The Six Dimensions of Mission Concept Formulation

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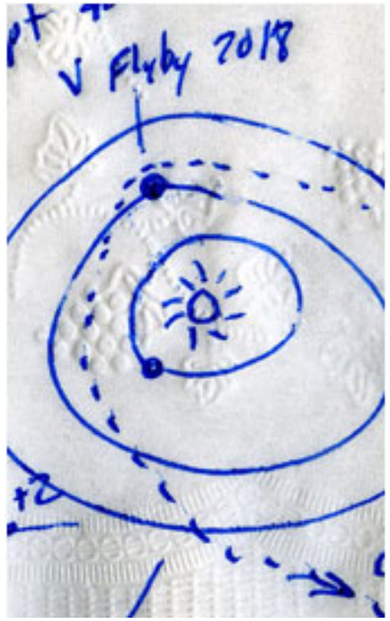
JPL Innovation Foundry

Jet Propulsion Laboratory, California Institute of Technology

Transforming Ideas into Mission Concepts

Idea



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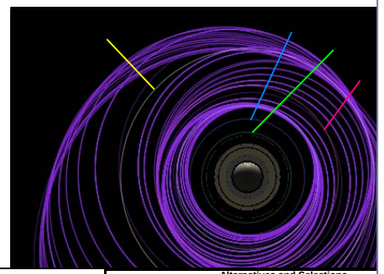
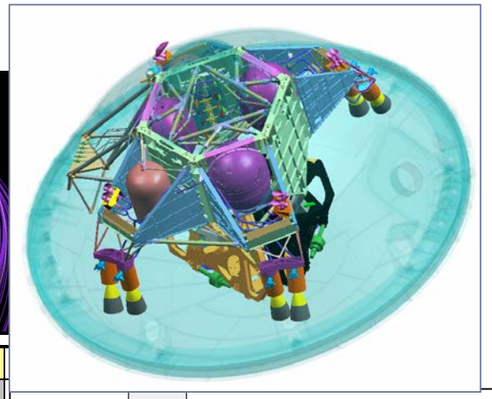
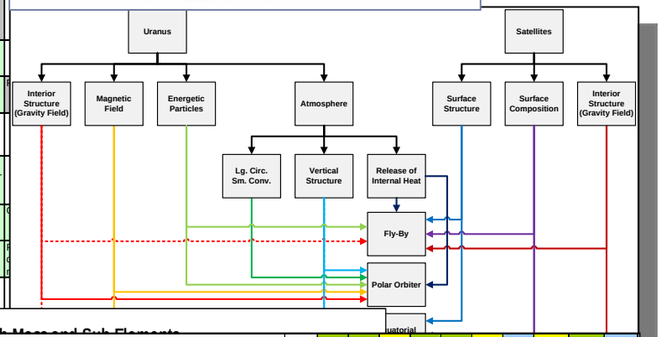
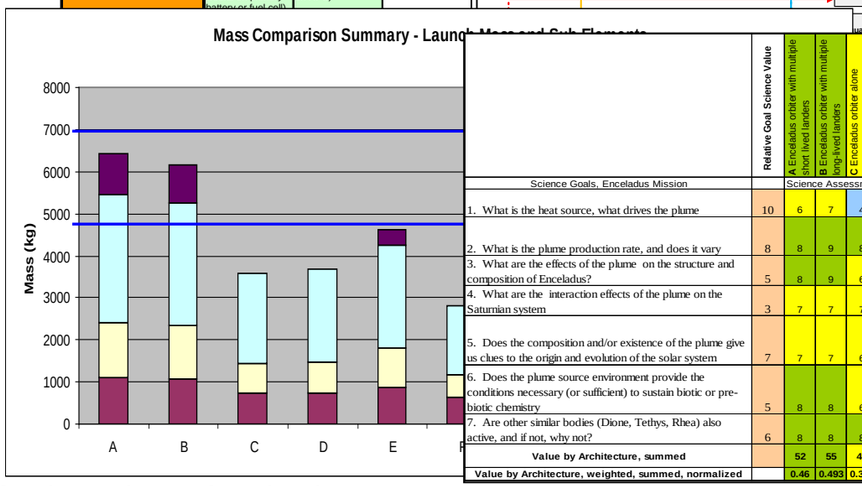




