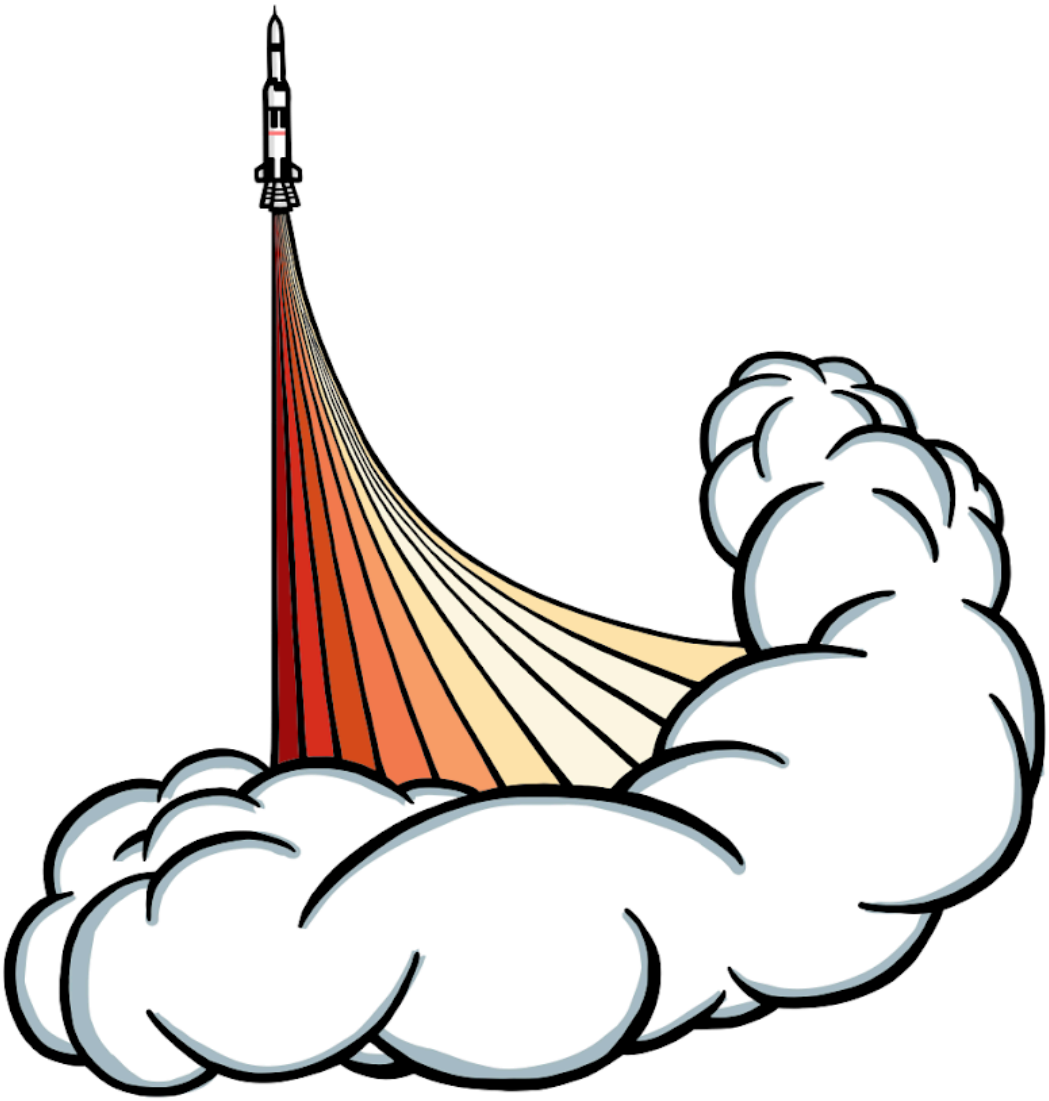


LAUNCHPAD

TUCSON, AZ

NOVEMBER 18-20 2019

Acknowledgements

The PI Launchpad thanks the members of the workshop planning committee for their incredible effort to make this event happen:

Erika Hamden, University of Arizona

Nicole Cabrera-Salazar, Movement Consulting

Ellen Gertsen, NASA Headquarters

Michael New, NASA Headquarters

The PI Launchpad thanks the Heising-Simons Foundation, in particular Cyndi Atherton, and NASA's Science Mission Directorate for their support of the workshop. The PI Launchpad also thanks the University of Arizona and Steward Observatory for hosting this workshop. We appreciate all of the reviewers, panelists, and participants contributing their time and energy to this workshop. We could not have done it alone!

The University of Arizona acknowledges the Tohono O'odham, on whose lands the University was built.

