



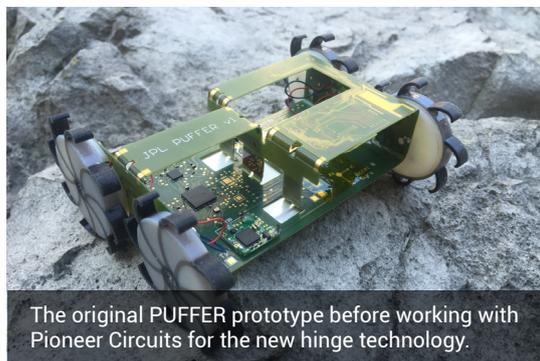
# PUFFER COLLAPSIBLE ROBOT CASE STUDY

## PIONEER CIRCUITS' JOINT PATENT ON A NEW MICRO-ROVER

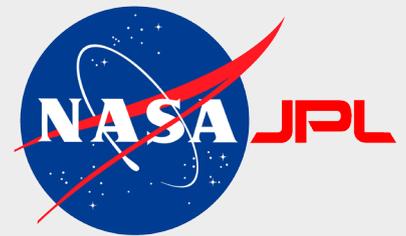
### CHALLENGE

The PUFFER's (Pop-Up Flat Folding Explorer Robot) concept addresses the challenge of developing robotic mobility in space exploration. The PUFFER challenge was to design a micro-rover capable of surviving the harsh environments of deep space while also being able to collapse and fold into more compact forms that will fit into small areas for detailed photographs and surface analysis.

The original PUFFER prototypes were having issues with passing its cycle and drop test operations. Design challenges included the mechanical design of the rigid-flex PCB joints to be able to work on a repeatedly folding robot structure, and for the lifetime of the PCB's copper traces to pass over repeated cycles. The original materials used for the joints were not compatible with current PCB manufacturing processes, and the PUFFER was only able to withstand 1000 test cycles, a very conservative number for a Mars application.



The original PUFFER prototype before working with Pioneer Circuits for the new hinge technology.



"Pioneer Circuits, Inc. has been a tremendously valuable partner on JPL's PUFFER rover project. [Pioneer Circuits] has provided the JPL PUFFER team with many key insights into the design of folding rigid-flex printed circuit boards... and worked enthusiastically with the JPL PUFFER team to develop novel rigid-flex PCB constructions to better address the unique requirements of the PUFFER project."

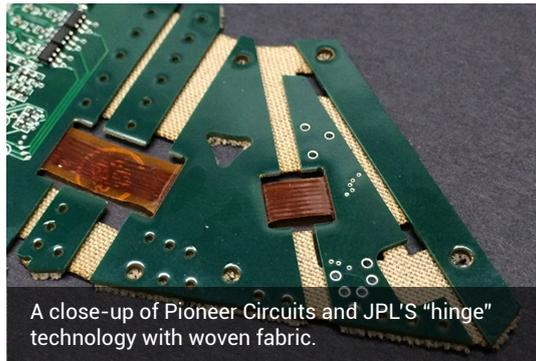
- JAAKKO KARRAS

JPL'S PUFFER PROJECT MANAGER

## SOLUTION

Pioneer Circuits, through concurrent engineering, set the parameters for the materials that would be selected, and helped to develop a high-temperature woven fabric "hinge" technology that is compatible with PCB rigid-flex manufacturing. The rigid-flex circuit technology is integrated into a highly reliable, composite structure that is the first origami micro-rover configuration ever developed.

To make the technology possible, Pioneer Circuits developed new bonding and process capabilities that would be compatible with this unique challenge. Integration of the high-temperature woven material as a layer in the PCB stack up allowed the mechanical and electrical functions to overcome limitations of typical polyimide builds. Using the material as a hinge would make the PUFFER more reliable and able to repeatedly collapse without damaging the copper traces. The new PUFFER design with Pioneer Circuits' help was capable of withstanding drop-testing that simulated the harsh space body environments, and was able to withstand over 5000 cycle tests, 500% more than the original designs.

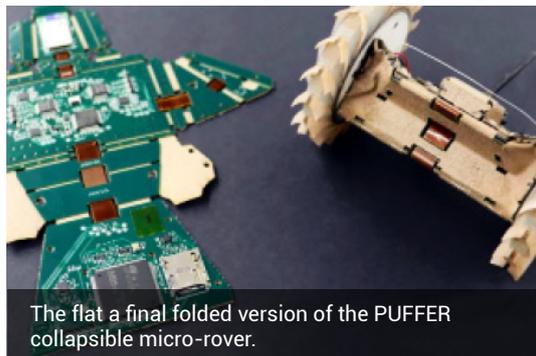


## IMPACT

Pioneer Circuits' work with JPL on the PUFFER developed multiple new technologies that are now being patented. Pioneer Circuits is joint on one of these patents.

The PUFFER micro-rover will now be able to ride on board with future space missions for thorough surface analysis.

The collapsing capability allows the PUFFER's microscope camera to focus for microanalysis. This "Game Changing" development will give NASA and JPL a cost-effective opportunity to explore the surfaces of space that were never before reached.



### INSIDE LOOK

The PUFFER technology was showcased at NASA's Science Day on Capitol Hill to members of Congress. In the image above, Kalind Carpenter (far left) and Jaakko Karras (far right,) both worked with Pioneer Circuits to create the PUFFER.

### TECHNOLOGY USED

The PUFFER micro-rover utilizes a new, patented "hinge" technology containing a high temperature woven fabric that is compatible with PCB rigid-flex manufacturing.

### ABOUT THE PUFFER

The PUFFER collapsible micro-rover is a part of NASA's "Game Changing Development Program." It is designed to be a compact rover that rides on board with future space vehicles to land on space bodies such as planets and asteroids for photographs and microanalysis.

### CONTACT US

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