Trades	Alternatives and Selections		
Launch vehicle	Atlas V	Delta IV-Heavy	Ares V
Cruise propulsion	SEP + GAs	Chemical + GAs	Propulsive only
Capture into Saturn system	Titan aerocapture (aerogravity assist)	Propulsive capture	
Pump-down mission design	Enceladus/Titan GAs only	Multiple moon GAs only	Multiple moon propulsively-leveraged GAs
RPS type	MMRTG	ARPS (advanced Stirling)	
Orbiter implementation	Enceladus Orbiter	Low-Energy Enceladus Multiple-Flyby (Saturn Orbiter)	High-Energy Enceladus Multiple-Flyby (Saturn Orbiter)
Lander/Probe implementation	Fly-Through Probes and Impactors	Rough Landers	Soft Landers
Number of landers	None	One	Three (regional distribution)
Lander lifetime/duration	Short-lived (~2 weeks on primary battery or fuel cell)	Long-lived (~1 year on RPS)	





	Relative Goal Science Value	A Enceladus orbiter with multiple short lived landers	B Enceladus orbiter with multiple long-lived landers	C Enceladus orbiter alone	D Enceladus orbiter becoming a long-lived lander	E Enceladus orbiter with single long-lived lander	F Low energy Saturn orbiter (flybys) alone	G High energy Saturn orbiter (flybys) alone	H Low energy Saturn orbiter (flybys) with a single long-lived lander	I Low energy Saturn orbiter (flybys) with multiple short-lived landers	Cassini
Science Goals, Enceladus Mission		Science Assessment - 0-10, 10 best									
1. What is the heat source, what drives the plume	10	6	7	4	5	5	2	1	3	6	1
2. What is the plume production rate, and does it vary	8	8	9	8	9	9	7	3	8	7	3
3. What are the effects of the plume on the structure and composition of Enceladus?	5	8	9	6	7	7	4	3	5	8	2
4. What are the interaction effects of the plume on the Saturnian system	3	7	7	7	6	6	8	7	8	7	7
5. Does the composition and/or existence of the plume give us clues to the origin and evolution of the solar system	7	7	7	6	7	7	7	5	7	7	3
6. Does the plume source environment provide the conditions necessary (or sufficient) to sustain biotic or pre-biotic chemistry	5	8	8	6	7	8	6	5	7	8	3
7. Are other similar bodies (Dione, Tethys, Rhea) also active, and if not, why not?	6	8	8	8	8	8	8	7	8	8	5
Value by Architecture, summed		**52**	**55**	**45**	**49**	**50**	**42**	**31**	**46**	**51**	**24**
Value by Architecture, weighted, summed, normalized		**0.46**	**0.493**	**0.393**	**0.439**	**0.446**	**0.353**	**0.246**	**0.393**	**0.449**	**0.187**

