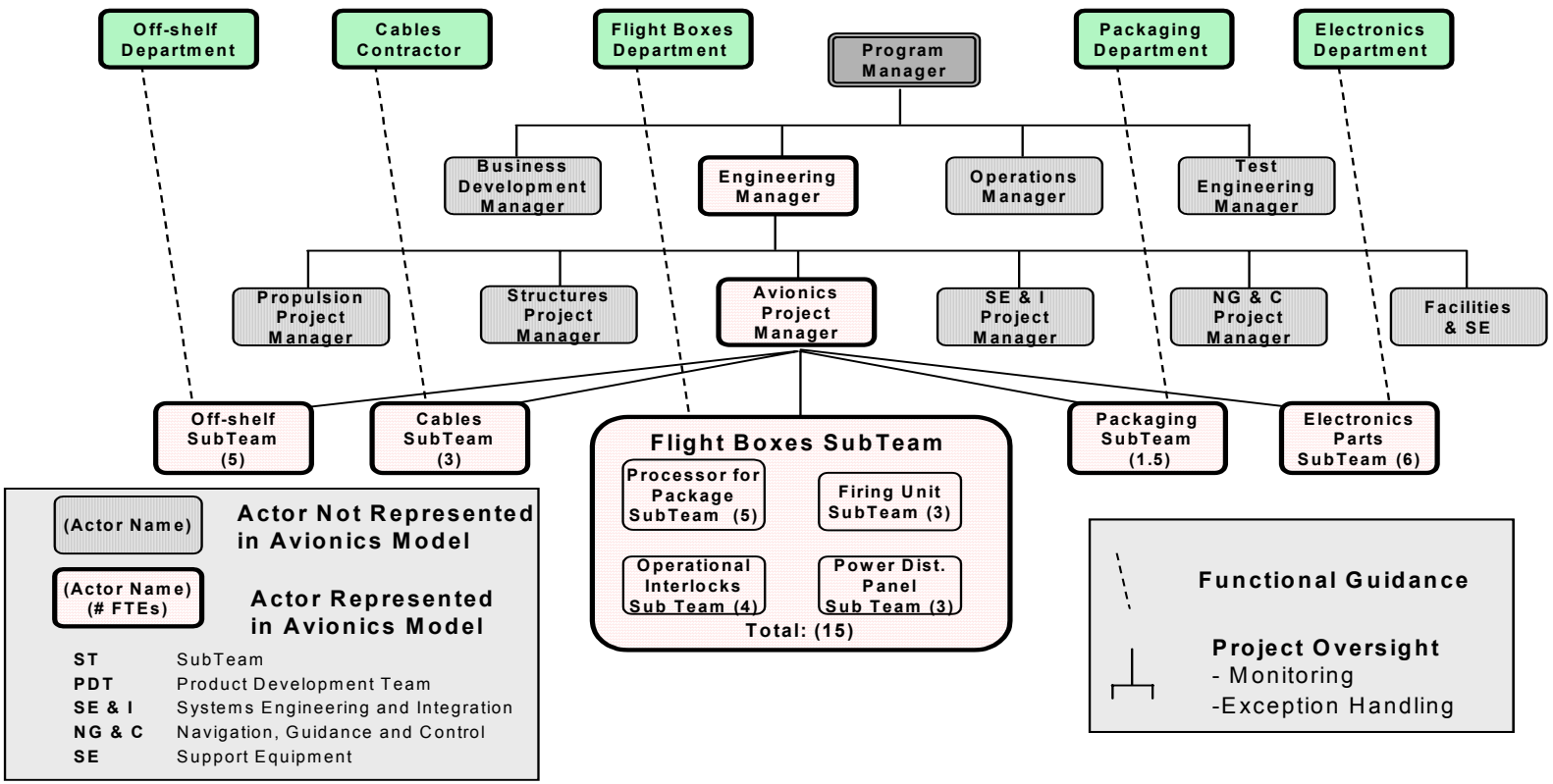
- Fast Track Project Case Study:
  The Lockheed Martin Launch Vehicle
- Techniques for Planning Fast Track Projects
  - PERT Simulation
  - The Critical Chain
  - Systems Dynamics Simulation
  - The VDT/SimVision Project Design Approach
- *Appendix*
  - *Trajectory of Ongoing Project Design Research*

Fast-Track Project Case Study:
Lockheed Martin Launch Vehicle

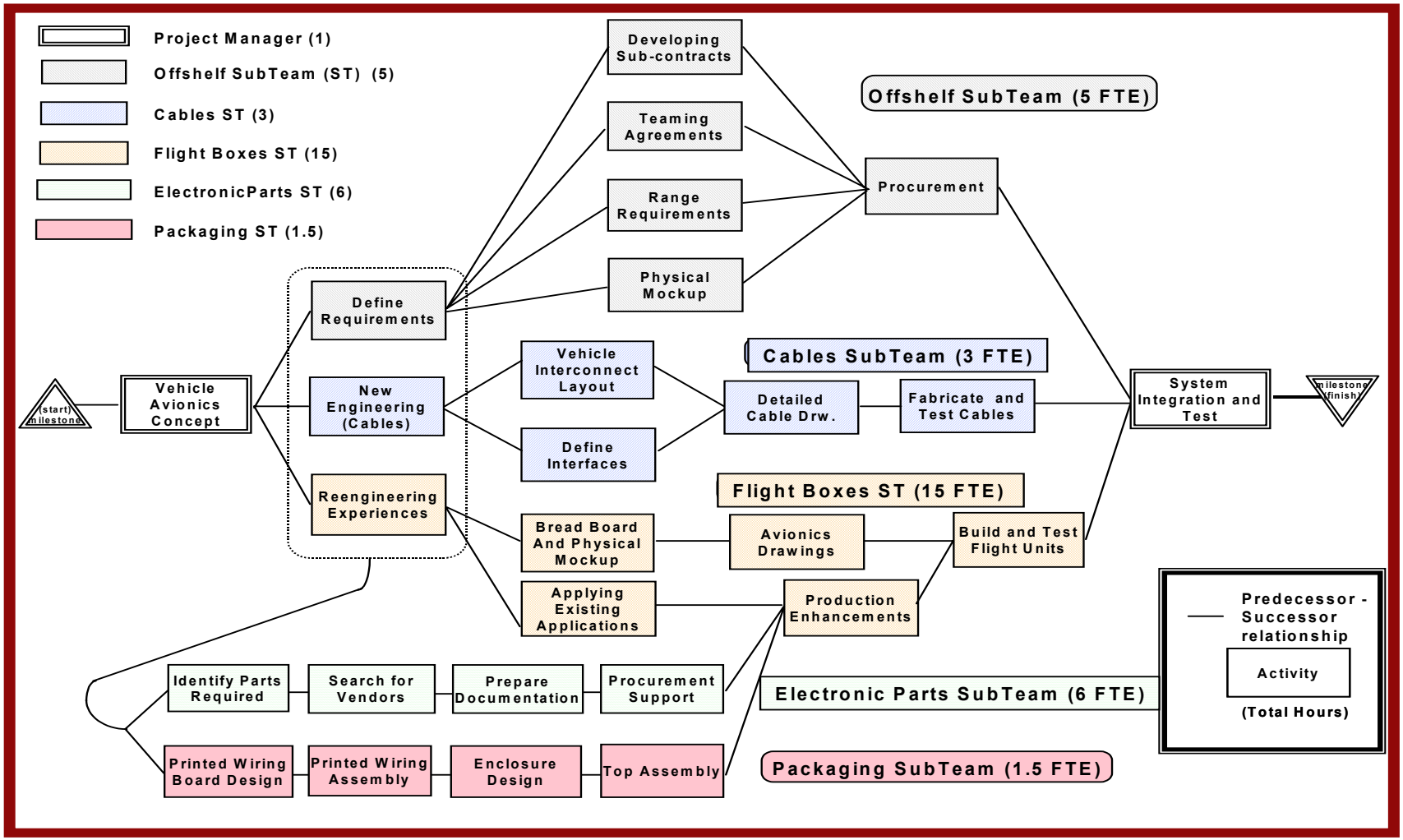
- **Goal:** *Shrink time-to-market for LMLV by* 80% vs. Trident missile!
- **Highly Concurrent**: many interdependent activities must be scheduled concurrently
- **Key components** will be outsourced to minimize cost



