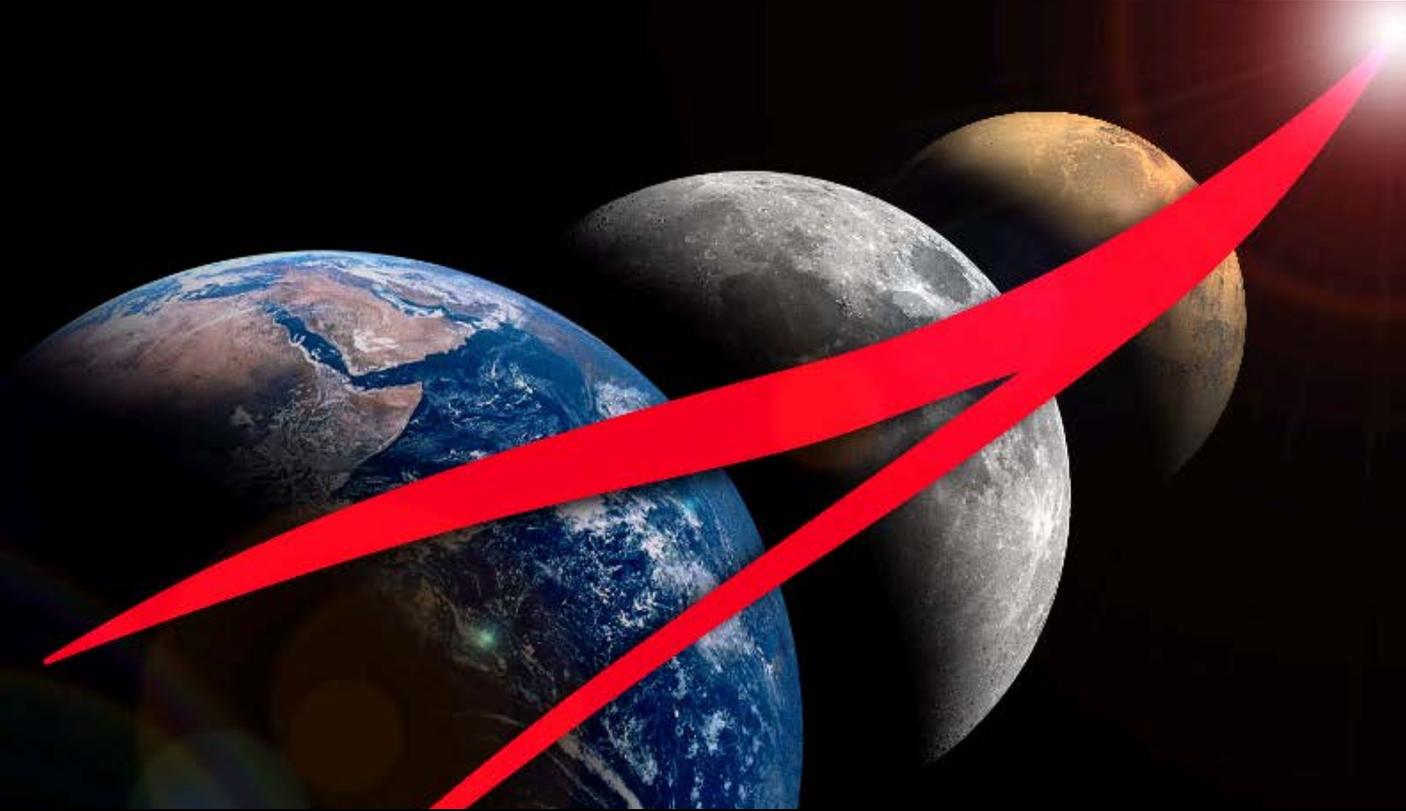


Developing a Mission Operations Trade Study Process for Constellation



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AGENDA



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- Background
- Process Goal and Requirements
- Process
- Documentation Requirements
- Mission Operations Design Analysis Cycle (MODAC) Web Application
- MODAC 0 – A Trial Run
- Conclusion



BACKGROUND



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- Constellation (CxP) is result of the Presidential Directive for the return of Humans to the Moon, Mars and beyond
- Mission Operations Project (MOP) is responsible for CxP Mission Operations including hardware, software, processes, procedures, and personnel
- MOP has a goal to significantly reduce the cost of operations from the historical costs for Space Shuttle Mission Operations
- MOP must also consider the four CxP Architecture Requirements Document Design Objectives:
 1. Mission Safety and Success
 2. Programmatic Risk
 3. Extensibility and Flexibility
 4. Lifecycle Cost



