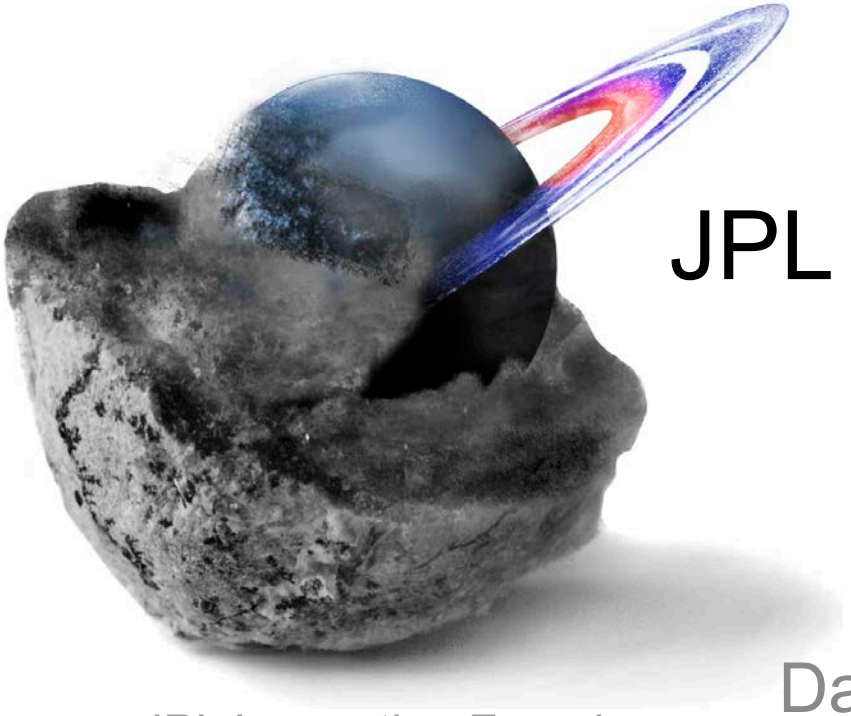

JPL Innovation Foundry

JPL Innovation Foundry

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NASA PM Challenge
February, 2012

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Executive Summary

- NASA supports the community of mission principal investigators by helping them ideate, mature, and propose concepts for new missions. As NASA's FFRDC, JPL is a primary resource for providing this service.

- The environmental context for the formulation lifecycle evolves continuously. Contemporary trends include: more competitors; more-complex mission ideas; scarcer formulation resources; and higher standards for technical evaluation.

- Derived requirements for formulation support include: stable, clear, reliable methods tailored for each stage of the formulation lifecycle; on-demand access to standout technical and programmatic subject-matter experts; optimized, outfitted facilities; smart access to learning embodied in a vast oeuvre of prior formulation work; hands-on method coaching.

- JPL has retooled its provision of integrated formulation lifecycle support to PIs, teams, and program offices in response to this need. This mission formulation enterprise is the JPL Innovation Foundry.

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Clear trends are changing the world of competed NASA missions

- More competitors
  - Increasing population of PIs with requisite credentials
  - Balance tilting toward PI-led missions vs. flagships
- More-complex mission ideas
  - Earth-system science; exoplanet observation; planet interiors; surface interaction, mobility, and return; outer solar system
- Scarcer formulation resources
  - Topline-constrained new-start opportunities
  - Phase A/B funding inadequate to bound risk
- Toughening standard of technical evaluation
  - Ratcheting expectation for PDR-level validation
  - Increasing risk aversion because of the recognition that formulation casts the die

SMD PI-led Mission Community Faces a Ratcheting Challenge

Simultaneous, competitive formulation…

…of a large number

…of deeply engineered concepts

…for ambitious science objectives

…achieved using only well-understood systems

…formulated on a strict diet

What Every PI Needs

- Darwinian evolution of a seed idea
  - Maturation into a toughened concept baseline
  - That can win, fly, and deliver

- Accurate forecasting despite incomplete data
  - Of the eventual state of truth regarding cost and risk
  - Of how NASA will model that state of truth when it evaluates the concept

What Every PI Expects

- Above all, to win
- Respect for the integrity of the scientific vision
  - Aligned pursuit of the best way to implement it
  - Proprietary protection
- Dedicated campaign team
  - Undistracted and undiluted
  - Never feeling the presence of parallel campaigns
- The best help NASA can muster
  - No stone unturned
  - Deepest experts applied as needed
  - Tangible, relevant lessons learned from NASA's prior concepts, proposals, and feedback
- Full immersion in decision-making ecology
  - Selective control over concept and proposal development
  - No surprises

Derived Requirements for a Supportive Mission Formulation Process

- Method
  - Stable, reliable, clear, understood, exercised
  - Tailored for each stage of the formulation lifecycle
- SME access
  - Standout subject-matter experts (technical *and* programmatic)
  - On-demand when (but only when) needed
- Facilities
  - Optimized for pace and interactions of formulation
- Smart access to prior art
  - Thousands of engineered concepts, hundreds of vetted proposals, tens of PI-led missions already “in the can”
- Hands-on coaching of the formulation craft

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MEETING THE CHALLENGE

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Foundry Infrastructure Elements

Method

- Concept Maturity Level scale
- Pre-Project Principles & Practices
- Campaign template tailoring
- Proposal Power Tools

SME access

- Skill cadre via matrix organization (technical, programmatic, and method)
- Concept innovation and maturation teams (A-Team, Team X)

Facilities

- Left Field (ideation)
- Design Center (concurrent engineering)
- Proposal Center (secure war rooms)

