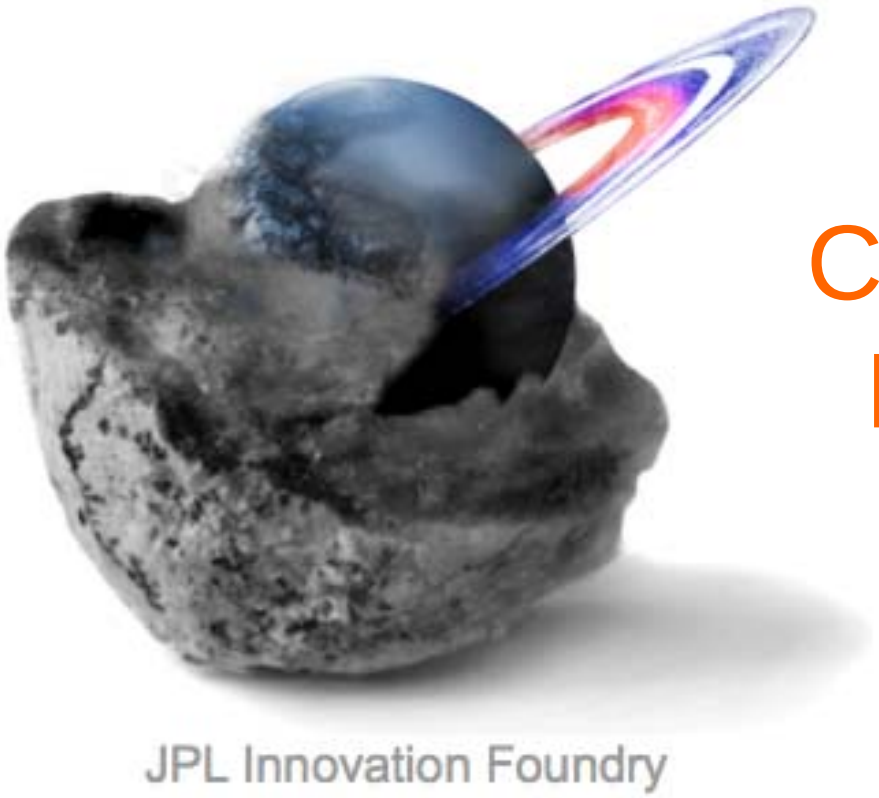
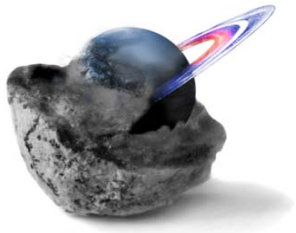


Concept Maturity Levels (CMLs)

Tony Freeman
Manager, Innovation Foundry
Jet Propulsion Laboratory,
California institute of Technology