MOP Design Analysis Goals and Requirements



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- The Mission Operations Project (MOP) Design Analysis Cycle assists in achieving a lower cost as well as to resolve specifics of design by performing studies
- Mission Operations Project (MOP) Design Analysis Cycle chose to use the four CARD Objectives to determine criticality of the analyses/trade studies.
- MOP Analysis Process Requirements
 - Simple
 - Easy to implement and use
 - Includes prioritization and documentation
 - Provides strategy for evaluation and approval
 - Defines roles and responsibilities
 - Aligns with Constellation Program
 - Aligns with other Constellation Projects

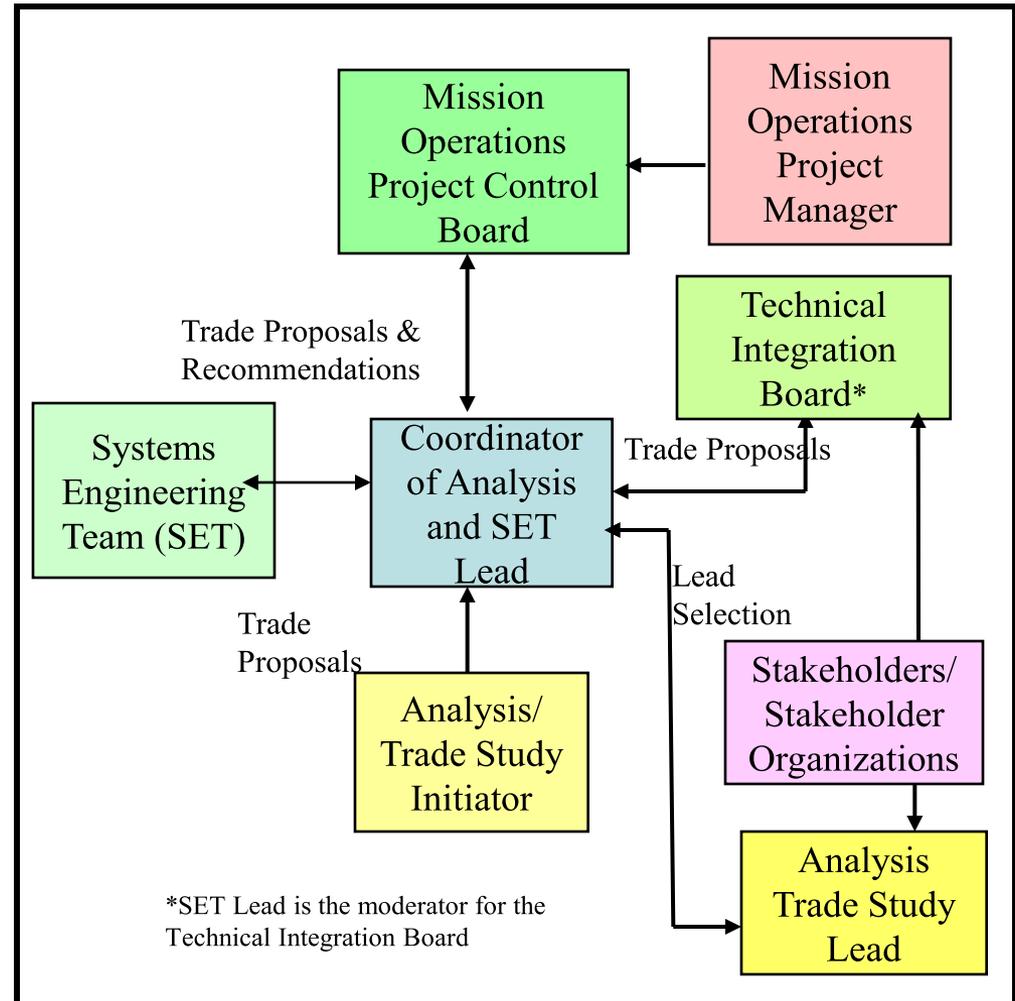


Process – Roles and Responsibilities



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- MOP Integrated Analysis Plan (IAP) Roles and Responsibilities Definition:



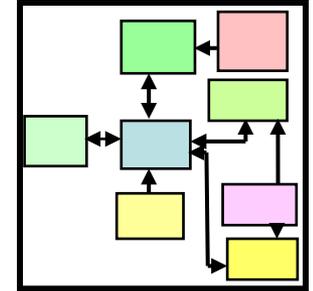
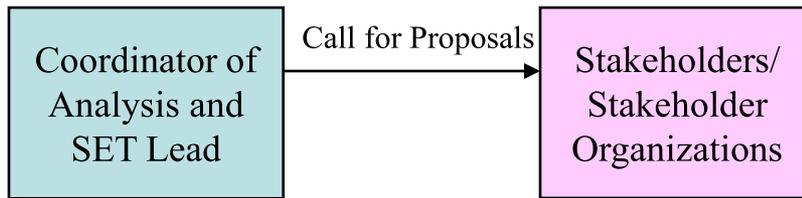


Process Steps

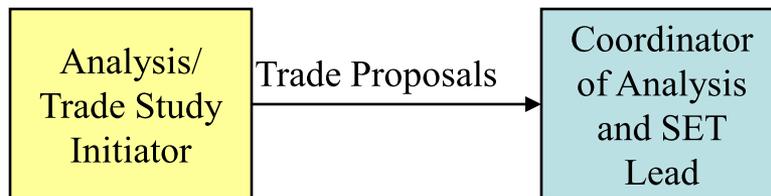


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- **Step 1:** The Lead Systems Engineer for Mission Operations Project issues a call for study proposals.



- **Step 2:** Study Initiators determine study needs and submit proposals.



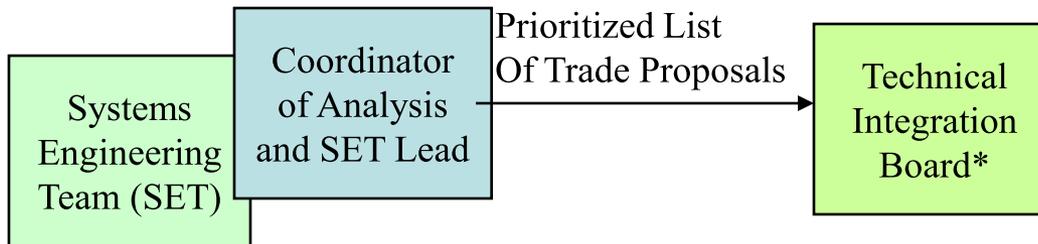
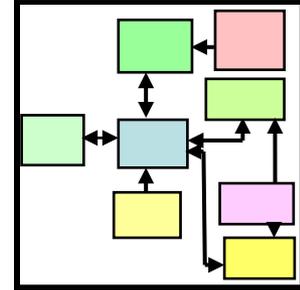


Process Steps



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- **Step 3:** Studies are prioritized by the Lead Systems Engineer and the Systems Engineering Team, and then presented to the Technical Integration Board for consideration.



*SET Lead is the moderator for the Technical Integration Board

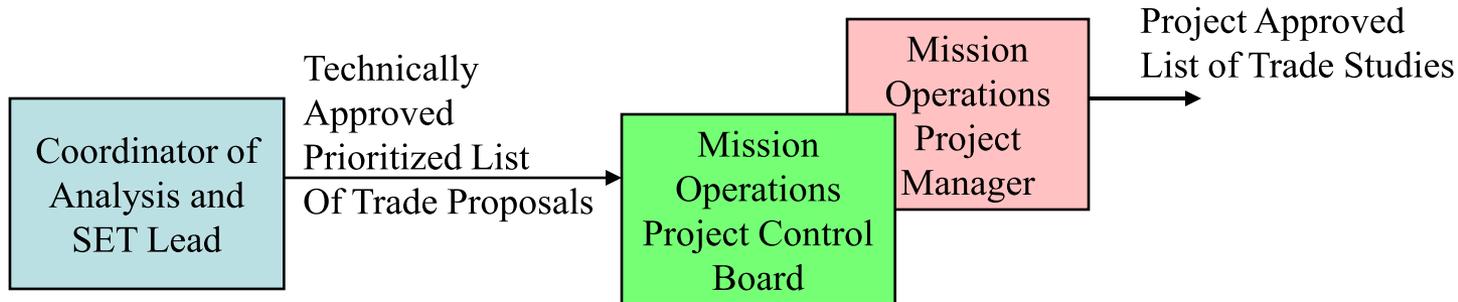
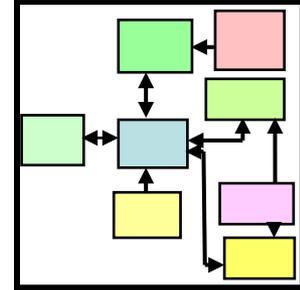


Process Steps



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- **Step 4:** The Lead Systems Engineer takes the technically approved prioritized list of trade studies and presents it to the MOP Control Board for authority to proceed.