Access to prior art

- Information management
- Knowledge management

Hands-on coaching

- Technical facilitation

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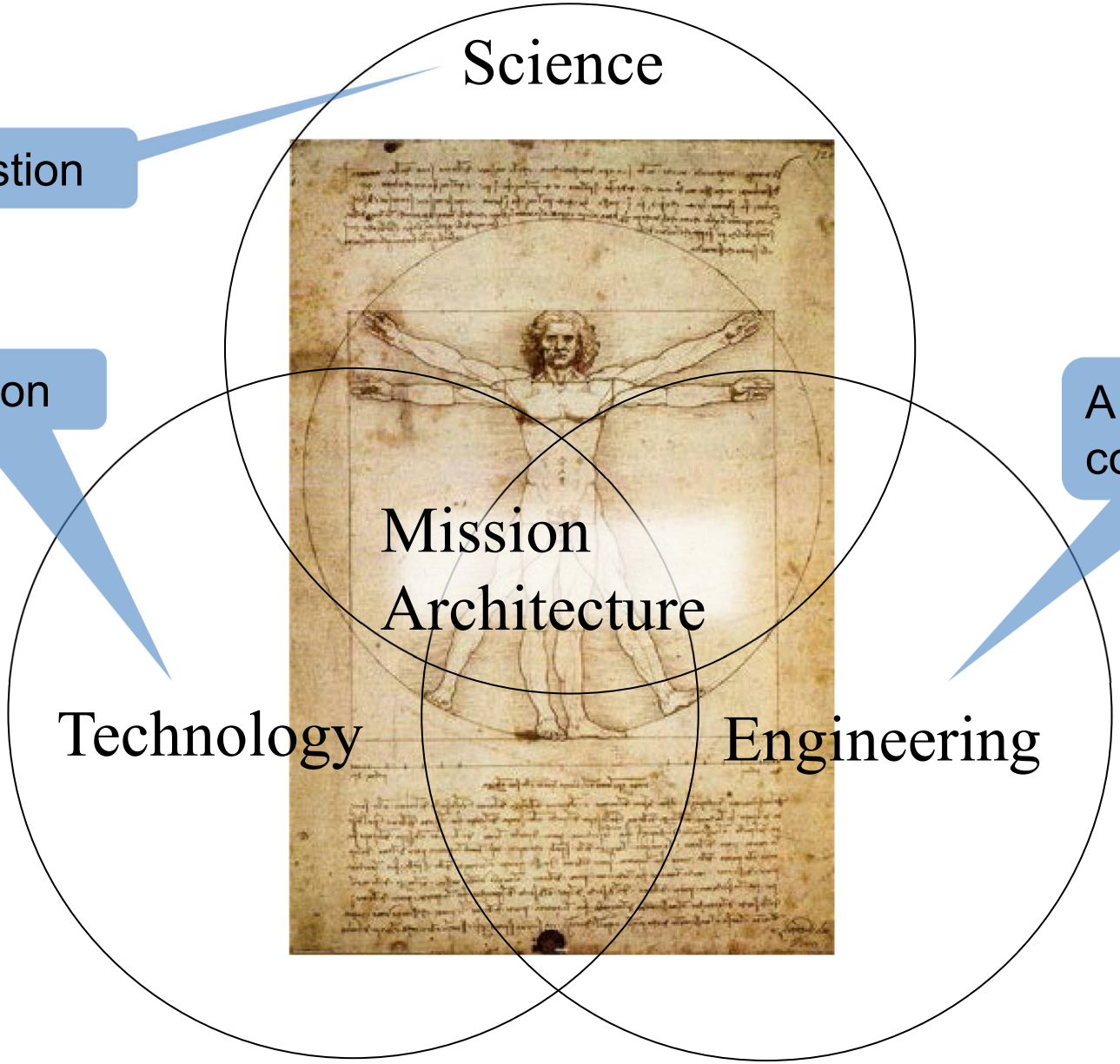
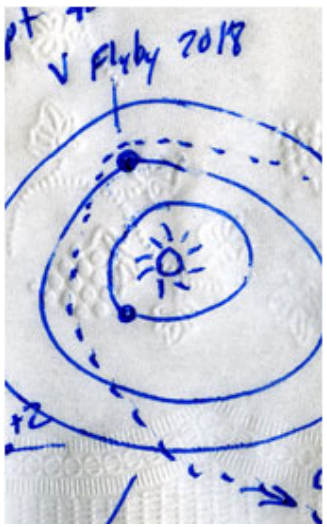
Every mission starts with a spark



…then the concept is developed



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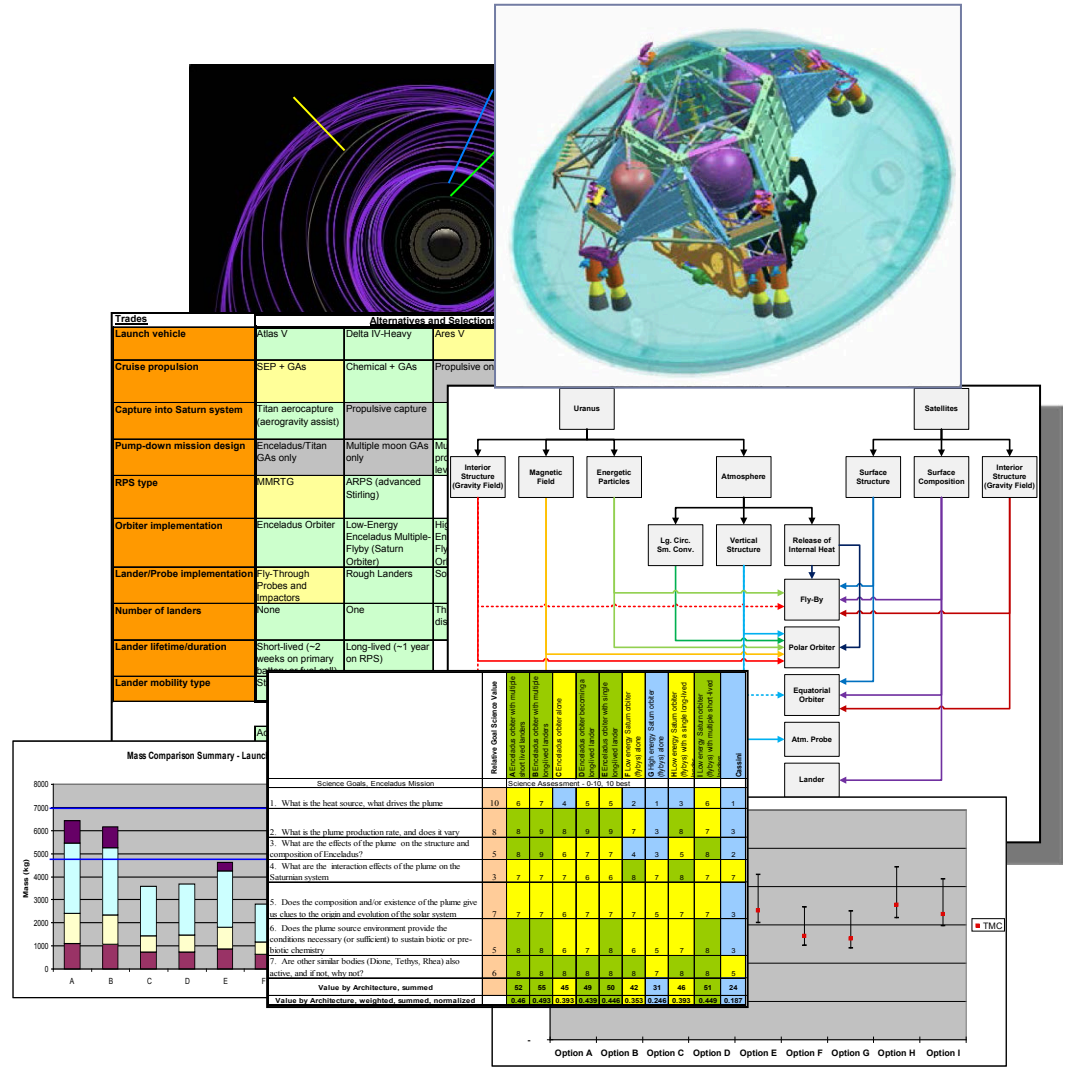

