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LOGISTICS IN HUMAN SPACEFLIGHT SYSTEMS

Abstract

The following quotation by astronaut Donald Pettit illustrates the underdevelopment of logistics in spaceflight: "All of these packages have a nine-digit barcode. We are required to log these in our inventory management system, but often the barcode reader doesn't work. For this case[...], you have to write down 189 alphanumeric characters (without a mistake). These numbers must later be typed up in a crew note[...]. So you think, "I will do all this inventory paperwork later"" This paper is dedicated to the transfer of established principles of terrestrial logistics to the domain of spaceflight in order to meet the increasing demands that spaceflight puts on logistics. The research described has two focal points: 1) Development of design principles for space logistics: The central value of this work is to systematically record logistical findings and experiences in spaceflight, make them available for further research and - in combination with the structured knowledge of terrestrial logistics - apply them to future applications in space and on earth. This part builds on previous knowledge of the classic logistics tasks of transport, handling and storage of goods, people and information as well as their control, monitoring and optimization. As result and conclusion, scalability, self-organization, adaptation, transparency and adaptability are central design and concept objectives in order to meet the urgent needs of spaceflights, such as optimal utilization of resources, especially with regard to space and time. 2) Development of self-organizing, scalable, homogeneous structures for an extra-terrestrial logistics framework: Inventing a holistic process for materials handling in space by leveraging multi-disciplinary expertise for logistics on earth is the key goal of this part. Seen from a solutions perspective, the idea is to soothe several issues of space travels and astronauts' daily routine by creating an easily reconfigurable, modular smart rack system that addresses room limitation, material handling tasks, documentation efforts and inventory management. To achieve this goal, the design principles for space logistics (part 1) are taken into account and as results a) A design guideline for material handling equipment in other gravities is derived, b) A standard smart rack system as commercial-off-the-shelf (COTS) is designed, c) The smart rack system is prototyped and evaluated for prospective deployments in space habitats. The rack system acts as an entity that is networked in a manner that it connects across onboard systems to physically and virtually organize material handling in an intuitive way with a conversational interface.