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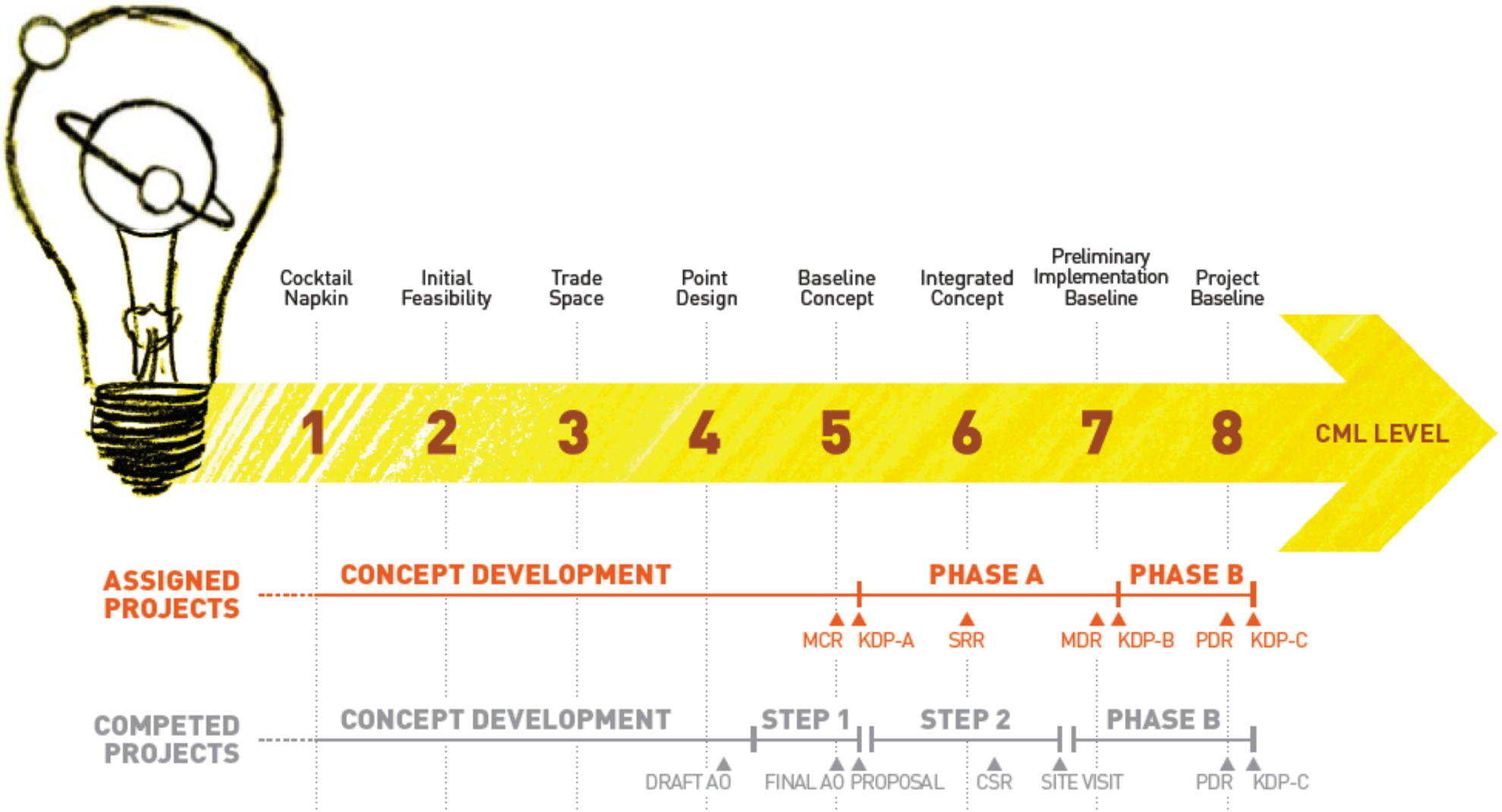
Concept Maturity Levels (CMLs)
for NASA Assigned and Competed Missions