One man's concept is another's doodle…

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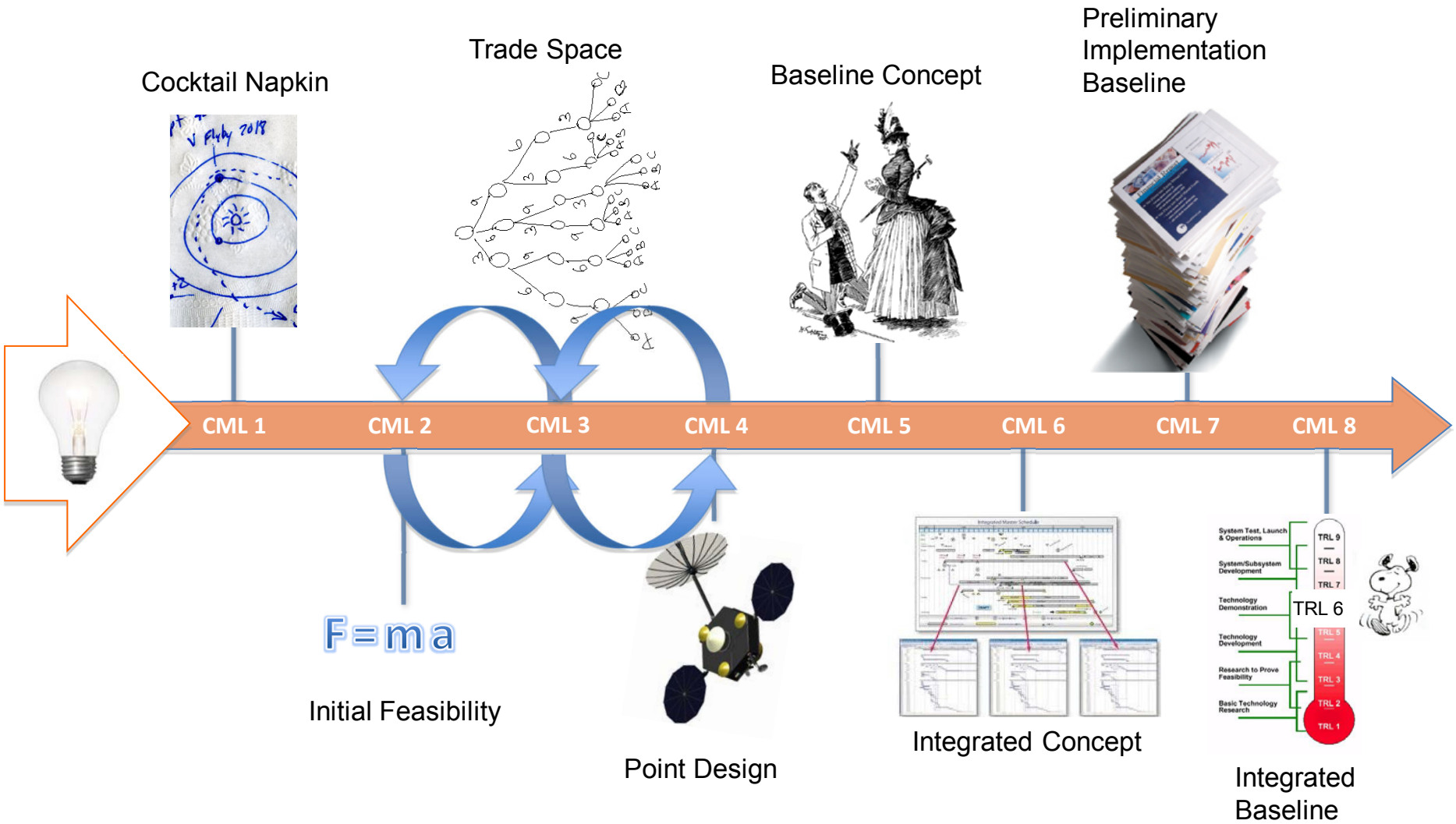
Concept Maturity Level: benchmarking *before* MDR/PMSR



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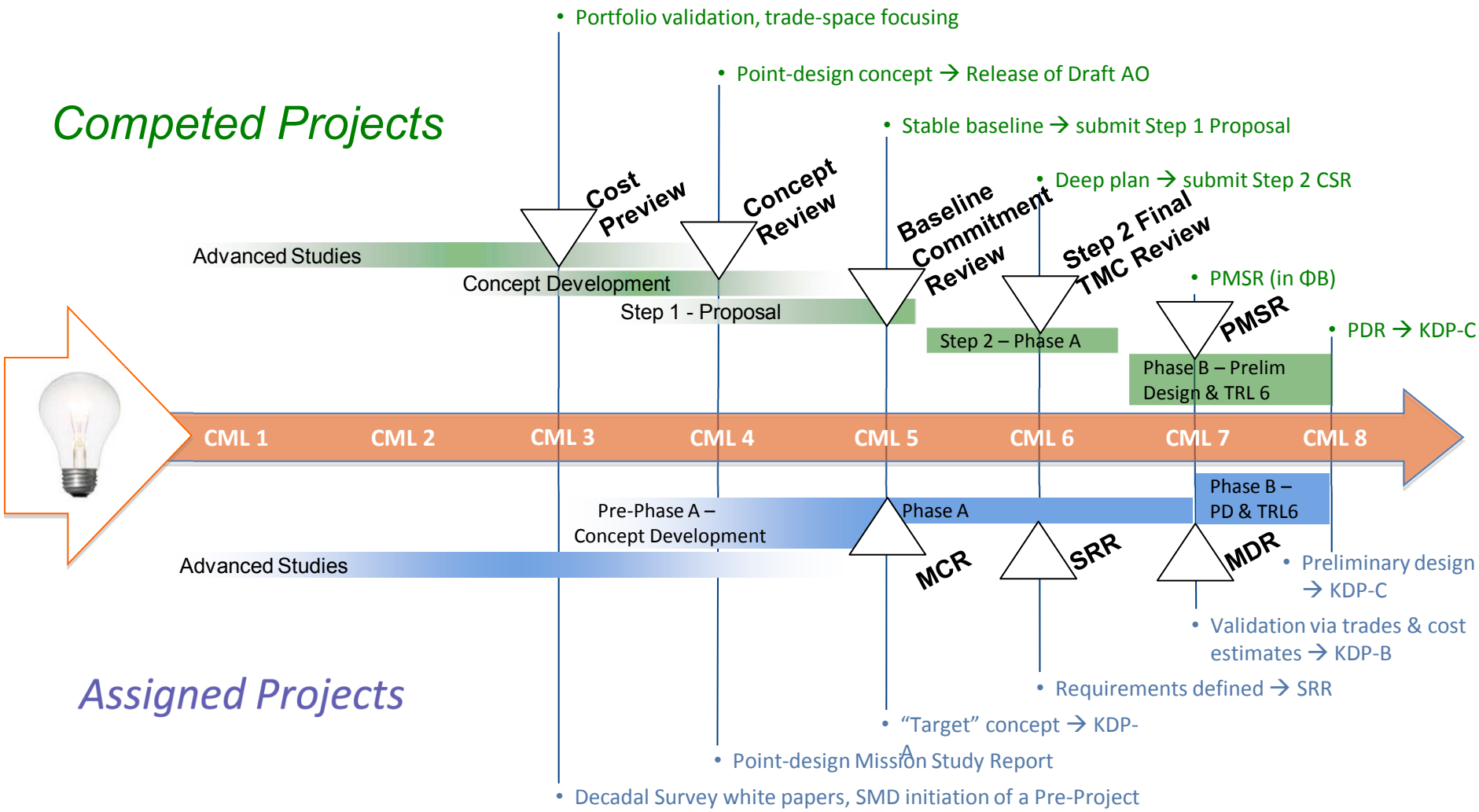
An onramp to the NASA project lifecycle