Organization of Avionics PDT



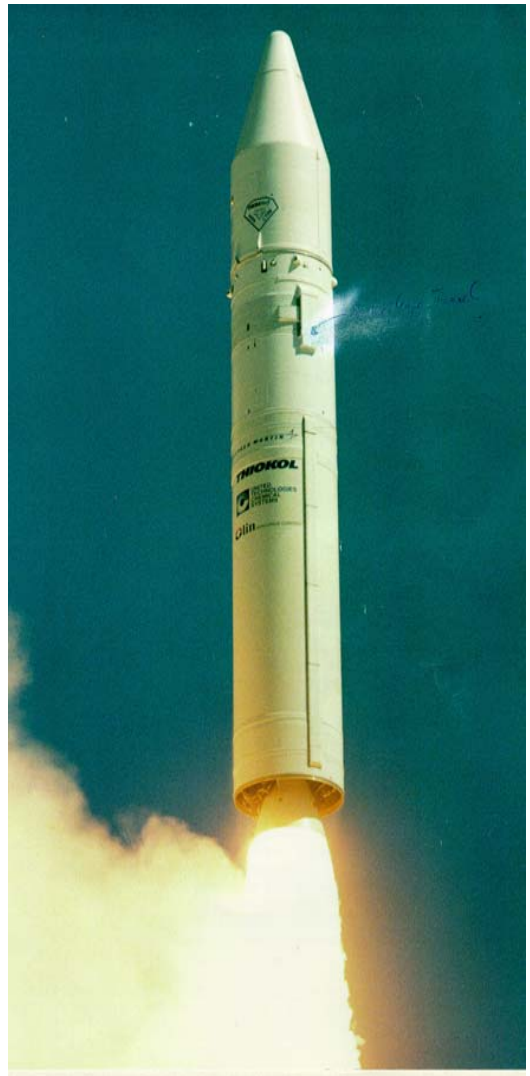
Activity Workflow for Avionics PDT



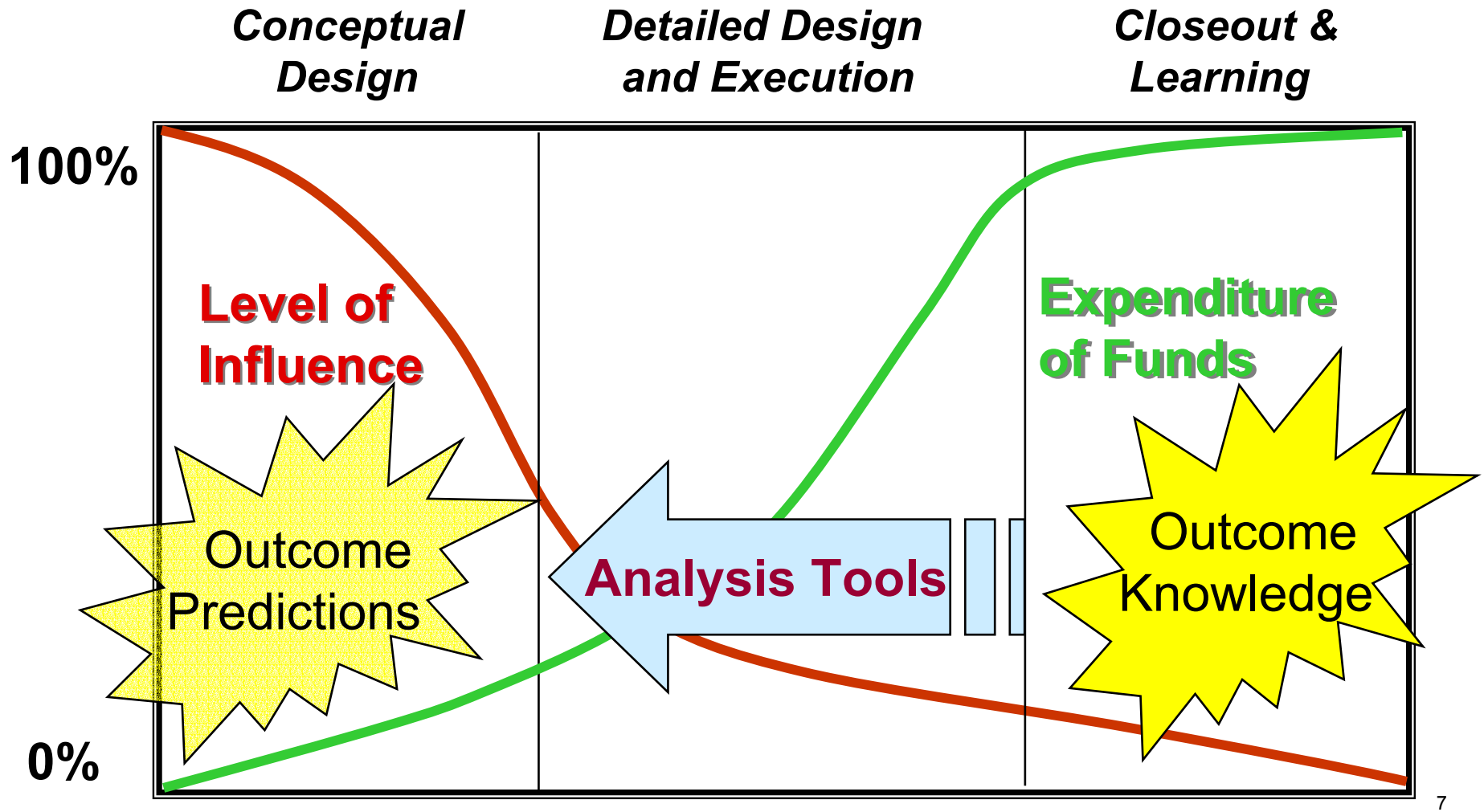
Case Study Results :

Lockheed Martin Launch Vehicle

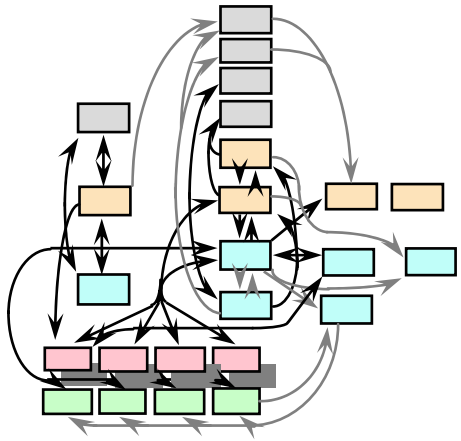
- LMLV1 launched in mid-April 1996 – almost **4 months later than planned**
- Launch vehicle "departed controlled flight" and **had to be detonated** by AF safety officer
- Analysis of telemetry data indicated most likely cause of failure to be a **misrouted cable** that shorted out!



Analysis Tools Can Enable "Project Design"



Fast Track Projects Are Information-Intensive



Product → **Process** → **Organization**

High performance, complex product has high level of inter-dependency between its subsystems

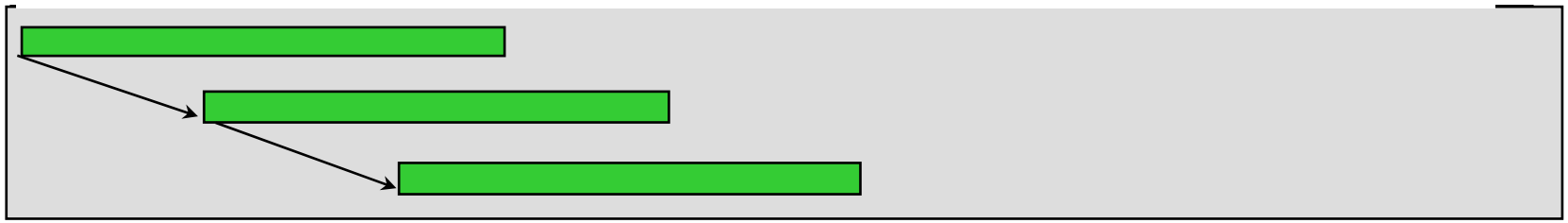
Fast-track schedule triggers unplanned coordination and rework for project organization

Project team must process large amount of information under extremely tight time constraints

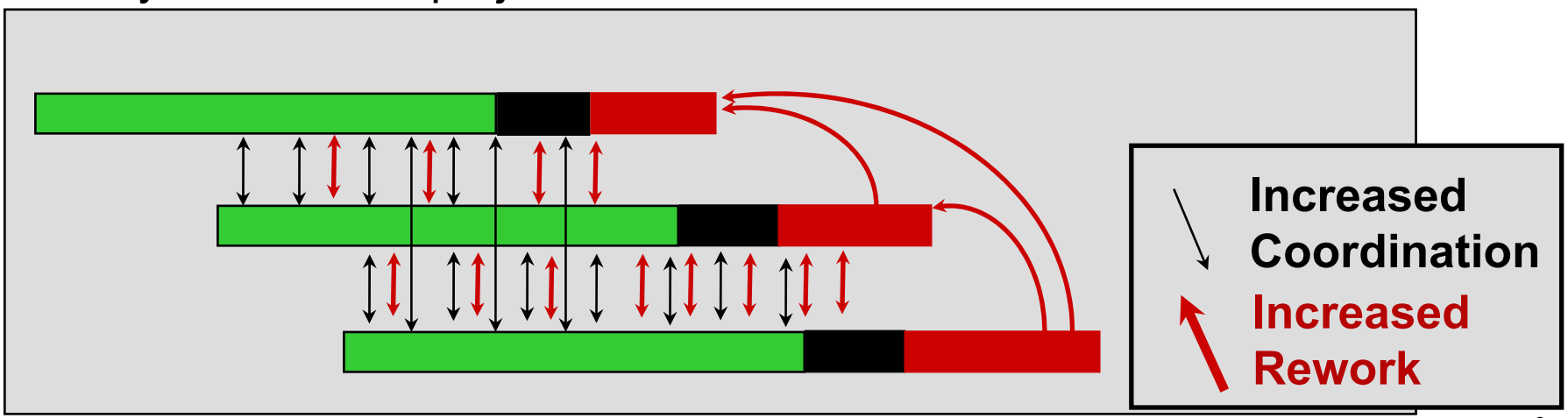
The Challenge of Fast-Track Projects:

"Concurrent Engineering" Incurs Large Overheads

CPM View of Fast-Track Project work—Overlapped Activities



Reality of fast-track project work!



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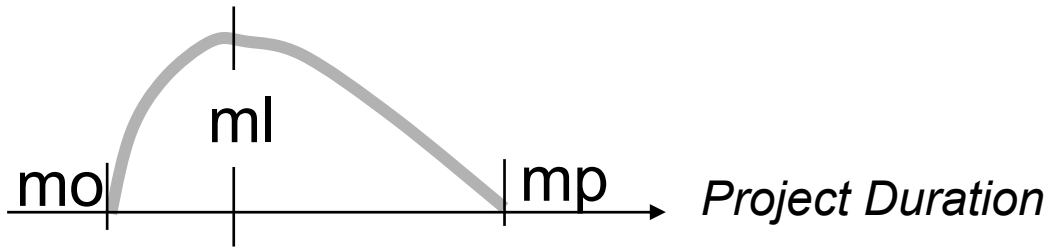
PERT Simulation

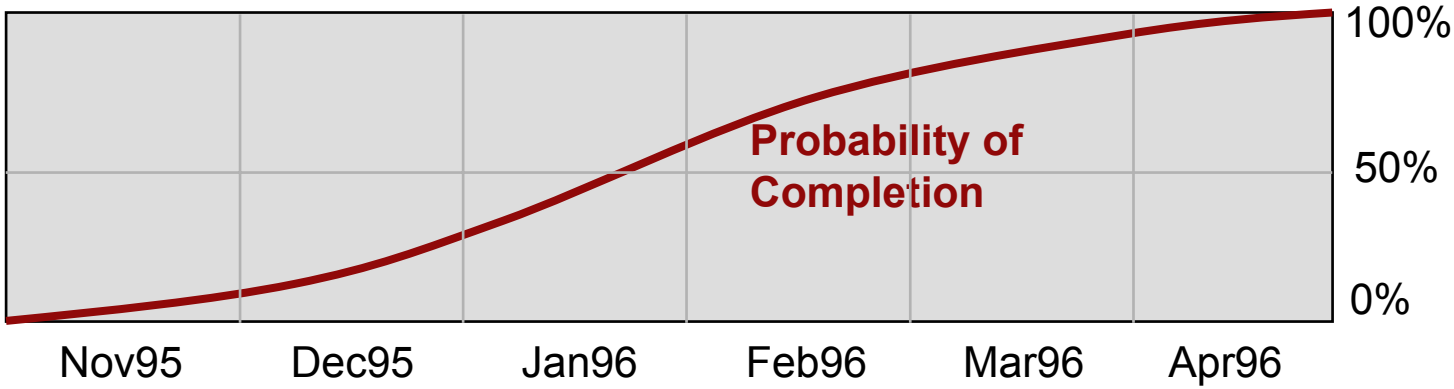
- Assume **each activity** has a **variable duration** that is described by a probability distribution *(Gamma)* as follows:



- Perform a large number of PERT simulations (~1,000)
  - **Independently** sample each activity's duration
  - Perform a **standard CPM analysis**, using the **sampled duration** for each activity
  - Use multiple (~1,000) CPM analyses to compute probability distributions of **project duration** and **activity criticality**

What Would PERT Simulation Have Told Lockheed Managers?