Table of Contents

PI Launchpad Code of Conduct

Participating in this workshop means:

- We treat participants with respect, consideration, and in a spirit of collaboration.
- We approach the workshop, our fellow participants, and activities with a beginner's mind, setting an intention to learn something new from each interaction and not assuming that others know the same things we do.
- We communicate openly with respect for others, critiquing ideas rather than individuals.
- We share the air, paying attention to who is participating and taking a step back to allow others to contribute if we have been dominating the discussion.
- We share lessons learned at the workshop but do not share others' ideas without their consent.
- We recognize that intent does not equal impact, acknowledging that behavior can be harmful despite our best intentions.
- We encourage each other's ideas and utilize "yes and" language rather than "no, but."
- We respect the pronouns of others.
- We are mindful of our surroundings and our fellow participants. We alert staff if we notice a dangerous or threatening situation or someone in distress.
- We respect the rules and policies of the meeting venue.

Accessibility Accommodations

- For accommodations that will facilitate your full participation on this visit such as ASL interpreting, CART captioning, captioned videos, Braille, wheelchair access, or electronic text, etc., please contact:
  Erika Hamden (**hamden@email.arizona.edu)** or
  Cathi Duncan (**cduncan@as.arizona.edu** // **520.621.1320**)

Unacceptable Behavior

- Personal attacks directed toward other participants.
- Harassment, intimidation, or discrimination of any form.
- Physical or verbal abuse of any participant.
- Examples of unacceptable behavior include, but are not limited to, verbal comments related to gender, sexual orientation, disability, physical appearance, body size, race, religion, national origin, inappropriate use of nudity and/or sexual images in public spaces or in presentations, or threatening or stalking any participant.
- Disruption of panel discussions or breakout sessions.

Consequences

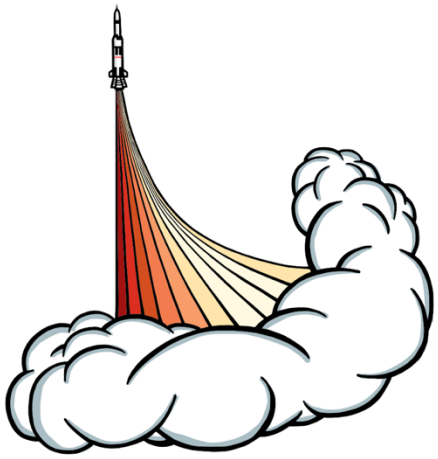
- Anyone requested to stop unacceptable behavior is expected to comply immediately.
- Staff may take any action deemed necessary and appropriate, including immediate removal from the meeting without warning or refund.

Reporting Unacceptable Behavior

- If you are the subject of unacceptable behavior or have witnessed any such behavior, please immediately notify Ellen Gertsen in person or by emailing your concern to **ellen.gertsen@nasa.gov**.
- Anyone experiencing or witnessing behavior that constitutes an immediate or serious threat to personal or public safety is advised to contact 911. Information on campus safety at the University of Arizona can be found here: www.arizona.edu/campus-safety or call the UA police at 520-621-UAPD (8273) for a non-emergency.

Notes:

Creating A Science Case



Based on the pre-workshop assignment, you should have identified a science objective (or several) that you will revisit over the course of the workshop. Write out your science goal and science objective(s) in the space below.

List the keywords (3-6) that you associate with your science objective and why.

List the theories that are relevant to your science objective. List measurements you can make that will test, support, eliminate, or distinguish between the listed theories. If there are no theories, describe what type of experiment/test you would conduct and what this investigation will prove or show. Are you trying to increase the breadth of data available and why is that important? What will these non-theory-based investigations prove or show?

Panel Session

Notes:

In light of the panel discussion, re-write your science question to be more specific, focused, and/or precise. Consider if there is a more compelling angle to approach what you want to do.

In 2-3 sentences explain why people should care about your science question. How would you tailor your pitch when communicating with people in your very specific subfield, people in the relevant science division at NASA Headquarters, and the general public?

If you previously identified multiple science objectives, which is most important? Why?

Breakout Session

For the remainder of the session, find a partner at your table.

First: Take 5 minutes to write out a summary of your most important science objective.

Use the following questions to guide your summary. Be specific – you will need to be able to explain your answers as if you were asking your partner to be a part of your science team and need to explain your mission idea to them:

- What scientific concept are you trying to understand?
- What kinds of tests will you ideally perform?
- Why hasn't this work been done before?
- What will your experiment/tests/observations show that we don't know?
- How is this timely given other NASA missions and/or priorities?

