Ultrasound Aboard the International Space Station

An interview with Victor Reddick *R.T., RDMS, RDCS*

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On March 8, 2001, NASA's Space Shuttle Discovery lifted off from Kennedy Space Center carrying a special payload—a modified Philips/ATL HDI 5000 Ultrasound System—destined for the International Space Station's Human Research Facility, where it will used for experiments and to monitor the astronauts' health over ten years. The ISS is the largest and most complex international scientific project in history. Led by the United States, the project will draw upon the scientific and technological resources of 16 nations, including Canada, Japan, Russia, 11 nations of the European Space Agency and Brazil.

We asked Victor Reddick, senior vice president of Global Marketing, Sales and Service of ATL Ultrasound (A Philips Medical Systems Company) to share his thoughts on this visionary project and its implications for medical imaging and ultrasound.

Q. This is an exciting time for you and for medicine in general.

A. Yes, we have been working on this project for more than five years, and it was incredibly exciting to know that our ultrasound system was part of the Discovery payload in what turned out to be a flawless liftoff on a beautiful morning. This is quite a milestone for ultrasound and medical imaging in general.

Q. What is the purpose of having imaging equipment in the International Space Station?

A. There are two reasons. First, the stakes are very high if an astronaut becomes ill or injured onboard the space station, so NASA wanted to make sure that they had highly functional diagnostic tools onboard should an incident or emergency occur. Second, and more far reaching for medicine and ultrasound in general, there are a number of ultrasound research studies planned to take advantage of the weightless environment inside the space station's laboratory.

Q. What kinds of experiments, and what does NASA hope to achieve?

A. Right now, NASA is considering three long-term experiments using ultrasound which include measuring cardiac output, evaluating muscle changes in microgravity by looking at fiber length and muscle thickness, and a cardiac study in which scientists would acquire as much diagnostic information as possible using standard echocardiography techniques.

Q. Why ultrasound?

A. Of course there are size and weight considerations, but more importantly, ultrasound is extremely versatile and provides a great deal of diagnostic information, and in real time. The utility of ultrasound in being able to look at everything from vascular flow to actual tissue to making precise measurements of muscle mass is important in determining how long an astronaut should remain in space. What happens with cardiac muscle and those of the lower extremities, for instance, will be important in determining how the human body can endure extended space flight, such as in a mission to Mars.

Q. How has ATL helped NASA to learn about ultrasound and how to use it?

A. We have, and have had for some time, clinical application teams on site at the Johnson Space Center in Houston training the astronauts. We are providing extensive training, but obviously the astronauts don't have time to become full-fledged sonographers, per se. However, the equipment settings are specialized with tissue-specific imaging setup techniques which make the equipment setup for a specific examination relatively easy. The astronauts will also get a good deal of direction while scanning–in real time–from physicians on the ground, so this combination should make the process highly productive.

Q. We've heard that there had to be substantial re-engineering on the system to get it to fit onboard the space station.

A. You wouldn't recognize the system at all if you were to walk, or float, through the Human Research Facility on the ISS! Our engineers teamed up with those from Lockheed Martin to work through a number of very complex engineering issues. They came up with a great plan for Lockheed Martin on how to reduce the system's size and weight by about 60 percent, and to ready it for some unusual conditions. Special shielding had to be developed to prevent galactic rays from compromising the electronics, for instance. They also had to figure out a way to cool the system with customized fans since in microgravity there is no convection to dissipate heat. It was quite a project, and it took a lot of combined brainpower to pull it off.

Q. What does this mean for ultrasound's status or, if you will, "image"?

A. As this information enters the public domain, I expect that this will help to raise awareness and further educate the scientific and lay communities alike that ultrasound has many more very important applications beyond OB/Gyn that are performed routinely now all over the world.

The fact that ultrasound was selected for this facility is also validation of the modality's importance and usefulness in medicine. All of the benefits we enjoy here–the ease-of-use, compactness, utility, and the importance of real-time images–were critical factors in the decision to include ultrasound onboard the ISS. Ultrasound continues to be one of the most rapidly growing areas in diagnostic medicine in terms of significant advancement in its technology and utility. I don't see that changing in the next ten years.

Q. How will ATL and NASA keep this system in good working condition?

A. As service calls are not an option, NASA will use a modified version of our remote system access technology that we use for our installed base around the world. On Earth, we use dial up technologies that directly connect with our customers' ultrasound systems to allow our technicians to check on system status, remotely diagnose and repair it, and provide system upgrades.

Several years ago, NASA adapted this technology and customized it for its own protocols, and they will communicate with the modified system through satellite link to and from the Johnson Space Center. Having this capability–well developed, mature and working in the field–was an important factor in

The HDI 5000, aboard the International Space Station.