- "There is uncertainty in project completion time"



- "Some near-critical activities may become critical"
  - Fast-track projects usually have multiple near-critical paths
  - A **"criticality index"** is computed for each activity, equal to the % of simulation trials in which it was critical

👍 & 👎 of PERT Simulation for Fast-Track Projects

- 👍 Shows how uncertainty in task durations affects uncertainty of project completion date
  - A straightforward extension of CPM approach and tools
- 👎 Assumes that activity durations vary independently
  - Does not model fundamental causes of variation in activity durations (e.g., poor designs, key skill deficits, bad weather, …)
  - Does not reflect that fact that positive or negative risk factors ("knights and villains") will impact multiple activities
  - Gives managers no guidance about where/how to intervene
- 👎 Assumes no effects of executing activities in parallel vs. in sequence
  - Provides no insights about the hidden cost of more aggressive fast-tracking (concurrent task scheduling)

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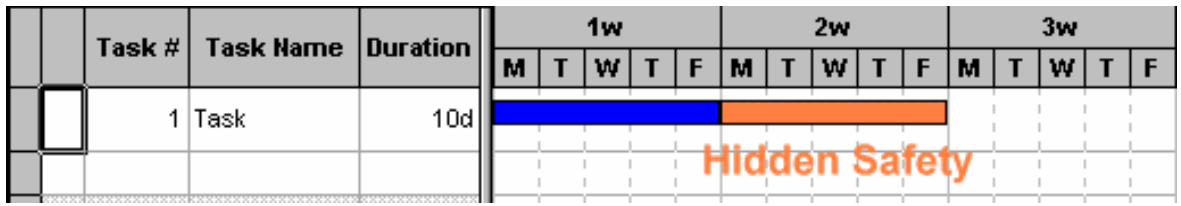
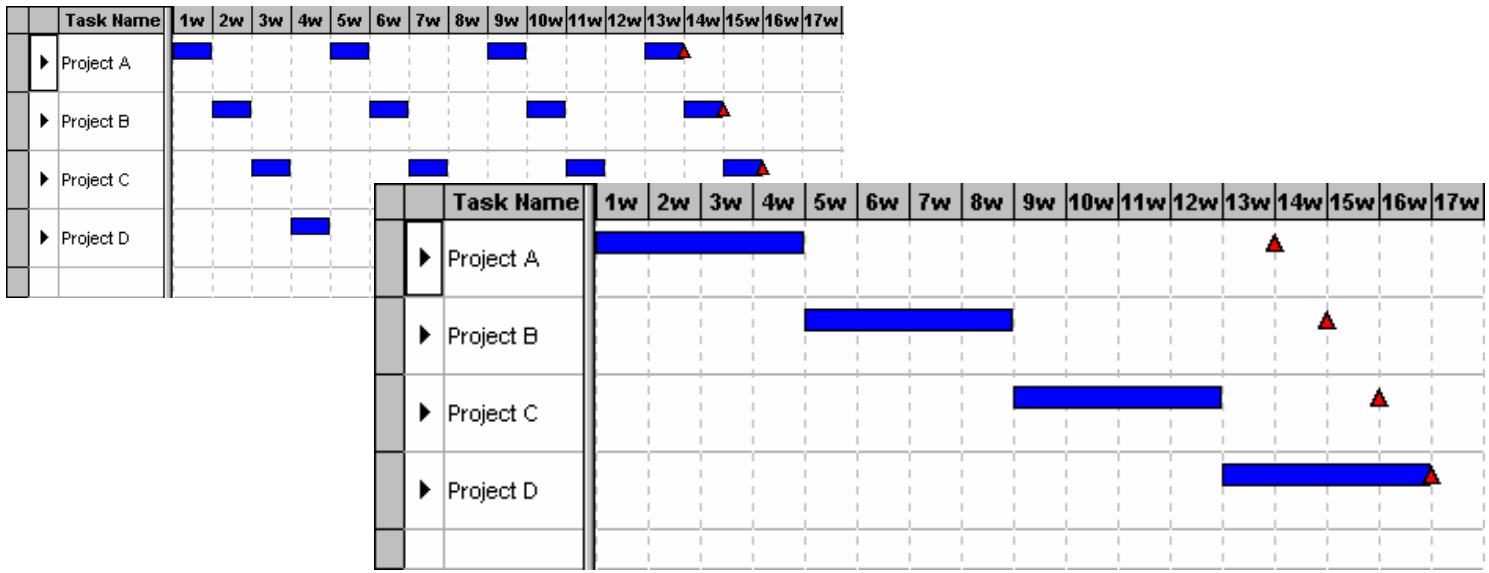
Critical Chain* Concepts—1

- Remove hidden safety from task estimates



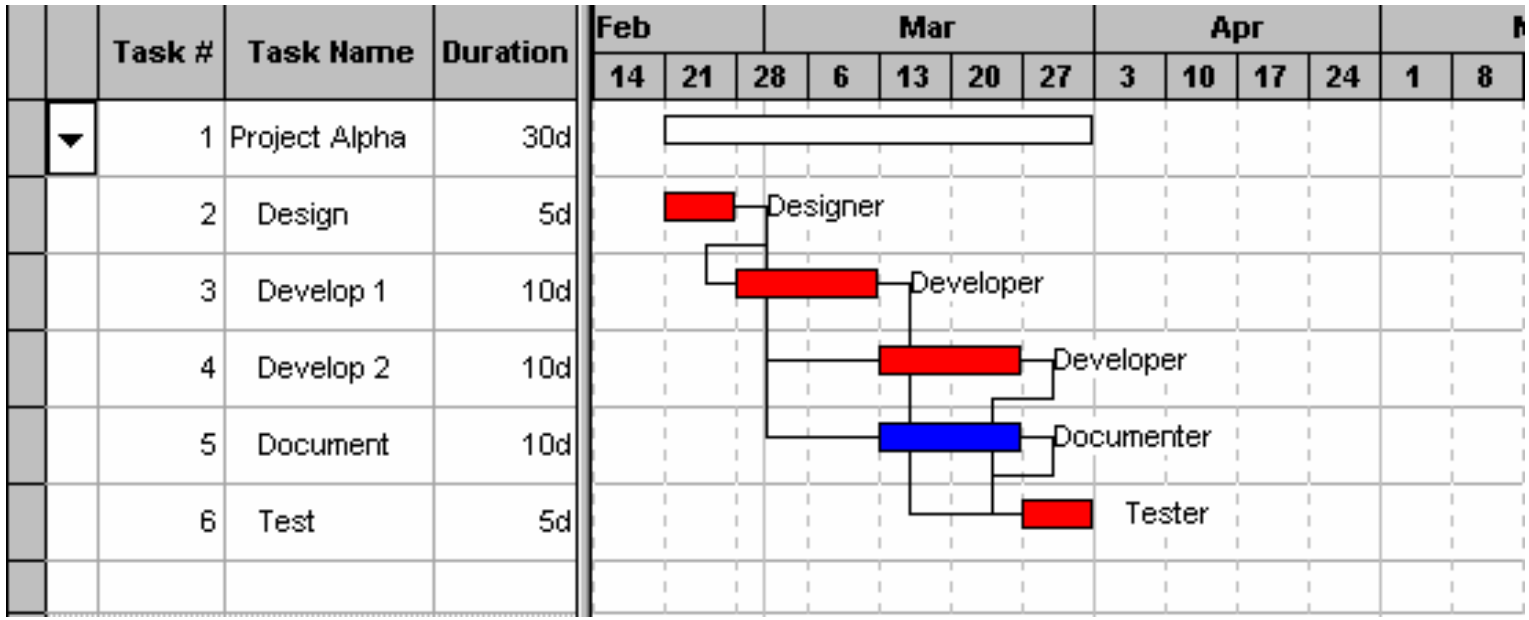
- Eliminate multitasking



** Sources: Eliyahu Goldratt, "The Critical Chain," and Scitor Corporation Web Site)*

Critical Chain* Concepts—2

- Plan backward from required completion date
- Calculate the Critical Chain (the resource constrained critical path)

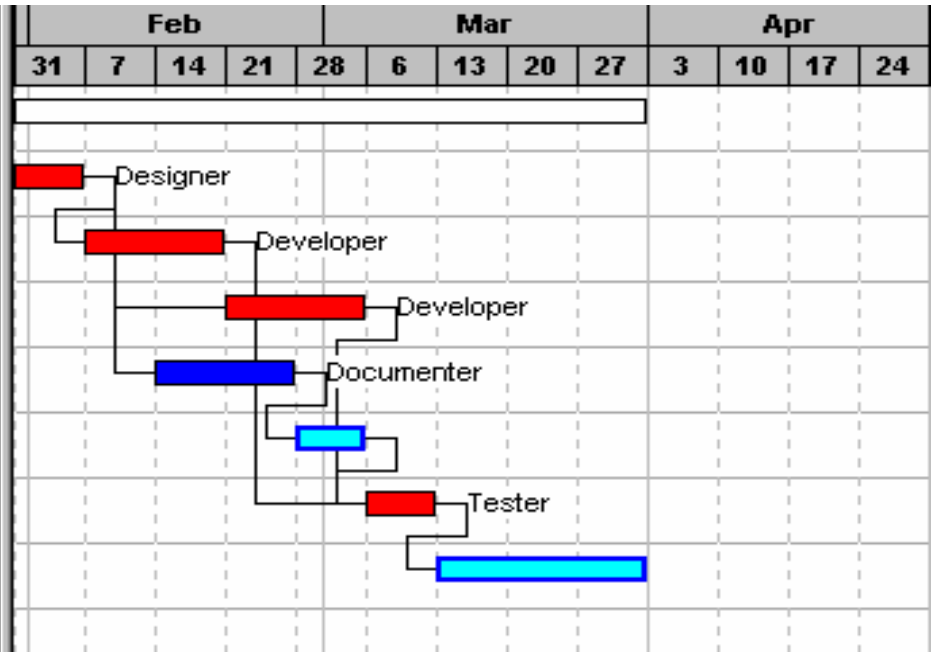


** Source: Eliyahu Goldratt, Scitor Corporation Web Site)*

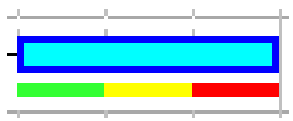
Critical Chain* Concepts—3

- Insert Project Buffer at end of critical chain; and insert Feeding Buffer at end of all non-critical chains

	Task #	Task Name	Duration
	1	Project Alpha	45d
	2	Design	5d
	3	Develop 1	10d
	4	Develop 2	10d
	5	Document	10d
	6	Feeding Buffer	5d
	7	Test	5d
	8	Project Buffer	15d



Track consumption of buffers during project



** Source: Eliyahu Goldratt, Scitor Corporation Web Site)*

What Could Critical Chain Analysis Have Told Lockheed Managers?

