

## Air and Space this Week

### Item of the Week

## ***ATHELSTAN SPILHAUS and MARS PATHFINDER***

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Project Mogul Cartoon Rocks Mars Yard

*A birthday and an anniversary this week spotlight two things one might not think, at first, fit together. But they do, and you know by now that I love connections such as the one below. **November 26, 2021** would have been the 110<sup>th</sup> birthday of Fred Spilhaus, an amazing scientist and engineer, and an even-more amazing proponent of science education. The Mars Pathfinder mission, the first with full, real-time Internet support, also served as an amazing engager of the education process. Both utilized an existing medium to great effect in reaching learners of all ages, but particularly younger ones.*

### **Athelstan Frederick Spilhaus**

Athelstan “Fred” Spilhaus was born in Cape Town, South Africa, on **November 26, 1911**. Science ran in his family; his grandfather was mathematician Thomas Muir, the guy to blame if you struggled with matrices and determinants in college math. But he was proving to be a good engineer, earning a B.S. at Cape Town before coming to America and earning an MS in Engineering from MIT. He had a love of the sea from boyhood, and used his periods off from school to go to sea; he must have known that somehow the sea and his career path were intertwined. And like any good engineer, he liked to tinker with things to learn more about them. One of the problems that had his attention was a way to determine the temperature of water from within a steel hull. But it was a difficult problem, and he wasn’t able to find a way to make the necessary measurements, at least then.

After finishing his M.S., Spilhaus moved back home to South Africa to take a significant position in the Union of South Africa Defense Forces for a year, then returned to the U.S. in 1935 to begin a two-year stint at the Woods Hole Oceanographic Institute, where he was able, among other things, to work more on his within-the-hull water temperature measuring device. He was successful, in perfecting his “bathythermograph,” and it would prove to be of enormous importance in the coming submarine warfare of WWII. Propagation of sound in water was affected by the temperature of the water, but even more so by the presence of a boundary (a “thermocline”) between two water masses of different temperature. Pre-War sub skippers found that a sharp thermocline boundary could reflect sonar signals from the destroyers seeking them, so “going beneath the layer” became an important defensive maneuver. Being

able to observe any abrupt change in water temperature around a sub was vital info for the skipper, and Spilhaus' device gave them that info.

Dr. Spilhaus became a U.S. citizen after the War and went on to have a brilliant career in a variety of disciplines. Among his accomplishments were becoming a founder and original planner, along with Buckminster Fuller, for the [Minnesota](#) Experimental [City](#) (one that would be, in today's parlance, extremely "green"), becoming Dean of U.Minn's Institute of Technology, starting the National Sea Grant Program, and being named as a member of the American Philosophical Society. He helped create the "skyway" system in Minneapolis, and he would become the first UNESCO ambassador to the U.N.

Spilhaus also did some military-related work, including using his oceanographic experience of long-distance sound transmission on [Project Mogul](#), an attempt to use very-high-altitude balloons carrying sensitive microphones to detect atmospheric nuclear testing by the Soviet Union. The test program for Mogul was based out of Holloman AFB in Alamogordo, NM. Test balloons would be launched from there, and then be tracked by radar to assess performance. Engineers would affix a tin-foil corner reflector to the balloon to magnify its radar return and facilitate tracking. One of their balloons, launched on July 8, 1947, malfunctioned and crashed near Roswell, NM. The locals thought it was the remains of a "flying saucer" and the Air Force didn't argue too much with the inadvertently-created cover story, and Roswell's principal source of income was born.

Two events affected Spilhaus' career profoundly, the launch of *Sputnik 1* by the Soviet Union on October 4, 1957, and being named by JFK to be the U.S. Commissioner to the 1962 Seattle World's Fair (of Space Needle fame). His experiences there solidified his futuristic thinking.

But IMHO, his greatest accomplishment came as the chair of the scientific advisory committee of the American Newspaper Publishers Association. Yes, you read that right; back then the newspapers were much more science-oriented than most news media are today. More later.