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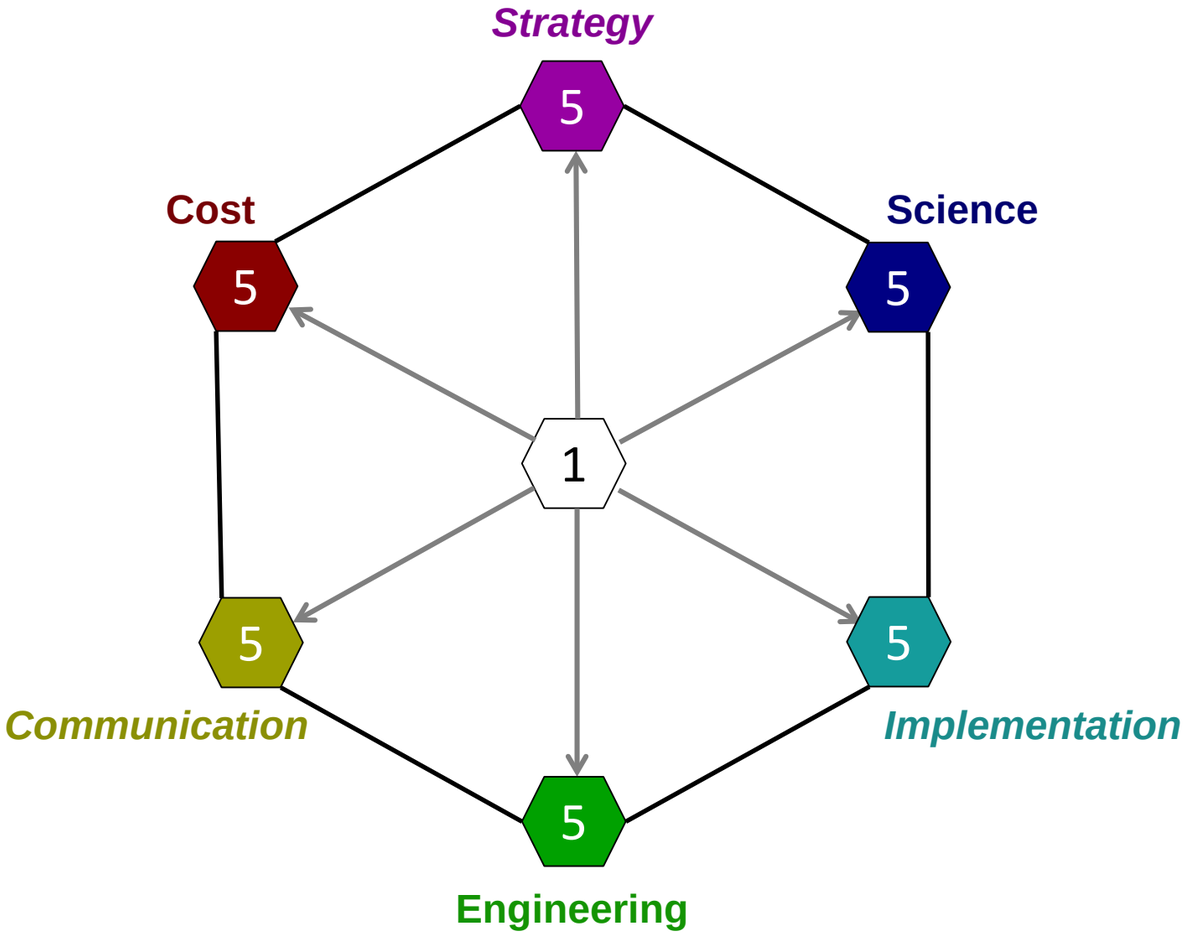
What are the Six Dimensions?



- **Science** – Compelling question
- **Engineering** – Feasible solution
- **Cost** – Programmatically acceptable
- ***Strategy*** – *To win*
- ***Communication*** – *That is effective*
- ***Implementation*** – *Robust plan & strategic partners*

