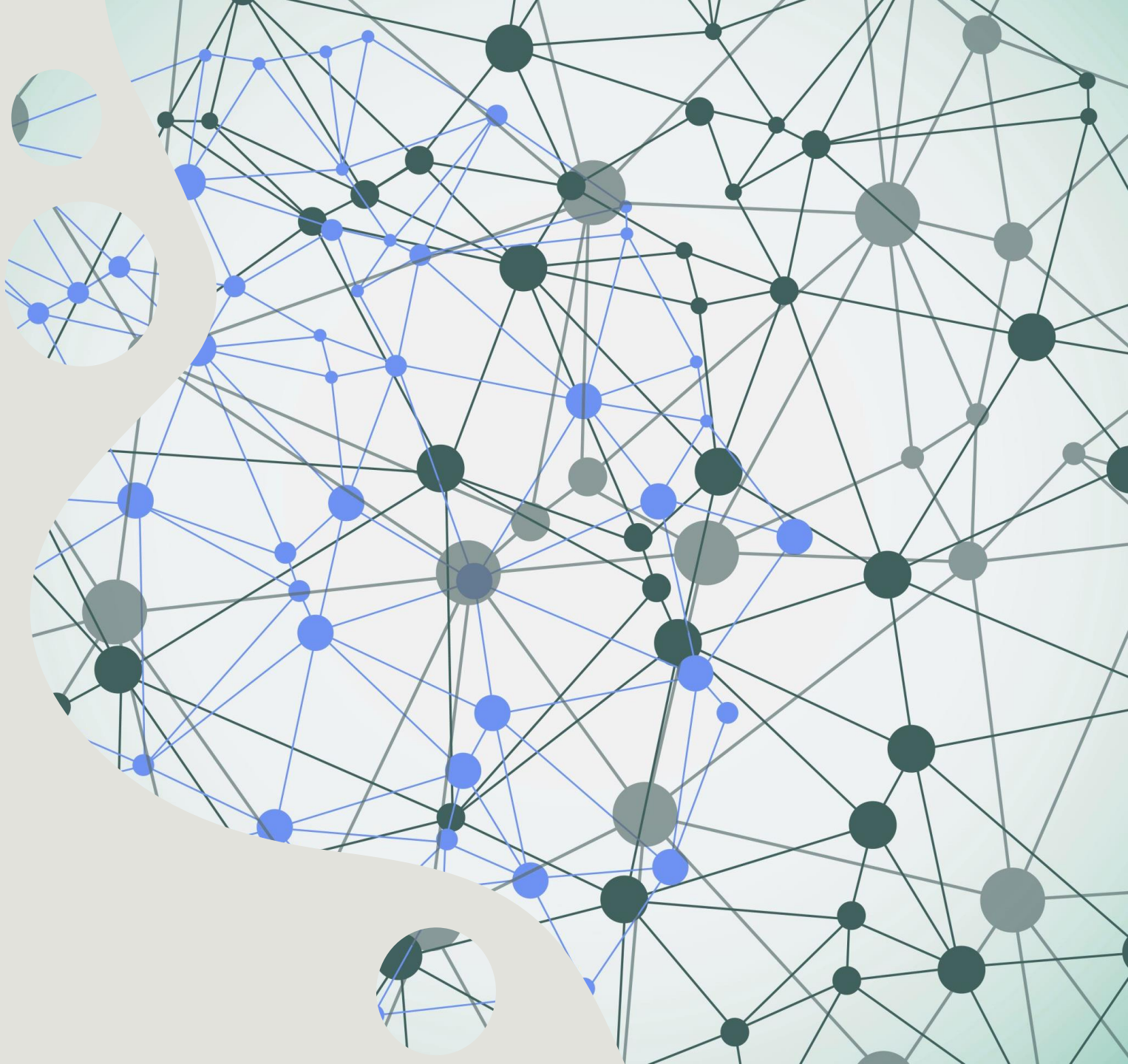
Research Thrust-1: Additively Manufactured Systems for Space Applications

Sub-project-3: 3D Printing Space Hardware using Thermoset Resins



Statement of R&D Problem

Heat shields that protect spacecraft from the heat of entering a planet's atmosphere are labor intensive to manufacture, cost prohibitive and the heat shield design is constrained by the manufacturing process. NASA has a need to significantly improve the manufacturing processes of Thermal Protection Systems (TPS) used on human-rated spacecraft and robotic missions with the intention of reducing cost and improving quality and system performance. The fabrication and installation of current TPS are labor intensive, cost prohibitive, and result in many seams between the segments. Future human missions to Mars will require the landing of large-mass payloads on the surface, and these large entry vehicles will require large areas of TPS to protect the structure.