### ***Mars Pathfinder***

The [robotic study of Mars](#) advanced rapidly in the 1960s with the successes of [Mariner 4](#) and [Mariner 9](#), and further in the 1970s with the fabulous Viking spacecraft, two orbiter/lander combinations. Budgetary constraints after Apollo curtailed Mars exploration; no U.S. missions were launched for Mars until 1992, when *Mars Observer*, a large mission, was sent on its way. Alas, it failed. But we hit our stride again later in the 90s, with the successful *Mars Global Surveyor* (orbiter) and *Mars Pathfinder* (lander with small rover) in 1996. Failure then came back to Mars; the *Mars Climate Orbiter* and the *Mars Polar Lander*, both launched in 1998, were lost. We've done very well since then, with major successes with *Mars Odyssey* (2001), the *Mars Exploration Rovers* (*Spirit* and *Opportunity*) of 2003, the *Mars Reconnaissance Orbiter* and its magnificent HiRISE camera (2005), *Phoenix* (2007), the *Mars Science Laboratory* (2011), *InSight* (2018), and *Perseverance/Ingenuity* (2020).

The string of recent successes attracts more public attention today, but for now I'd like to focus on the *Mars Pathfinder* mission that launched on **December 4, 1996**, twenty-five years ago.

*Pathfinder* had several important technical “firsts.” It would be our first serious attempt to rove the martian surface, but making it to the surface OK was a major technical challenge. The engineers could not design a rocket-powered landing system that could deliver a small rover to the surface within their weight and other constraints, so they figured out a way to let the rover carrier just crash into the surface after its parachute had killed most, but not all, of its speed. An ingenious system of air bags, inflated just before impact, would allow the rover carrier to land, and then disgorge its cargo. The carrier would have the communications and control systems for the rover, named *Sojourner*, which had a volume of about two cubic feet. Its range would be very limited, but it could rove around over a few tens of square meters area and make measurements of rock composition. The air bag system worked as designed, and little *Sojourner* was soon exploring its landing site.

The other important technical first, after roving and air bags, was the distribution of information from the mission via the Internet. Recall, this was 1996 technology, so the World Wide Web and even e-mail were in their infancy. But the folks who would find Mars exploration interesting were also the folks most likely to be up on the latest computing/communications technology....

### **The Important Thing They Have in Common**

Athelstan Spilhaus understood the high level of interest the general public had in all things Space-related, and he used his position as chair of the science advisory committee for the American Newspaper Publishers Association most effectively. After Sputnik, he became concerned that young Americans were insufficiently interested and competent in science and technology. Many others felt the same way, exemplified in many ways, including the creation of curriculum study advisory groups that created basic educational materials many now-senior scientists cut their teeth on. Since he had great connections to newspapers across the country, he began writing a piece he called “Our New Age” for the Sunday funnies. “Rather than fight my own kids over reading the funnies, I decided to put something good in the comics, something that was more fun and might give a little subliminal education.”

Spilhaus’ strip was very popular; by 1959 it was in 102 U.S. and 19 foreign newspapers. He took some heat from some of his colleagues, who thought the funnies were a poor venue for scientific material. Any who dared say that to his face got a reply something like, “Which of you has a class of five million every week?” That usually shut them up.

I’ll give JFK the final word on that subject. He once told Spilhaus that, “The only science I ever learned was from your comic strip in the *Boston Globe*.”

You receive *Air and Space this Week* because you care about informing the next generation and helping them understand the value of STEM education, to themselves, their families, and our Nation. Here is a lesson for us; Spilhaus found a way to engage the interest of young people in their formative years. Yes, it wasn’t particularly scientifically rigorous, but it was certainly very effective. He paved the way for folks like Mr. Wizard, Carl Sagan, Neil deGrasse Tyson, Bill Nye, and others to follow.

The Mars Pathfinder mission performed a similar role. Yes, it did return some interesting scientific observations, and yes, it did prove up some new engineering/technology approaches, but in my opinion, the greatest value of the Pathfinder mission was how dramatically it engaged the public, especially the same demographic that Spilhaus so capably reached.

Outreach success was helped initially by the innate public interest in Space/Mars, especially in the decade following Apollo. The notion that a lander was being delivered to Mars to crash-land swathed in airbags also attracted attention. But what really engaged the young target audience were two things entirely different.

