Shape Morphing Adaptive Radiator Technology (SMART) for Variable Heat Rejection

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OVERVIEW
The proposed technology leverages the temperature dependent phase change of shape memory alloys (SMAs) to drive the shape of a flexible radiator panel. The opening/closing of the radiator panel, as a function of temperature, passively adapts the radiator’s rate of heat rejection in response to a vehicle’s needs.

INNOVATION
This technology would enable active thermal control systems (ATCS) of manned vehicles to meet the Evolvable Mars Campaign’s target for 12:1 heat rejection turndown ratio with a single loop ATCS. This project focused on developing a morphing radiator panel optimized to balance its competing requirements of thermal conductivity, flexibility, and stiffness.

OUTCOME
• Analysis and testing indicated that it is possible to create a morphing radiator with both flexible and thermally conductive carbon laminate panels.
• Demonstrated SMA - driven panel actuation in a laboratory and thermal vacuum environment. 8/2016
• Fatigue testing verified panel design can actuate 100 cycles in ambient conditions without failure. 10/2016

INFUSION SPACE
• Conduct thermal and structural testing to verify multi-panel prototype radiator’s design integratory. AES or STMD sponsored thermal vacuum testing can evaluate the radiator’s response to transient heat loads expected by a mars transit vehicle.
• A flight demo on an ISS express pallet can demonstrate operation in a space environment.

PAPERS
The following papers will be presented at the 2017 AIAA Science and Technology Forum and Exposition:
1) Design and Fabrication of a Composite Morphing Radiator Panel Using High Conductivity Fibers
2) Experimental Characterization of a Composite Morphing Radiator Prototype in a Relevant Thermal Environment

FUTURE WORK
This work will continue as a FY17 center level IRAD project with our current collaborators. Development will focus on creating a practical radiator design that will incorporate both the SMAs and radiator tube in a higher fidelity panel design. Custom SMA development will also be conducted at NASA GRC, addressing the current need to actuate the radiator at temperatures required for future manned spacecraft.