JPL-PURDUE RAPID MISSION DESIGN PILOT STUDY

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Introduction: Astrodynamics and mission design tools can have a large impact on the design of innovative mission concepts that maximize science value and reduce mission costs [1]. The Planetary Science Decadal Survey recommends a sustained investment in the development of new interplanetary trajectories and mission design tools that would provide a rich set of options for future missions. Currently, no easy-to-use tool exists that allows users to quickly evaluate trajectories and mission design options. Such a tool would be valuable for the planetary science community to quickly explore the mission design trade space for studies (such as the Decadal concept studies) before committing to a point design [2]. The present study aims to fill this gap by providing the planetary science community with an interactive, easy-to-use, web-based tool that performs a comprehensive exploration of the trade space and compares trajectory design options for future missions.

Study Objectives: The suite will consist of a set of tools that enable a user to start from a set of simple mission requirements and select a set of options (i.e., launch vehicle, interplanetary trajectory, orbit insertion technique) to accomplish the objectives. The suite will provide the user with a low-to-mid fidelity mission concept. The suite will be made available to the end users (i.e., planetary scientists, mission designers, executives, program managers) as an interactive, easy-to-use, web-browser interface on the cloud.

Current Status: The study is currently in its pilot phase. Current capabilities allow the user to (a) search for trajectories to Uranus and Neptune, and (b) to evaluate launch performance from a list of available launch vehicles. The trajectory search tool, as shown in Figure 1, allows one to select the destination body along with constraints such as the allowable launch window, maximum C3, maximum time of flight, maximum arrival speed, allowable gravity assist flyby bodies, and trajectory type (chemical or SEP).

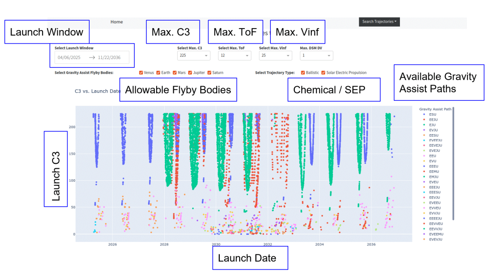

Figure 1: Available trajectory options to Uranus.

The user is then presented with several plots (one of which is shown in Figure 2) that list interplanetary trajectories that satisfy the specified constraints while further allowing for trade studies of the available options. The tool also allows the user to select a launch vehicle and to calculate launch performance for all valid trajectories as shown in Figure 3.

Figure 2: Plot showing time of flight vs. launch window.

Figure 3: Launch performance calculator.

Planned Work: The trajectory database will be incrementally expanded to include all planetary destinations. A comprehensive trajectory database will be created using both in-house and external trajectory search tools (STOUR, STAR) [3]. The ability to add analysis capability for approach trajectory, EDL, aerocapture, probe delivery and link budgets using the open-source AMAT package towards an end-to-end rapid mission design suite is currently planned [4].

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References: [1] Planetary Science and Astrobiology Decadal Survey 2023-2032. [2]. Girija, A. P., Ph.D. Dissertation (2021). [3] Landau, D. et al. *J. Astr. Sci* (2022). [4] Girija, A.P. et al. *J. of Open Source Software* (2021).