The “must-have” holiday gift item for younger students at this time was a radio-controlled model car. One about the size of *Sojourner*. Imagine the dreams of the kids who wanted such a car, and driving it on interesting terrains – like Mars!

*Sojourner* could not wander far from its landing site, but it could move around the many rocks that littered its vicinity. One of its primary missions was to study the rock composition, so traverse planners quickly got busy looking for the most interesting rocks to sample first.

There were a lot of rocks, and everyone involved had to make sure they all were discussing the same ones. Someone with a whimsical nature started naming various rocks something other than a multi-digit identification number. They named them after cartoon characters. Yes, cartoon characters. This wasn’t the first time a landing science team gave a rock an informal name, such as “Big Joe” at the *Viking Lander 1* site, but the cartoon names were used much more at *Pathfinder’s* site. The trend of naming rocks and other features would grow considerably as we landed progressively-more robust rovers.

NASA scientists and news coverage now began talking about things like the composition of Yogi and Boo-Boo, or the erosional history of Scooby Doo.

So, let’s review. We have a mission heading to Mars, and will crash-land protected by airbags. Interesting. Its rover looks like a holiday gift on steroids. It examines a number of interestingly-named rocks. And the information is put out by a new, highly-efficient communications system, whose first-adopters are pretty much the same audience inspired by the mission. What could go wrong? Optimists chortled. Perhaps this new medium would allow an additional 10,000 people to be reached!

There was just one problem. NASA’s mission website got crushed by demand; the mission would eventually deploy the first use of mirror sites to spread the load. Mission managers grossly underestimated the traffic they would need to accommodate; the initial website had over *two billion* hits. Obvious now, but more understandable in the context of the times.

NASA has always supported formal and lifelong educational efforts, and they learned quickly from their *Mars Pathfinder* experience. They offered naming contests for the names of mission elements (*e.g. Spirit, Opportunity*) and they expanded their efforts to support learning for early childhood through high school students with a variety of content and delivery methods; see the Education section of the website for links. ***They had found an effective way to use an existing medium to engage younger learners, just as Dr. Spilhaus had done decades before.***

Some might call folks like Dr. Spilhaus and those who followed, and missions like Mars Pathfinder, science or Space “popularizers.” It’s a true enough expression, to be sure, but I prefer to think of them as science or Space “Inspirers,” and I include myself, and you, in that group! We must always be flexible enough in our approach to engaging the public to be maximally-effective, *without losing the value of the content*.

**CODA:** The next Mars lander/rover mission for the U.S. were the twins *Spirit* and *Opportunity*, in 2004. They also used the airbag landing technique, but were significantly more capable than the much smaller *Sojourner*.

NASA was well-aware of the (younger) public interest that the interest, and pressure on the website, would be very high. They used it to engage learners of all ages in a variety of STEM-related thinking. One example, with which I am quite familiar, was the creation of semi-realistic rover driving exhibits for Museum use. NASA partnered with the Robotics Institute at Carnegie-Mellon to design and build museum-proof rovers, similar in size and design to the *Sojourner*. They were equipped with a TV camera and a navigation system, so the visitor could look ahead, and then order the rover to turn and advance to their specification. All the museums receiving the rovers had to do was to build a “Mars Yard” where the rovers could operate safely.

NASM had recently opened the Udvar-Hazy Center, so we put in for two rovers, and got them, with all of the equipment necessary to operate them remotely. One of our teachers-in-residence organized a local school effort to design and build the Mars Yards needed. Local merchants donated the materials, a group of art students worked with shop class students to design and build the Yards (no mean feat – there are a lot of rules and regulations any museum exhibit must follow, even a temporary one). The Yards were a huge success, and garnered significant local and national attention.

Athelstan would have been proud.

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### ***Mars Pathfinder***

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*Sojourner*: <https://nssdc.gsfc.nasa.gov/nmc/spacecraft/display.action?id=MESURPR>

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### **What They Have in Common**

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*Perseverance* Naming Contest: <https://mars.nasa.gov/mars2020/participate/name-the-rover>

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