Next: Take turns describing your science objective to your partner. Use the following questions to guide and record feedback from your partner:

1. What positive feedback did you receive?

2. What changes do you need to consider?

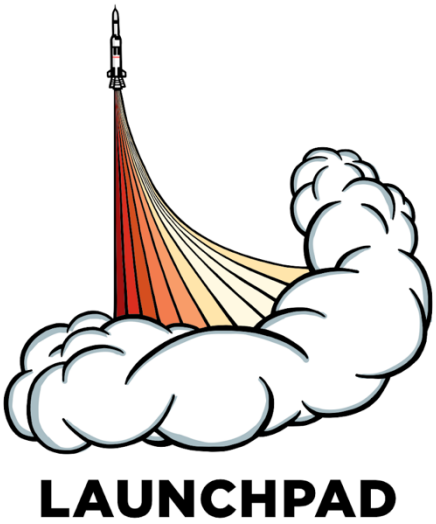
3. What feedback did you find most useful?

4. What feedback did someone else receive that may be applicable to you? What else did you hear that is worth considering? Other thoughts?

Finally: What questions do you still have about this process? If there is time, share them with the table for discussion.

Requirements

Lightly adapted from the NASA Systems Engineering Handbook



Based on the pre-workshop assignment, you should have identified some initial requirements related to your science objective(s). All mission formulation starts with the science objectives, which flow down to **Level 1 Requirements**. Level 1 Requirements are the scientific determinations and/or results that NASA and the mission agree represent the minimum that must be accomplished for an objective's completion. From those requirements, the measurement and other implementation requirements flow. In the previous section, you developed your science objectives; now you will develop the Level 1 and lower-level requirements. Write out your responses below.

1. What are your science goals? These are broad scientific efforts that a mission will make progress on, but not completely achieve.

2. What are your science objectives? These are focused scientific efforts that address a mission goal, and that a mission must achieve.

3. What are your Level 1 Requirements? What are the relevant aspects of the physical system, what are the verification parameters for these results? Why do you need these aspects at these verification parameters (you can motivate these by theories, predictions, and/or previous data)? Ensure that you are not pulling lower-level requirements up into the Level 1s.

Level 1 MadLib:

The mission shall [**quantitative scientific-result verb**] [**aspect of the physical system**] [**preposition**] [**verification parameter(s)**].

The mission shall _____ _____

_____ _____

_____

Level 2 and lower-level requirements flow from the Level 1 Requirements. These requirements are what guide instrument function and performance and get inserted into your Science Traceability Matrix. The questions below can help guide your thinking in developing lower-level requirements.

1. What is the measurement you need to make (e.g. in situ measurement, flux measurement, magnetic field strength, etc.)? This measurement will be unique to your mission. What signal to noise do you need and at what signal strength? How do these measurement requirements flow down from the Level 1 Requirements? What is the threshold level of performance that you can accept and still achieve your Level 1 science requirements? What about your baseline—your ideal level of performance if all the programmatic variables are in place?

2. At what location do the measurements need to be made? Why? Does the location of the measurement need to change and in any particular order?

3. Do you expect your signal to change with time? Why? How frequently do you need to sample the signal? Once? Every day? 5 times randomly spaced? How often do you need to repeat a measurement before you have sufficient data to answer your initial question? This will help to set your mission duration and other parameters.

4. Do you need simultaneous measurements in different places or from different places? Why?

Level 2 MadLib:

The [**noun for instrument technique, science system or approach]** shall [**quantitative scientific-result verb**] [**aspect of the physical system**] [**preposition**] [**verification parameter(s)**].

The _____shall _____

_____ _____

_____

_____

_____

_____

Write down how you will verify your requirements. Verification can be performed by test, inspection, demonstration, analysis. Each requirement (at all levels) must ultimately be verified to ensure the mission is a success.

_____

_____

_____

_____

_____

Revisit your requirements using the questions below:

1. Are they written correctly? (“shall” is a requirement, “should” is not)
2. Are the requirements technically correct? Are they traceable to the science, make using valid assumptions, and essential?
3. Do the requirements satisfy the science team?
4. Are the requirements feasible?
5. Are the requirements verifiable?
6. Are the requirements redundant or over- specified?

_____

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For Reflection/Discussion:

Rewrite your science goal(s) and objectives. Your goal(s) should address the science questions identified, but need not be quantitative or measurable. Your objectives should be specific, measurable, aggressive but still attainable, and focused on outcome not method.

Write down your requirements. Your requirements should be based on your science objectives and reflect the necessary functions and features of the system (the WHAT not the HOW) in order for it to be a success. Look at your requirements and see if they fall into these categories:

Functional Requirements – What functions need to be performed to accomplish your objectives?

Performance Requirements – How well does the system needs to perform its functions?

Lower Level Requirements (below Level 2) How have you decomposed requirements into various levels and/or subsystems?