Accessing the Matrix. Managing the Environment.

APPLYING EXPERTS AND INFRASTRUCTURE

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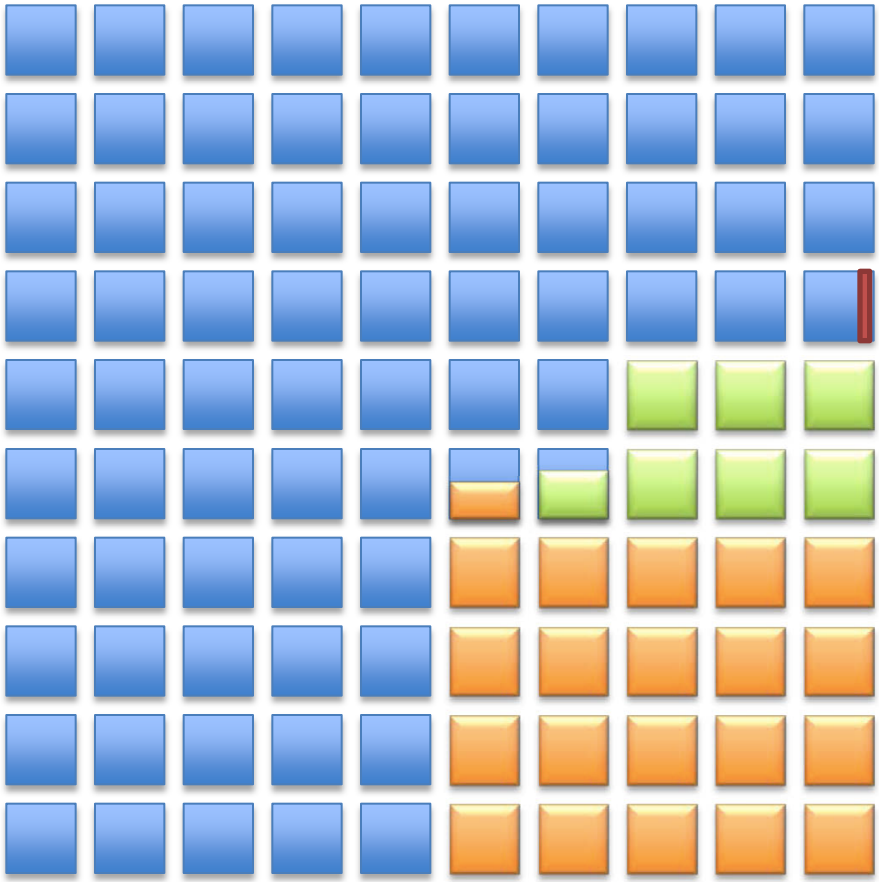
¼ of the JPL population engages in proposals



27%, 2010 data

= 50 Lab employees

13 provided institutional support

334 provided Program Office, Line, Review, or Service Support

1026 directly created proposals

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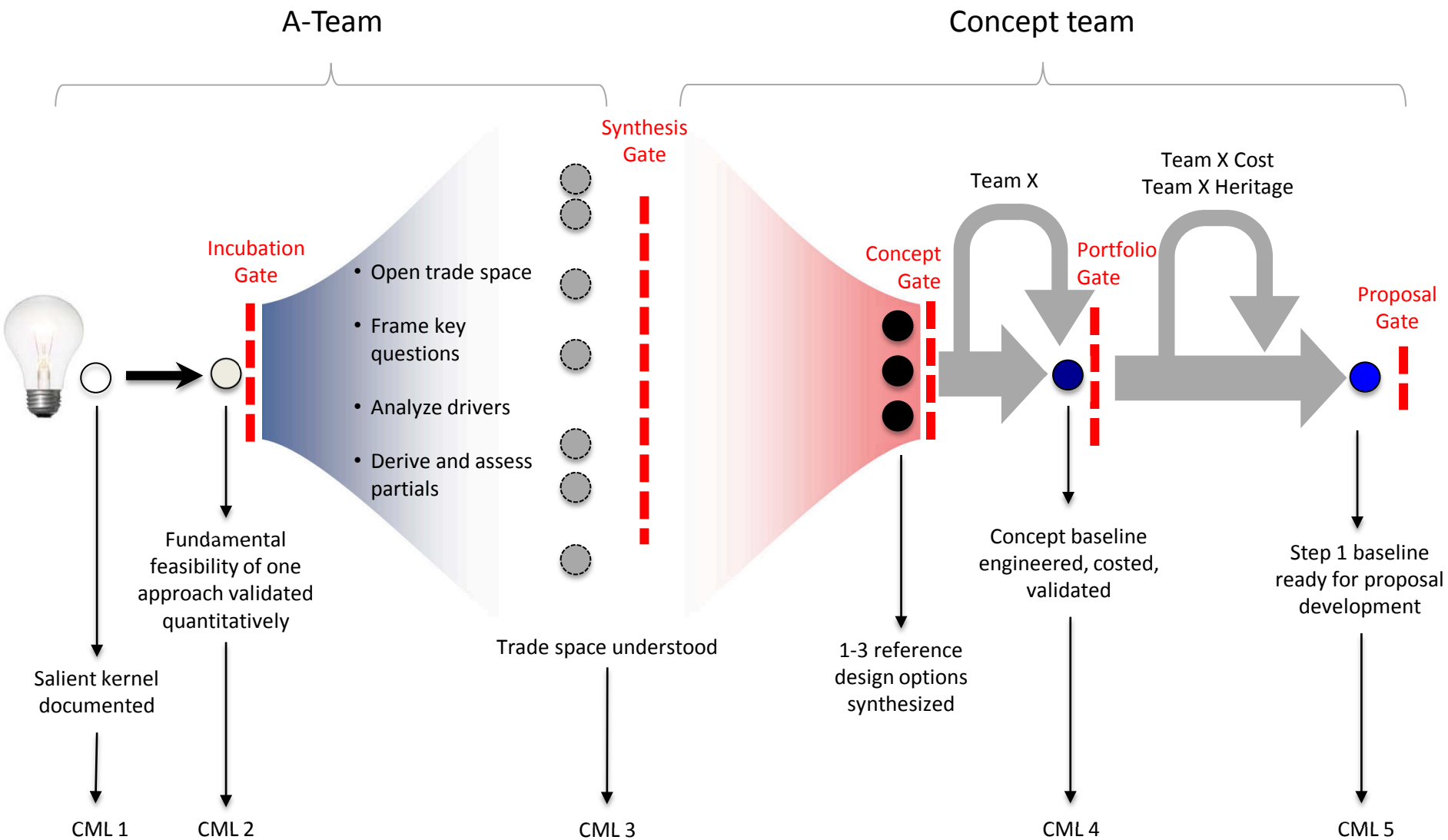
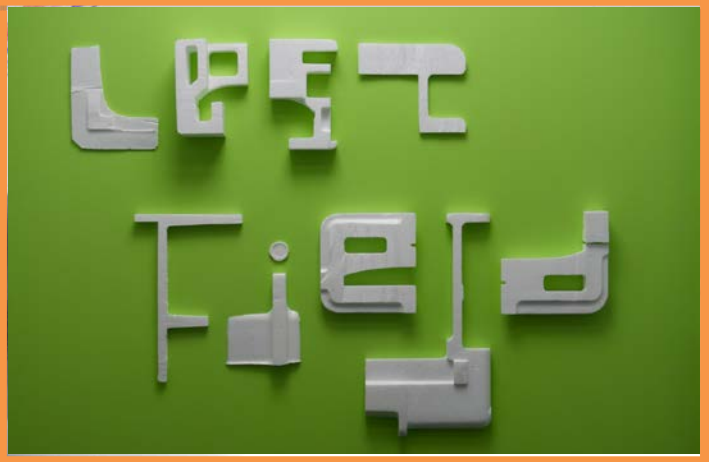
A-Team focuses small, expert teams where the leverage is highest