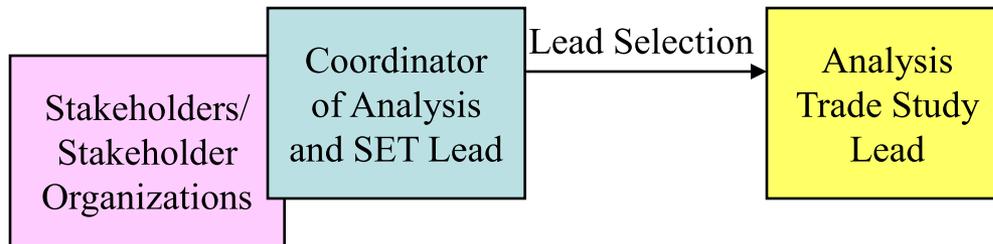
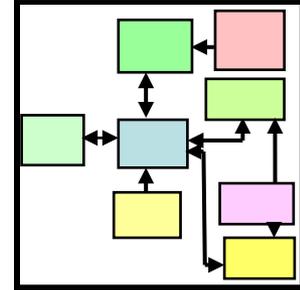


Process Steps



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- **Step 5:** The Lead System Engineer in coordination with the Stakeholders selects Trade Study Leads for each trade study selected for implementation.



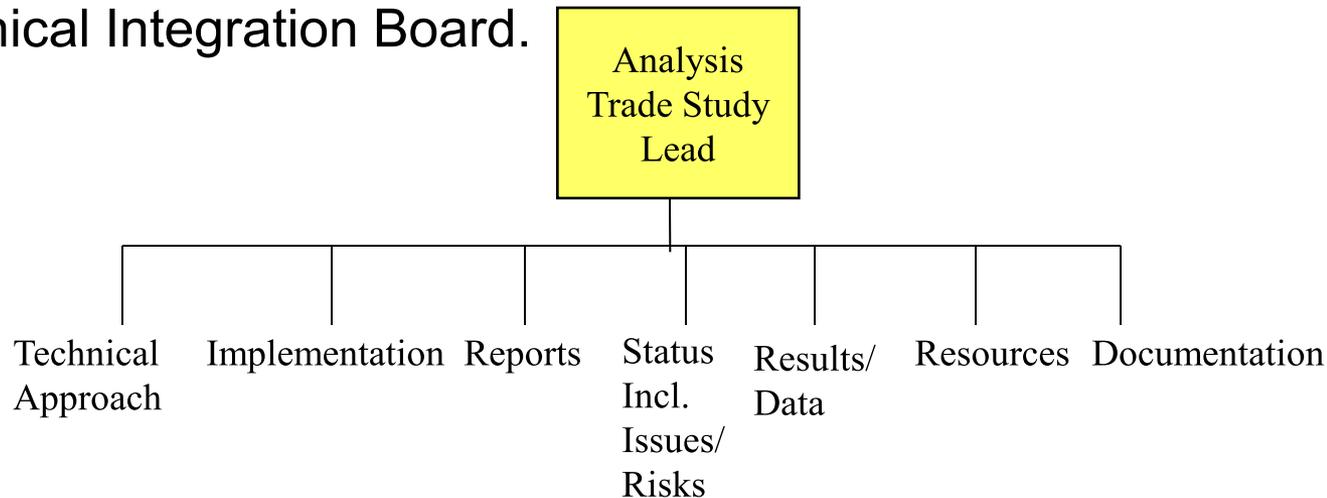
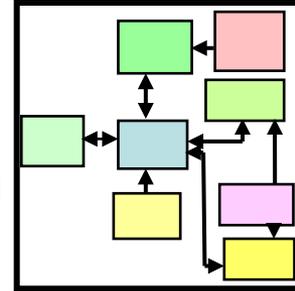


Process Steps



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- **Step 6:** Trade Study Lead, the study team and associated stakeholders perform the trade study. The Leads and their teams are responsible for implementing the technical approach that was documented in the proposal, making the technical assessments, documenting the findings and the data from the study and identifying issues/risks. The Study Lead is also responsible for presenting interim and final reports to the Technical Integration Board.



