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# ADDITIVE BIOMANUFACTURING FOR SCALABLE CONSTRUCTION IN SPACE

**Abstract**

NASA's Technology Roadmap calls for "innovative physical manufacturing processes to combine the 'digital thread' that integrates modern design and manufacturing". A technology demonstration by Made in Space, Inc, proved the reliability of 3D printing in low Earth orbit. The geometric tolerance and mechanical performance of parts 3D printed in the International Space Station Additive Manufacturing Facility are comparable to Earth standards. This foundation of method efficacy substantiates extending the set of materials 3D printed in space to include multi-functional options, such as living cells. The reason to use biology in an additive manufacturing paradigm is scalability, the ability to in perpetuity make many large parts without depleting material stockpiles. This is a risk mitigation strategy. Conventional, non-biological options such as plastic, metal, or ceramics, bottleneck the maximum construction volume based on quantities sent from Earth. A biological feedstock potentiates spontaneous resupply, as biology grows, self-replenishes will appropriate care. This increases the speed of an iterative design cycle, a fail fast then pivot strategy to build in an isolated environments. Our objective is a technology demonstration to test the utility of proposed additive biomanufacturing method in constructing a functional, replacement part for the ISS water treatment system. Specifically, to 3D print a living filter made of viable sea sponge cells, then test the filter's capacity to remove toxins. The methodology defines four tasks: (1) Characterize the essential attributes that make the sea sponge of interest to NASA, those being filtration and self-regeneration. (2) Computer Aided Design (CAD) of the filter by optimizing high surface area to volume ratios. (3) Computer Aided Manufacturing (CAM) to prototyping the cell-laden filter using the CAD model. This bioprinting method was translated from successful tissue engineering technique to layer-by-layer build models of human tissue. (4) Test the filtration capability of the prototyped living filter. Results show concept development, but great potential in combining this effort with a bimoinig approach. Alternatively, cells known to be robust in lab and in space would be genetically reprogrammed to absorb toxins and pollutants. Those genetically engineered cells would be used in place of more sensitive sponge cells. This combined biomining-3D printing technique offers great promise to provide a functional, stable living filter, even more, a scalable additive bio-manufacturing paradigm for space.