The Most Important Trades Often Happen During Project Planning: Using Set-Based Practices to Optimize those Trade-Off Decisions

Brian M. Kennedy
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Trade-Offs for the design of a UAV

Need to decide:

- Sensor Packages
- Wingspan
- Fuel Capacity
- Propulsion System
- Fuselage Length
- Weight
- Altitude

Analysis

To satisfy targets:

- Range to Target
- Time to Target
- Endurance at Target
- Area Scanned per Unit Time
- Size of Targets Detected
- Survivability
- Detectability
- Per Unit UAV Cost

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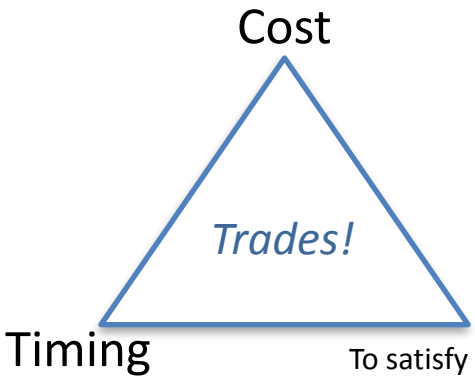
Trade-Offs for the project planning of the design of a UAV

Need to decide:

- Who does What
- What needs to be Learned
- What Options to Evaluate
- What Resources to Use
- What Testing to Do
- What Innovation
- What Risks



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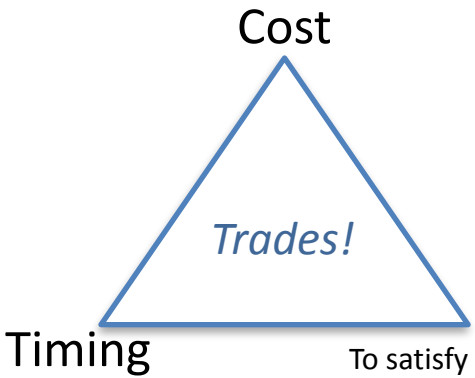

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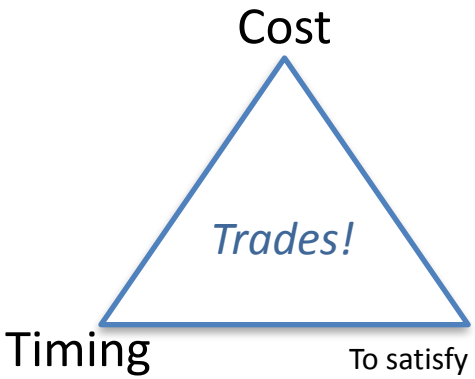

Traditional tools (Gantt, PERT, Project, etc.) show timing dependencies and perhaps support cost roll-ups, but they don't let you see all of these Trades!!

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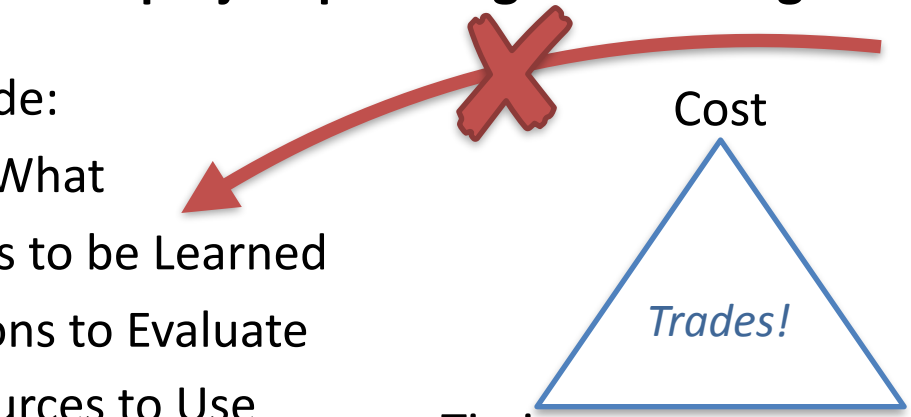

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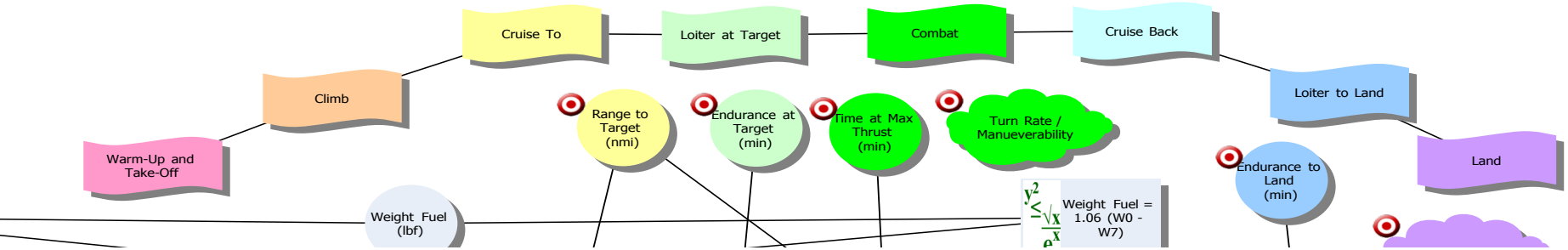
How? Use the same Set-Based Causal Map to do your Planning Trades!



In the same way that we laid out the steps of the UAV's target mission (to serve as a color coding for the rest of the Causal Map), you can lay out the development steps.

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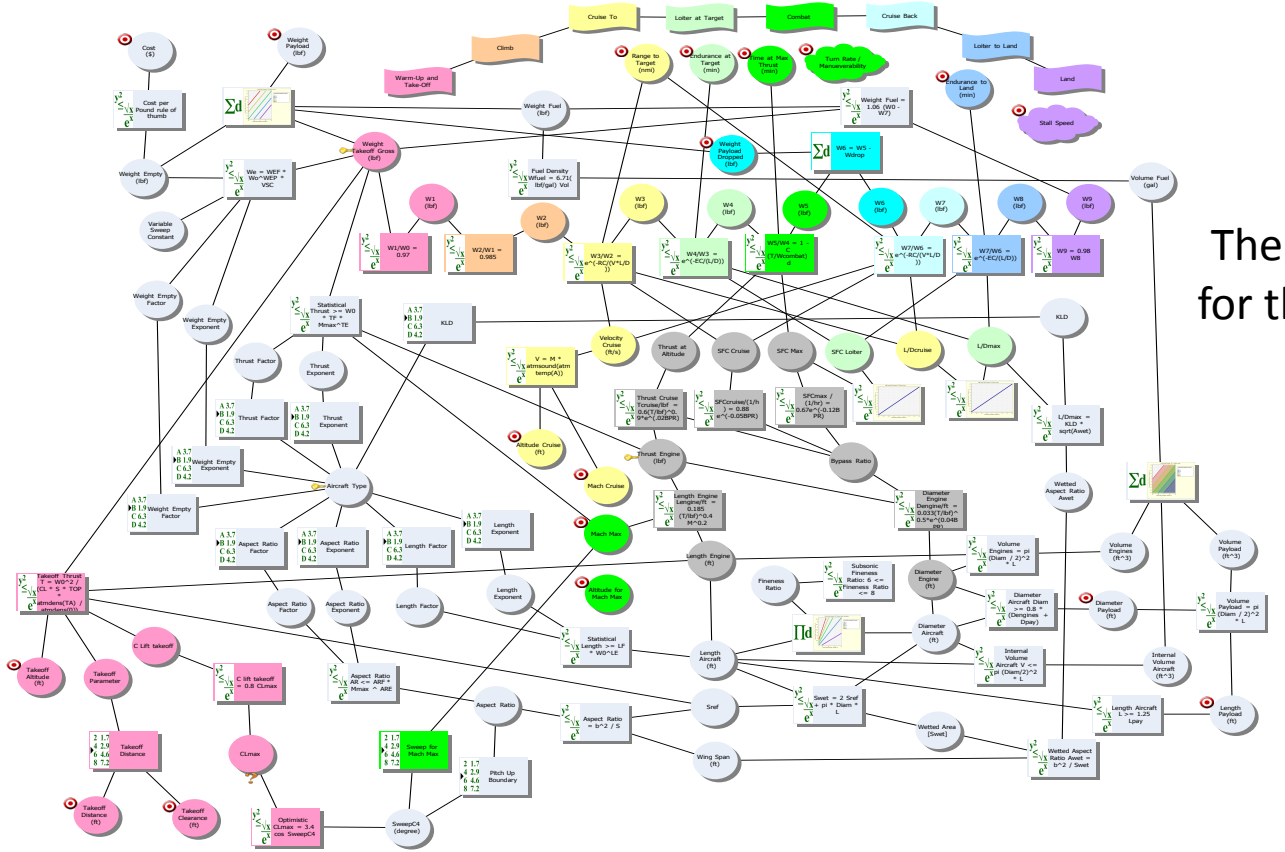
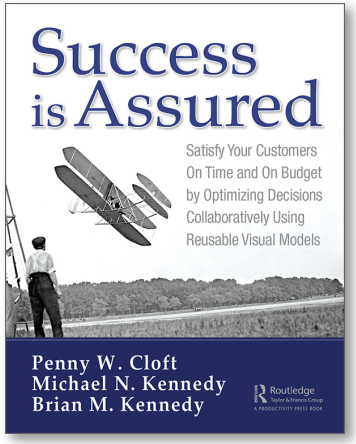