- During the Planning Stage
  - "Start some project activities earlier!"
  - Earlier start time may not have been feasible.
- During the Execution Stage
  - " Cable team project and feeding buffers are being consumed by activity overruns!"
  - Analysis could have alerted managers earlier in the project to bring in extra cable resources

👍 & 👎 of Critical Chain for Fast-track Projects

- 👍 Highlights latest starts
- 👍 Shows impact of eliminating multi-tasking
- 👍 Tracks impact of activity delays on buffers
- 👎 Does not relate size of buffer in Feeder Chain or Critical Chain to degree of complexity or interdependence of activities in that chain
- 👎 Does not predict relative schedule risks of particular activities or chains in advance—vs. “task criticality” in PERT Simulation

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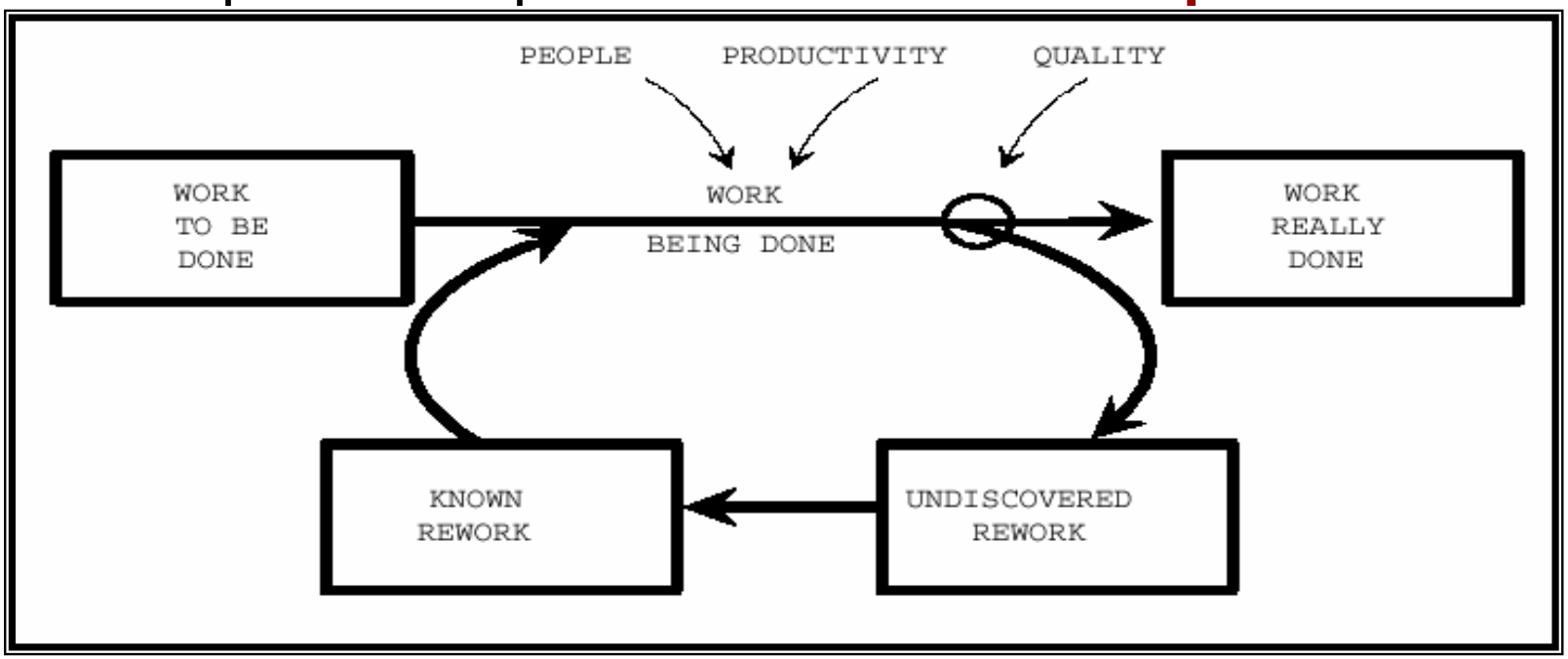
System Dynamics Approaches

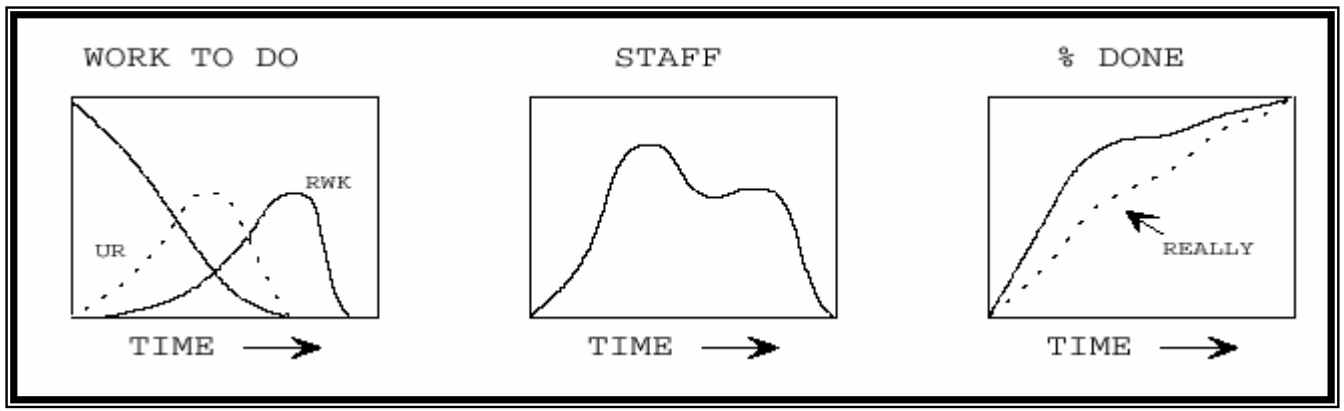
- Model projects as "**stocks and flows**" of **work**, **resources**, **information**, **motivation**, etc.
- Express relationships between variables as arbitrarily simple or complex **finite difference equations**



** Source: "The Rework Cycle: Why Projects Are Mismanaged" by Kenneth Cooper, PMNet, 1993*

What Would a System Dynamics Model Have Told Lockheed Managers

- Showed impacts of **positive and negative feedback loops on performance**
- Show impacts of **delayed feedback loops**—(oscillation)



- Could provide insights about overall schedule risks due to fast-tracking this project
- Unlikely to have identified specific problems in this case

** Source: "The Rework Cycle: Why Projects Are Mismanaged" by Kenneth Cooper, PMNet*

👍 & 👎 of System Dynamics for Fast-Track Projects

- 👍 System Dynamics is a broadly applicable simulation language
  - SD has been applied to problems as diverse as business supply chains (e.g., “The Beer Game”) and natural ecosystems (e.g., sustainability of fisheries, forests, …)
- 👎 System Dynamics is a broadly applicable simulation language
  - No built-in objects or behaviors to model projects in detail
  - Insights it can provide about projects tend to be generic and high level (e.g., rework example)
  - “Stocks & flows” architecture is ideally suited for modeling flows of goods & info in ecosystems or supply chains

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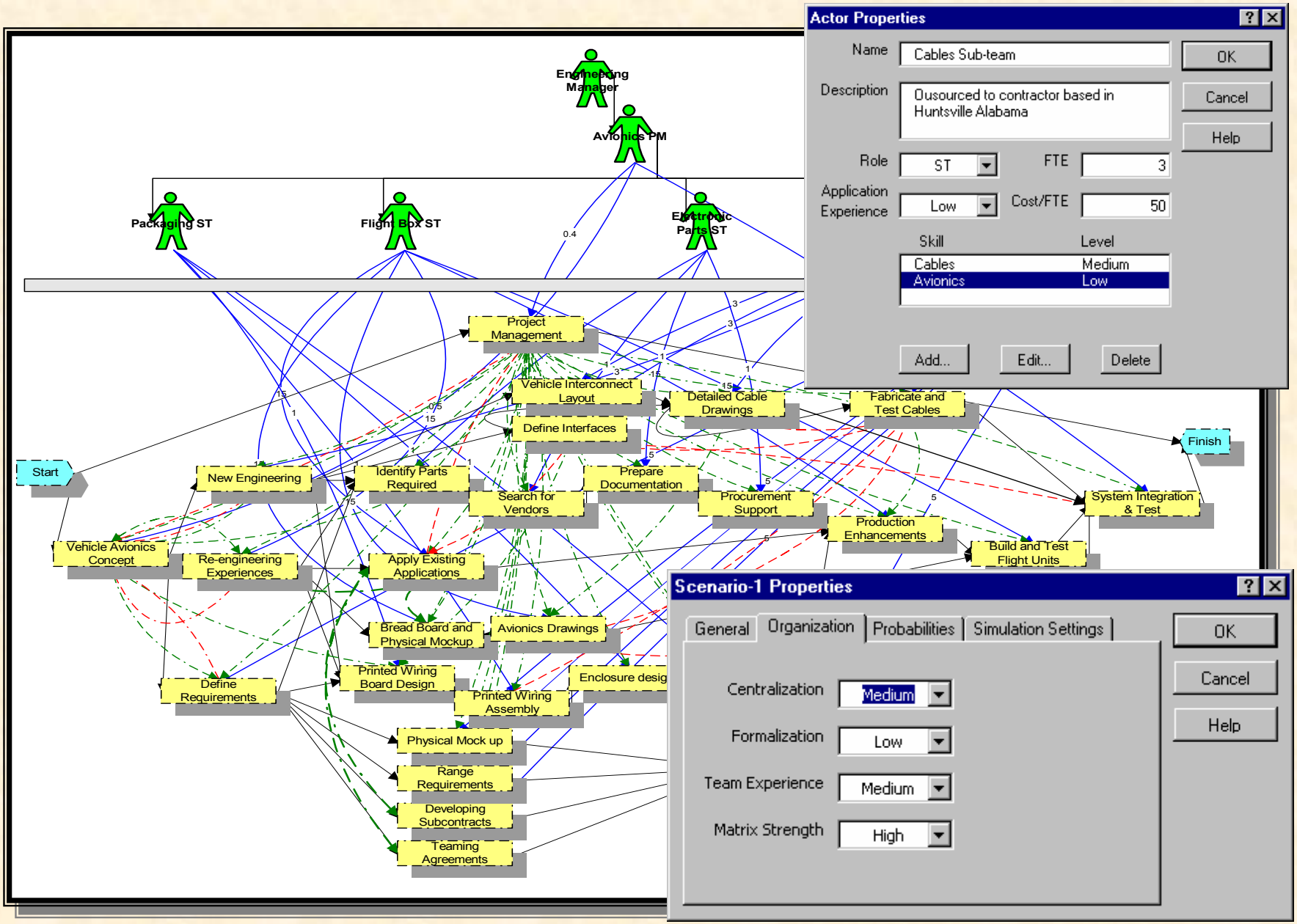
VDT Project Design Case Study:
Lockheed Martin Launch Vehicle

Project Design Approach

- **Model** planned fast-track work process and proposed organization realistically
- ***Simulate*** *organization executing work process to predict schedule/ quality risks*
- **Compare** predicted performance *vs.* plan, and "intervene" to mitigate risks
- **Iterate** to find "optimal" project design