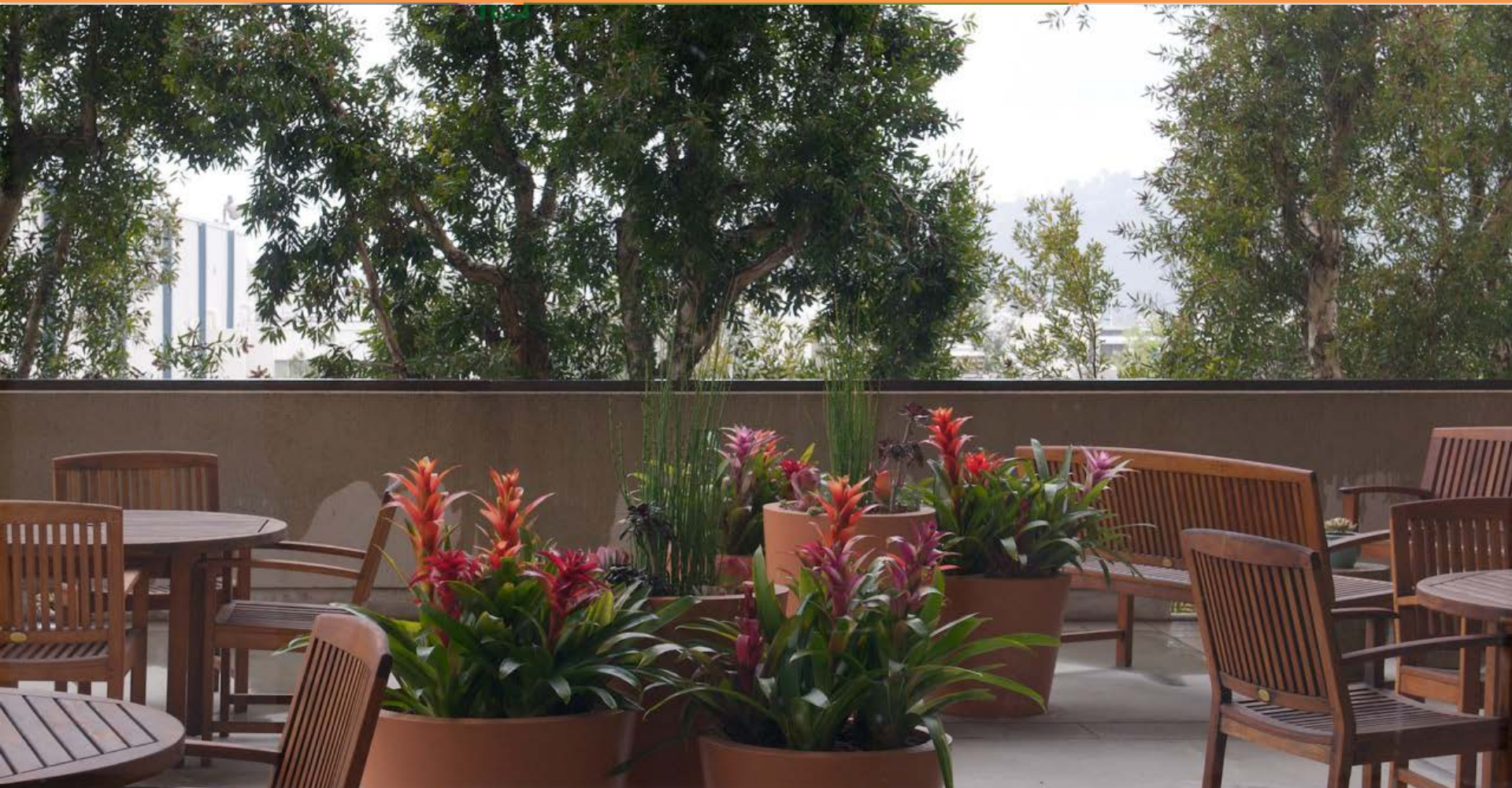
F=ma


LEFT
FIELD

DEFER JUDGMENT

F=ma

OUT
THERE



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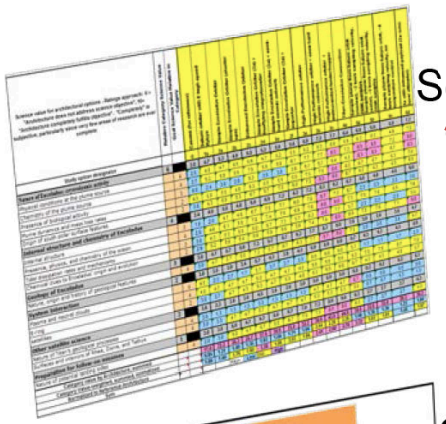
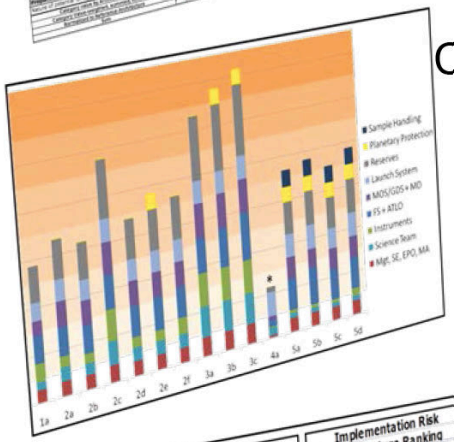
“Analytical fictions” innovated, “partials” quantified, viable options synthesized