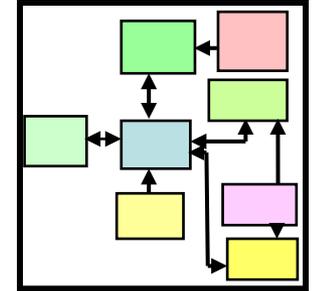
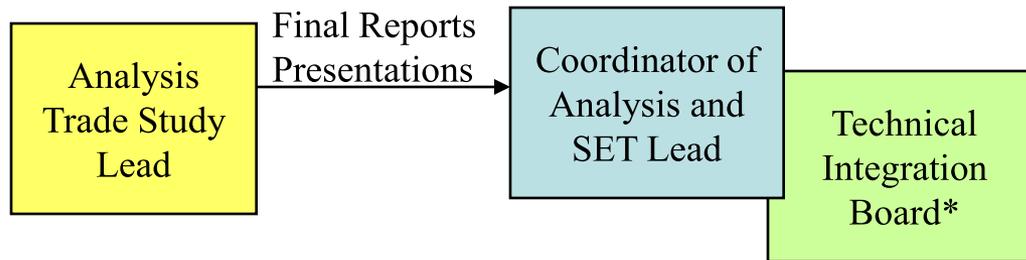


Process Steps

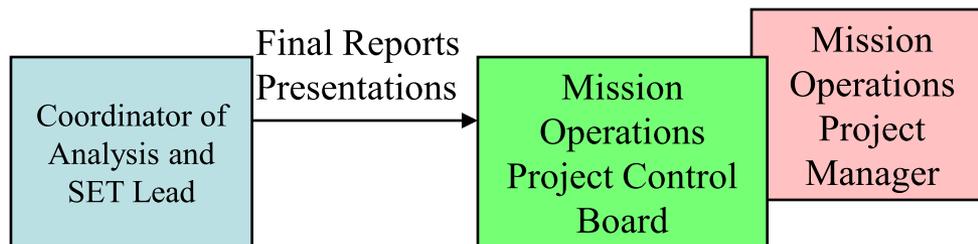


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- **Step 7:** Lead presents the final report to the Lead System Engineer and the Technical Integration Board.



- **Step 8:** Lead Systems Engineer presents final reports to MOP Control Board.





Documentation Requirements



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- Proposal Documentation must include:
 - Description and Technical Approach
 - Schedule
 - Scoring Assessment
 - Resources
 - Participants
- Analysis/Trade Results must include:
 - Disposition and Recommendation
 - Trade Study Results Information
 - Associated Requirements and References
 - Re-evaluation Plan
 - Final Cost



Documentation



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- Originally documentation was in template form
- Templates contained fields for needed information
- Templates were too time-consuming for users to fill out
- A web application was needed.

Sample Proposal Template



Trade Name	
Description	
Safety & Mission Success	
Programmatic Risk	
Extensibility & Flexibility	
Life Cycle Cost	
Metrics and/or Subjective Criteria	
Time Frame for study	
Applicable Requirements	



MODAC Web Application



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- A small group developed requirements – Lead System Engineer, the Process System Engineer and the Software Engineer
- Some fields were combined for ease of use
- The initial need was the trade study proposal portion of the web application, followed by an initial display and finally by the trade study results
- An agile/rapid development process was used
- The trade study proposal design featured tabs for the main sections and pull down selections where possible.



Trade Study Proposal



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modac Studies Trade Study Request Download Scoring Chart Help

1. Description and Technical Approach

Trade Study Name *

Cycle * MODAC-0 Phase * SRR

Description *

Technical Approach *

Next

2. Schedule Estimate

3. Scoring Assessment

4. Resources

5. Participants

6. Finish

Trade Study Description and Technical Approach



modac Studies Trade Study Request Download Scoring Chart Help

1. Description and Technical Approach

2. Schedule Estimate

Design/Plan Complete *

Mid Term Status Complete *

Implementation Complete *

Results Presentation Complete *

Dependencies *

Next

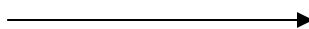
3. Scoring Assessment

4. Resources

5. Participants

6. Finish

Trade Study Schedule Estimate





Trade Study Proposal



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Trade Study Scoring Assessment



The screenshot shows the 'modac' interface for 'Trade Study Request'. The navigation menu includes 'Studies', 'Trade Study Request', 'Download', 'Scoring Chart', and 'Help'. The main content area displays a list of objectives with associated sliders and weights. A 'Score' of 4 is shown in a yellow box.