The full Causal Map for that UAV's Trades

details are in:



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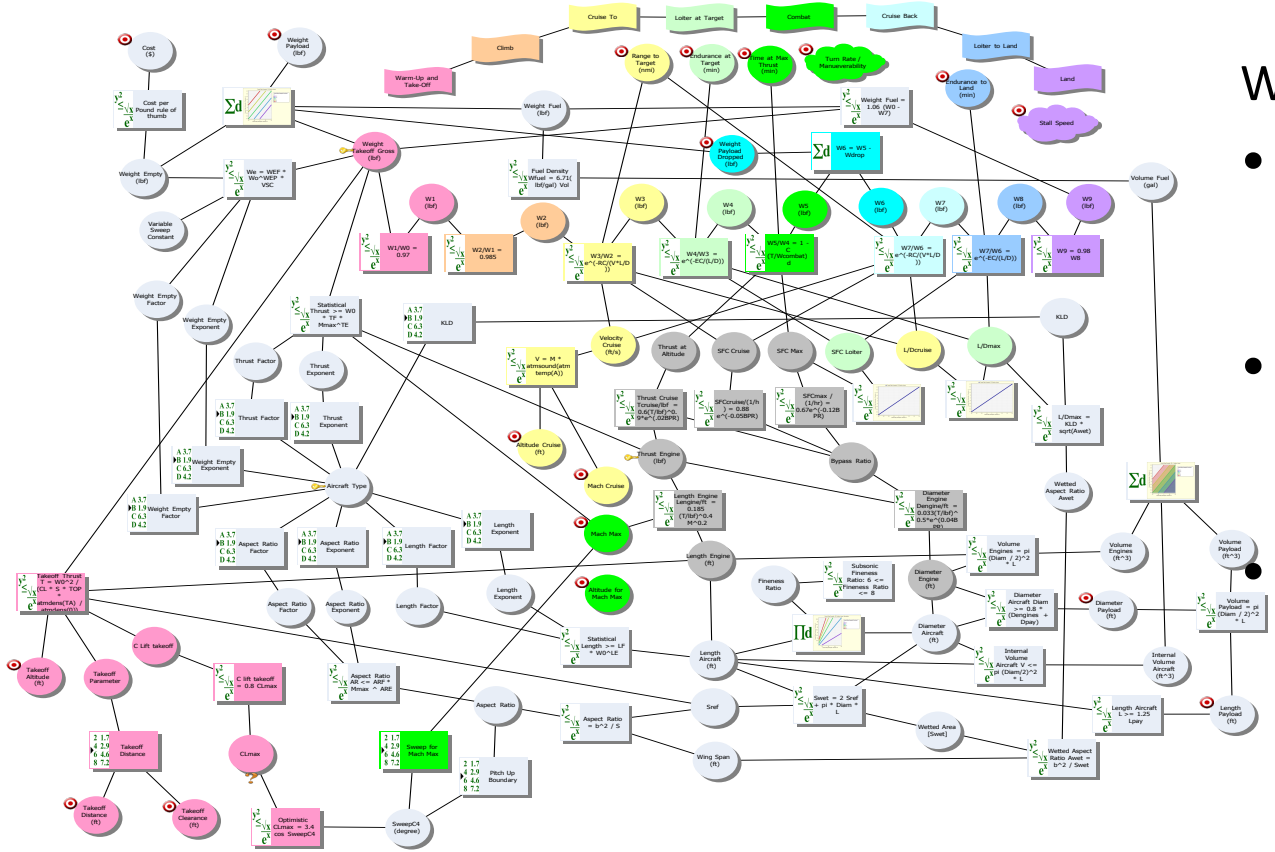

Which of these decisions:

- have alternatives that will require extra learning, testing, headcount, etc.?
- carry extra risks that need to be managed or eliminated via upfront learning efforts?
- limit performance such that innovations will be needed to overcome those limits?