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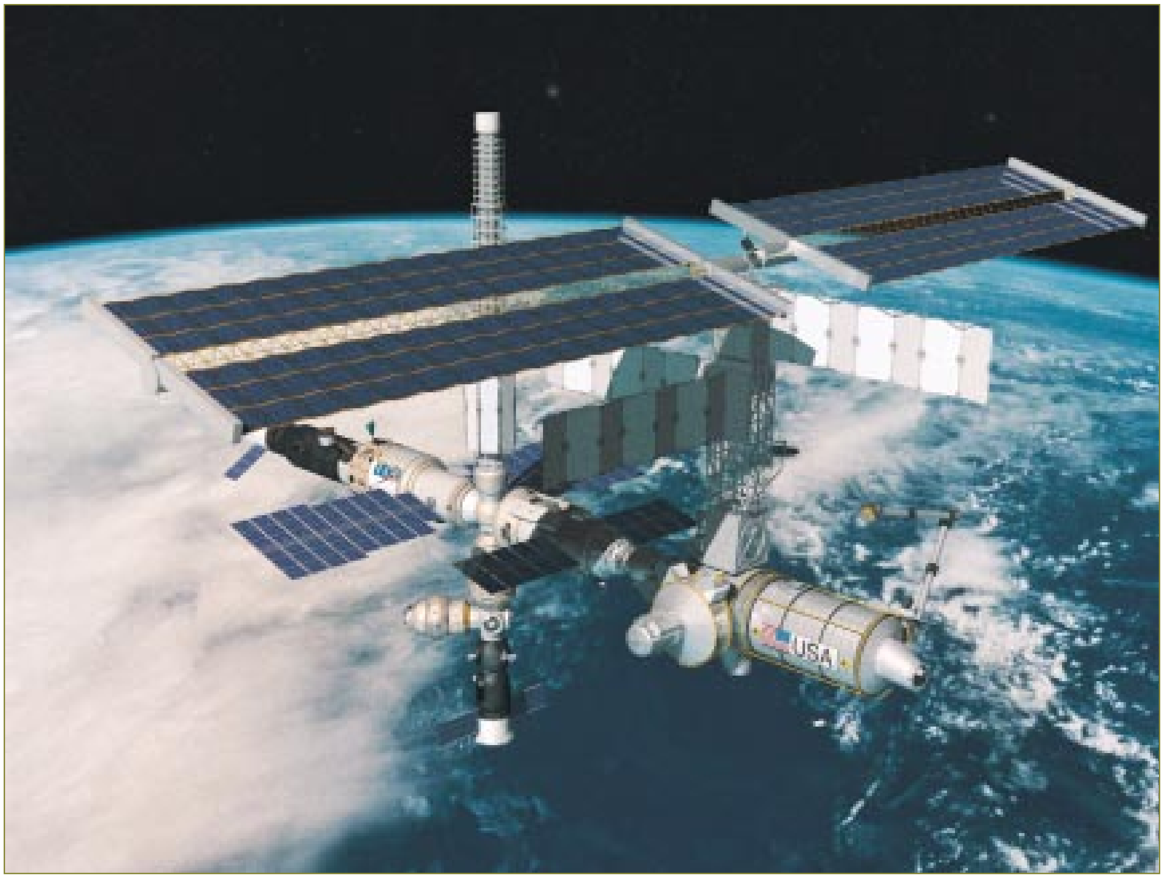
selecting whose system would be used aboard the ISS.

Q. What are some of the immediate "spin off" benefits for radiology professionals?

A. We've already touched on telemedicine applications. Clearly, using remote system diagnostics reduces downtime, which, as any radiology professional knows, is very costly on many levels. I expect that we should be able to learn more about how to improve remote system diagnostics through this experience.

Another major spin off is making more advances in the miniaturization of ultrasound systems. As we touched on earlier, in order for the HDI 5000 system to meet



the weight requirements for shuttle liftoff and size requirements for the Human Research Facility, NASA and Lockheed Martin had to trim the overall weight and size specifications of the system by roughly 60 percent. And, of course, the goal was to do so without losing any functionality or compromising image quality. What we've learned from this complex reengineering will certainly help in making more advances in product development. The ultrasound industry as a group has continuously pushed the envelope and is steadily developing smaller and more mobile systems. As we look at trends in the industry, it's not hard to imagine that ten years from now we may see handheld units that provide the kind of quality we see in today's most advanced systems. Clearly this could enhance the utility and ease of use of ultrasound.

Q. You touched on quick set up times in an earlier comment. Do you envision further system automation?

A. That is a very good question. This particular project has helped us to think of ways to make operating the ultrasound system easier for the astronauts, perhaps even more consciously than we would have before. This has stimulated a lot of discussion about getting even more creative about automation. For this project we did a lot of ergonomic work around making the control panel flexible and easy to use. This got us thinking, Why do we even need a control panel? Why not just put on some glasses and operate the system through voice commands using sophisticated speech recognition technology?

This project may accelerate the desire to automate such functions. Industry wide, there is a push to move toward greater automation in ultrasound. There is a great deal of talent in our company putting their minds to work on making things better.

Q. So this NASA project might have tangible benefits for our audience.

A. Without a doubt. What we are learning will certainly be applied to product development. The idea is to make the modality, and ultimately the end user, more efficient and productive from both a patient care and an economic standpoint.