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COMPARATIVE ANALYSIS OF SYSTEMS FOR SUSTAINABLE FOOD PRODUCTION DURING LONG-TERM MISSIONS

Abstract

Human Exploration of Mars is one of the key goals identified by the International Space Exploration Coordination Group in its Global Exploration roadmap. To reach this objective, there are many issues still unresolved. In the context of long-term manned missions, such as those with destination Mars, a sustainable food production system is necessary to provide good, nutritious food and to reduce the total mass that needs to be shipped. There are already several alternatives which promise to solve the problem, yet no real solution has extensively been tested and validated. In this study, a comparative analysis of some of these alternatives is performed, and the best are kept for further evaluation. The second goal of this paper is to provide a preliminary analysis of the systems, subsystems and structures required for food production and preparation in long duration missions. Both the pros and the cons of physico-chemical and bio-regenerative solutions are analysed to understand their feasibility and their suitability with respect to different scenarios for a manned mission on (and to) Mars. Furthermore, the difference between various crops and cultivation techniques is described and used to determine how the relative systems, instrumentations and procedures would affect the mission in terms of resources consumption, crew-time required for maintenance and cultivation and complexity added to the mission. Eventually, a Design Reference Mission to test the selected technologies and capabilities is produced. To reach the aim of this paper, a Model Based System Engineering approach is pursued. This study is carried out in the framework of the II Level Master's programme SEEDS (SpacE Exploration and Development Systems), a project born from the collaboration between the Politecnico di Torino (PoliTo) , the Institut Supérieur de l'Aéronautique et de l'Espace (ISAE) and the University of Leicester, with the participation of Agenzia Spaziale Italiana (ASI), Centre National D'Etudes Spatiales (CNES), European Space Agency (ESA), Thales Alenia Space and Altec.