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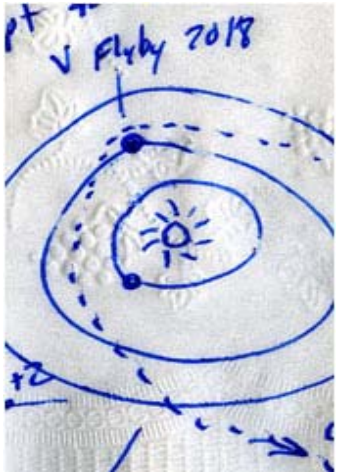
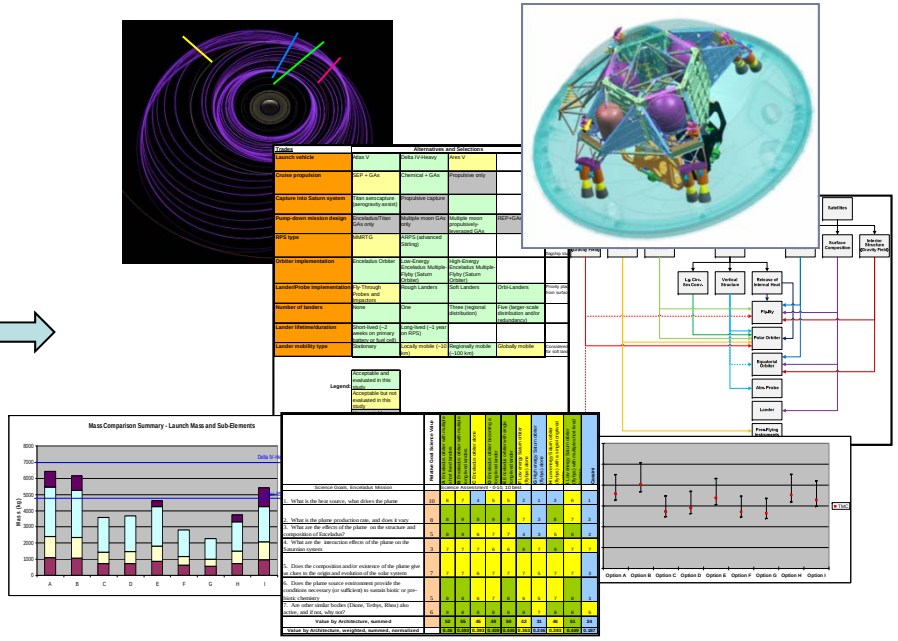
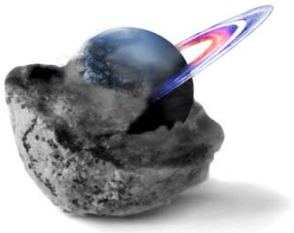
Absent: a Common Language for Concepts

- How mature is your concept?

