# Supportability Technologies for Future Exploration Missions

Future long-duration human exploration missions will be challenged by resupply limitations and mass and volume constraints. Consequently, it will be essential that the logistics footprint required to support these missions be minimized and that capabilities be provided to make them highly autonomous from a logistics perspective. Strategies to achieve these objectives include broad implementation of commonality and standardization at all hardware levels and across all systems, repair of failed hardware at the lowest possible hardware level, and manufacture of structural and mechanical replacement components as needed.

Repair at the lowest hardware levels will require the availability of compact, portable systems for diagnosis of failures in electronic systems and verification of system functionality following repair. Rework systems will be required that enable the removal and replacement of microelectronic components with minimal human intervention to minimize skill requirements and training demand for crews. Materials used in the assembly of electronic systems (e.g. solders, fluxes, conformal coatings) must be compatible with the available repair methods and the spacecraft environment.

Manufacturing of replacement parts for structural and mechanical applications will require additive manufacturing systems that can generate near-net-shape parts from the range of engineering alloys employed in the spacecraft structure and in the parts utilized in other surface systems. These additive manufacturing processes will need to be supported by real-time non-destructive evaluation during layer-additive processing for on-the-fly quality control. This will provide capabilities for quality control and may serve as an input for closed-loop process control. Additionally, non-destructive methods should be available for material property determination. These nondestructive evaluation processes should be incorporated with the additive manufacturing process - providing an in-process capability to ensure that material deposited during layer-additive processing meets required material property criteria.

Subtractive manufacturing processes will be required to complement the additive manufacturing process to transform the near-net-shape part into a finished part that meets dimensional and surface finish requirements. Ideally, the subtractive processing capabilities will be incorporated with the additive processing system to eliminate transfer of parts from one system to another. Compact, multi-axis machining systems to accomplish this should be of the minimum mass and volume possible.

Technologies are also needed for prevention, detection, and mitigation of corrosion (i.e. the deterioration of materials due to reactions with their environment) in spaceport facilities and ground support equipment. Tools are needed for the evaluation and detection of hidden corrosion, including a system to detect corrosion under paint on either side of the structure without requiring removal of any components or thermal protection system elements covering the structure. Improved corrosion control coatings are needed that require minimal repair.

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