Space Technology Mission Directorate (STMD)

Project Title: Deployable Composite Structures

Contract/Grant Number: NNX11CH11P

Program: SBIR

Managing Center/Institution: LaRC / Composite Technology Development, Inc.

Start/End Dates: 2/11 – 9/11

Phase I Project Summary

Firm: Composite Technology Development, Inc.
Contract Number: NNX11CH11P
Project Title: Deployable Composite Structures

Identification and Significance of Innovation: (Limit 200 words or 2,000 characters whichever is less)
NASA is seeking innovative structure technologies that will advance expandable space modules and surface based habitats. In response, CTD has created a new class of deployable structures referred to as Composite Rollable Extendible Slit-Tube Structures, or CRESTS. CRESTS are secondary structures that are designed to be easy-to-install and serve as room dividers, storage space and equipment rack mounting sites, and cable routings, thereby greatly increasing the utility of the primary pressurized volumes. CRESTS are stowed by rolling slit-tube beams, lateral support battens, and floor or wall surfaces into a single compact tube. The lightweight graphite composite structures can be configured as room dividers or as load bearing floors, making them appropriate for expandable modules for orbital habitats or surface exploration. In addition, CRESTS have been designed for linearly expanding modules or for toroidal inflatable orbital habitats.

Technical Objectives and Work Plan: (Limit 200 words or 2,000 characters whichever is less)
The objective of this technology is to increase the utility of inflatable habitats by creating secondary frameworks that can support interior partitions, storage space, and mounting points for equipment, cabling, and fluid lines. Inflatable structures provide a lightweight and compact means to create large living volumes for space explorations either on planetary surfaces or in orbit, but the very nature of the inflatable structures means that when inflated they are essentially empty.
Like any system launched into orbit, secondary structures for inflatable habitats must be lightweight and stow compactly. Assembly labor for any space mission is also highly constrained, therefore the structures must be simple and quick to install. In order to get the highest utility from the available mass, these structures must perform all the required functions. In other words, they must be simple, self-deploying structures that serve simultaneously as room dividers, hardware mounting points, cable routing locations and storage. In Phase I, CTD demonstrated innovative deployable composite structures that have minimal mass, have high packaging efficiencies, and multi-functional utilization for expandable exploration space modules and surface based habitats.
The Phase I was accomplished with five tasks: Requirements Definition, Conceptual Design, Fabricate Prototype Structure, Prototype Demonstration and Program Management.

Technical Accomplishments: (Limit 200 words or 2,000 characters whichever is less)
The circular deployable structure was conceived during the Phase 1 program to provide a secondary structure for toroidal inflatable habitats. A detailed conceptual design was developed for the structure. A conceptual study of the room dividers, rack mounting locations, and cable routings that could be added to the toroidal inflatable volume by using this structure was also completed. Structural analysis of the circular structure established beam sizing of the circular structure and loads on the inflatable structure. Feasibility of the conceptual design was established by fabricating and testing sub-scale prototypes. These prototypes included the first

structure that could curve when it is unrolled from a conical mandrel and a full thickness beam structure capable of carrying the required kick loads. At the end of the Phase 1 effort, the circular deployable structure was advanced from TRL 1 to TRL 3.

NASA Application(s): (Limit 100 words or 1,000 characters whichever is less)
The intent of this technology development is to provide NASA with a means for enhancing the utility of inflatable habitats for future space exploration. The first direction that extended space exploration will take us is still undefined, but it is becoming more evident that expandable structures can greatly increase the crew living environment where ever we go. CTD will be ready and is advancing the technology TRL of secondary structures appropriate for expandable habitats for both surface and zero-g exploration. With the goals set by NASA to support the manned exploration of other planets, the development of innovative structure technologies that will advance expandable exploration space modules and surface based habitats is a necessity. The proposed deployable technology will make significant progress toward this end by providing a low-cost, mass-minimized deployable structure that can be used to maximize operational volume and structural performance of a crewed or material transfer pressure vessel.

Non-NASA Commercial Application(s): (Limit 200 words or 2,000 characters whichever is less)
The most immediate Non-NASA application for this technology is to work with companies developing low earth orbit commercial habitats and help advance their product lines. Full-scale demonstrations of working hardware that will greatly increase the utility of their type of habitat will be essential to attract commercial investment. This technology is protected by patent and by unique materials and engineering for extremely thin composites, making collaboration efforts the best possibility for product advancement. However, licensing of technology can also be considered to allow commercial entities to have a higher degree of design control.

In addition, all forward progress with stiffer laminates, more complex geometries, integration techniques and deployment methodologies are applicable across all of CTD's rolled structure programs. CTD has taken rolled space solar arrays and modified them for quick-setup terrestrial arrays and man-portable bridges.

Name and Address of Principal Investigator: (Name, Organization, Street, City, State, Zip)
Dr. Robert Taylor, Composite Technology Development, Inc., 2600 Campus Drive, Suite D, Lafayette, CO, 80026

Name and Address of Offeror: (Firm, Street, City, State, Zip)
Composite Technology Development, Inc., 2600 Campus Drive, Suite D, Lafayette, CO, 80026