LMLV Project Avionics Team: *VDT/SimVision* Model



Actor Properties

Name: Cables Sub-team

Description: Ousourced to contractor based in Huntsville Alabama

Role: ST

FTE: 3

Application Experience: Low

Cost/FTE: 50

Skill	Level
Cables	Medium
Avionics	Low

OK | Cancel | Help | Add... | Edit... | Delete

Scenario-1 Properties

General | Organization | Probabilities | Simulation Settings

Centralization: Medium

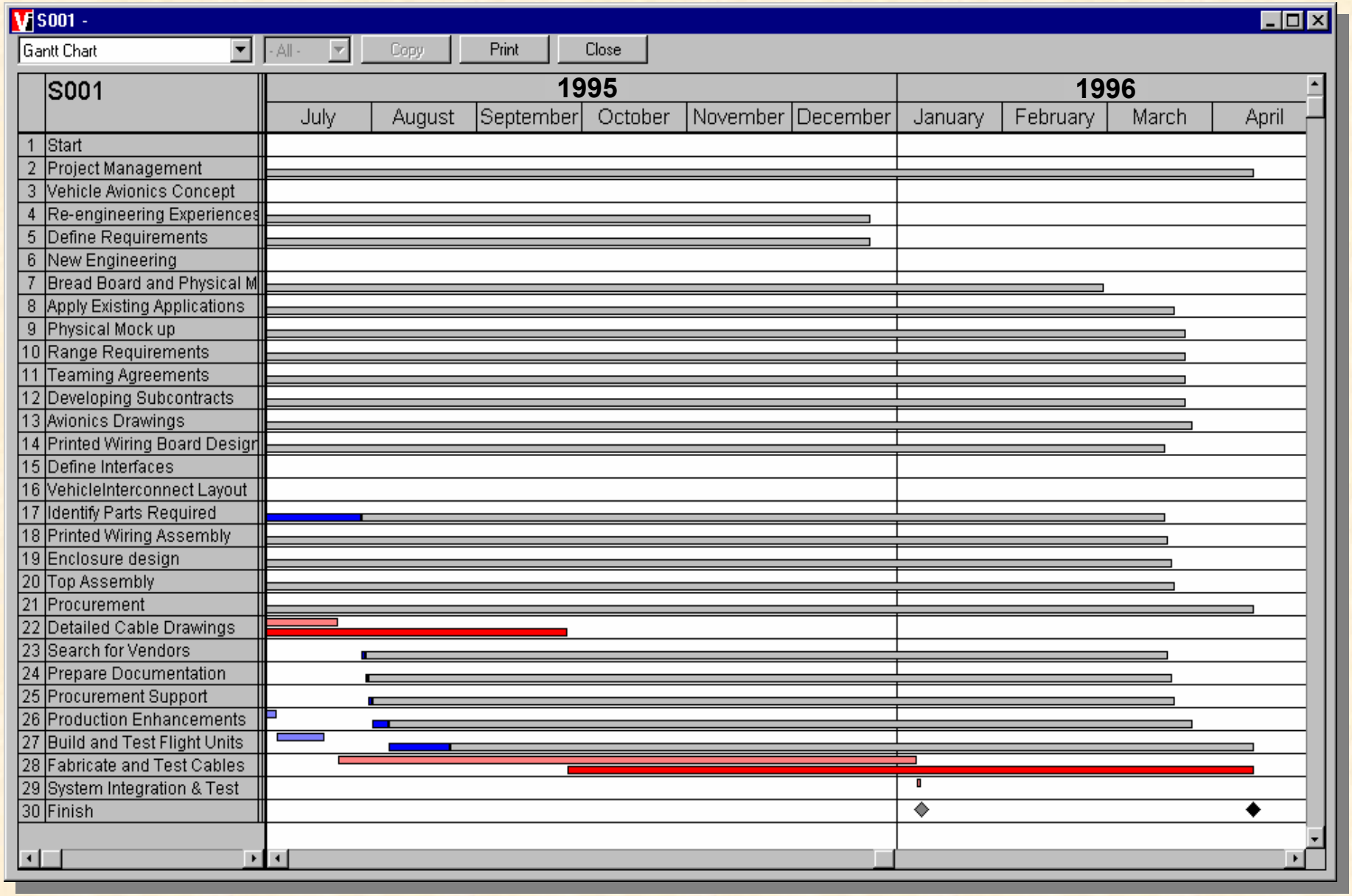
Formalization: Low

Team Experience: Medium

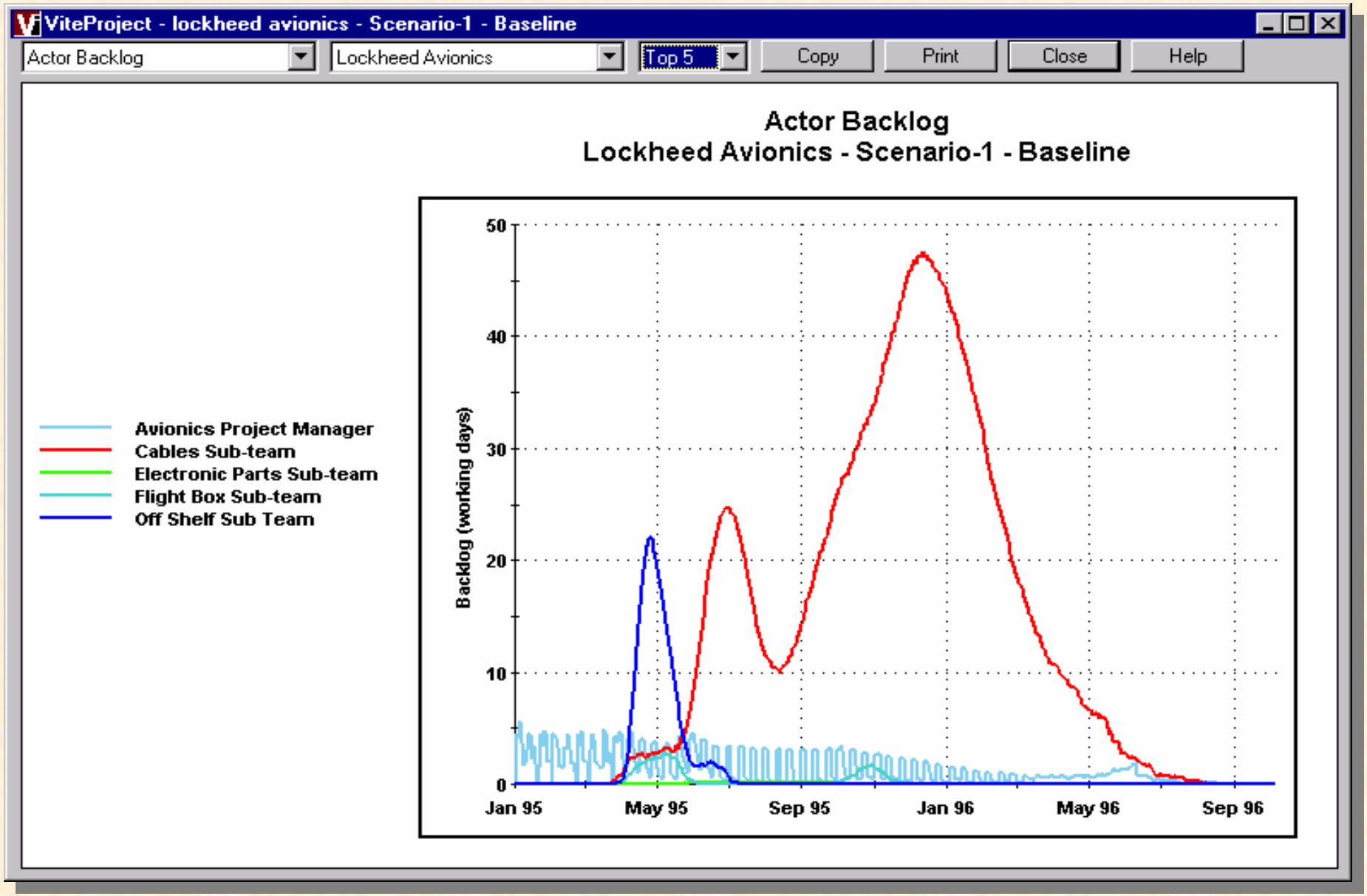
Matrix Strength: High

OK | Cancel | Help

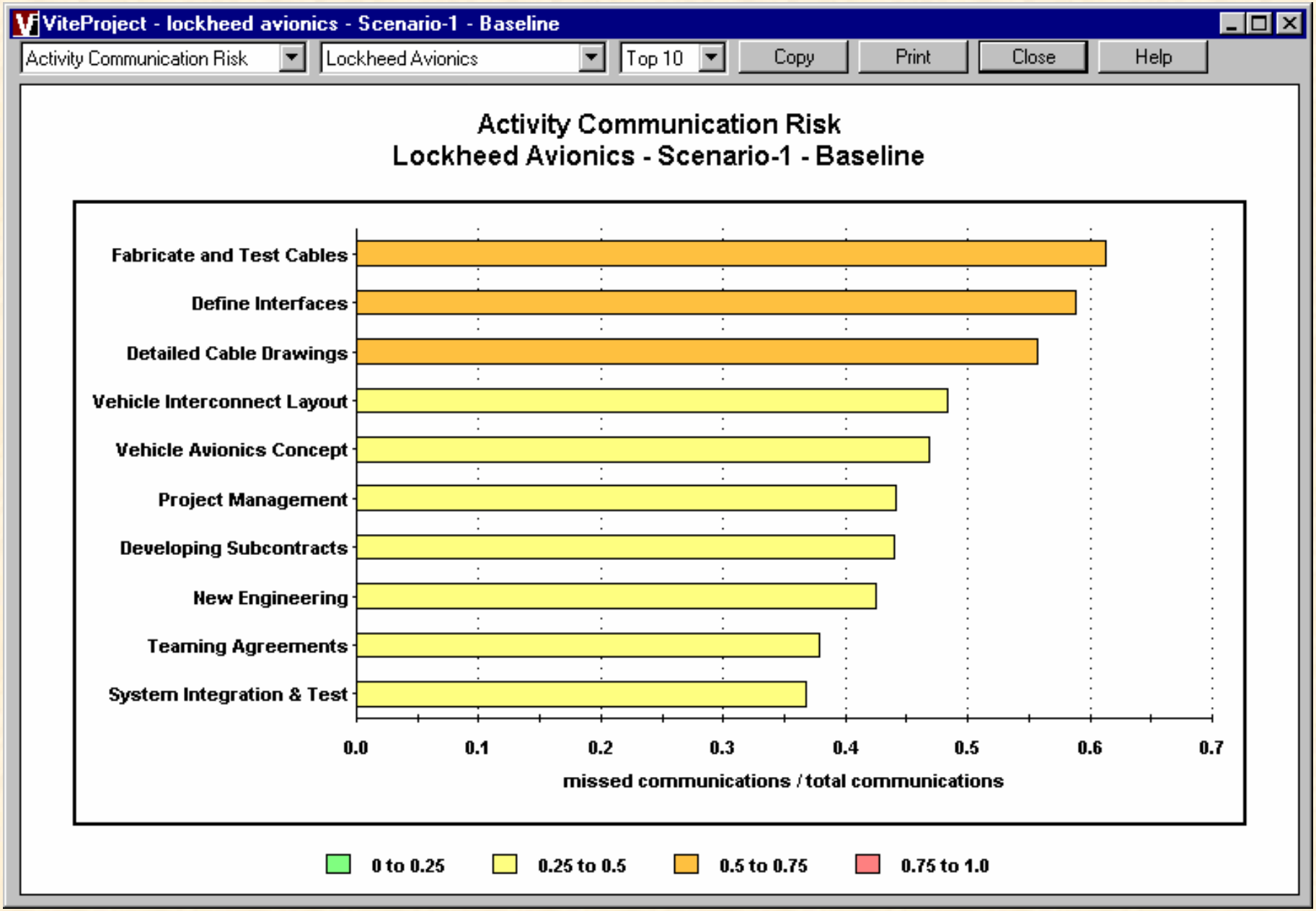
LMLV Project Avionics Team: Gantt Chart



LMLV Project: Actor Backlogs

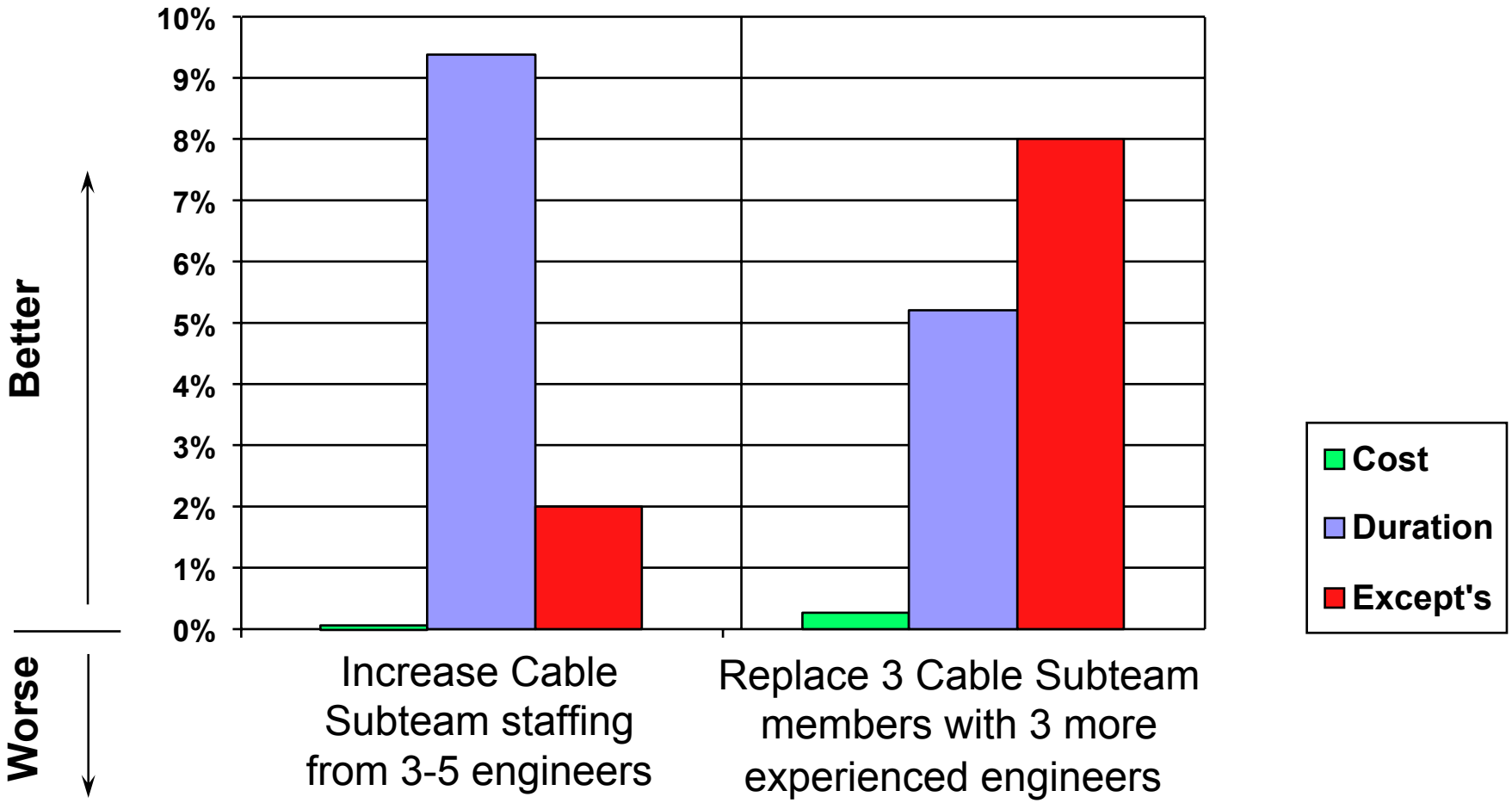


LMLV Project: Process Quality Risks



Project Design Guides Managerial Interventions