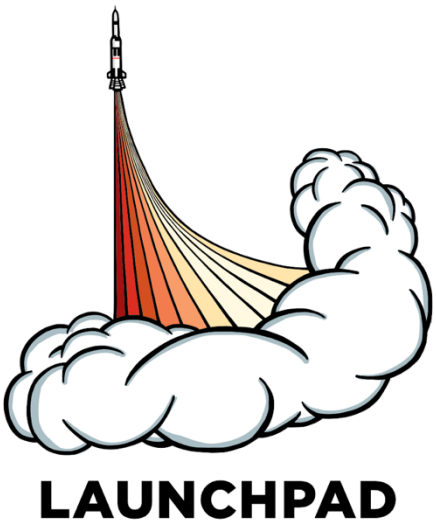
System or Sub-System Requirements – How do define success for parts of a mission?

For Reflection/Discussion (continued):

Driving Requirement – What is your driving requirement and why? This should be the most important aspect of your mission.

Write down your Concept of Operations to describe the operations of the system and how the system will be used to meet requirements.

Science Traceability Matrix



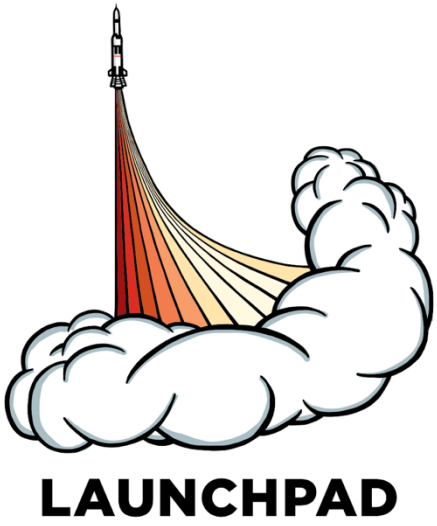
Use the answers to the previous questions to start developing an STM.

1. Science Goals	2. Science Objectives (SO #.#)	Scientific Measurement Requirements		Instrument Requirements				8. Top-Level Mission Functional Req's
		3. Physical Parameters	4. Observables	5. Category		6. Threshold Mission	7. Baseline Mission Requirement	

1. Science Goals	2. Science Objectives (SO #.#)	Scientific Measurement Requirements		Instrument Requirements			8. Top-Level Mission Functional Req's
		3. Physical Parameters	4. Observables	5. Category	6. Threshold Mission	7. Baseline Mission Requirement	

Use the space below to write notes, brainstorm or build your own STM:

