3. Specific Requirements

This requirements section outlines the necessary functionalities and user interactions for the simulation tool, based on the data derived from the elicitation techniques of brainstorming sessions, introspection, card sorting, profiles, scenarios, and task analysis, ensuring a comprehensive and engaging user experience.

3.1 Functional Requirements

3.1.1 Home Page and User Authentication

3.1.1.1 The system shall provide a home page that serves as the main entry point for users. *(B, I) [Critical]*

3.1.1.2 An authentication window shall allow users to enter a username and password for secure access, shown after a user selects the “Login” button. *(B, I, TA) [Critical]*

3.1.1.3 The system shall display an error message and allow retry if the login credentials are incorrect. *(TA) [Critical]*

3.1.1.4 The system shall provide a "Guest" button for users who wish to access the application without logging in. *(B, TA) [Critical]*

3.1.1.5 The system shall disable unsupported features if the user proceeds as a Guest. *(TA) [High]*

3.1.1.6 The system shall grant access to the main menu upon successful authentication. *(TA) [Critical]*

3.1.2 Cookie Management

3.1.2.1 The system shall allow users to open a card for managing cookie settings, displaying details of data being tracked. *(TA) [Normal]*

3.1.2.2 Users shall have the ability to opt in or out of tracking by selecting toggle options. *(TA) [Normal]*

3.1.2.3 The system shall provide "Accept" and "Decline" buttons for users to confirm their cookie preferences. *(TA) [Normal]*

3.1.3 Error Handling

3.1.3.1 If the web server is down, the system shall notify the user that the application is unavailable and suggest trying again later. *(TA) [Critical]*

3.1.3.2 If login fails, the system shall display an error message with an option to retry. *(TA) [Critical]*

3.1.3.3 If the cookie management card is ignored, the system shall auto-set the user's selection as accepted or declined. *(TA) [High]*

3.1.4 User Interaction Features

3.1.4.1 The system shall support touch control for mobile devices to enhance user interaction. *(B, TA) [Low]*

3.1.4.2 The application shall include QR code scanning capabilities to access space-related photos and resources. *(B, CS) [Low]*

3.1.4.3 The system shall offer different levels of interactivity, ranging from simple to complex, to accommodate varying user preferences. *(B, P) [Low]*

3.1.4.4 The system shall support user's recording and transfer of data whether that be to internal or external storage. *(I, TA) [Low]*

3.1.5 Data Visualization and Simulation

3.1.5.1 The running simulator shall include two visualization windows, one to display data and the second to image the simulated visuals of the spacecraft or rover operations. *(I, B) [Critical]*

3.1.5.2 The system shall include a data readout window displaying the following parameters during the simulation:

- Relative gravity in relation to Psyche
- Distance to Psyche
- Rate of descent
- Angle of descent
- Speed of the spacecraft
- Rate of ascent
- Angle of ascent
- Time elapsed since the beginning of descent
- Current and interim orbit data
- Simple indicators for:
    - Takeoff failure
    - Liftoff failure
    - Sampling failure
    - Landing success
    - Takeoff success
    - Sampling success *(B, I, S, CS) [Critical]*

3.1.5.3 The system shall provide realistic rendering for spaceflight, approach maneuvering, landing, and takeoff simulations, including an animation sequence for more casual visual engagement. *(B, I, CS, TA) [High]*

3.1.5.4 The simulation shall incorporate physics simulation features, enabling 3D movement and rendering of the spacecraft. *(B, TA) [High]*

3.1.5.5 The system shall provide options to toggle graphics settings to optimize performance. *(TA) [Normal]*

3.1.6 Visual Performance

3.1.6.1 All visual components shall operate at a frame speed range of 15-30 frames per second to ensure smooth rendering of a 3D environment across all intended devices. *(I, TA) [Normal]*

3.1.7 Simulation Controls

3.1.7.1 The application shall display a main menu after authentication or guest login occurs, or when a user attempts to save a mission. This will include:

- Load Mission (to load an earlier saved data set)