"What-if Analysis" of LMLV Avionics Team



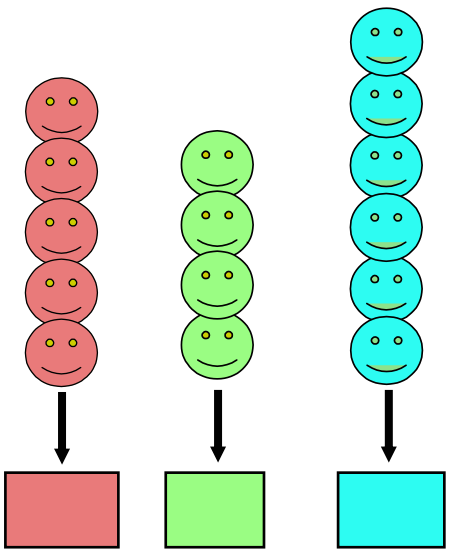
Lockheed Martin Launch Vehicle:

Project Design Results

- *Simulated organization executing work process to predict schedule and quality risks*
  - VDT/***SimVision*** predicted launch date delay to within a few days, one year ahead!
  - VDT/***SimVision*** identified cable team quality risk that ultimately caused LMLV to fail!
- *Predicted performance impact of two potential managerial interventions* (although these results were not used)

But Project Participants also Coordinate. And they Generate & Handle Exceptions

Project Participants Perform Assigned Tasks



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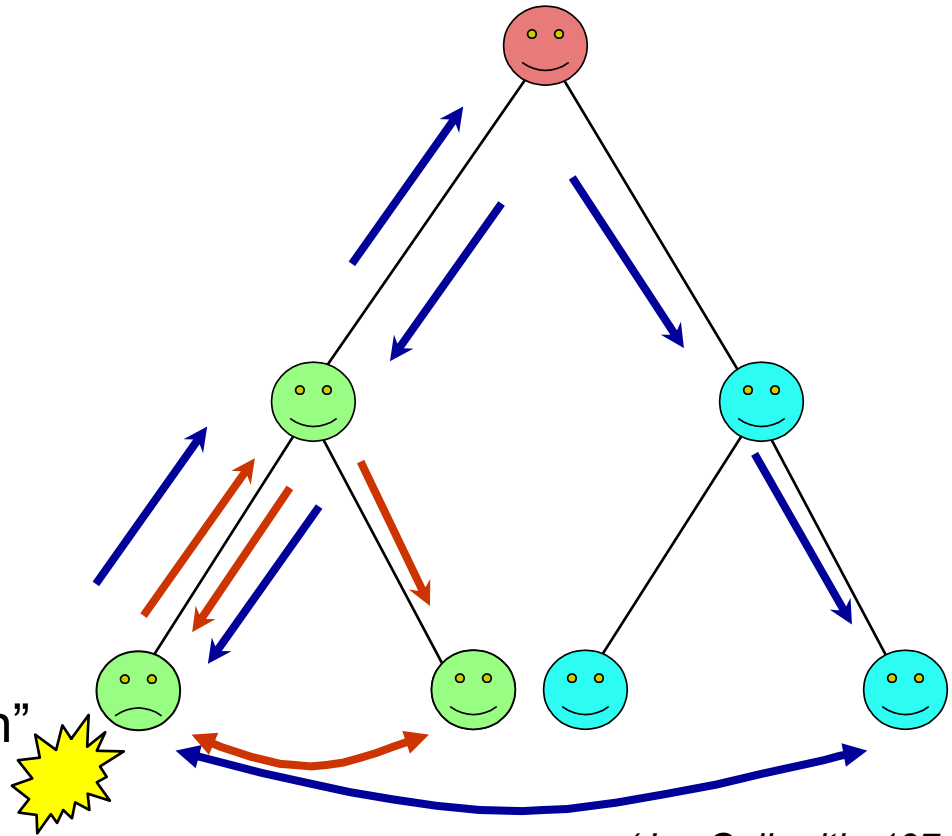
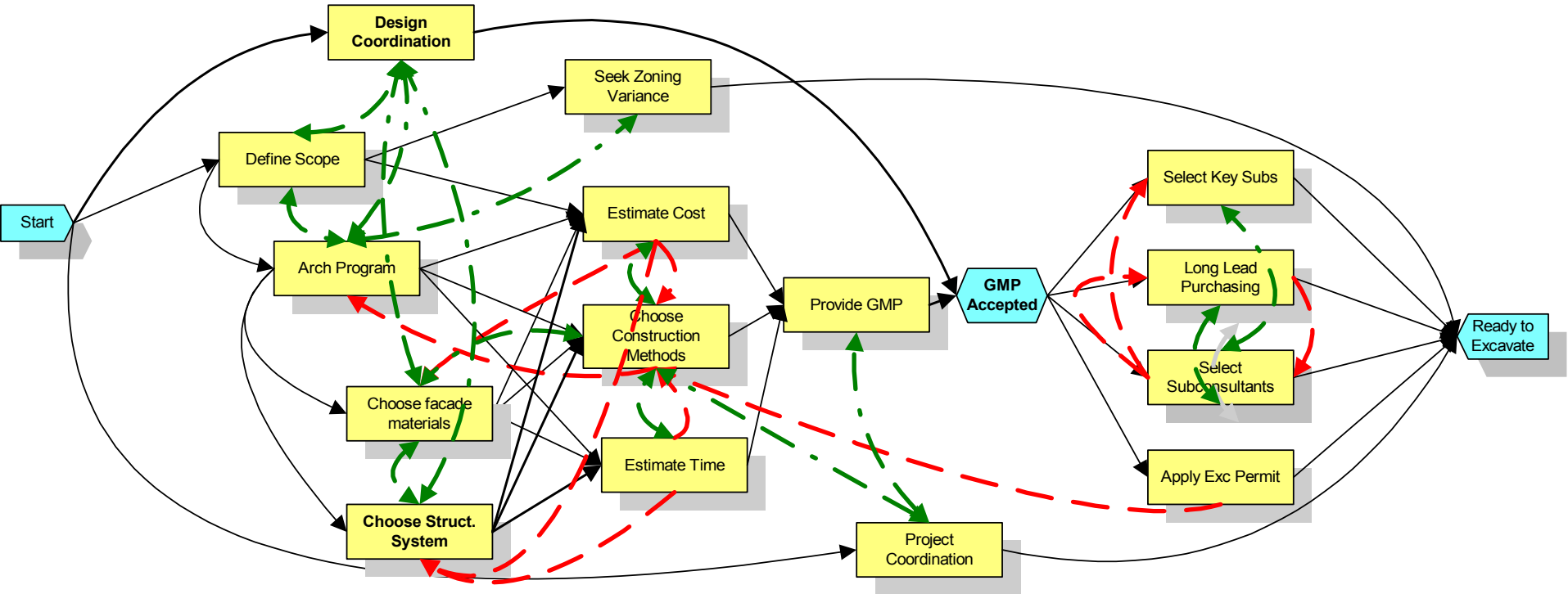


(Jay Galbraith, 1974)

