THOMAS WYSMULLER

What NASA Has Done and Where NASA Is Going

This is the edited transcript of an address by Thomas Wysmuller to the Schiller Institute conference in Morristown, N.J. on Feb. 16, 2019. Mr. Wysmuller chaired the Oceanographic Section of the 2016 World Congress on Oceans held in Qingdao, China, and is a founding member of The Right Climate Stuff group, composed of "retired and highly experienced engineers and scientists from the Apollo, Skylab, Space Shuttle and International Space Station eras."


EIRNS/Stuart Lewis
Thomas Wysmuller

Let me start by letting you know that Kesha Rogers says what she means, and she means what she says. We've been involved with Kesha down in Houston at a number of presentations that she's organized; she's been invited to the NASA TRCS [The Right Climate Stuff] group. She is a firm believer in the continuity of the space program, and I applaud your efforts in that, Kesha. [applause]

NASA's Contributions Benefit the World

Sixty years and we're back on track and getting better. Most of you don't even know that we're back on track, but we really are. We've had almost a moratorium on space development over the last number of years. I'm going to talk about what we have done; how NASA has benefitted not just America, but the world. Then I'm going to talk about where we're going to be going.

We've had advances in aeronautics and spacecraft design, chemistry, clothing, electronics, exploration, medicine, physics, and maybe most important, technology management. Because that's where NASA really excelled. Let's look at some of these things.

Aeronautics & Spacecraft Design. We have safer aircraft because of NASA research on wind shear sensing. The pilot now has information that ahead of the plane there is wind shear; this was developed by the agency. Non-Destructive Testing (NDT) is used for aircraft soundness, engine parts, so you don't have to break a piece of metal to find out when it's going to break. You don't have to take apart a plane. That saves an awful lot of money.

Human Factors Training (HFT) is how people behave in the cockpit in emergencies. That has been credited with saving a number of aircraft in emergency situations. NASA developed that technique. We've also pioneered research in lightning effects; not just planes getting hit by lightning, but the effects of lightning on ground controls, and radars. We've been able to harden airports so that they don't get affected by lightning strikes. Spacecraft hatch door fixes—most of you know about the tragic fire that was on the pad where the astronauts couldn't get out of one of the earlier Apollo flights. One of the Apollo flights landed in the ocean, and the astronaut couldn't get out; we had to change that. Now we have easy egress in emergencies.

Heat shield systems we've improved. The International Space Station [ISS] structural integrity—The station, by the way, has components and modules that were developed in a number of countries. Canada has one, Japan has one, the European Space Agency has one. We've been able to put them together and manage so that the ISS is structurally sound; it's been flying for a number of years. Hundreds of astronauts have visited it.

Chemistry. How about chemistry? Most of you are aware of plastic wraps and space foods and things like that. Carbon fiber materials were also developed by NASA. They're lightweight and good for building things in space. NASA has made advancements in metallurgy, particularly powder metallurgy, coating. Jet planes could not fly as well as they do, without the powder metallurgy that makes turbine blades harder and less subject to heat strain.

Battery development and fuel cell development have been important. Fuel cells are important in even thinking about building a lunar outpost. Propulsion maneuvering for spacecraft—sometimes jets get stuck. In fact, Neil Armstrong was selected as the first person to land on the Moon because he had saved a prior mission—the spacecraft was out of control with an open fuel jet that was stuck, and the spacecraft was rotating at almost 1 rpm per second! He managed to save the mission and his life and astronaut Charles Duke's life, too.

Look at environmental chemistry. All kinds of issues exist in space that astronauts have to be aware of. We have detectors on satellites that see what's going on, on the planet. We've made major milestones in understanding our planet from space.

Most of you are probably wearing some clothing that was improved by NASA, particularly hi-tech fabrics (advanced composites). The integration of synthetic and natural fibers, fireproof garments. Every firefighter in the country now wears material that was developed by NASA, here on Earth, such as lightweight insulation, fastenings—not just Velcro, but other fastening systems; space suit technologies spin-offs are all over the place. Bullet-proof outerwear—police departments all over the world have them; soldiers have them.