Proposal Process



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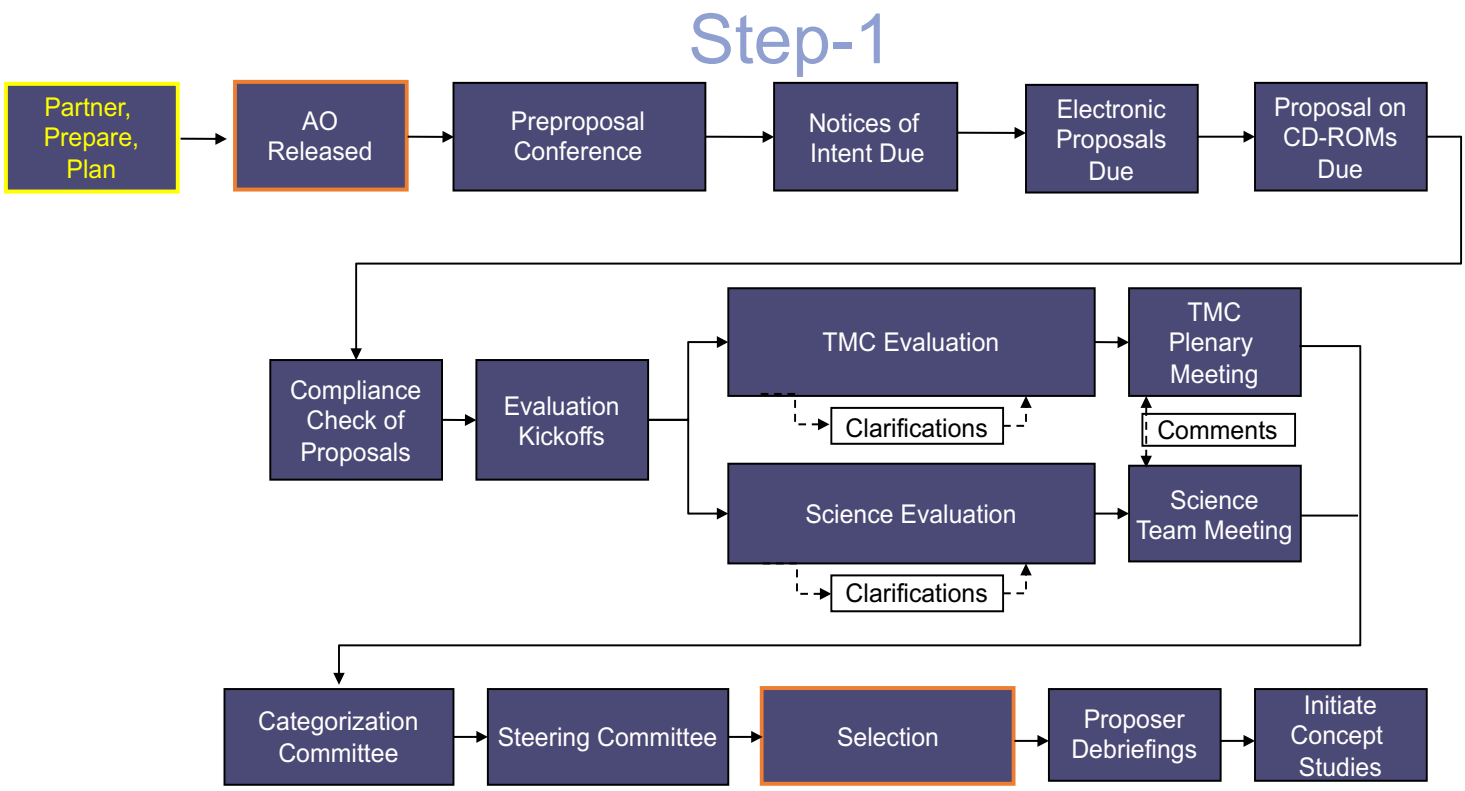
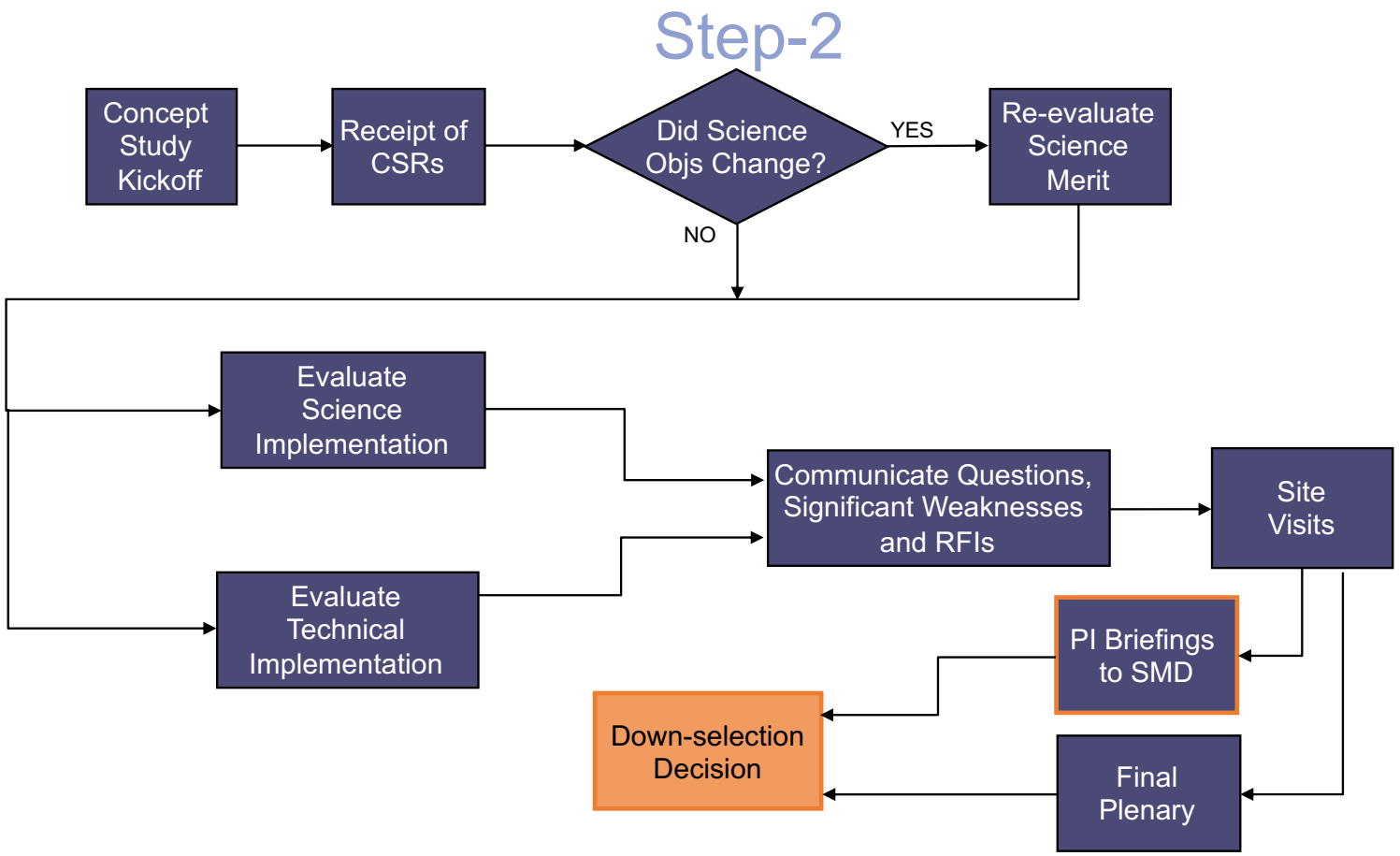
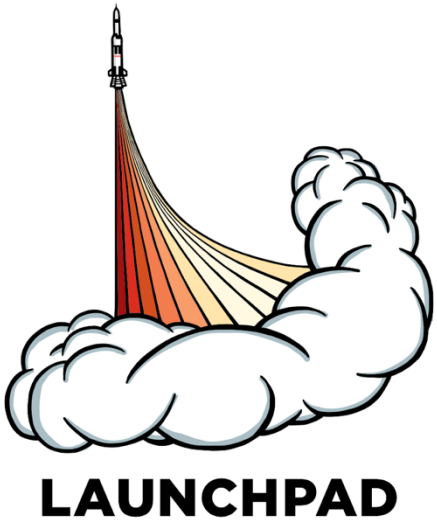