- Write Mission (to save simulation data - both visuals and parameters)
- Exit
- Dropdown menu having interaction options from simple to expert
- Configure button
- Start button *(TA) [Critical]*

3.1.7.1 The settings menu shall appear if the configuration button is pressed. This will display all simulation parameters, allowing data to be entered by the user. *(TA) [Critical]*

3.1.7.2 Pressing the start button shall begin the simulation using input data if the configure button was selected, otherwise a default data set is used. *(TA) [Critical]*

3.1.7.3 The system shall provide controls for spacecraft or rover operations whenever maneuvering, landing, ascending, descending, or takeoff simulations are being run. *(I) [High]*

3.1.7.4 The system shall provide controls for starting, pausing, stopping, and resuming the simulation. *(B, I, CS, TA) [Critical]*

3.1.7.5 The application shall include spacecraft controls such as thrust, rotation, and other settings, allowing users to program or manipulate the spacecraft prior to beginning or during the simulation. *(B, I, TA) [High]*

3.1.7.6 The system shall feature diverse sampling controls to enable users to select different sampling types and instruments. *(B, I) [Critical]*

3.1.7.7 The system shall support batch simulation control, enabling users to run multiple simulation scenarios in succession. *(I) [Normal]*

3.1.8 Error Handling for Configuration

3.1.8.1 If any input parameters are invalid, the system shall display an error message and ignore the invalid options. *(TA) [Critical]*

3.1.8.2 If the survey mission program is invalid, the system shall display an error message prompting the user to rewrite it. *(TA) [High]*

3.1.9 Error Handling for Simulation

3.1.9.1 If the spacecraft sustains fatal damage, the simulation shall stop with options

to restart or adjust parameters. *(TA) [High]*

3.1.9.2 If the survey mission is inoperable due to timing or other issues, the system shall display an error message with adjustment options. *(TA) [High]*

3.1.10 Mission Success and Research Contribution

3.1.10.1 The system shall support users in successfully executing and contributing to the planning of future Psyche missions, from launch to the collection and analysis of samples on the asteroid Psyche. *(P) [High]*

3.1.10.2 The simulation shall provide resources for publishing research findings in high-impact journals and contributing to future NASA missions or programs. *(P) [Low]*

3.1.10.3 The tool shall facilitate engagement with the public and academic communities through science outreach initiatives. *(P) [Normal]*

3.1.11 Engagement and Learning

3.1.11.1 The simulation shall aim to spark curiosity and critical thinking about physical concepts, accommodating various learning styles to maintain student engagement or satisfy a general user's curiosity. *(P) [Low]*

3.1.11.2 The simulation tool shall include resources for publishing research in undergraduate journals and gaining hands-on experience with telescopes and other equipment. *(P) [Low]*

3.1.11.3 The system shall offer educational content designed to deepen students' understanding of physics concepts, metallurgy, and the scientific method of data collection. It should aid in preparing them for standardized exams (e.g., AP, SAT, ACT). *(P, S) [Low]*

3.1.11.4 The system shall include features that allow teachers to customize lessons and track student progress. *(S) [Low]*

3.1.11.5 The simulation shall provide accessible, easy-to-understand explanations of scientific concepts related to the Psyche mission. *(P, S) [Low]*

3.1.12 Collaboration Features

3.1.12.1 The tool shall include features that enable users to share their enthusiasm for space exploration with family, friends, or online communities. *(P, S, TA) [Low]*

3.1.13 Data Compatibility

3.1.13.1 The system shall be compatible with existing NASA software tools to streamline workflows and communication among team members. *(S) [Normal]*

3.2 Non-Functional Requirements

3.2.1 Performance Requirements

3.2.1.1 The system should be responsive and able to handle multiple simultaneous users without performance degradation. *(B) [Normal]*

3.2.1.2 The home page shall load within 3 seconds. *(TA) [High]*

3.2.1.3 Settings adjustments shall update in real-time and save without noticeable delay. *(TA) [Critical]*

3.2.2 Usability Requirements

3.2.2.1 The interface shall be intuitive and user-friendly, accommodating users with varying levels of understanding regarding scientific topics. *(S) [Critical]*