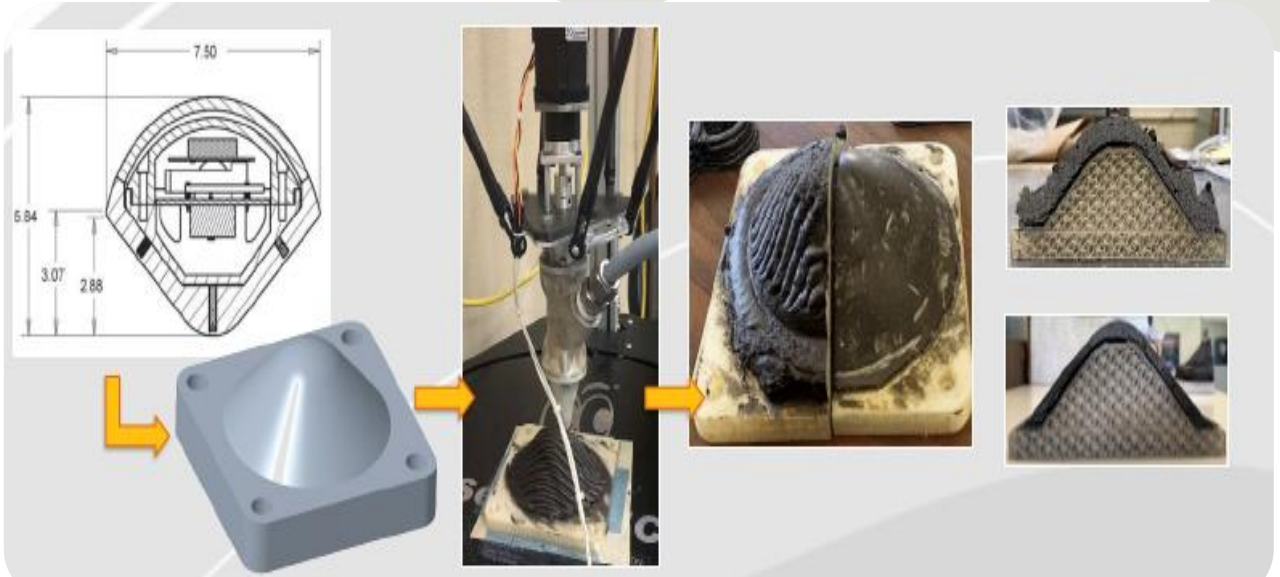
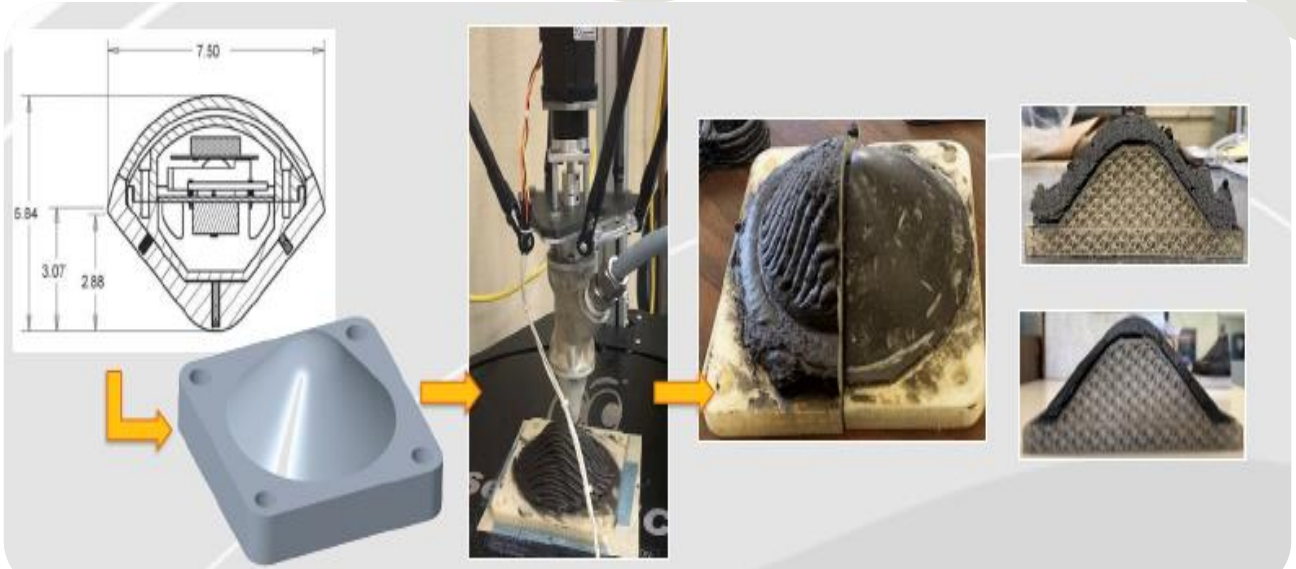


Figure 4. 3D printed resin based TPS prototype

Statement of R&D Problem

A sustained lunar presence will require the development of lunar-return vehicles, which will also need TPS. In order to reduce the cost and complexity of these vehicles, new TPS materials and compatible additive manufacturing (AM) techniques are needed such that both spacecraft TPS and structures can be manufactured with automated systems. Furthermore, a future capability to use AM to fabricate and repair TPS in space will be needed. Highly filled thermoset resin mixtures are a class of materials that can be used to produce thermal protection for spacecraft or other spacecraft components. Some preliminary study has proven the feasibility of additively manufactured TPS using thermoset resin as shown in Fig 4. While this technique has shown promising future in manufacturing light weight yet cost and functional effective TPS, there are still many technical gaps that need more research investigation.



3D printed resin based TPS prototype