Step-1
Partner, Prepare, Plan
AO Released
Preproposal Conference
Notices of Intent Due
Electronic Proposals Due
Proposal on CD-ROMs Due
Compliance Check of Proposals
Evaluation Kickoffs
TMC Evaluation
Clarifications
TMC Plenary Meeting
Comments
Science Evaluation
Clarifications
Science Team Meeting
Categorization Committee
Steering Committee
Selection
Proposer Debriefings
Initiate Concept Studies


Step-2
Concept Study Kickoff
Receipt of CSRs
Did Science Objs Change?
YES
NO
Re-evaluate Science Merit
Evaluate Science Implementation
Evaluate Technical Implementation
Communicate Questions, Significant Weaknesses and RFIs
Site Visits
PI Briefings to SMD
Down-selection Decision
Final Plenary

Notes:

Science Team



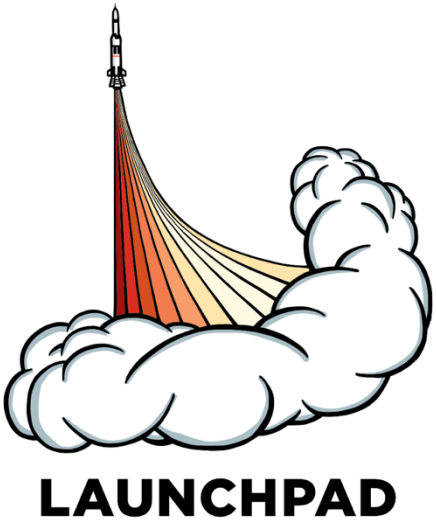
What skills/expertise do you think you need for your team and why?

Which skills/expertise that you identified do you as the PI have and which do you not have? What other skills/expertise do you have that may be relevant?

What gaps might you need to fill in and how would you do that?

Notes:

Support

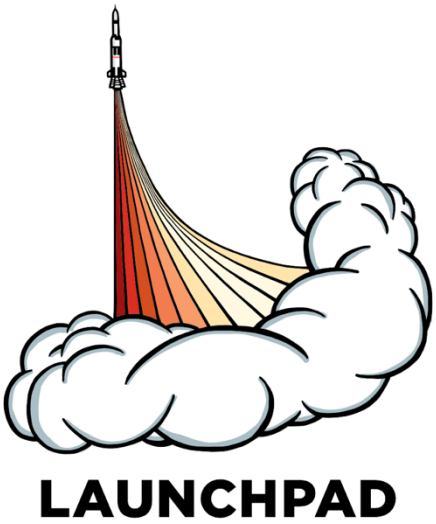


What support do you think you need from your institution? How supportive is your organization?

Who should you talk to at your institution? (Write down their name!) What will you ask for?

What will your institution not support and how can you get the support elsewhere?

Speed Networking



Who did you talk to? _____

What did you learn?

What are your next steps?

How will you follow up?

Who did you talk to? _____

What did you learn?

What are your next steps?

How will you follow up?

Who did you talk to? _____

What did you learn?

_____

_____

_____

What are your next steps?

_____

_____

_____

How will you follow up?

_____

_____

Who did you talk to? _____

What did you learn?

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_____

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_____

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What are your next steps?

How will you follow up?

Who did you talk to? _____

What did you learn?

_____

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What are your next steps?

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How will you follow up?

