Quantitative Reasoning Signature Assignment-Astrobiology mission of exploration-assignments

Mission Design - Target and Key Question Selection

Step 1: Target and Key Question Selection

Assignment: Read through the attached list of targets and associated key questions (KQ). Select the top-3 most interesting questions and rank them in order of your preference.

Target #1:

KQ#1:

Target #2 (can be the same as T1 if KQ is different):

KQ#2:

Target #3 (can be the same as T1 and/or T2 if KQ is different):

KQ#3:

Team Mission Status Report #1

Video Report

This portion of the first mission report involves thecreation of a video presentation entitled "Meet the Team." This video must be less than **five minutes**. It should include an introduction to the team. Each team member must describe their role in developing the mission content (Project Manager, Environmental Scientist, Measurement Scientist, or Engineer) and how they plans to approach that role. In addition, the video should describe the key question that each member has adopted and explain why they think it is important for astrobiology and life in the Cosmos. Features that make a video especially compelling include a cool team name, scenes of the team working together, graphic elements that illustrate important points (such as the target planet), and consistent presentation (i.e., all videos should be shot in landscape mode with similar sound levels and graphical themes).

Written and Illustrated Report

This portion of the first mission report involves creation of a written and illustrated mission document entitled “Mission to [INSERT TARGET NAME] – Team [INSERT TEAM NAME].” The content of the report must include the name of the mission target and a discussion of each team member’s Key Question under consideration (four Key Questions total). The report should also include a discussion of the relevance of the Key Questions to the field of Astrobiology in general and to the search for life on the target specifically. The report must also include a Project Management section that describes how the team is going to work on their reports throughout the semester. Examples of this kind of content include:

- Team members roles and responsibilities
- A timeline and schedule of meetings
- Deadlines for each team member to meet their input milestones
- Areas of concern and plans to mitigate them.

As a reminder the deadlines for all reports are:

September – Team Mission Status Report #1 [Meet the Team (video) and Mission to TARGET (written and illustrated report)]

October – Team Mission Status Report #2 [What Do We Know About TARGET (video) and Mission Environmental Report (written and illustrated report)]

November – Team Mission Status Report #3 [What Don't We Know About TARGET (video) and Mission Measurement Report or What We Plan to Measure at TARGET (written and illustrated report)]

December – Team Mission Final Report [The Mission Plan (video) and Mission Operations Report or How We Plan to Make Our Measurements (written and illustrated report)]

The report must include at least one graphic element that includes quantitative data relevant to their mission. The report is **limited to five pages total** (not counting references and citations). Reports may be shorter if all information is included as requested. Fonts should be 12-point, single-spaced, with standard page size (8.5 x 11") and margins (1"). Reports should be submitted as a PDF.

Individual Contribution Summary

Each student must submit an Individual Contribution Summary report. This report must describe all of the work that the team member did to support the Mission Report development. This report is also an opportunity for students to provide confidential information to the instructor. Be sure to include your thoughts on the mission, the larger questions that we are addressing in this course, and how this activity helps achieve the course objectives as outlined in the Syllabus.

The summaries are **limited to three pages**. Reports may be shorter if all information is included as requested. Fonts should be 12-point, single-spaced, with standard page size (8.5 x 11") and margins (1"). A graphic element is not required but can be included. Screenshots from the video are also acceptable content.

The instructor will provide feedback on all of the submitted content (video report, written and illustrated report, and the individual contribution summary). Only the Individual Contribution Summary counts toward the course grade. Students can resubmit their Individual Contribution Summary for reevaluation prior to the next team report milestone.

Team Mission Status Report #2

Video Report

This portion of the second mission report involves creation of a video presentation entitled "Target [TARGET NAME AND LOCATION]" This video must be less than **five minutes**.

The video must include a description of the mission target. In addition to describing the planetary-scale properties, the team must identify the local region to be investigated. In other words, **where** on the target is your mission going? The choice of locale **must be linked** to the key questions. Why is that location the best **place** to address your questions?

In addition, since the teams have access to a time machine, the video should address **when** the mission will arrive in the target's history. Is it the modern day, the ancient past, or the future? The choice of time period **must also be linked** to the key questions. Why is that period the best **time** to address your questions?

This discussion will help start to define the mission approach. For atmospheric missions, will the spacecraft skim the atmosphere, float on a balloon, or cruise around in a drone? If you are exploring a surface environment, will you be roving, hopping, or stationary? If exploring the subsurface, do you a need a boring machine or a submarine? How will the instruments be placed on the vehicle? Do they need to observe from a distance or get up close? You don't have to answer these questions in this video, but they should be food for thought for the Measurement Scientist and Mission Engineer. All team members should have input and provide concurrence on the mission environment.

