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CHALLENGES AND SOLUTIONS FOR RESEARCH EFFICIENCY IMPROVEMENT USING A MANNED SPACE STATION

Abstract

Increase of research efficiency onboard manned space stations is a fairly important problem because of the large scale and considerable costs of such projects. Similar problems occur in the current ISS project. Salyut and Mir manned space stations were traditionally considered as multipurpose research laboratories. Such approach made it possible to develop technologies to optimize research programs based on the following ideas.

Research onboard multipurpose space stations provide an opportunity to expand experimental program significantly through efficient use of the equipment available. Continuous operation of a certain specific device is known to be problematic because of limited opportunities to conduct the specific experiment; in reality, scientific experiments are performed within certain "time windows". Efficient planning of experiments onboard the space station makes it possible to expand its research program, as compared with a specialized spacecraft.

The program of experiments onboard the ISS is aimed, to a large extent, at research in microgravity, biomedical sciences and engineering. These areas of research are certainly important, however, in order to improve the efficiency of the ISS utilization, it is necessary to expand the range of scientific programs onboard the station.

Use of optimization techniques makes it possible to increase significantly the efficiency of research conducted onboard the orbital stations. A criterion of optimization used in the process of these techniques development was the program's information worthiness defined in terms of scope, value and quality of obtained data. The stated problems are usually reduced to integer-valued linear programming. In addition to this, research performed on manned space station provide flexibility in the program of experiments, repairs of research equipment due to crew activities and supported cargo traffic from the ground, etc.

Ample opportunities of research program efficiency increasing are offered by use of automated cargo vehicles after they have fulfilled their primary functions. Technologies developed for the cargo vehicles make it possible to conduct various experiments aboard them: microgravity experiments, Earth and atmospheric studies, etc. Multi-purpose research programs implementation onboard space station involves addressing to many complicated scientific and engineering problems such as development of a special experiment control system, use of mathematical modeling, etc. The paper presents technologies, methods and ways to increase space station utilization efficiency and offers some proposals for the ISS and future manned space stations.