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_____

Who did you talk to? _____

What did you learn?

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What are your next steps?

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How will you follow up?

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Who did you talk to? _____

What did you learn?

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What did you learn?

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How will you follow up?

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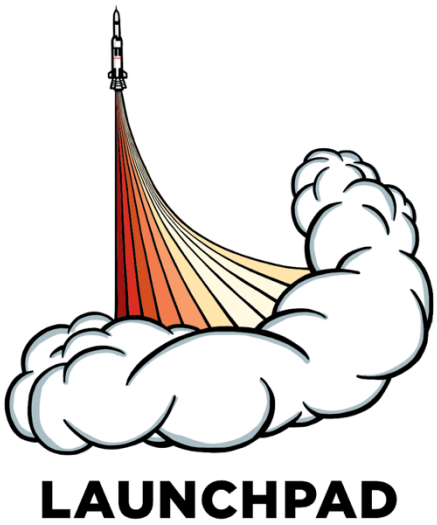
Pitch Development and Practice



Scientists are often used to a method of communication that relies on conveying information, usually to similarly educated peers, and then defending that information. This is the same general method used for scientific writing. However, unlike other writing you may be used to, a mission proposal is a sales document. Storytelling can be a key differentiator between a funded proposal and one that doesn't make it.

Storytelling will help you succinctly convey to potential partners what your mission is about and will help CONVINCE those partners to join you. Having a coherent story for your mission also helps ensure that your science team and mission partners have a common understanding of the mission. Developing a story that guides and structures your proposal will create greater emotional investment by the reader (the review panel).

Storytelling is something that can be taught and practiced. Think about stories in your life that you've enjoyed. Consider WHY you liked them. What parts resonated with you? What parts bored you? As you develop your skills as a storyteller, you will become more aware of the power that a well-structured story has and how you can use that power in your proposals.

Some of the concepts you will need to convey in a story are: Why do you care about this? Why should someone else care about it? Why is now the time to do something? What drove you to this idea? What are the challenges? How will you overcome them?

Using the following guide, craft a compelling story about you and your mission:

1. Keep it simple.
2. What are your 3 key words or messages that help convey your mission?
3. Identify your goal
4. Explain what you want to do in as simple words as possible.
5. What is your "unique selling proposition" or what is special about you AND your idea?
6. Tell who you are: describe you and your experience. You want to give them confidence that you are a good leader.
7. What is your previous work and or contributions? Don't say "I wrote so and so paper", describe the actual results using a good, specific, example.
8. Describe why YOU and you alone are the person to lead this mission.
9. Why now is the time for your science investigation? What is special about this time? If this is such a good idea, why hasn't this been done before?
10. CALL FOR ACTION – depending on who you are talking to, make an ask here – join the science team, become a partner, etc.

First: Practice a 30 second version to get a scientist interested. Based on the guide, what are the most important things for you to cover in your story?

Next: Practice a 30 second version for an engineer. Based on the guide, what are the most important things for you to cover in your story?

Finally: Practice a 3-minute version for someone who could be on your science team. Based on the guide, what are the most important things for you to cover in your story?

Notes:

Feedback form

Instructions: Pair up and use the questions below to provide feedback to your partner. It is **HIGHLY** recommended that you use your partner's phone to record their presentation

Did they clearly address all the follow questions? If not, what are they missing?

1. What are the 3 key words or message?
2. What is the goal?
3. What do they want to do?
4. What is the "unique selling proposition?"
5. What is the relevant previous experience (e.g. work and/or contributions)?
6. Why is this the right person to lead this mission?
7. Why now is the time for the science investigation?
8. What is the Call for Action?

Continued on Back

Feedback form

Instructions: Use the questions below to provide feedback to your partner.

What did you remember?

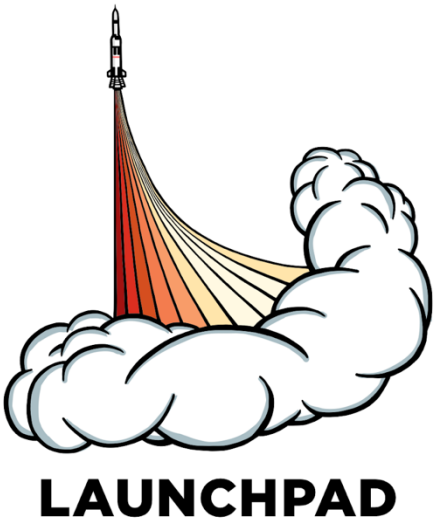
What was the main point?

What did you like?

What recommendations do you have to improve future presentations?
Examples: How can they prepare better? How can they improve the structure?

Notes:

Proposal Timeline



You will develop a timeline to guide your proposal development process.