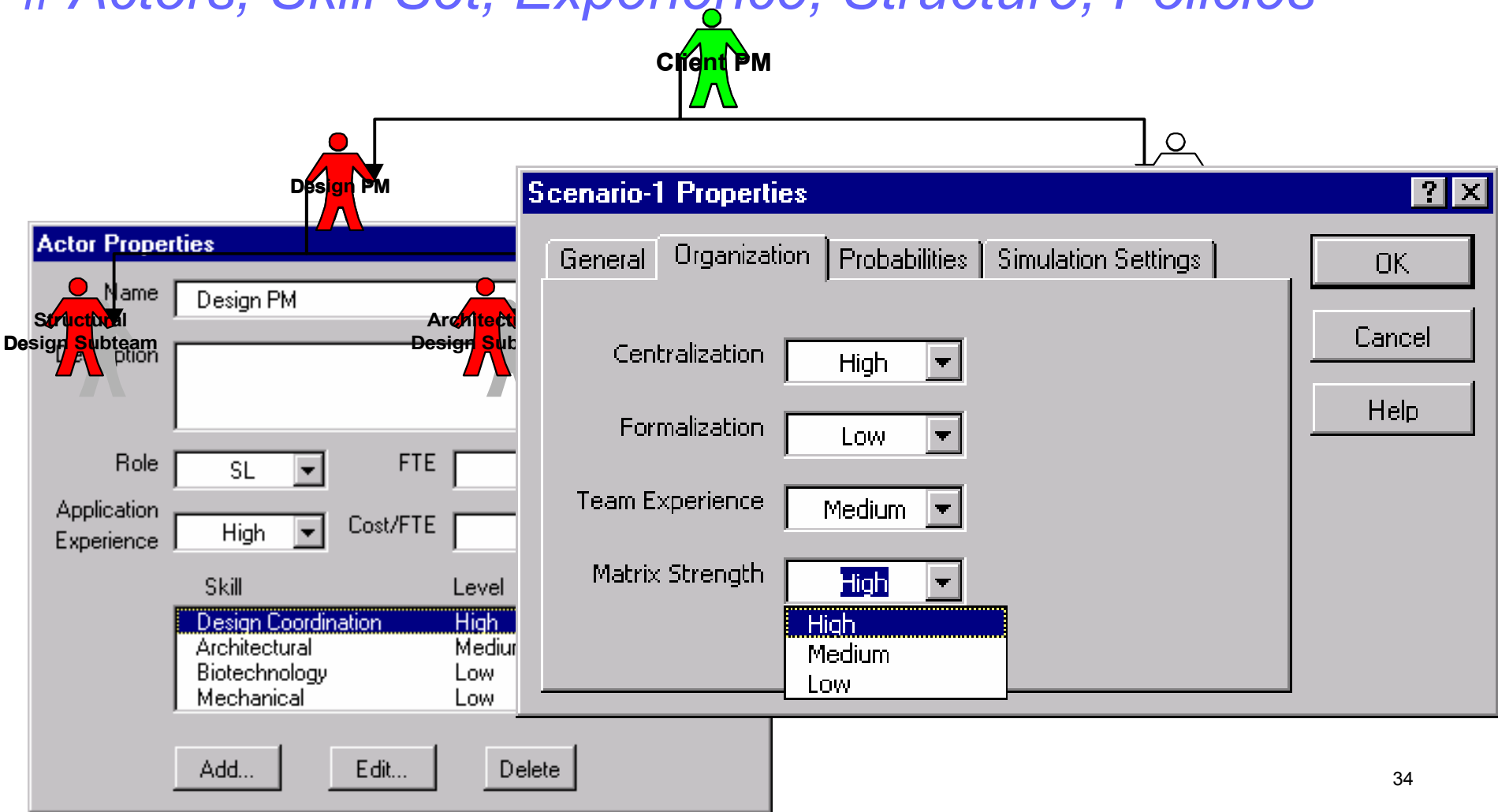
Info. Volume is Derived from Project Tasks:

Direct Work, Communications, Rework



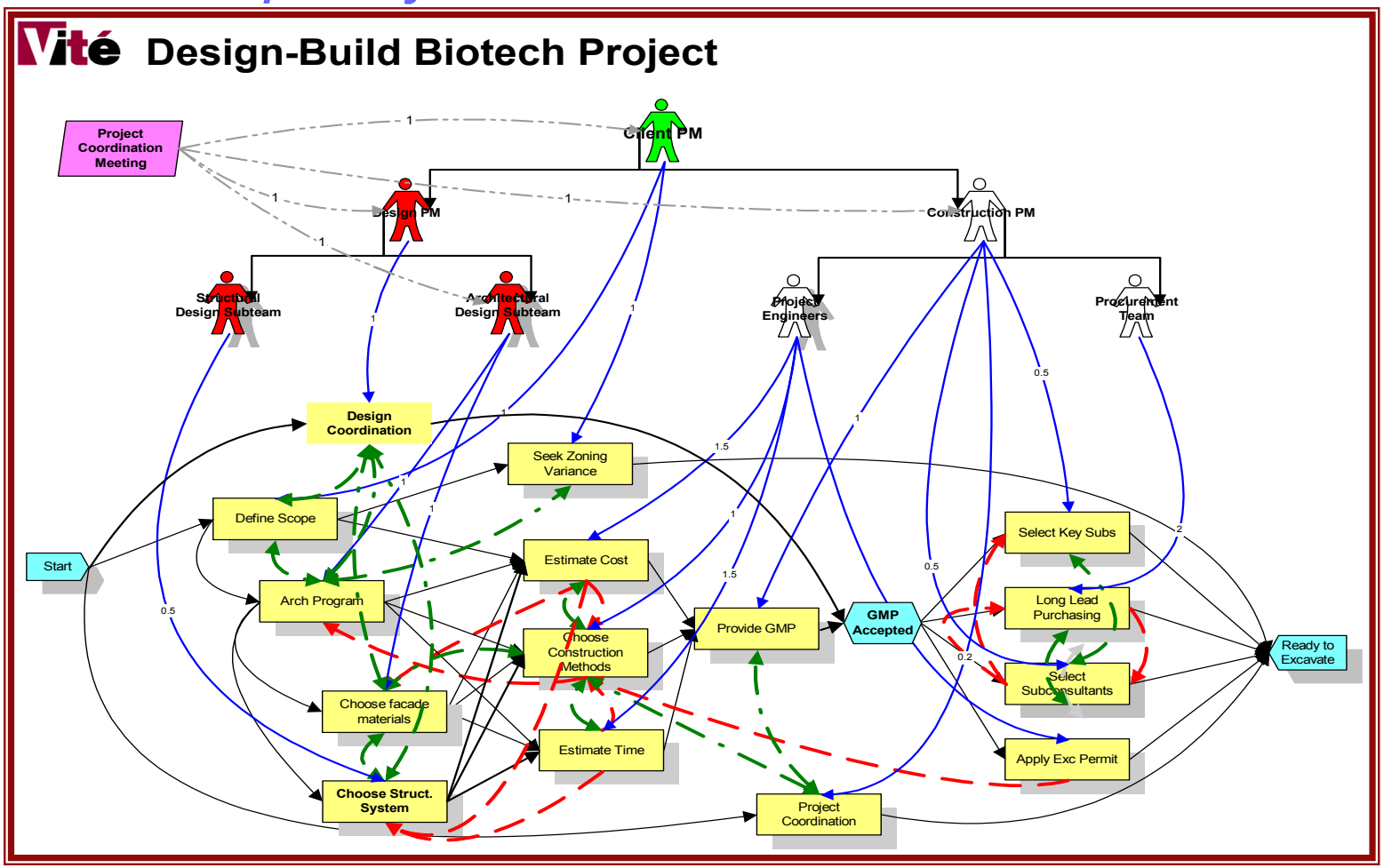
Team Information Processing Capacity is Derived From:

 # Actors; Skill Set; Experience; Structure; Policies



VDT/SimVision Information Processing Model:

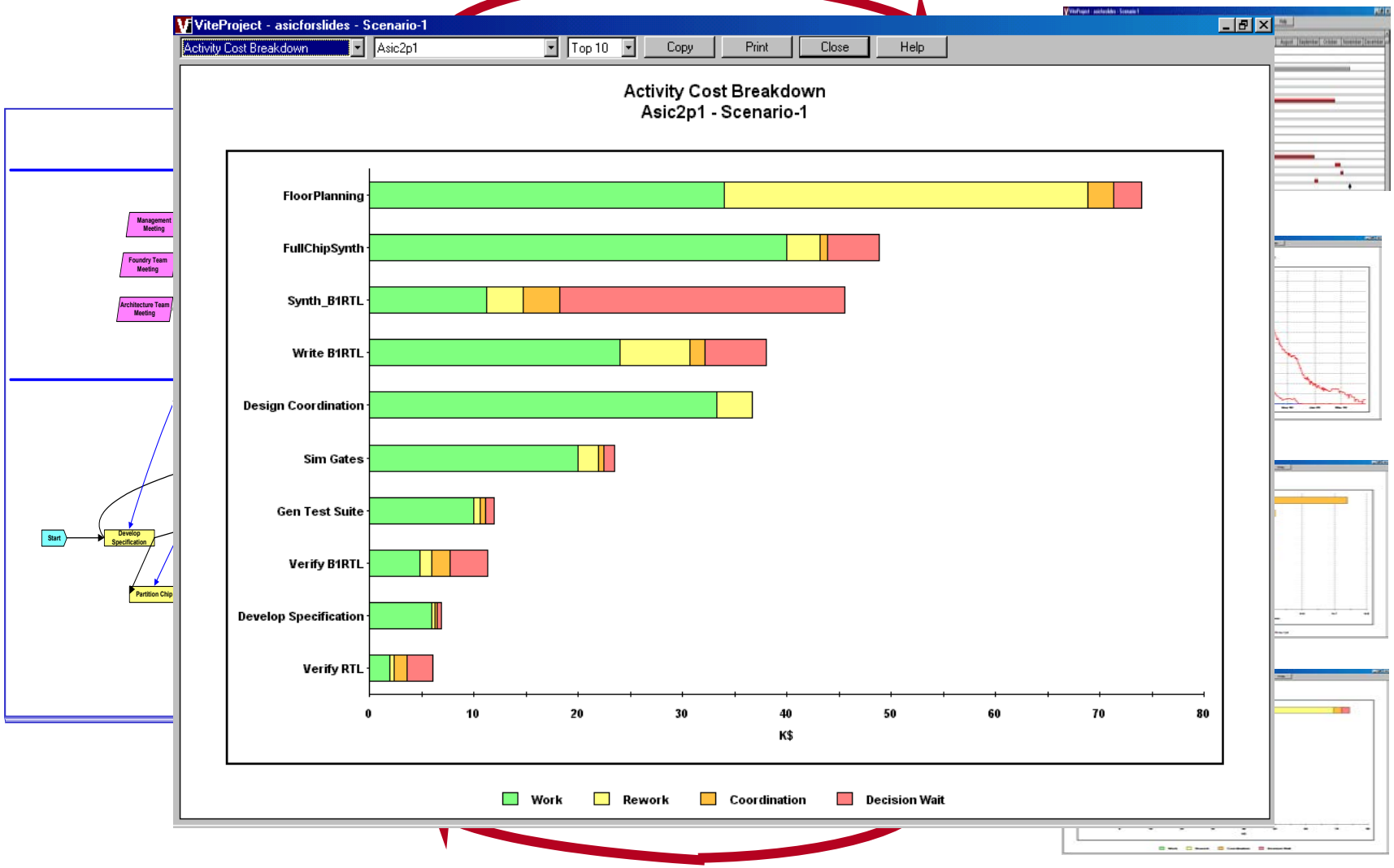
Team IP Capacity >= Task IP Demand?



