

IAF SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems (1)

Author: Dr. Angelo Vermeulen
Delft University of Technology (TU Delft), The Netherlands

Mr. Mikhail Sirenko
Delft University of Technology (TU Delft), The Netherlands

Mr. Alvaro Papic
Delft University of Technology (TU Delft), The Netherlands

Mr. Jason Kiem
Delft University of Technology (TU Delft), The Netherlands

Mr. Andreas Theys
Delft University of Technology (TU Delft), The Netherlands

Prof. Frances Brazier
Delft University of Technology (TU Delft), The Netherlands

EVOLVING ASTEROID STARSHIPS: A BIO-INSPIRED APPROACH FOR INTERSTELLAR SPACE
SYSTEMS

Abstract

The hostile and unpredictable environment of deep space requires a new conceptual approach for interstellar flight, one that differs radically from any current design in aerospace. A design solution is proposed in which the starship is attached to a C-type asteroid and whose architecture evolves over time. The starship gradually mines resources of the asteroid, while at the same time using it as a shielding structure against frontal impacts. The extracted raw materials are used for cultivation of the onboard ecosystem and expansion of the starship's architecture, the latter of which is primarily conducted by mobile 3D printers. Within the bounds of its sensing horizon, the spacecraft can detect prospective high-energy particle collisions and radiation events along its upcoming flight path. Subsequently, the starship will adapt itself by changing its interior and exterior morphology. This constant evolution aims to minimize the spacecraft damage and loss of functionality, and handles the inherent unpredictability of the mission. The Delft University of Technology Starship Team (DSTART) simulates this concept using an array of different techniques. The ecosystem dynamics are approached using agent-based modeling, while the evolving architecture of the starship is approached with genetic algorithms. The starship simulation relies on four distinct timelines. A first timeline provides real-time updates on the state of the starship's regenerative ecosystem, with a focus on population sizes, mass fluxes, and radiation impact. ESA's MELiSSA project was used as a conceptual blueprint for the ecosystem. A second timeline deals with the growth of the starship architecture, taking into account material supplies, mining rates, 3D printing speeds and wear of existing structures. The third timeline forecasts the impact of future particle collisions and interstellar radiation as assessed within the sensing horizon. The fourth and final timeline is concerned with the evolution of the starship architecture as a response to this forecast. This is done by comparing the structural integrity and ecosystem health of different variations of the starship's morphology. The first results of this work will be presented, as well as an overview of the implications for space system design.