Electronics. One of the problems we had in early space flight was that things were heavy; spacecrafts were heavy; vacuum tubes were heavy. So, transistor and microchip development.

We did not invent the transistor at NASA, but we improved it, and then we abetted it by integrated circuitry. All designed to shrink the electronics, make them lighter, and make them more effective. We have antenna development, worldwide GPS. None of that would have happened without NASA. Remote sensing—optical and electromagnetic; this is sensing things from far away, including an astronaut's bloodstream, so we could sense that and send it back to Earth to let people know these astronauts are pretty healthy. Imaging systems have been improved markedly; the earliest photographs of the landers on the Moon were pretty grainy. Now, we have tack-sharp imaging systems. Photovoltaic systems. A number of household electronics have been improved. Blenders, vacuum cleaners, all have been abetted by technology developed at NASA.

Exploration. In 1990, the Hubble Space Telescope opened up the universe. We are the only species on this planet that can conceive of a Hubble Space Telescope, send it up there, and know what we're looking at. It took us quite a while to get that going. More than 250 robotic and lander rover missions on the Moon, on Venus, on Mars. Some of them are still functioning. Remote antenna development, so we can actually get signals back and forth, and improved camera data transmission rates.

We've gotten lots of lunar and martian rocks; actually we have 14 rocks from Mars that we found *on Earth* because they matched a composition of rocks that we knew were on Mars; we found them on Antarctica. It must have been a meteor that blasted into Mars millions of years ago, as we have found martian rocks buried in the ice in Antarctica.

Multi-wavelength exploration systems have improved our surface and subsurface analysis. Interesting is Near-Earth-Orbit asteroid monitoring; we didn't have that before. We know that there was a giant asteroid that wiped out the dinosaurs, and one that hit the Chesapeake Bay 35 million years ago. We have advanced warning now; we never had that. Solar observation—the Sun is the most important thing for life on this planet; without the Sun, we're all gone. Sending satellites near the Sun, NASA has learned an awful about the Sun. We now have a satellite inside the orbit of Mercury, studying the Sun.

Medicine. You can't walk into a hospital today and not be positively affected by developments that NASA helped bring along. MRI and CAT scanning technology. Insulin and hematological pumps so you can do a heart transplant and continue the body circulation going; that was a development that was abetted by NASA. Infrared temperature sensing—you can now go into a hospital and they can sense your temperature without touching a mucus membrane; that used to be a great spreader of disease. Basically they look at the infrared signal coming off your eardrum; they don't have to touch anything that would get you sick.

Human safety (food hazard analysis) has been developed. When you have a long-term mission on the Space Station or Apollo spacecraft, food can spoil. We have learned what makes food spoil, and how to prevent it from spoiling; that's been passed on. Artificial limb design improvements—we've learned from designing the legs on robotic explorers how to better improve the legs on people who need prosthetic legs or arms.

Physics. Basic research has been abetted by NASA with space telescopes and things like that. We now know with precision where the planets are; that's what I mean by solar system metrics. Astronomy advancement has been stunning, and we're about to launch the

FIGURE 1

White House

Directly after signing Space Directive 1, President Trump accepts a toy spaceman from Jack Schmitt, the last human to walk on the Moon. Buzz Aldrin is behind Schmitt. Peggy Whitson is on the far right. Dec. 11, 2017.

Webb telescope that's going to see the universe in different wavelengths. I'm going to recommend postponement of that. Energy management. Better communication and bandwidth enhancement. Not just from Earth to space and between the planets, but here on Earth. We're able to transmit radio signals and TV signals far better than we did in the 1950s and 1960s when we first started doing the research.

Thermal research advances—aviation, aeronautical systems and safety. Your planes are safer. The "A" in NASA stands for aeronautics—National Aeronautics and Space Administration; there's a whole section of the agency that does this.