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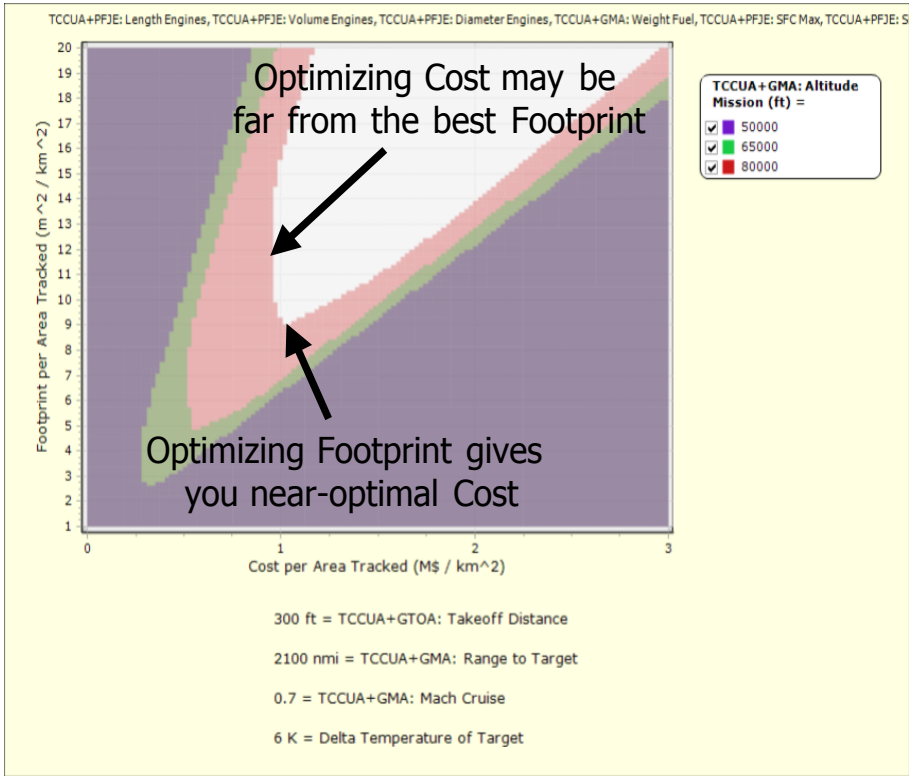
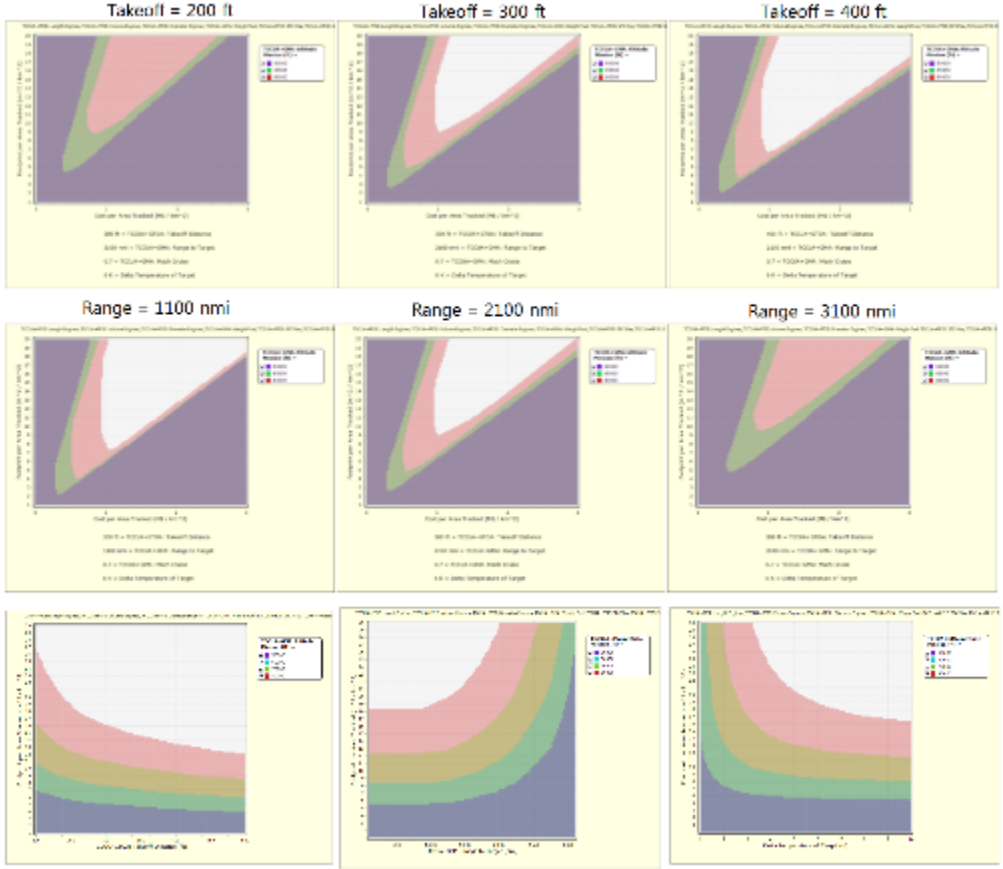
Quick UAV Design example (Set-Based system design for a mission)





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Benefits of Applying Set-Based System Design Techniques

- See how your Project Planning Decisions will impact your Timing, Cost, & Targets
- See the Causal Structure of the full Decision Space, as well as the Limits of it
- See the Sensitivities, and let those guide Human-in-the-Loop Optimization

- Accommodate Uncertainty – Make wise decisions even though things are Uncertain
- Accommodate Ongoing Learning – As you learn, just continue narrowing decisions
- Use the Limits and Structure to Focus Your Learning Efforts where most valuable

- The Visual Models enable effective Collaboration Across Different Areas of Expertise
- The “Eliminate the Weak” paradigm of converging to more optimal solutions enables Concurrency across different groups focused on different sub-systems (sub-missions)
- The Set-Based visual models are highly reusable and enable continuous improvement each time they are reused

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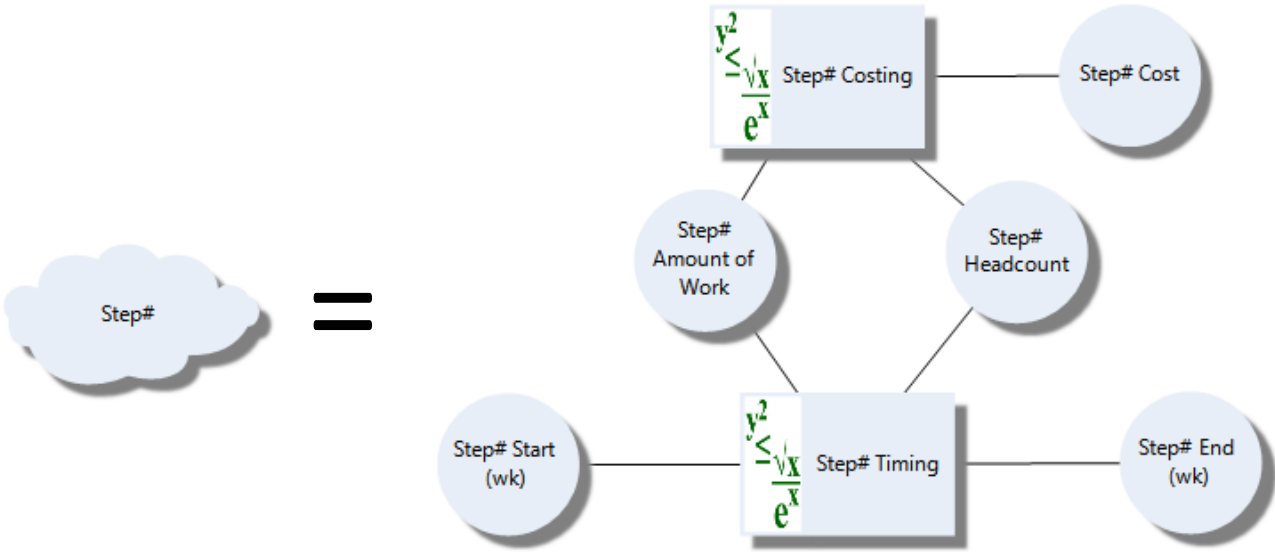
Causal Map for a single Process Step

Need to decide:

- When to Start
- When to End
- Headcount
- Resources
- Amount of Work



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Causal Map for a single Process Step

Need to decide:

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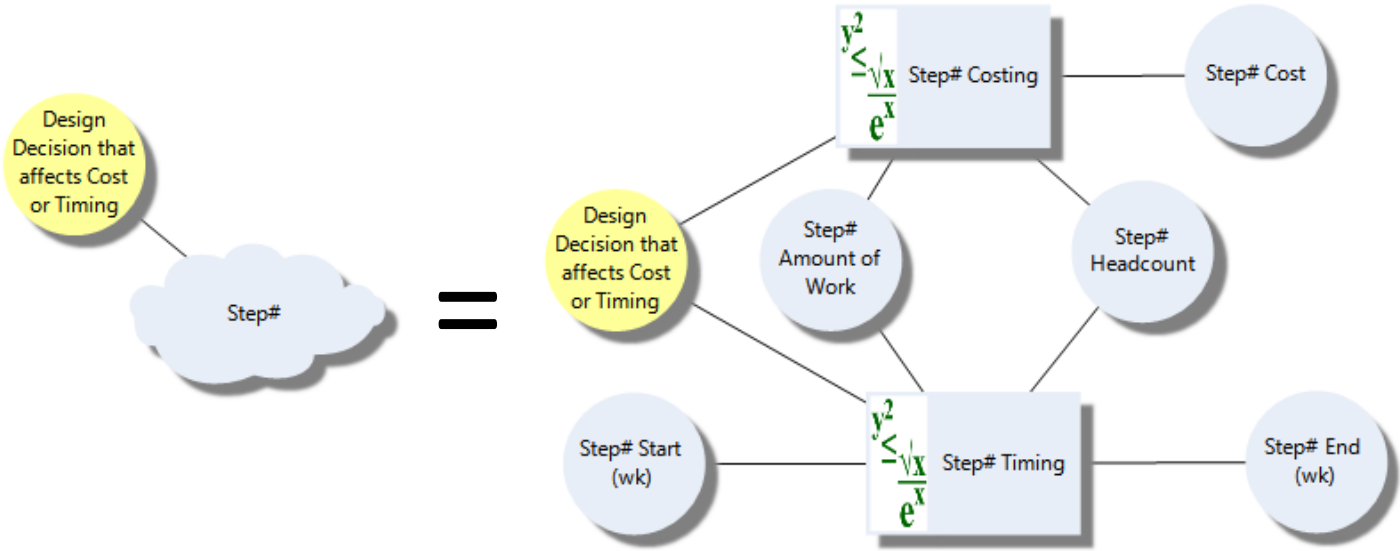
- Design Decisions to be Considered



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Causal Map for a single Process Step

Need to decide:

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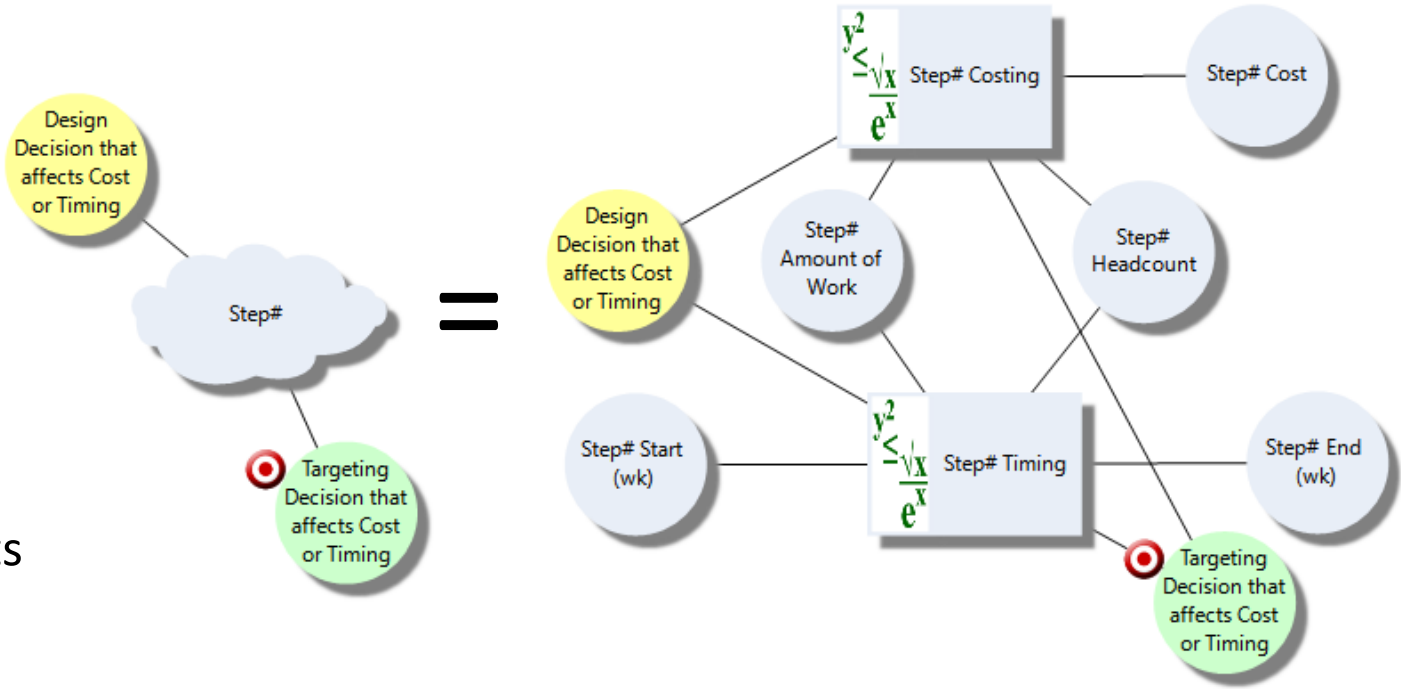
- When to End
- Headcount
- Resources
- Amount of Work
- Design Decisions to be Considered
- Targets for Results



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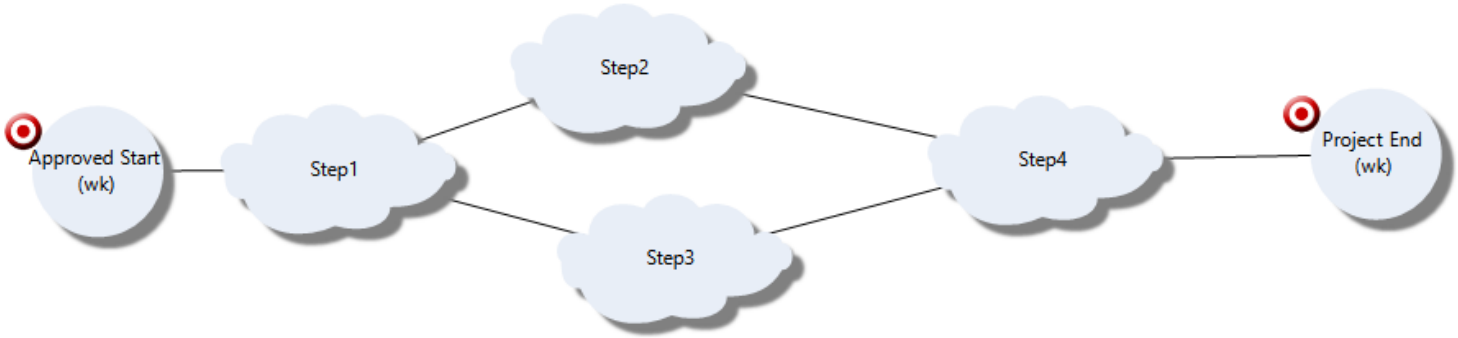
Causal Map for a Project Plan