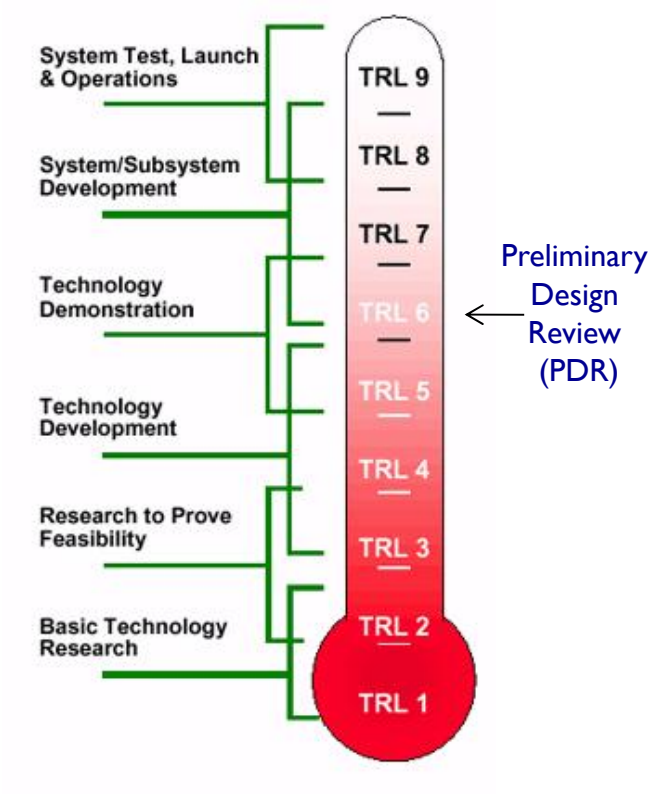


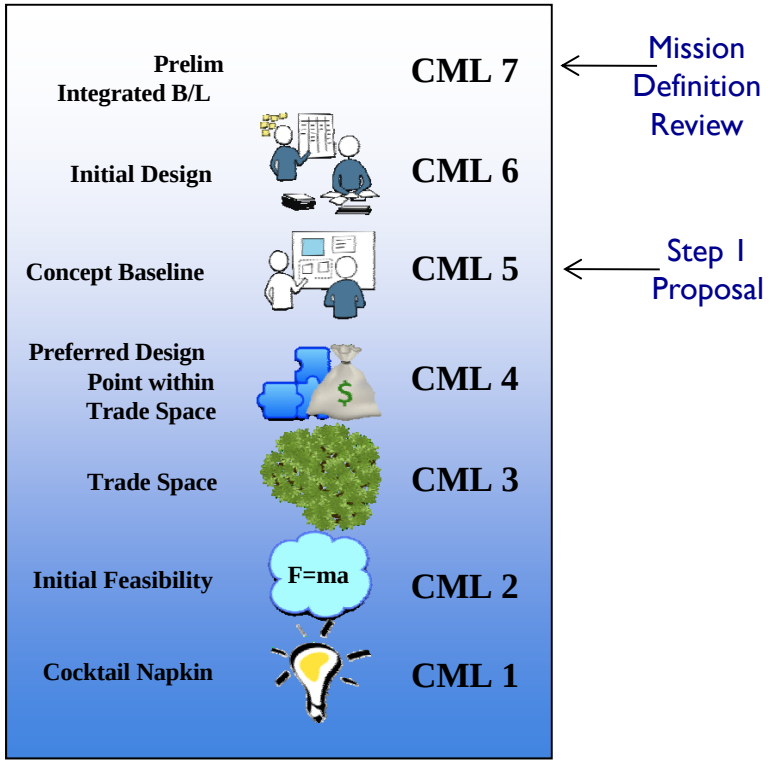
This or that?