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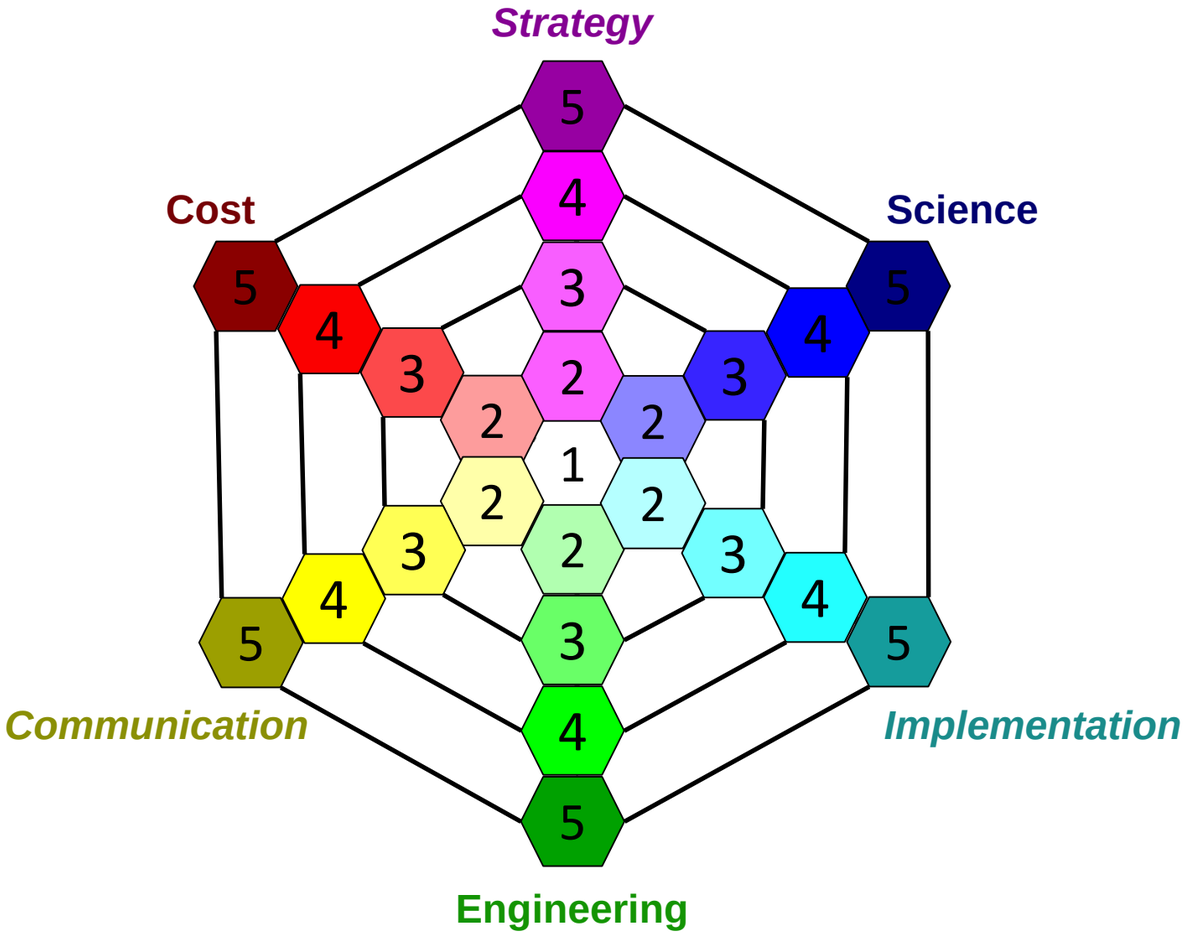
Mature Concept to be Self-Consistent in All Dimensions



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How has JPL Matured Concepts in These Dimensions?

	CML 1	CML 2	CML 3	CML 4	CML 5
Science	State of the Art Assessment	Science Return Diagram (Investigations)	Science Return Diagram (Payload)	Science Traceability	Science, Technical, Mgmt. and Cost Review
Engineering	Idea Generation	Initial Feasibility	Trade Space Exploration	Design Study	Science, Technical, Mgmt. and Cost Review
Cost	Analogy Cost Assessment	Cost Binning per Mission Type	Cost Subsystem Trades	Cost Study Assessment with Line Org oversight	Science, Technical, Mgmt. and Cost Review
Strategy	Identify Next Steps	Strategic Roadmap	SWOT Analysis, Win Themes	Proposal Outline	Science, Technical, Mgmt. and Cost Review
Communication	Science Story	White Paper Outline, Boundary Objects	Outline Executive Summary	Proposal Outline	Science, Technical, Mgmt. and Cost Review
Implementation	Identify Strategic Partners	Risk Identification	Commercial S/C Selection	Technology Readiness Level (TRL) Assessment	Science, Technical, Mgmt. and Cost Review