First: Identify which type of opportunity is most appropriate for your concept (e.g. Discovery, Explorer, etc.) _____

Next: Work backwards and fill in the dates.

Date of Next Opportunity: _____

Start developing idea and concept: _____

Contact NASA centers as potential partners: _____

Develop mission concept (STM maturation): _____

Contact interested science team members: _____

Define science goals and objectives, STM refinement: _____

Potentially NASA center concept study is conducted: _____

Discuss partnering for industry partners, Finalize science team: _____

Drafts of sections:

- Initial system designs: _____
- Baseline reviews: _____
- List of trades to close for proposal: _____

Draft AO released, freeze most parts of design: _____

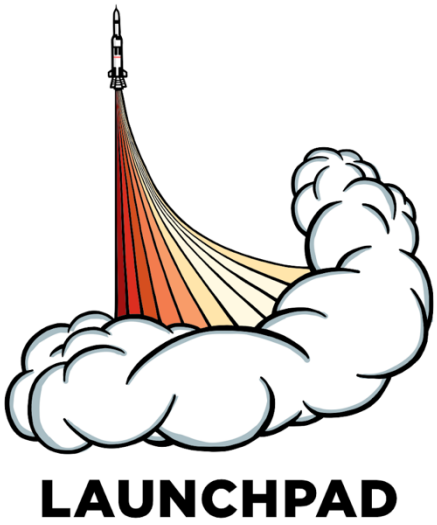
Other color team reviews: _____

AO released: Begin formal writing, design is basically frozen: _____

Due date: 3 months after AO release: _____

Finally: What is the cadence if you wanted to submit to a future opportunity? _____

Storytelling



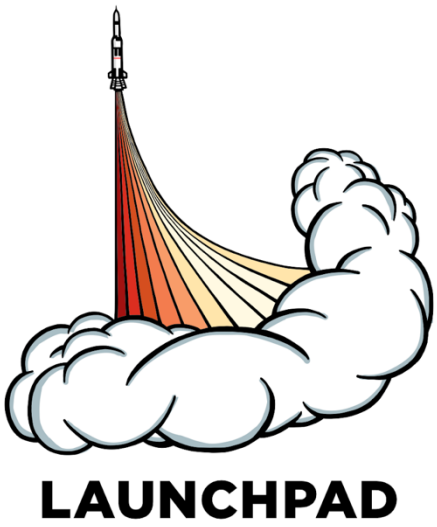
Based on everything you have learned; how will you revise your pitch?

Notes:

Notes:

Notes:

Reading List for Further Thought



Program and Project Management Resources:

- NASA Space Flight Program and Project Management Requirements (NPR 7120.5E): https://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=7120&s=5E
- NASA Space Flight Program and Project Management Handbook: https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20150000400.pdf
- NASA Systems Engineering Processes and Requirements (NPR 7123.1B): https://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=7123&s=1B
- NASA Systems Engineering Handbook: https://www.nasa.gov/sites/default/files/atoms/files/nasa_systems_engineering_handbook_0.pdf

Proposal-Writing Resources:

- Science Office for Mission Assessments (SOMA): https://soma.larc.nasa.gov
- 2019 Astrophysics Explorer AO: https://explorers.larc.nasa.gov/2019APSMEX/
- 2019 Discovery AO: https://discovery.larc.nasa.gov
- 2019 Heliophysics MIDEX AO: https://explorers.larc.nasa.gov/HPMIDEX/
- Earth Venture Instrument-5: https://essp.larc.nasa.gov/EVI-5/
- Colloquium on Writing Successful Proposals: https://www.youtube.com/watch?v=xoLYRjm48-U (video) and https://smd-prod.s3.amazonaws.com/science-red/s3fs-public/atoms/files/06-05-2019_Zurbuchen_Writing%20Successful%20Proposals_FINAL.pdf (slides)

Implicit Bias Resources:

- Implicit Bias Module Series - Kirwan Institute
- Whistling Vivaldi - Claude M. Steele
- Blindspot: Hidden Biases of Good People - Mahzarin R. Banaji & Anthony G. Greenwald

Books about Writing and Storytelling:

- Randy Olsen: Houston, We Have a Narrative: Why Science Needs a Story
- Stephen King: On Writing: A Memoir of the Craft (2010, 10th anniversary edition)
- Dale Carnegie: How To Win Friends and Influence People
- William Zinsser: On Writing Well: The Classic Guide to Writing Nonfiction
- William Strunk: The Elements of Style
- Annette Simmons: The Story Factor: Inspiration, Influence, and Persuasion through the Art of Storytelling
- Benjamin Dreyer: Dreyer's English: An Utterly Correct Guide to Clarity and Style

Books about Teams:

- Ed Catmull: Creativity, Inc.: Overcoming the Unseen Forces That Stand in the Way of True Inspiration

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