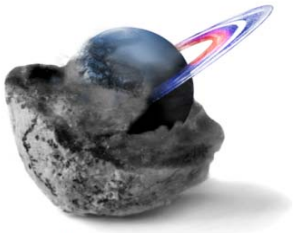




CML Scale is Based on the TRL Scale

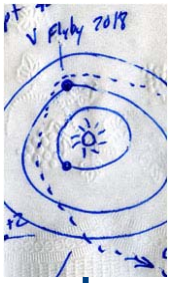




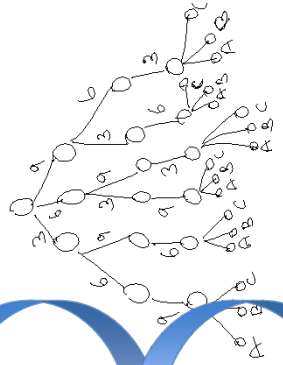


CMLs: A Powerful Communication Tool

Cocktail Napkin

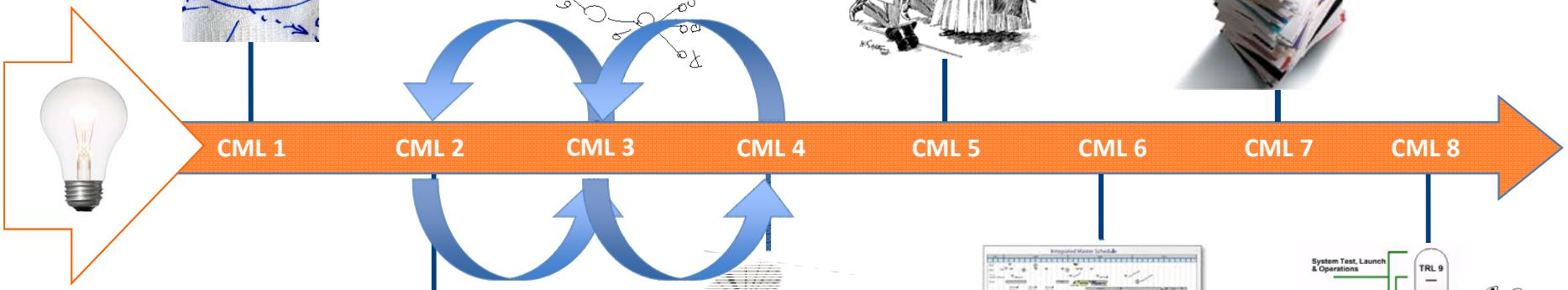


Trade Space



Baseline Concept

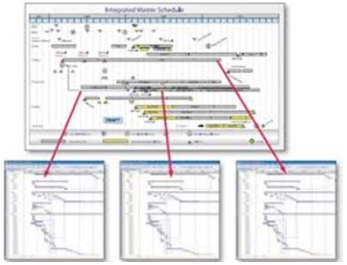
Preliminary Implementation Baseline



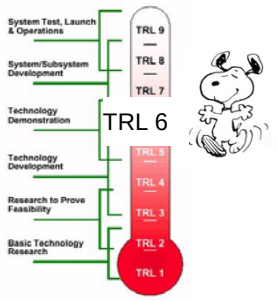
F=ma

Initial Feasibility

Point Design



Integrated Concept



Integrated Baseline

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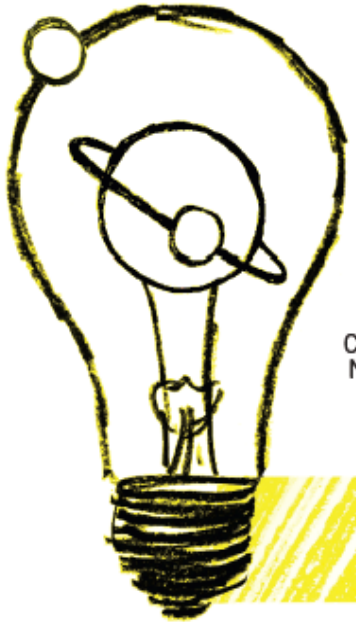
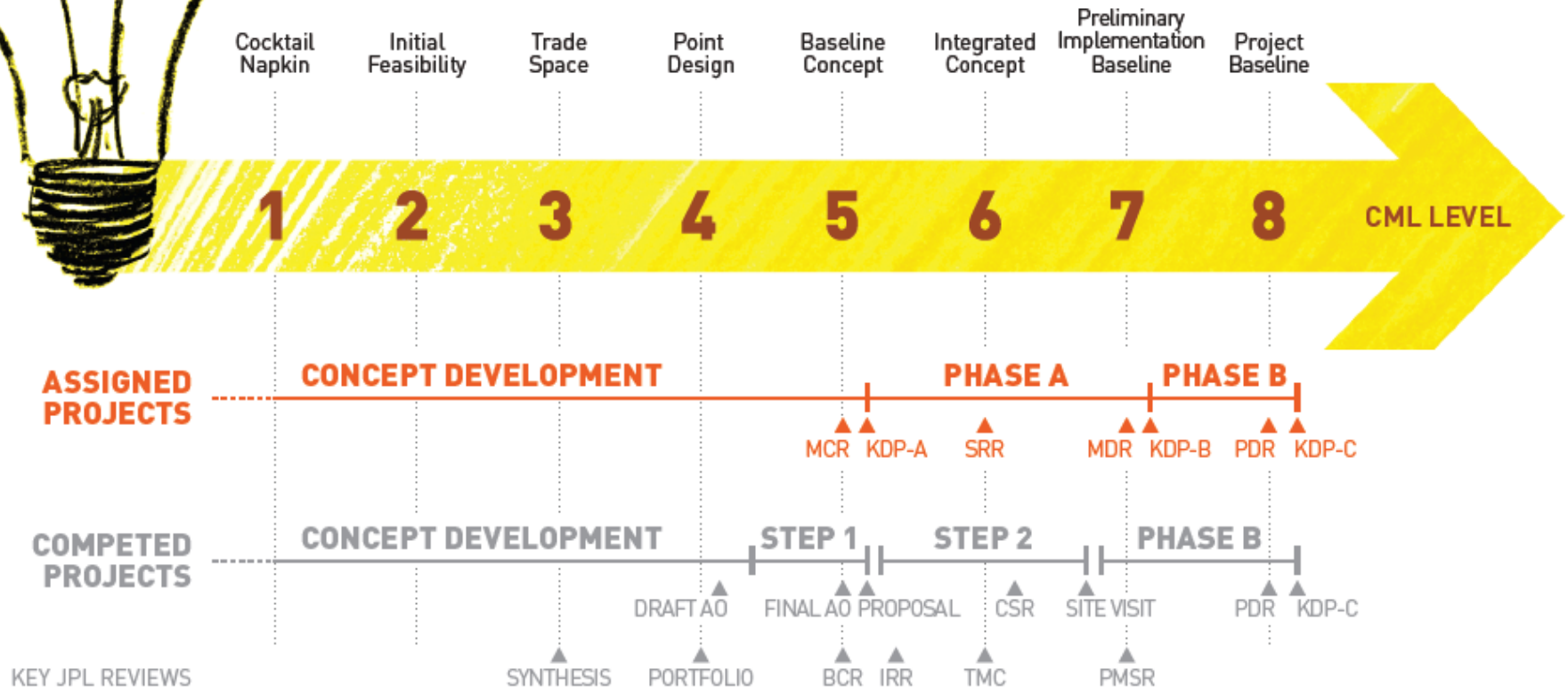
CONCEPT MATURITY LEVELS (CML)