- The Steps alone capture the Timing dependencies



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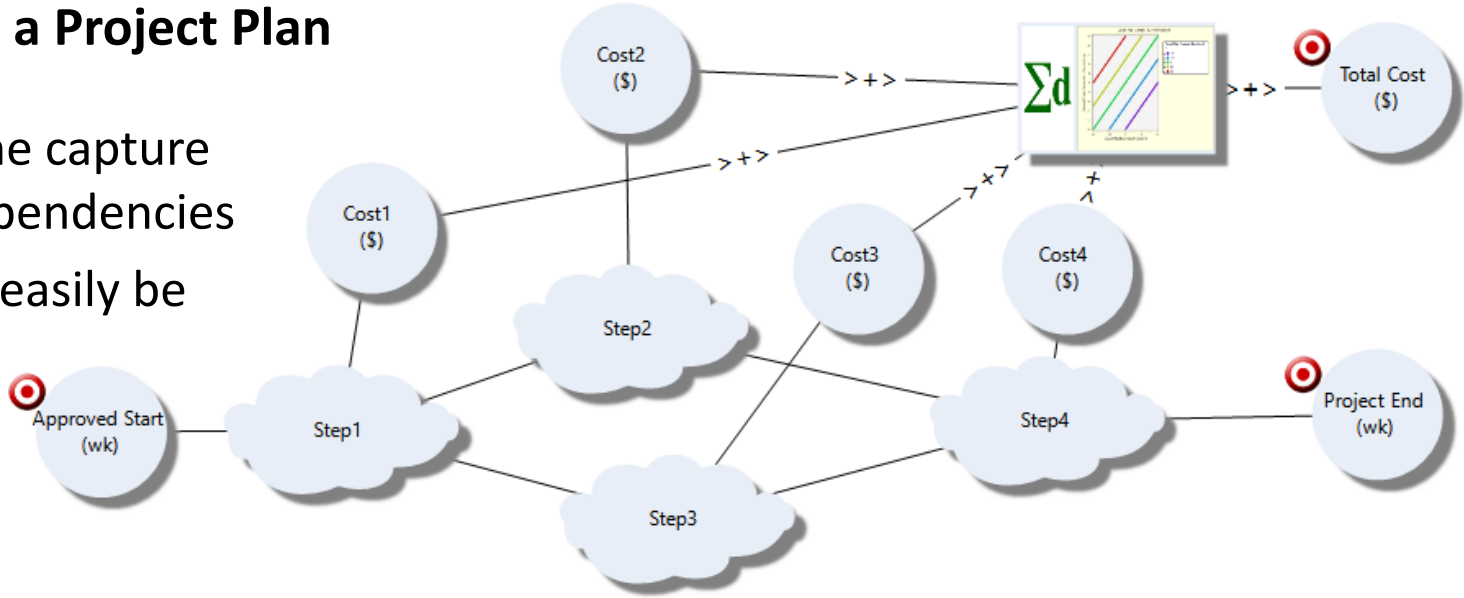
Causal Map for a Project Plan

- The Steps alone capture the Timing dependencies
- The Costs can easily be summed up



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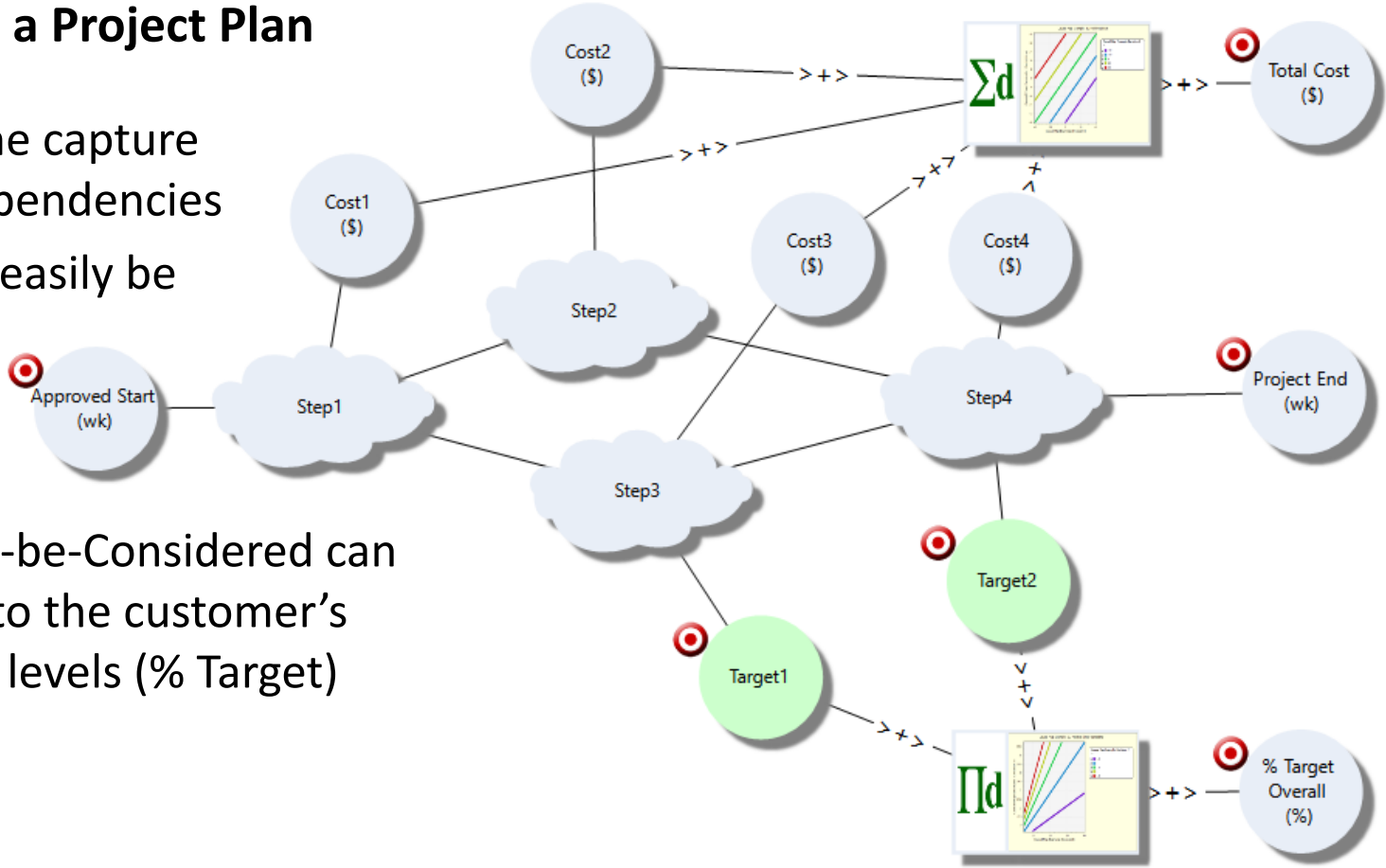

- The Targets-to-be-Considered can be compared to the customer's Goal and Veto levels (% Target)

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Causal Map for a Project Plan — Visually Simplified

