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Novel Concepts and Technologies to Enable Future Building Blocks in Space Exploration and Development (3)

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DISCUSSION ON BOTTLENECK AND COUNTERMEASURE OF IN-SPACE ASSEMBLY TECHNOLOGY

Abstract

Bees, termites can construct magical nests with secreted mucus through professional collaboration millions of years ago; human being can produce nano chips, assembly aircraft carrier through sophisticated equipment and long production line today; but in-space assembly technology using modules to assembly large structure, has not yet been maturely applied to construct space telescope of large aperture after 40 years of relentlessly research, and this is a problem worth discussing. A typical assembly system includes modules to be assembled, assemblers and tools. Modules need to be designed for easy alignment, adjustment and locking etc, which can be described as characteristic of assemblability. Assemblers and tools work coordinately to put modules together , which shows manipulative ability. An assembly task is doable when the manipulative ability of assembler and tool match with the requirements of modules assemblability, or it's impractical. Although many ground and in-space assembly tests have been demonstrated by USA, Japan and other countries since 1970s , in-space assembly technology is still not matured and popularized so far, restricted mainly by space manipulation ability, modules assemblability, reliability of the whole assembly process and so on. From the perspective of assemblers manipulative ability should match the modules assemblability, several typical cases of natural biological construction, human ground construction, and in-space construction are systematically analyzed, and the bottleneck that restricts the development of in-space assembly technology is discussed, corresponding countermeasure is explored. It is impractical to improve the reliability of the whole assembly process through by launching many redundant backup modules, limited by current high cost of space launching and space servicing ability, so the feasible

path is to increase the modules (and interfaces) versatility and interchangeability without significantly increasing the quantity of modules carried by the rocket. And technical feasibility of in-space assembly is determined mainly by the performances of space robots, and the assemblability and interchangeability of modules (and interface). Therefore, a feasible way for developing in-space assembly technology is proposed here: increasing assemblability and interchangeability of modules (and interfaces) dramatically to match current spatial manipulation ability, based on the judgement that the spatial manipulation ability will not improve evidently in the next 5-10 years disclosed by last 20 years development history of space robots. At last potential methods for improving assemblability and interchangeability of modules are sorted out.