for NASA Competed and Assigned Projects





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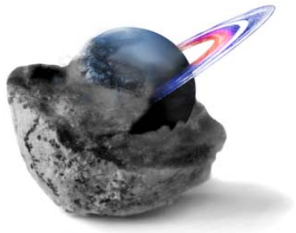
From Communication to Concept Development

Lifecycle Phase		Pre-Phase A					Phase A	
		Advance Studies			Concept Development		Early Formulation	
CML		1	2	3	4	5	6	7
Name		Cocktail Napkin	Initial Feasibility	Trade Space	Point Design	Baseline Concept	Integrated Concept	Preliminary Implementation Baseline
Lifecycle Gate		-	-	-	Concept Gate (Draft AO Out / Mission Study Report)	Baseline Commitment Gate/ MCR	Step 2 Submittal	PMSR/MDR
Science								
Attribute	P4 Section							
Science Objectives & System Requirements	5.3	Science objectives described in one sentence	Objectives described to levels that allow comparison with previous investigations and NASA science community documents	Objectives linked to investigations and measurements; Science return as a function of cost, risk and programmatics quantified	Produce draft Science Traceability Matrix; Initial Level 1 requirements considered; Specifying one Baseline and one Threshold Science investigation; Key Performance Parameters listed	Science Traceability Matrix (or equivalent) produced; Preliminary PLRA produced (assigned projects)	Proposed Level 1 requirements documented Level 2 & 3 driving requirements listed; Full and minimum success criteria defined; Baseline PLRA submitted @ SRR (assigned projects)	Update PLRA if necessary; Preliminary Level 2 & 3 requirements listed
Science Data System	5.4	-	Identify science data drivers	Science data rates and volume included in trade space analysis	Science data system sizing	Science data processing architecture, release and archive approach defined	Science data management approach (includes Level 0, 1, 2 data products) defined	Same as for CML 6



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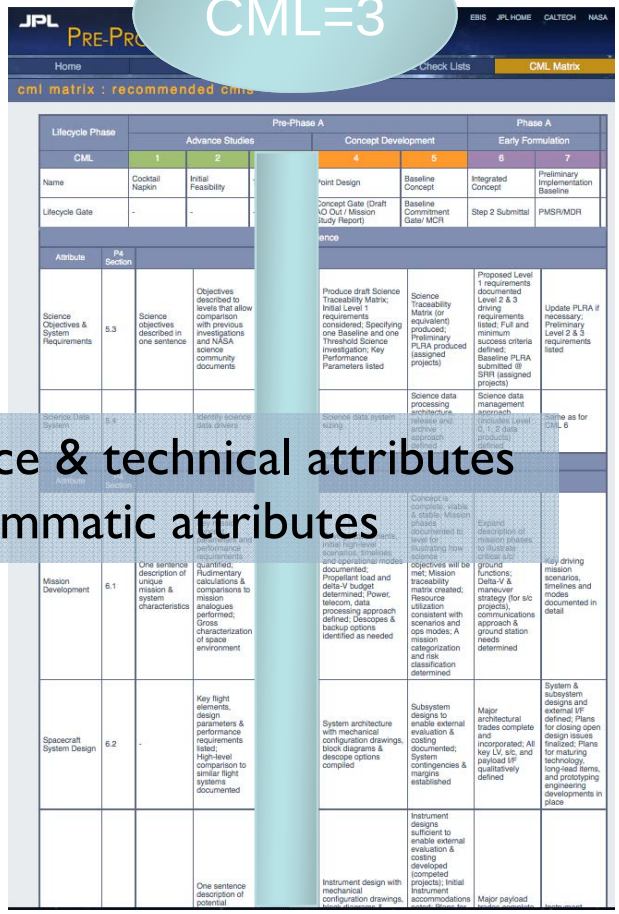
Application to Discovery 2010 Proposals