Features that make a video especially compelling include slick graphics and images of the target, use of team members as subject matter experts - providing commentary on the target, a good summary of the state of knowledge of the target environment, clear mapping between the target to all members' key questions, scenes of the team working together, an indication that all team members had input on the choice, creative use of labels, fonts, and graphical insets, a musical score, and consistent presentation (i.e., all videos should be shot in landscape mode, videography should be clean with seamless transitions, audio should have similar sound levels, and graphics should have a consistent theme and style).

Written and Illustrated Report

This portion of the second mission report involves creation of a **written** and **illustrated** mission document entitled “Mission to [INSERT TARGET NAME, LOCATION, AND TIME PERIOD].”

The content of the report must include a full description of the mission target at the planetary scale, as well as the locale and time period that the team is targeting.

The report should describe the process that the team followed to select the target, the research that was performed, and a detailed description about what is known. This includes the selection of both time and place.

The target location and time period should clearly map to each team member’s Key Question. Why is that time and place the best choice to address ALL of the questions the team is grappling with?

Examples of this kind of content include:

- A discussion of the trade space the team used for their selection (list of possible locations and time periods, pros and cons of each one, and a rationale for the final choice).
- Summary of previous missions to the target and their key scientific findings
- A discussion of why the target is of astrobiological interest, based on previous investigations
- A description of the local environment, the region on the target where the mission will focus (images and concept drawings really help here)
- A description of the geologic history of the target, the particular time period chosen, and why this period is best for the mission (place the target in the broader context of the history of the solar system)
- A look ahead to future reports. How does this choice influence the measurements that can be made and the mission design?

As a reminder the deadlines for all reports are:

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November – Team Mission Status Report #3 [What Don't We Know About TARGET (video) and Mission Measurement Report or What We Plan to Measure at TARGET (written and illustrated report)]

December – Team Mission Final Report [The Mission Plan (video) and Mission Operations Report or How We Plan to Make Our Measurements (written and illustrated report)]

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Individual Contribution Summary

Each student must submit an Individual Contribution Summary report describing all of the work the team member did to support the Mission Report development. This report is also an opportunity for students to provide confidential information to the instructor. Be sure to include your thoughts on the mission, the larger questions that we are addressing in this course, and how this activity helps achieve the course objectives as outlined in the Syllabus.

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The instructor will provide feedback on all of the submitted content (video report, written and illustrated report, and the individual contribution summary). Only the Individual Contribution

Summary counts toward the course grade. Students will have a chance to resubmit their Individual Contribution Summary for reevaluation prior to the next team report milestone.

Team Mission Status - Final Report

Final Video Report

This portion of the final mission report involves creation of a video presentation entitled "Investigating [TARGET NAME AND LOCATION]" This video must be less than **six minutes**.

The video must include a description of the mission science and the mission plan. In addition to describing the scientific data to be acquired, the team must clearly map their measurements to their key questions and to their mission target (location and time period). In other words, **how** will the acquired data answer the questions being posed?

In addition, the team must identify the suite of instruments that will be used to make these measurements. The video should address the question - **why** are these the right instruments for the mission? The video should also include a mission profile. Questions that need to be addressed include, **what kind of vehicle** is the team using (orbiter, lander, rover, submarine, drone, etc.)? What is the **timeline of operations** for each instrument? **How many** of each type of measurement will be made? **Why is that the right number** of data products to answer the key questions? The total data collected must fall within the data limit of 10 Gigabytes of data.

Finally, the team should end the video with their **major discovery**. Be creative and tell us what you learned by making all of those measurements and analyzing the data!

All videos will be viewed during the final exam period. Awards will be given for the best videos in each of these categories:

1. Best Science
2. Best Mission Plan
3. Most Informative
4. Most Humorous
5. Best Production
6. Best Group Scene
7. Best Individual Performance
8. Best Musical Score
9. Best Special Effects
10. Best Overall Video

Final Written and Illustrated Report

This portion of the second mission report involves creation of a **written** and **illustrated** mission document entitled “[INSERT TEAM NAME]: A Mission to [INSERT TARGET NAME].”

