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In-Space Rapid Manufacturing

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MSFC Rapid Prototyping

RP Process	Build Technique	Build Materials
Laminated Object Manufacturing (LOM)	Materials are Sheet-Fed and Automatically Laminated Together	Paper (wood), Plastic *Composite
JP-System 5	Sheet-fed Manual Stack	Paper
Stereolithography	Laser-cured Resin	Epoxy 5170
Selective Laser Sintering	Laser-sintered powders	polycarbonate, sand, nylon, rubber, wax
3D Printing	Ink-jet technology	wax
Fused Deposition Modeling (FDM)	Melt Extrusion, or "Hot Glue Gun" Technology	wax, ABS plastic, *Ceramics, *Metals

* Under Development

In-Space Mfg. Objectives

- Develop and demonstrate capability to directly fabricate components in space using rapid prototyping technology
 - Ceramics (Alumina, Silicon Nitride, Zirconia)
 - Metallics (Stainless, Inconel, etc.)
 - High strength/temperature plastics (PEEK)
 - ABS Plastic (Starting Point)
- Perform materials science experiments on rapid prototyping candidate materials in microgravity.

Applications/ Advantages

- Space Station:
 - Reduce spares inventory (part CAD files stored on disk)
 - Replace broken parts on demand
- Build variations of designs for other on-board experiments.
- Determine the effects of microgravity on materials properties and rapid prototyping manufacturing methodologies.

Approach

- The FDM and LOM systems exhibit the best capability for operation in microgravity.
- Purchase FDM 1600 (\$35K) and modify for flight.
- MSFC and JSC work jointly to modify FDM apparatus, and apply for KC-135 flight tests to prove concept with ABS material. Next goal is to fly on STS.
- Current materials development through MSFC and SBIR/STTR contracts include ceramics & metallics using FDM and LOM, which will lead to installation of rapid prototyping system(s) on Space Station.

Summary

- In-space manufacturing using FDM or LOM rapid prototyping technology offers significant benefits/research opportunities for Space Station and future exploration initiatives.
- MSFC, as the agency leader in rapid prototyping technology, should extend this leadership role to in-space manufacturing.
- Request support/approval to solidify roles and responsibilities with JSC, finalize plans, and proceed with equipment procurement.