CML=3

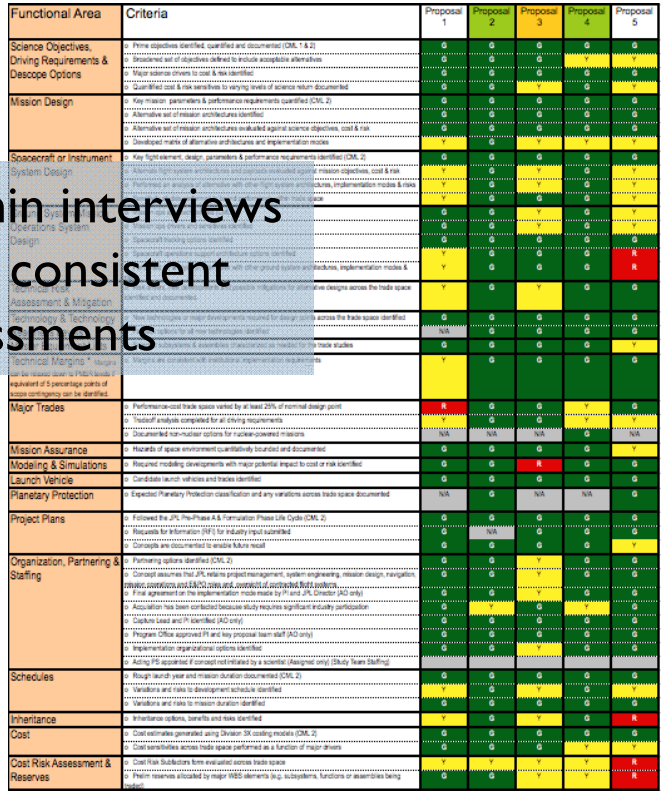


CML Matrix

15 science & technical attributes
9 programmatic attributes

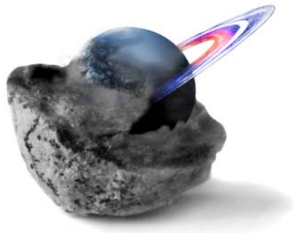
CML 3 Assessments

30-min interviews yield consistent assessments



Check List

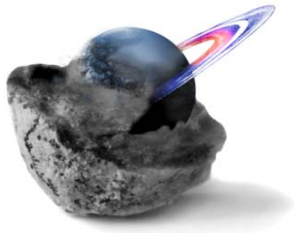
Developed a "check list" from the CML Matrix for concept evaluations



Application to Discovery 2010 Proposals

- Evaluated the maturity of the Discovery mission concepts at their Cost Preview (prior to writing the Step 1 proposals)
  - Held interviews with each study team

- Results:
  - All proposal concepts were basically “green”
  - New proposals were not as mature as those resubmitted
  - Proposal teams need to expand their trade space exploration activities
  - Check list was very useful for finding concept weaknesses



Conclusion

- CMLs are catching on at:
  - JPL
  - NASA
  - National Research Council's Planetary Science Decadal Survey Panels
- Many uses
  - communication tool
  - evaluating and sorting concepts
  - identifying areas that need strengthening
  - input to estimating cost uncertainty
- Will improve concept robustness prior to moving into Project Formulation