Technology Management. Here's something that NASA had started—open patents. If we had a patent that gave NASA information technology, it was an open patent; everybody could use it. It was not a secret, it was not sealed. Cost Plus Fixed Fee contracts and Cost-Plus Incentive Fee contracts—if we wanted to do something that we didn't know could be done, we would ask contractors to do the research, and we would pay them an incentive fee if they got it right. Sometimes we had no idea we could do it right. Progress reporting, program evaluation and research techniques—Kepner-Tregoe (KT) and other problem-solving systems. It was the KT system that figured out what happened to Apollo 13. That was a situation where we had no evidence whatsoever, no hard evidence to look at, and we figured out what happened.

Most important maybe is the work breakdown structure. In order to send a spacecraft to Mars, to the Moon, you have to know *every little piece of information* that has to happen. We would color-code them: green would be something that we know somewhere we could build; orange would be something that maybe we could build; red was, "Oh, this is not going to work; we have to do something to find out." We did those work breakdown structures for every launch, every Moon mission. They were stunningly competent. Why? Because when all the blocks in the work breakdown structure were filled, we knew we could make it happen; and we did.

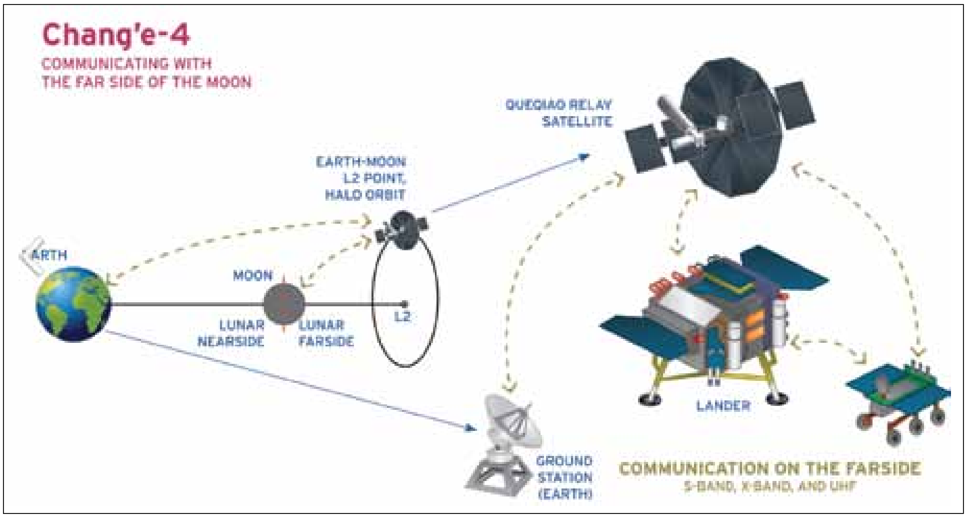
Where to, NASA?

On December 10, 2018, President Trump signed a new space policy and program directive, "White House Space Policy Directive 1," ordering NASA to go back to the Moon. So, here [**Figure 1**] you have Jack Schmidt, the last guy to walk on the Moon, giving President Trump a little spacesuit guy. Buzz Aldrin is behind him. Buzz doesn't want to go to the Moon; he wants to go to Mars. I'm going to talk about Buzz in a bit. And there's Peggy Whitmore, who has spent more time in space than anybody else: three missions, 600 days in space. We're all celebrating that directive.

We have never landed anybody or anything on the far side. But guess what? China did, and China just did that last month! [applause] Here's how they did it. They put a relay satellite behind the Moon at Lagrange Point 2 [**Figure 2**]. That's the point where, if the Moon rotates around the Earth, that point rotates around the Earth with it. So that relay satellite will always be in the same spot. (Notice it goes around in a circle.) Why? Because, from Earth, you want to be able to relay. The Chinese put that relay satellite in orbit, and then on January 3, 2019, they put down a lander and a rover.

We have a 2-minute video for you to see the landing of the Chang'e-4. You'll see the horizon slowly compress. Two billion people have seen this video, very few of them Americans. Starting out at about 10 miles up, now, Chang'e-4 is coming down. Notice the horizon is getting tighter and tighter as it comes down. Now the spacecraft is getting close. Then something strange happens: now, look where it's heading, close to a hill. If it lands on that hill, that's a little bit dangerous.