This report includes both the

- Mission Measurement Report or What We Plan to Measure at TARGET
- Mission Operations Report or How We Plan to Make Our Measurements

The content of the report must include a full description of the mission science and the mission plan. In addition to describing the scientific data to be acquired, the team must clearly map their measurements to their key questions and to their mission objectives [characterizing their location(s) at the desired time period(s)]. In other words, how will the data acquired answer the questions being posed? This mapping should be presented in the narrative and as a **Science Traceability Matrix**. The matrix should be a table with the following columns:

- Key Question (e.g., What are the hazards in the Solar System that pose a risk to the Earth?)
- Mission Objective (e.g., Measure the effect of sunlight (aka the Yarkovsky Effect) on the orbit of a potentially hazardous asteroid)
- Measurement Requirements (e.g., Produce a shape model of the asteroid; Measure the reflectance at each point on the surface; Measure the emission of heat from each point on the surface as a function of local solar time)
- Rationale for Requirements (e.g., The shape model is necessary to determine the orientation of the surface relative to the Sun at each location on the asteroid. The surface reflectance constrains the amount of incoming sunlight that is absorbed by the surface. The heat flux is a determination of the amount of outgoing thermal energy. Combined these factors drive the Yarkovsky Effect on the asteroid)
- Measurement Instruments (e.g., scanning lidar; narrow-angle camera; infrared spectrometer)
- Data Product for each Measurement (e.g., the lidar produces 3D topographic maps of a region; the camera measures the amount of reflected light, the infrared spectrometer measures the amount of thermal photons emitted from the surface)
- Total number of Data Products (e.g., 1000 lidar 3D images, 6000 images, 25,000 infrared spectra)
- Total data volume (1000 lidar images @ 5.1 Mbit each = 5100 Mbits, 6000 images @ 1.2 Mbit each = 7200 Mbits, 50,000 spectra @ 50 kbit each = 2500 Mbits) = 14800 Mbits = 1850 Mbytes = 1.86 Gbytes

There should be at least one row in the matrix for each Key Question. It is OK to have multiple rows if more than one measurement is being used to answer the question.

The report should also include a **Concept of Operations**. This part of the document describes the mission profile. Describe what the spacecraft looks like, and how it will move, land, dig, rove, etc. Discuss the location of the instruments and how they need to be oriented relative to the target. Provide a graphic element that shows the spacecraft design with the instruments on board.

The Concept of Operations should also include the sequence of measurements and a rationale for the amount of data collected from each instrument. Be sure to stay within the mission requirement of 10 Gigabytes of data!

The concept of operations should be described in the narrative and should also be presented as a graphical element, most likely a timeline illustrating the sequence of events over the course of the mission.

End the report with a **discussion of your major discoveries**. Be creative! Imagine that your mission is a complete success - what did you discover? How did your discovery revolutionize the field of Astrobiology?

Final Individual Contribution Summary

Each student must submit a final Individual Contribution Summary (ICS) report. A portion of the final grade will be based on the quality of the ICS, the video report, and the group written report.

The report should include these sections:

INTRODUCTION: Provide an overview of the mission activity and set up the following sections.

MY KEY QUESTION: This final ICS must include a discussion of the student's key question and how it was incorporated into the measurement plan and the mission design.

THE TARGET: The report must also include a discussion of the mission target, including the specific location and time period chosen. Most importantly, the relevance of these selections to the broader field of astrobiology must be discussed.

THE DISCOVERY: The ICS should include the student's thoughts on their mission's major discovery. In addition, this section should include the importance of the mission activity, culminating in this discovery, and its value in achieving the following Expected Learning Outcomes (as described in the course syllabus):

- The ability to utilize multiple perspectives and make meaningful connections across disciplines and social positions, think conceptually and critically, and solve problems
- Competency in working with numerical information by critically analyzing quantitative information, generating ideas that are supported by quantitative evidence, assessing the relevance of data and its associated implications in a variety of contexts, and communicating those ideas and/or associated interpretations using various formats (graphs, data tables, illustrations, video presentations, or written reflections).

MY CONTRIBUTIONS: This report must describe all of the work that the team member did to support their team. It should include a description of their mission role and how they fulfilled their obligations to the team. It should also include a description of the student contributions to the team reports.

CONCLUSION: A final section summarizing the student's thoughts on the mission and the value of the activity for understanding the field of astrobiology.

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The instructor will provide feedback on all of the submitted content (video report, written and illustrated report, and the individual contribution summary). Only the Individual Contribution Summary counts toward the course grade. Students will **NOT** have a chance to resubmit this final Individual Contribution Summary for reevaluation - so make it count!