Objective	Rationale	Criticality	x	Weight	Total
Safety & Mission Success	<input type="text"/>	<input type="range"/>	1 x	1	1
Programmatic Risk	<input type="text"/>	<input type="range"/>	1 x	1	1
Lifecycle Cost	<input type="text"/>	<input type="range"/>	1 x	1	1
Extensibility & Flexibility	<input type="text"/>	<input type="range"/>	1 x	1	1

Score: 4

The screenshot shows the 'modac' interface for 'Trade Study Request'. The navigation menu includes 'Studies', 'Trade Study Request', 'Download', 'Scoring Chart', and 'Help'. The main content area displays a list of objectives with associated sliders and weights. A 'Score' of 4 is shown in a yellow box.

1. Description and Technical Approach
2. Schedule Estimate
3. Scoring Assessment
4. Resources
5. Participants

Study Lead *

Team Members *

Stakeholders *

Next

6. Finish

Trade Study Participants



Trade Study Application Main Display



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Main Display Menu

Trade Studies Menu

List of Studies

TDS	Study
MOP-XX-0001	Lunar Mission Timing Sensitivity
MOP-01-1001	Authorized NASA Facilities/External Facilities
MOP-01-1002	Data Exchange with CxP Office Mission Planning
MOP-01-1003	Coordinate Mission Planning with NASA Crew Health Services
MOP-01-1004	Exchange Video with NASA JSC Video Services
MOP-01-1005	Receiving Eastern Range Info
MOP-01-1006	Document for SR&QA Plan

Basic Study Information For Highlighted Study

Study: Lunar Mission Timing Sensitivity

Request Date: Wed Aug 22 08:23:00 GMT-0700 2007

Request By: Don Kerr

Study Lead: TBD

MODAC Cycle: 0

Phase: SRR

Description and Technical Approach

Description

The task is to complete a trade study on the timing sensitivity of the lunar mission using STK (Satellite Tool Kit). The input data will be a specific delta V for the Earth-Moon system. STK will be used to find a launch date or burn start time. If the input data is a specific launch date or burn start time, STK will be used to find the correct delta V for the system. A 2nd input will be the lunar landing site, and using STK the Lunar Orbit Insertion (LOI) delta V for the spacecraft will be determined. After all the calculations have been made, a visual product of the trajectories used in a lunar mission will be created.

Approach

Highlighted Study Scoring Assessment

Objective	Rationale	Criticality	X	Weight	Total
Safety & Mission Success	All mission trajectories require the	10	X	4	40
Programmatic Risk	The mission is at risk without knowing the	10	X	3	30
Lifecycle Cost	This trade study must be completed in some	5	X	2	10
Extensibility & Flexibility	The trade study allows choices to be made to	5	X	1	5

Score 85



Trade Study Results



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Results tab contains the required information that for the final presentation

Description	Schedule and Resources	Participants	Results	Attachments	Edit
1. Description and Technical Approach					
2. Schedule Estimate					
3. Scoring Assessment					
4. Resources					
5. Participants					
6. Results					
<input type="button" value="Next"/>					
Disposition	<input type="button" value="Prelimina"/> ▼	<input type="button" value="Partially Comp"/> ▼	Requirements	<input type="text" value="results entered here"/>	
Recommendation	<input type="button" value="Follow-on NOT Required"/> ▼		References	<input type="text" value="results entered here"/>	
Study Results	<input type="text" value="results entered here"/>		Re-eval Plan	<input type="text" value="results entered here"/>	
			Final Cost	<input type="text" value="results entered here"/>	
7. Finish					



MODAC 0



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- Process and web application vetted using TBD's from the Mission Operations Project Mission Systems Requirements Document that needed to be resolved.
- Thirteen were selected. All were documented using the web application. The process was followed including producing interim and final reports.
- Eight of the thirteen TBD's were resolved.
- The results were presented to the MOPCB.
- Updates to the web application were made based on user input.
- Training on the web application generally required only 10 to 15 minutes.



Conclusion



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- MODAC 0 was successful and the process and the web application were also deemed a success. They are both being used for MODAC 1 that is currently underway.

Mission Operations Project will continue to evolve and CxP will accomplish its goal of putting humans on the Moon, Mars and Beyond.