Predictions from VDT/*SimVision* Project Design Approach

Model

Simulation Results



Steps in VDT/SimVision Project Design

- Identify client's key business issues and risks
- Develop Flexibility Matrix and trade-offs
- Model "Baseline Case"
  - Lay out 5-10 key business milestones per project
  - Identify and sequence 5-10 activities per milestone
  - Lay out organization:
    - structure, positions, capacity, skills, decision making policies
  - Assign each task to ***one responsible position***
- "Flight-simulate" Baseline Case
  - Diagnose backlogs, schedule and quality risks
  - Explore potential interventions to mitigate risks
- Choose a project design that is likely to succeed

Level of Effort for Project/Program (Re)Design

Elements of Fast-Track Program Design and Redesign	**Client Effort** *(FTE-days)*	**Analyst Effort** *(FTE-days)*
Gather data from client about business objectives, milestones, tasks, costs, staffing, known risks, etc.	0.5	0.5
Build “straw-man” as-planned, baseline model	0	1-2
Discuss and refine model	0.5	1-2
Diagnose risks with baseline case	0.25	0.5
Evaluate multiple potential interventions	0.25	0.5
Produce recommendations and report	0	1.0
Ongoing Redesign (Tracking) per cycle	***0.5***	***1.0***

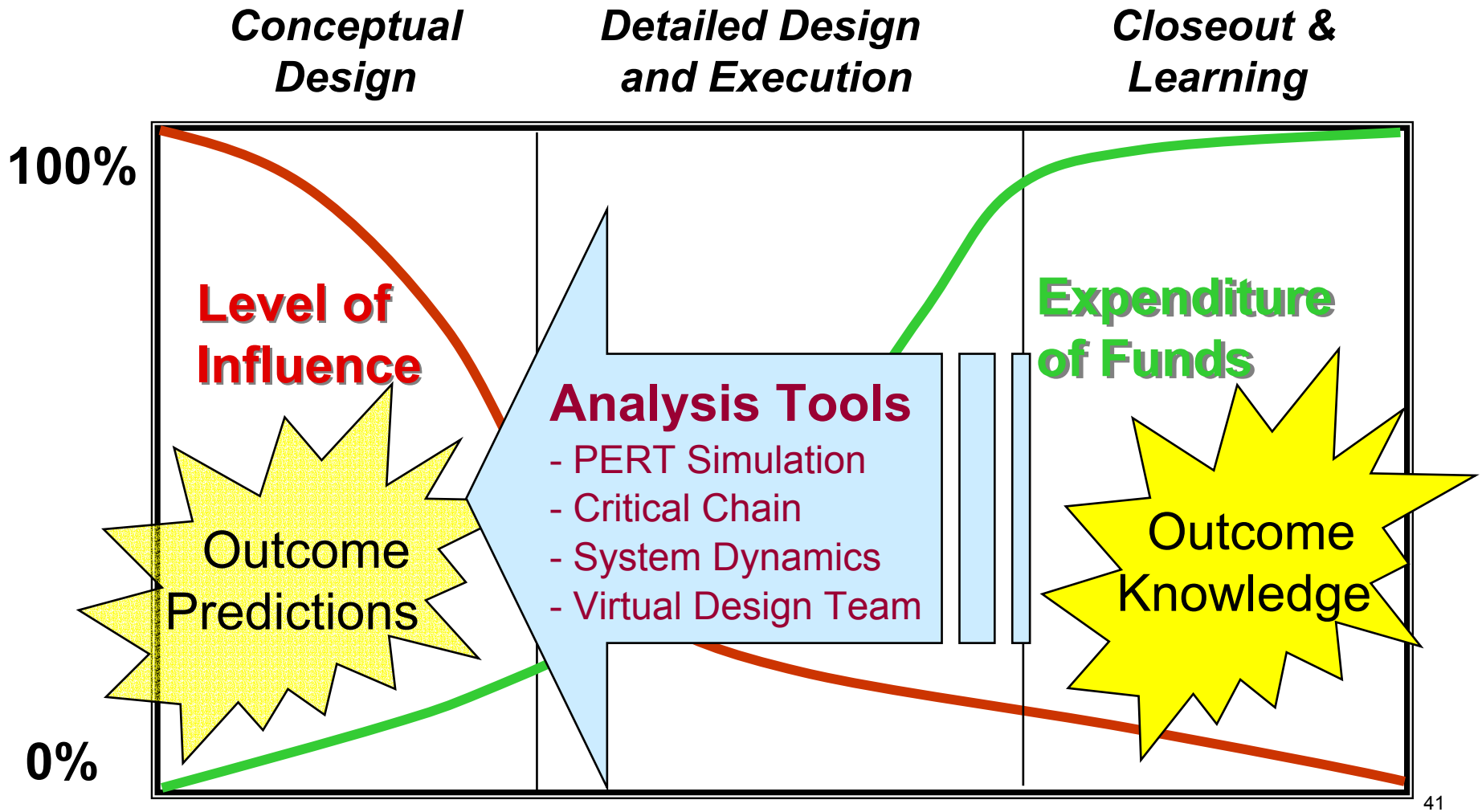
VDT Fast-Track Project Design: Examples

- Reduce time to market for complex manufacturing facilities
- Facilitate roll-out of new wireless telecom infrastructure across multiple regions
- Develop best practices template to accelerate factory start-ups
- Identify and correct subcontractor management problem that would have delayed project 4 mo.
- Help to meet ship milestone date required to close sale with large customer
- Align goals and accelerate rollout of innovative consumer product by 3 months
- Identify and mitigate critical quality risks to accelerate rollout of new server product
- Help to define scope, schedule and organization for strategic IT projects

👍 & 👎 of VDT/SimVision for Fast-Track Projects

- 👍 VDT/SimVision uniquely highlights impact of fast-track work process on cost, schedule and process quality
- 👍 VDT/SimVision shows impacts of differences in participants skills & experience on project outcomes
- 👍 Small models and graphical inputs/outputs engage executives in project design process
- 👎 Models only organizational risks—not technical or market risks (these risks require separate “scenarios”)
- 👎 VDT organizational model assumes hierarchical exception handling

Analysis Tools Can Support "Fast-Track Project Design"



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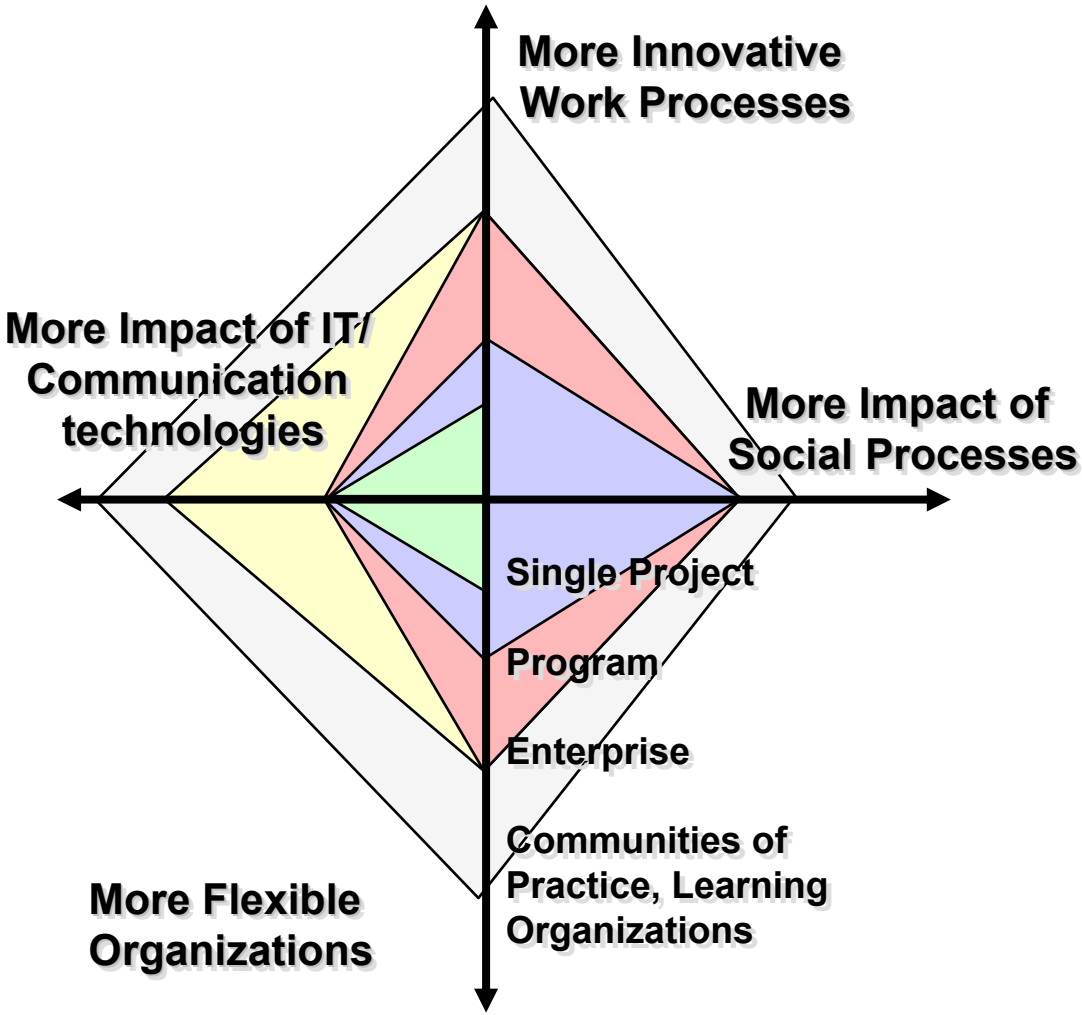
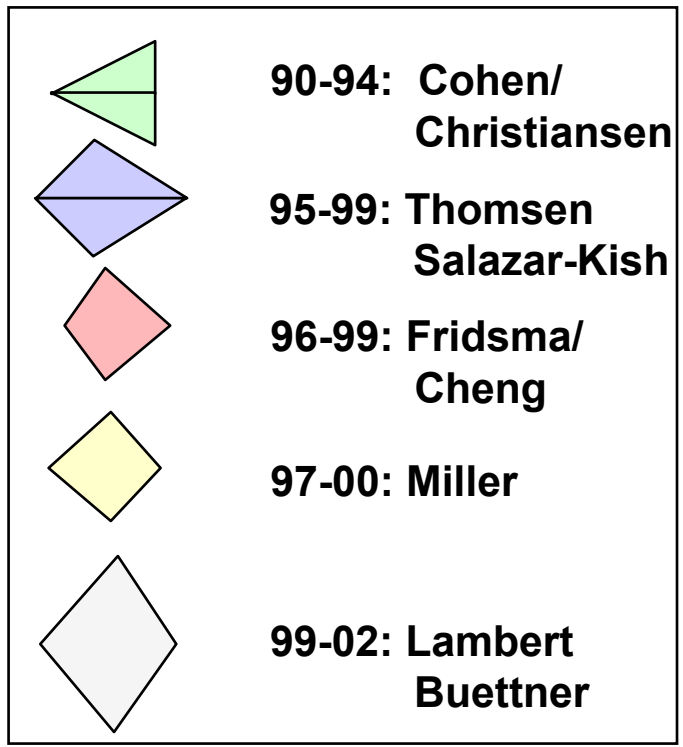
Trajectory of Past VDT Project Design Research





Ongoing Stanford Project Design Research