



## **Alliance Spacesystems' Robotic Arm Still Doing the Heavy Lifting for NASA's Mars Phoenix Lander**

**Now working beyond its retirement date, the California-built robotic arm provides the muscle to keep Phoenix mission going.**

PASADENA, CA (Oct. 16, 2008) Mars' Arctic is looking a little more like Muscle Beach as a fit senior named Phoenix continues to flex its mechanical arm, digging into the Martian surface on a mission for NASA.

"Every joint is working beautifully. Every component so far has been flawless," said Lucy Abajian, project manager of the Phoenix robotic arm at Alliance Spacesystems, <http://www.alliancespacesystems.com>, where the arm was designed, fabricated and built for NASA's Jet Propulsion Laboratory.

The arm and its backhoe-like scoop has dug trenches, lifted samples and delivered them for intensive study by instruments onboard. It has even moved a rock – a task it was not originally designed to do – to allow scientists to get at the soil underneath. Even though the arm continues to work beyond its three-month design lifetime, "there's no sign of wear or degradation," Abajian said.

Alliance Spacesystems has provided all the robotic arms that have become such a high-profile part of Mars missions in recent years. The company is providing the robotic arm for NASA's next Mars rover -- the Mars Science Laboratory, set for launch in 2009.

Regardless of how well all systems are operating, the sun will eventually set on the solar-powered lander as winter darkness closes in on the North Pole of Mars. Mission managers expect the end to come within weeks as power diminishes. Abajian, however, views the lander's waning days or weeks as an opportunity to learn how the robotic arm systems hold up to the demands of the extended operation.

### **What's Going to Wear Out First?**

"Of course I don't want to see the arm go down, but there's a greater good to come from watching things wear themselves out," said Abajian. An extreme example is the slow degradation of the Alliance-built robotic arms on Mars rovers Spirit and Opportunity, now years beyond their design lifetimes. They have provided lessons for the design of other robotic systems made by the company. "What's going to wear out first? It will help us with future missions because we'll know what to look out for."

The cold, dusty and windy environment of Mars can wreak havoc on lander and rover systems, particularly those with moving parts like a robotic arm. Temperatures can reach Earthlike highs at the surface during the day, then dip below -70 degrees Celsius (-94 degrees F) or colder. Martian dust is abrasive and tends to stick to spacecraft surfaces. “And if something goes wrong, you can’t go fix it,” said Abajian.

“As you trench deeper into the soil, it gets colder, so the joints and actuators at the end of the arm are colder than those at the surface. Different materials expand and contract at different rates, and they can actually pry each other apart.” To mitigate those problems Alliance Spacesystems engineers used the same materials in the structure, mostly aluminum, as much as possible. “We had to use steel and titanium in certain areas of the arm. Areas transitioning between two metals are where we had to be especially careful.”

### **Keeping it Clean**

“Dust is definitely a concern, and we were concerned about relying on any type of seal that could wear out in the Mars environment,” said Abajian. “We had to come up with ways to build the arm to allow parts to move but at the same time not allow dust into the mechanisms.” Labyrinth-like openings keep out big particles, and spring-loaded Teflon seals protect against fine particles. Some dust may enter but not far enough into the system to grind away at parts.

Flex cabling runs the length of the arm and allows secure electrical connections while the arm moves. Engineers designed it so that at each joint it coils and uncoils like a clockspring, allowing movement while keeping the cabling secure.

The team benefited from Alliance Spacesystem’s heritage in robotic systems design for earlier landers and rovers. Alliance designs for previous missions were hybridized, optimized for Phoenix’s unique loads, tasks and spacecraft geometry, and subjected to extensive engineering analysis. Now, knowledge from the Phoenix experience is being applied to the Mars Science Laboratory arm.

### **“Not Just Another Engineering Task”**

Abajian, a 2002 aerospace engineering graduate of UCLA, started at Alliance Spacesystems as a college intern, and quickly worked her way up to project management.

Working on Mars hardware at Alliance, she said, “is definitely not just another engineering task. Mars is great. It’s just warm enough and just close enough to explore.” Building mechanisms like the Mars Phoenix arm is one step on a long journey of discovery, she said. “To me there’s a bigger purpose behind it. We’re learning about Earth and our history.”

Alliance Spacesystems, LLC, an MDA company, provides customers with world-class aerospace engineering expertise in a small, customer-focused business environment. In addition to robotic arms, the company is a leading provider of mechanical systems engineering, custom design and fabrication in composites structures, robotics and

mechanisms, and mechanical analyses for systems operating in extreme environments. Alliance Spacesystems' innovative products are in use on interplanetary spacecraft, telecommunications and scientific satellites and in many challenging terrestrial applications.

NASA Phoenix images and video are available here:

[http://www.nasa.gov/mission\\_pages/phoenix/images/index.html](http://www.nasa.gov/mission_pages/phoenix/images/index.html)

Alliance Spacesystem images accompanying this release are available here:

[http://www.alliancespacesystems.com/images/stories/for\\_media/hires\\_images/Phoenix\\_RA\\_01\\_HI.jpg](http://www.alliancespacesystems.com/images/stories/for_media/hires_images/Phoenix_RA_01_HI.jpg)

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