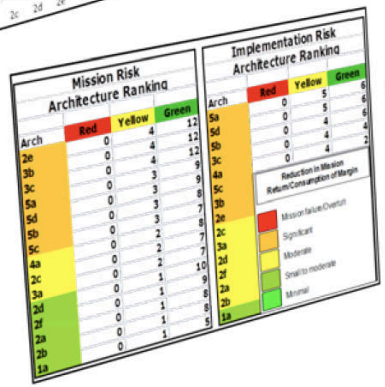


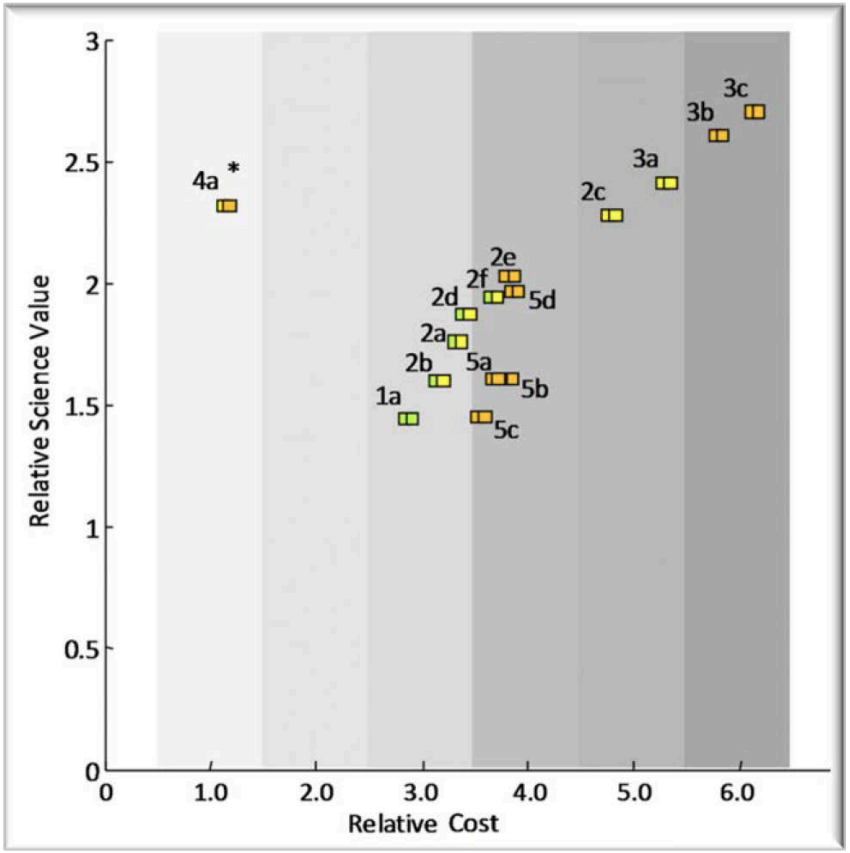
Science Value



Cost

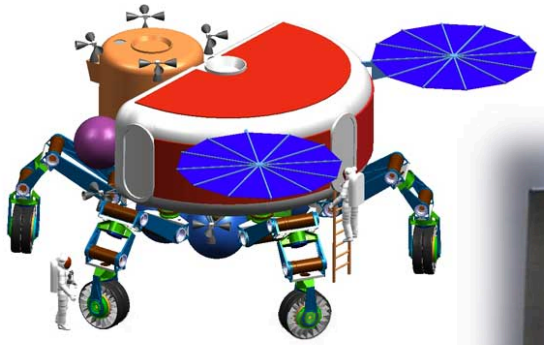
Risk

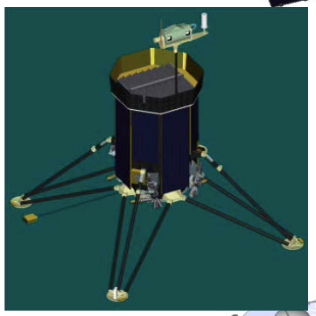


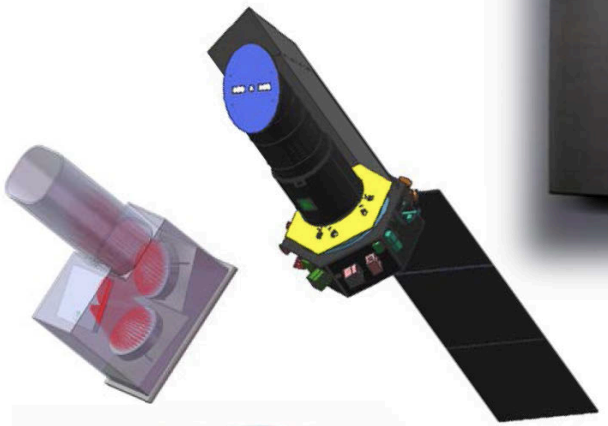


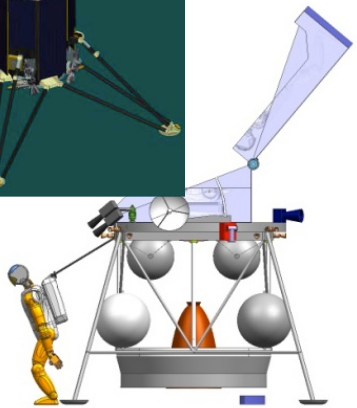
- Avoid fixating on a point solution
- Assess many architectures
- Understand tradespace maneuverability