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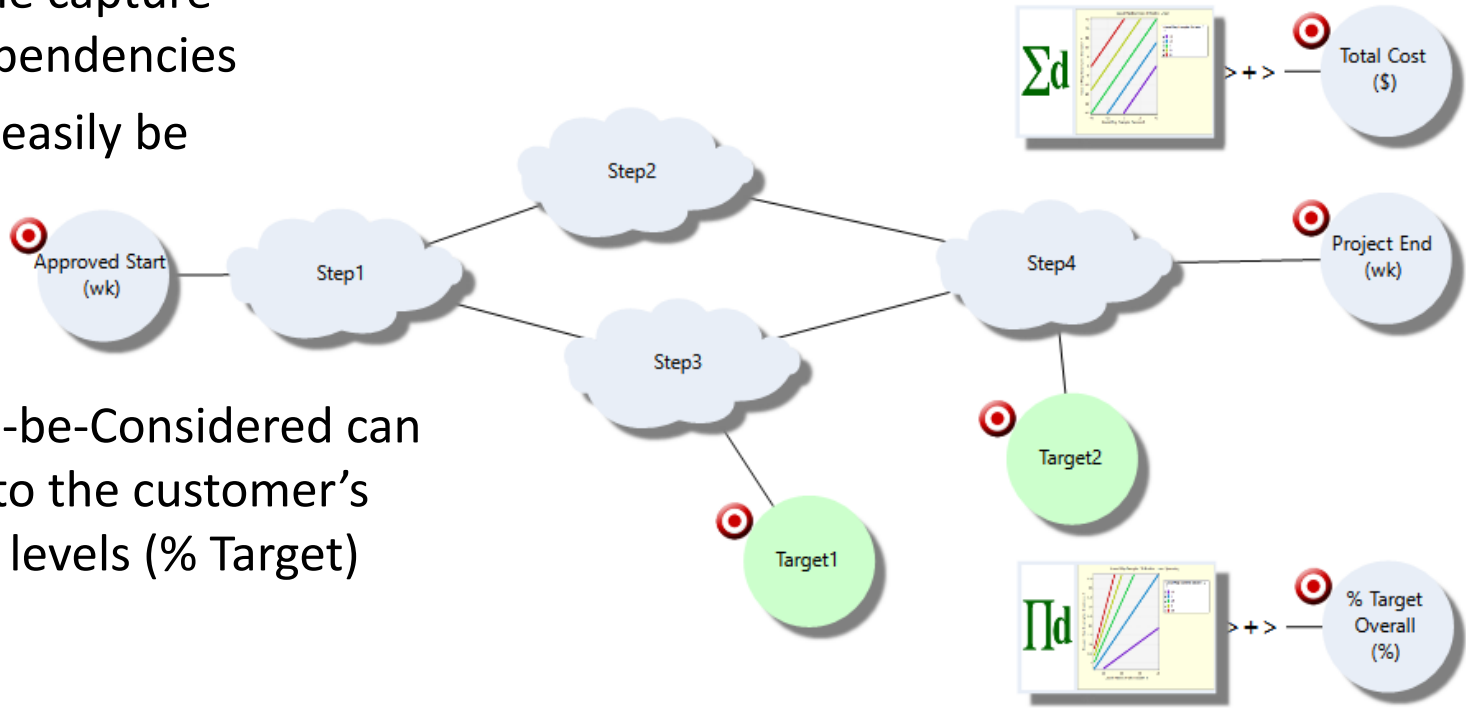
- The Costs can easily be summed up



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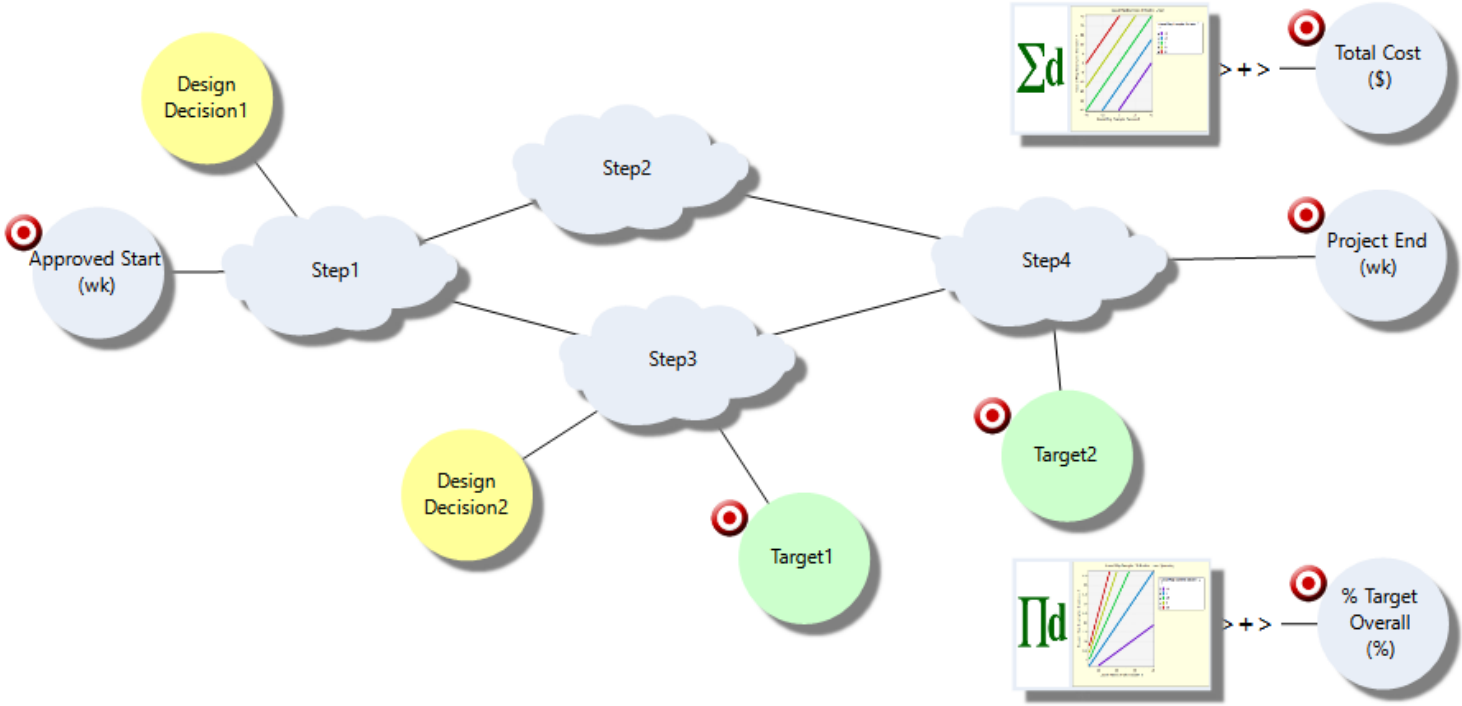
Causal Map for a Project Plan — “So, what Decisions might impact this?”



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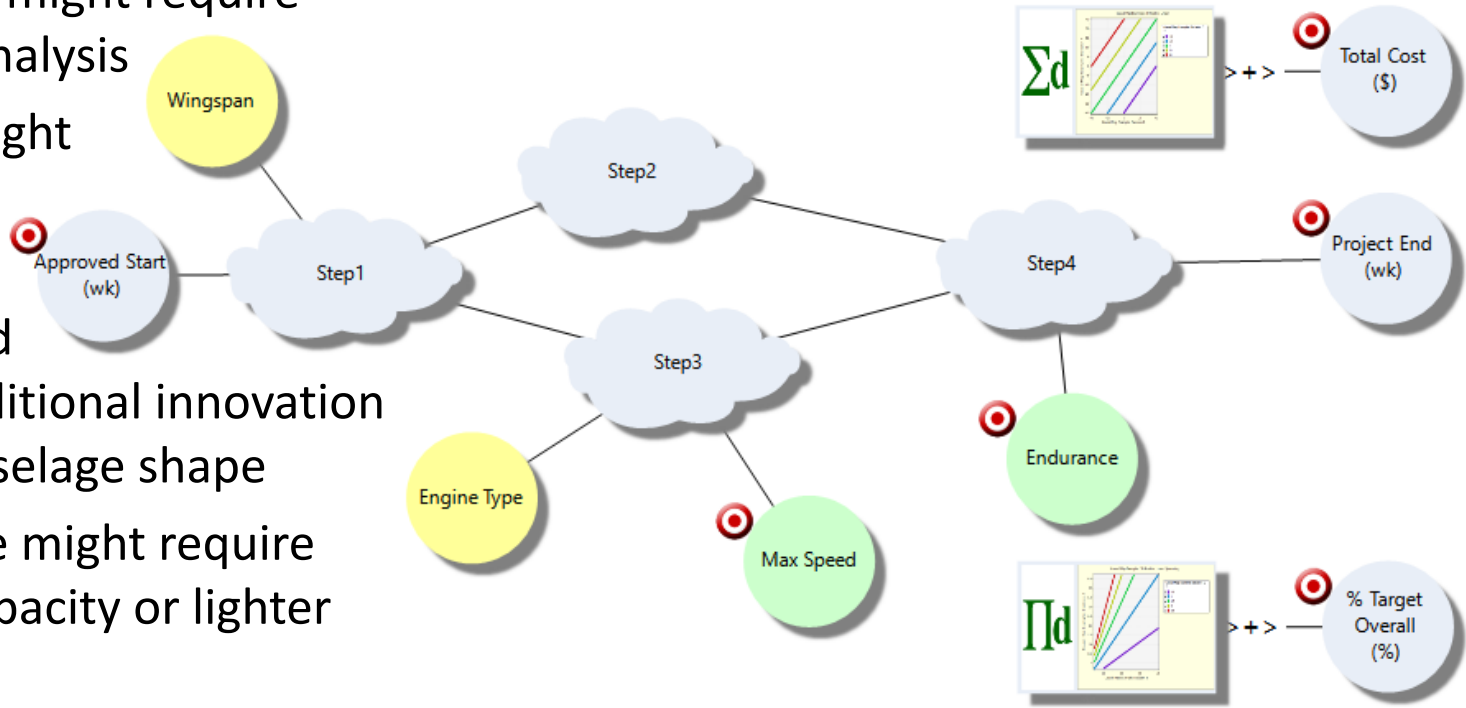
Causal Map for a Project Plan — Concrete Design Decisions and Targets