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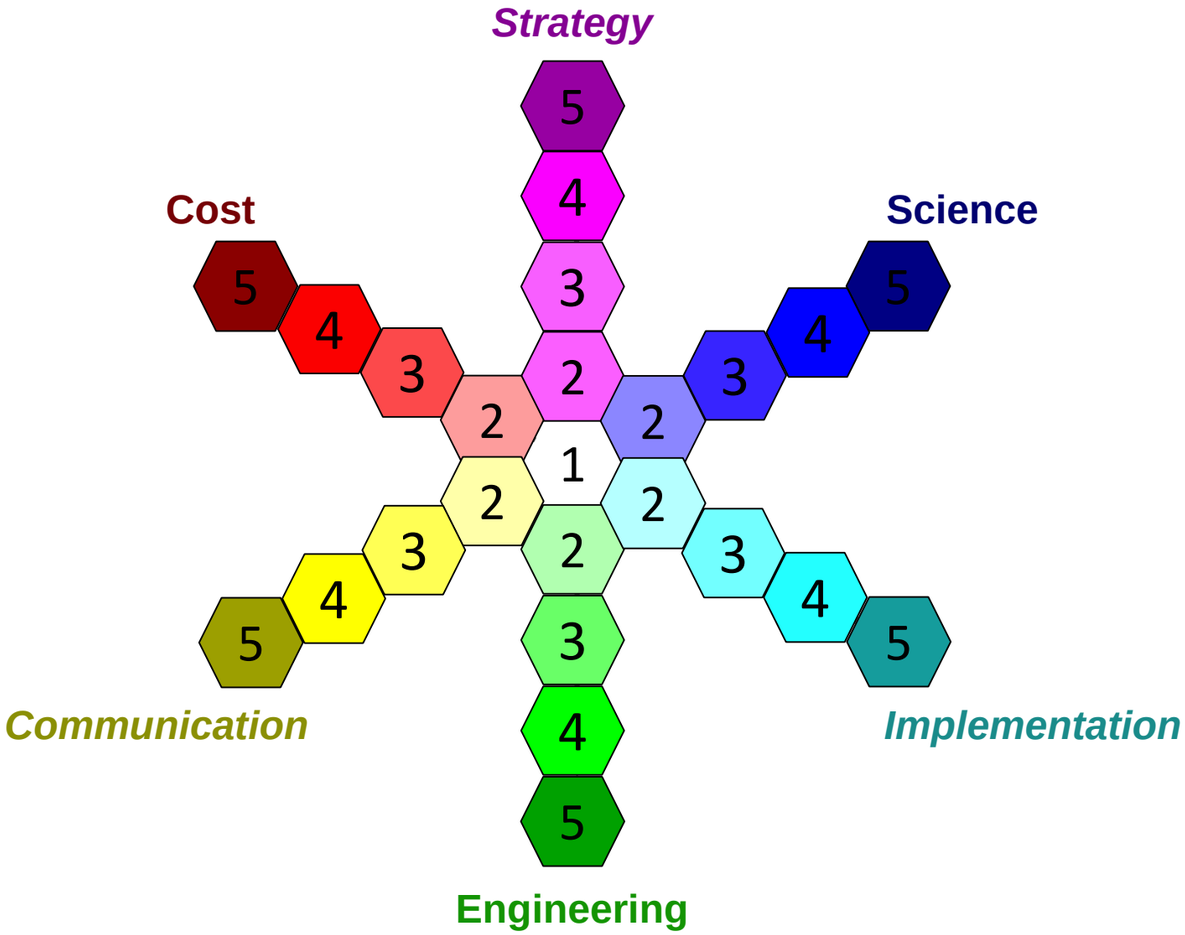
Summary



- Concepts need to be ***STRATEGICALLY*** matured in ALL dimensions of the hexagon
- Each concept team has unique challenges to overcome in different dimensions
- Independent assessment will identify teams' blind spots
- Early identification of challenging areas will help teams focus on solving the *right* problems

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