Concurrent engineering efficiently advances to CML 4

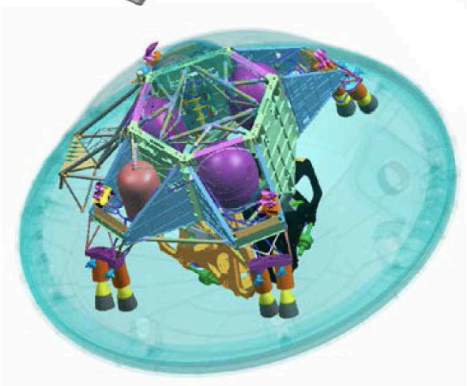


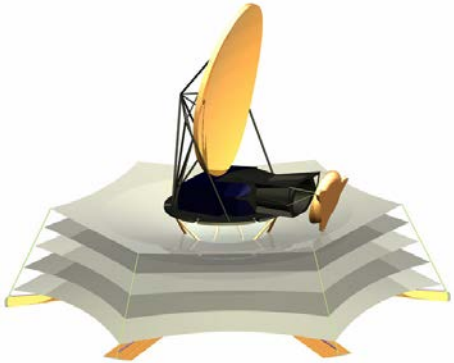




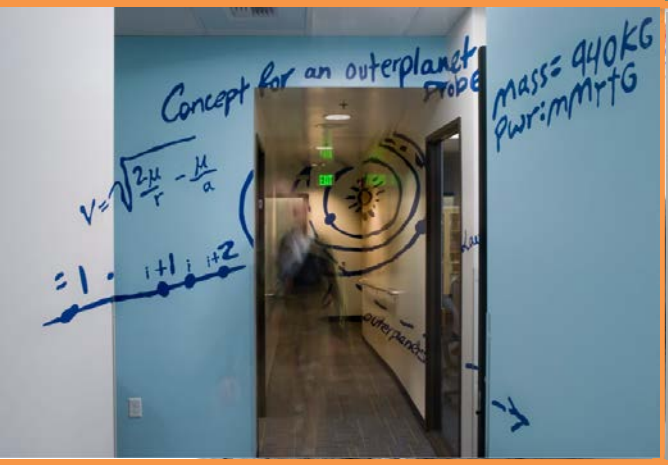


- Architectures
- Space Missions
- Flight Systems
- Instruments





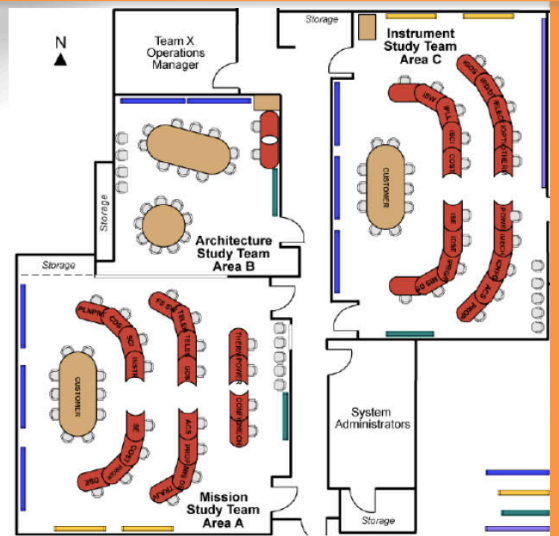
active
corpus
callosum

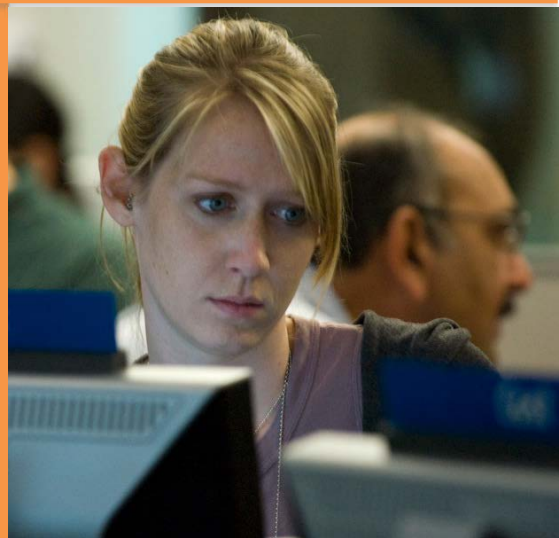

Concept for an outerplanet
mass= 940KG

TEAM X
Jet Propulsion Laboratory

Configuration
CMIS
ATMS
CrIS
VIIRS
ERBS

TEAM X


N
Team X
Operations
Manager
Storage
Instrument
Study Team
Area C
Storage
Architecture
Study Team
Area B
Storage
CUSTOMER
System
Administrators
Mission
Study Team
Area A
Storage



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Upgraded concurrent engineering theaters based on experience of 10^3 studies

Capturing the Wealth of Lessons Learned

PRE-PROJECT PRINCIPLES & PRACTICES

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Guidance for each concept element

Technical

- Science Objectives & Requirements
- Mission Development
- Spacecraft/Instrument System Design
- Ground System Design
- Technical Risk
- Technology
- Inheritance
- Master Equipment Lists
- Technical Margins
- Trade Studies
- Modeling & Simulation
- Launch Services
- Planetary Protection
- Verification & Validation

Programmatic

- Acquisition and Surveillance
- Project Organization
- Schedules & Margins
- Cost Estimation & Risks
- Project Scope
- Documentation
- NEPA Compliance
- Subsystem Make-Buy
- Work Breakdown Structure
- Testbeds, Models & Spares
- Export Compliance
- Mission Assurance Management

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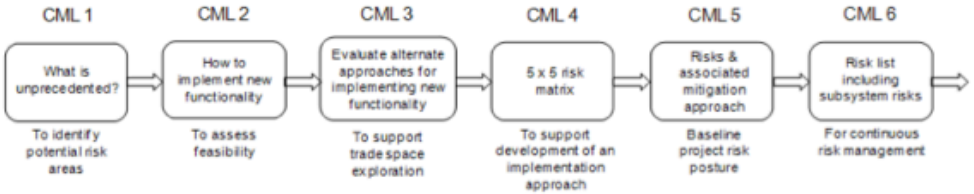
…organized in the progressive CML framework

5 Engineering Principles and Practices

5.8 Technical Risk Assessment and Mitigation

Risk management involves identification, analysis, tracking and mitigation of risks. These risks need to be identified early and continuously re-evaluated.



Advanced Studies Sub-Phase

1 **Unprecedented Capabilities** (CML 1): Identify unique and unprecedented mission capabilities that are outside of the JPL or NASA experience. (G)

Rationale: Unprecedented capabilities represent potential risk areas that should be identified to inform the initial feasibility studies.

2 **Implementing New Functionality** (CML 2): Identify alternative approaches, along with advantages and disadvantages for implementing new functionality, new technology or significant engineering development. (R)

Rationale: Can not conclude the concept is feasible without assessing new technology and major engineering developments and identifying potential backup approaches.