- Longer Wingspan might require extra structural analysis
- Electric Engine might require battery research
- Higher Max Speed might require additional innovation and analysis in fuselage shape
- Longer Endurance might require additional fuel capacity or lighter weight materials



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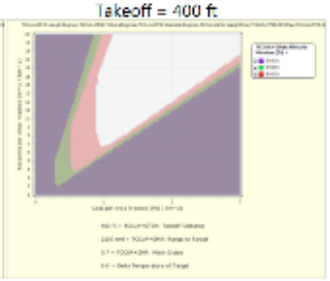
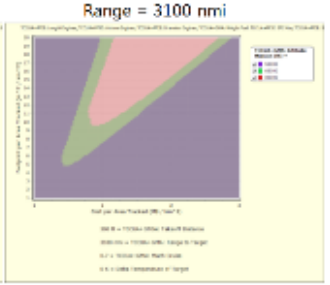
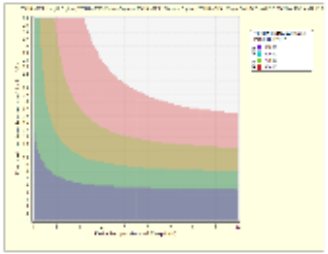
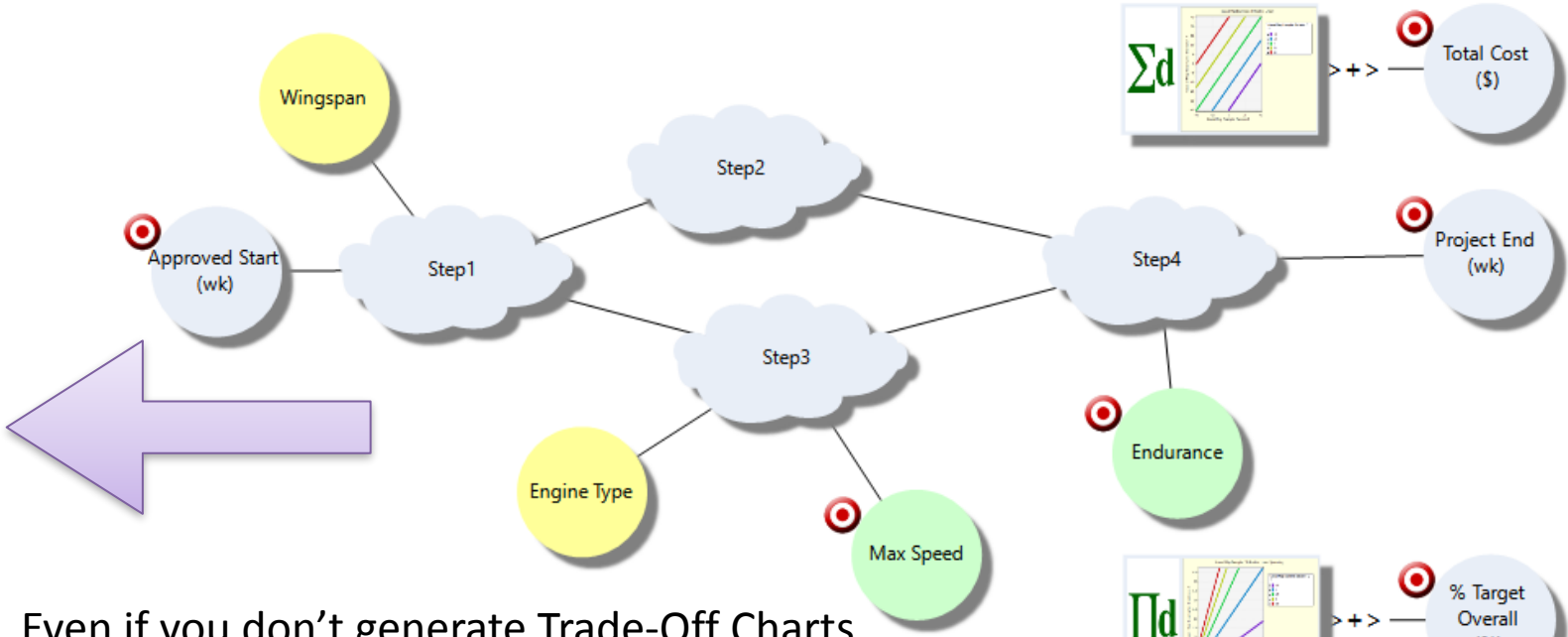
Causal Map for a Project Plan — Improved Collaboration









Even if you don't generate Trade-Off Charts from your Project Planning Causal Maps, you will still get huge benefits from the improved collaboration — the improved thinking.