FIGURE 2



CC/The Planetary Society/Loren Roberts

So as it's coming down closer and closer to the hill, the Chinese controllers a said "Uh-uh! We're going to go somewhere else." And they could do that, through the relay satellite. If it were to land on the hill, it may tip over a little bit. Now, you'll see a zoom in on the lander. It's not going to land in a crater here; here's another hill. It's heading right toward it. Can't do that! It takes 3 seconds for the correction signal to get back from Earth, that's why there's a little bit of a delay. Now it moves slightly off that hill. It's coming down; it's landing, there's dust getting kicked up, and dust settling; and you're going to get a tack-sharp look at where Chang'e 4 landed on the lunar far side. That's worthy of applause. [applause]

FIGURE 3

CNSA

FIGURE 4

CNSA

In the background [**Figure 3**], by the way, you can see the hill that it missed. This is not the one you want to land on. Then, the Yutu-2 rover was sent out [**Figure 4**]. You can see the tracks it has made. It's doing exploration right now, taking very good pictures. Go online, google Yutu-2. They've made a beautiful panorama of the lunar far side where they landed. This is a neat achievement.

Why hasn't America done this? We basically put our space program on hold for the last eight years. We've had remote satellites, but those projects were started in the 1980s and 1990s, and they went to the outer planets.

Get NASA Going Again!

We need to get the agency going again. How are we going to do that? When we went to the Moon with Apollo, we went directly to the Moon and we landed. That was very expensive, and it required a big rocket. It was President Kennedy's achievement, and of course of the Apollo astronauts.

We need to have way stations in between; the International Space Station, depots, and space tugs. We've decided on the Lunar 'Gateway' Project. The Lunar Gateway has space tugs; they never land on Earth. They get taken into space, and shuttle back and forth between the Moon and the Gateway.

Buzz Aldrin was in that Space Directive 1 signing ceremony, because he wants to go to Mars, and Mars is part of the Lunar Gateway idea. He was very happy about it, because this is going to be a gateway to Mars, too. This is what the gateway looks like [**Figure 5**]. It's going to orbit the Moon. It's a couple of modules stuck together with some solar cells; we're going to be able to put people in there.

Jim Bridenstine, the new administrator of NASA, about two days ago was talking to industry about how we are going to use the lunar gateway; putting it out for bids. We're going to put bids out for space tugs, we're going to put bids out for landers, and rejuvenate the space program. Bridenstine wants it done very quickly. He's giving the industry until mid-March to come up with proposals. NASA's going to evaluate them,

FIGURE 5

NASA/Dennis M. Davidson

Artist's depiction of human activities on the Moon.

FIGURE 6

NASA

The Gateway Lunar Orbital Platform.

they're going to pick them, and then they're going to put together a decent program [**Figure 6**]. We want to have rovers and habitats on the Moon, people being able to walk around. People looking for helium-3, which you can take back to Earth and incorporate into fusion technology.

Buzz Aldrin has a picture of himself standing there in front of Stonehenge with a great T-shirt on that says, "Get Your Ass to Mars!" This is typical test-pilot language. Phobos is the fast-moving, inner moon of Mars. It goes around the planet three times in one day; very fast. I'm suggesting that we go to Phobos first, before we go to Mars. Phobos [**Figure 7**] is a fascinating moon, with stripes—geologists would have a field day there. This image [**Figure 8**] is what Mars looks like from Phobos; that's how close it is to the planet.

By the way, it's easy to get back from Phobos. Number one, when you go there, the moon is moving so fast you don't need that much fuel. When you take off to go back to Earth, get off on the other side, and you can save fuel on the way back.

Going to Mars is not that important, even if I just told you about going to Phobos. Why? It's what we learn by the journey, the technology we develop, the same kind of thing we did with Apollo. We're going to spread it all over the world again. That's how we use it; that's how humankind will flourish.

Space-faring is a wonderful alternative to war. Thank you, folks.

FIGURE 7

NASA/JPL-Cal Tech/Univ. of Arizona

Phobos

FIGURE 8

Artist's depiction of Mars as seen from Phobos.