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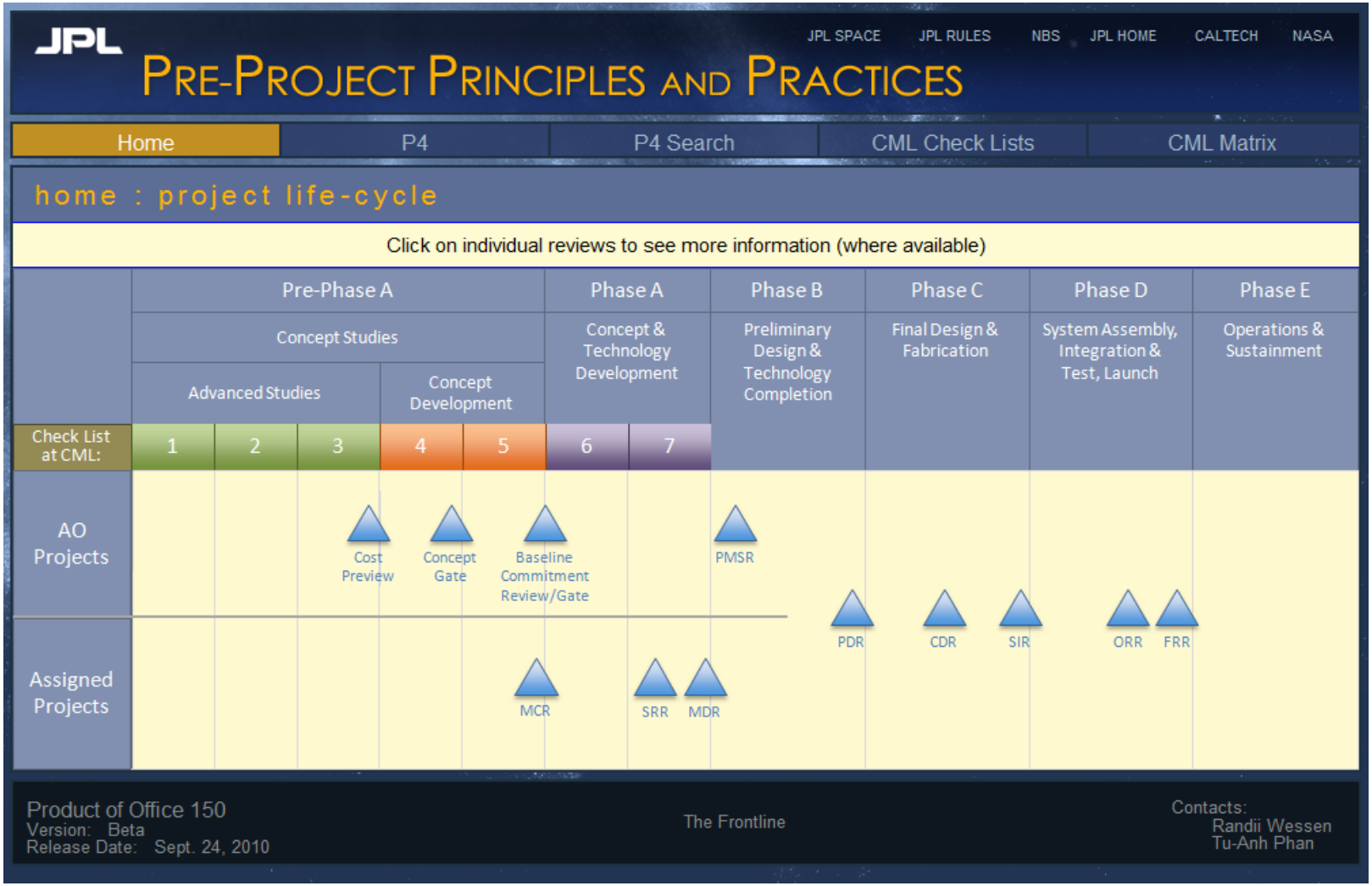
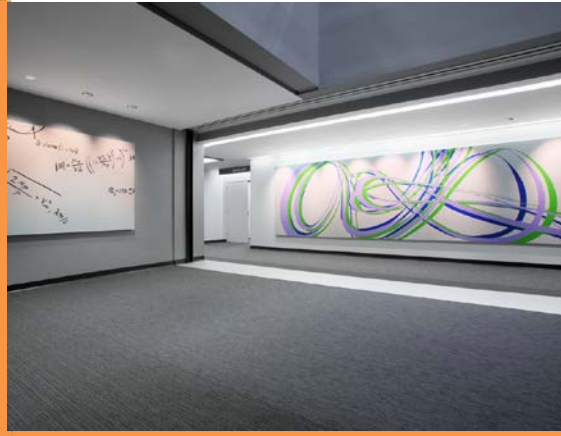
…and Web-hosted for partner teams



LEVAN

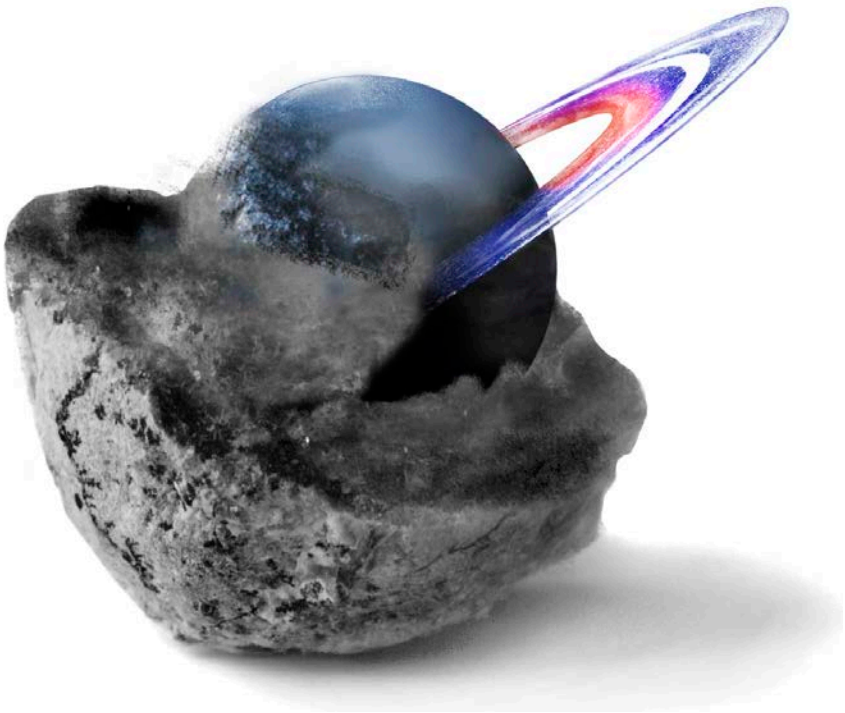


PROJECT FORMULATION

JPL Innovation Foundry

Summary: JPL Innovation Foundry is improving NASA mission formulation

- Concepts (CML 1-6)
  - New tools for low maturity stages where leverage is highest
  - Seamless transitions through the stages of maturation
- Campaigns (CML 5-6)
  - Hand-crafting of the pitch
- Formulation skills
  - Excellence in more than technical dimensions
- Knowledge management
  - Systematic leveraging of already vetted knowledge products



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