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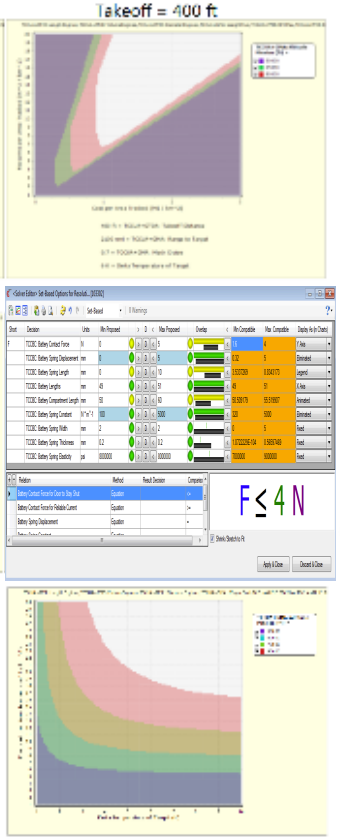
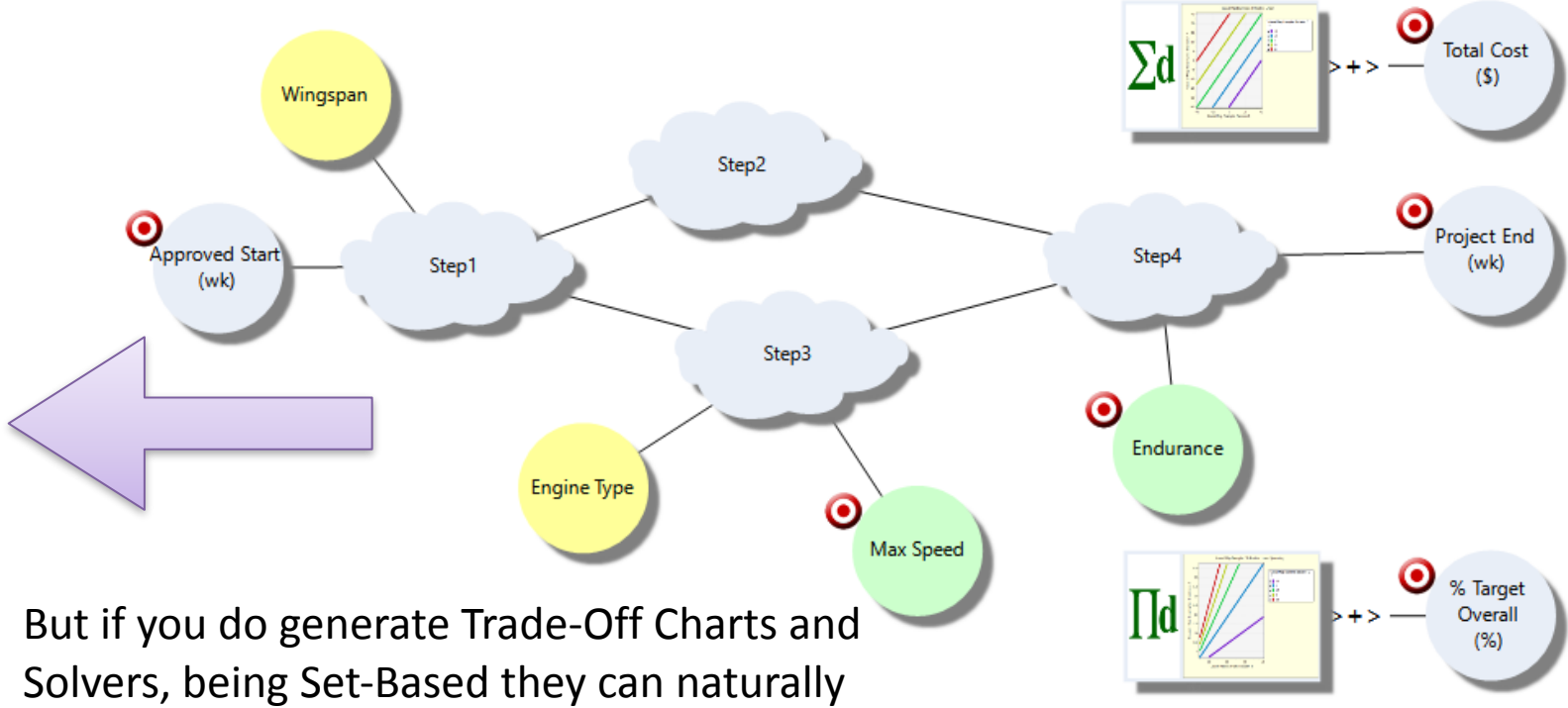
Causal Map for a Project Plan — Improved Collaboration





But if you do generate Trade-Off Charts and Solvers, being Set-Based they can naturally accommodate all the uncertainty that you will have early in the Project Planning effort.

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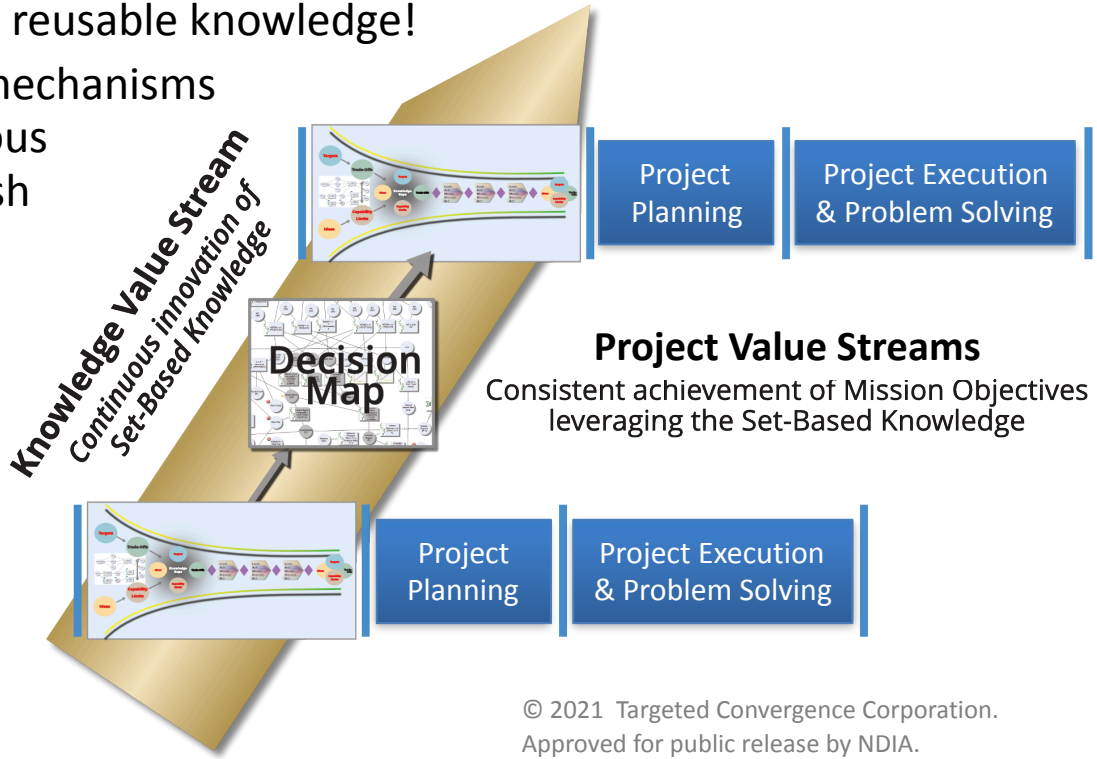
That Set-Based Knowledge is Reusable and Continuously Improvable

- The Visual Knowledge makes it easy to review, critique, and improve.
- And when easy-to-review, it becomes trustworthy.
- And only if trustworthy, is it truly reusable knowledge!
- By putting in place appropriate mechanisms for Knowledge Reuse & Continuous Improvement, teams can establish a Knowledge Value Stream that feeds their Project Planning & Execution Value Streams.
- The key Enablers for that are the Causal Decision Map and the Trade-Off Chart / Solver.



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Any Questions??

- There's a short (2-minute) video trailer on our book at:
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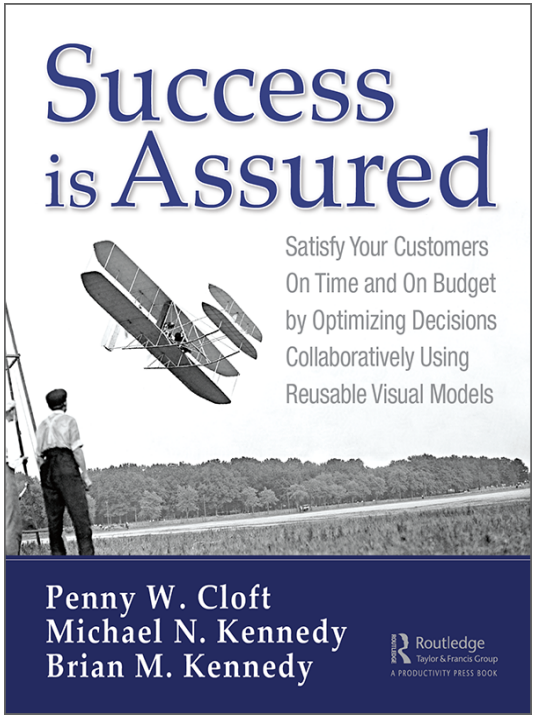

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