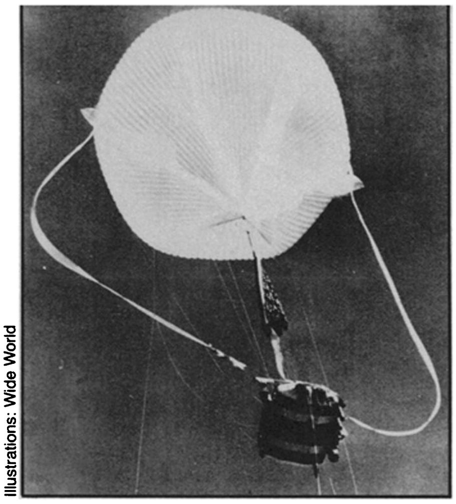
Ballooning Science


Illustrations: Wide World

Jules Verne lifts off on global attempt.

Recent advances in research ballooning could keep sport balloonists aloft

BY SUSAN WEST

On Feb. 12, Maxie Anderson and Don Ida soared above Luxor, Egypt, fulfilling an aeronaut's dream — to glide around the world dangling beneath a helium-filled balloon. But on Feb. 14, the adventurers were earthbound once more, surrounded by a curious crowd in a field near Mirchpur, India, less than 3,000 miles from where they started.

One month earlier, however, and with much less fanfare, a recently developed weather balloon that one researcher says could easily be modified for manned flight achieved Anderson and Ida's goal. While the adventurers' failure, as well as that of several similar recent attempts, can be attributed to many factors, it is likely, judging from the accomplishments of their research-oriented colleagues, that would-be global balloonists might do well to be less adventurous and more scientific about their sport. In fact, according to Vincent Lally of the National Center for Atmospheric Research (NCAR) in Boulder, Colo., the only sure-fire, currently available ways to girdle the globe in a balloon are those used by scientists.

Ballooning for science began as early as 1900, when free balloons carrying instruments were sent skyward to explore the upper air. Though the human factor is usually omitted from research balloon flights, scientists sometimes manned their experiments. In 1911 and 1912, for instance, Austrian physicist V. F. Hess lofted about 3 miles into the air to prove the existence of cosmic rays. Balloons remain a critical tool for meteorologists. Sent aloft in fair weather and in foul, they carry telescopes beyond the interference of the atmosphere, sample atmospheric particles and, as an inexpensive substitute for some satellite data, take vertical slices of atmospheric winds, temperatures and pressures.

Balloonists of all persuasions have to deal with the same principles. The lighter-than-air helium inside the "envelope" or body of the balloon causes it to rise. When the sun strikes the balloon at dawn and begins to warm the helium, it expands and the balloon rises; at twilight, the cooled helium contracts and the balloon falls. To combat the nighttime descent, a certain amount of ballast is released each day—about 10 percent of the total weight, says Lally. But this makes the balloon lighter, so that with each warming dawn, it rises higher than it did the day before. If the balloon rises too high, the helium expands to the limit of the envelope and it bursts. To counter that, balloonists use a "zero-pressure" balloon that has a vent through which helium can be released. But the release of helium means that the balloon will fall farther at night and more ballast will have to be released, which in turn means the balloon is still lighter at the next dawn, and so on. The duration of the flight depends on how long the scientists or aeronauts can walk the tightrope between ballasting and venting.

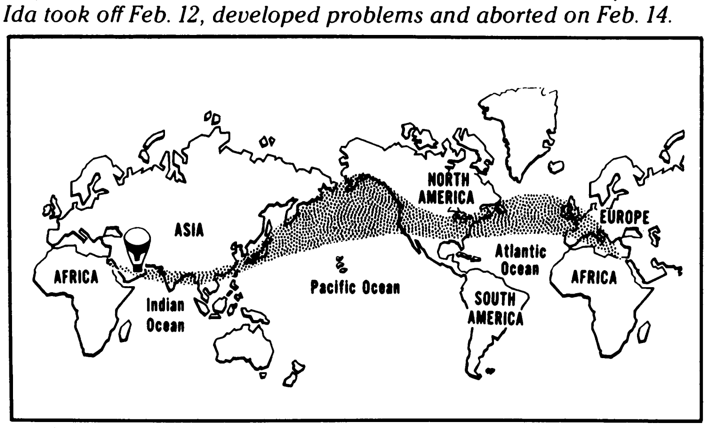
That tightrope nearly gave way in 1978 when Ben Abruzzo, Larry Newman and Maxie Anderson crossed the Atlantic in the *Double Eagle II.* Starting out at 10,316 lbs., including the helium, the aeronauts progressively jettisoned 299 lbs., 1,104 lbs., 1,155 lbs., 939 lbs., 1,199 lbs. and 711 lbs. and released 748 lbs. of helium, according to an article in the Sept.-Oct. 1978 BALLOONING. By the flight's end they had pitched 60 percent of the total weight, 95 percent of all their equipment including food and clothing.

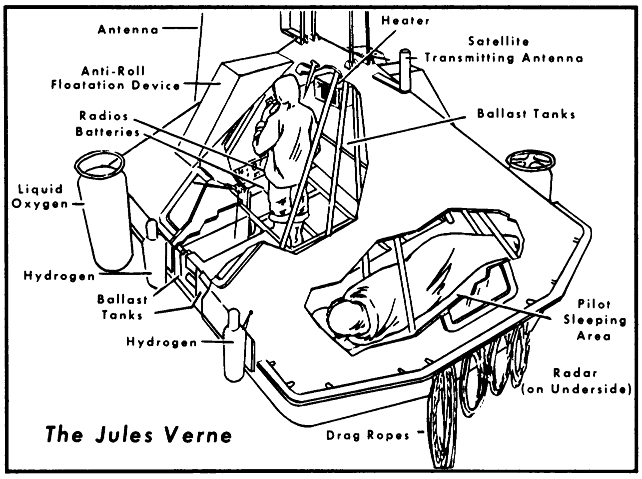
The ballasted zero-pressure balloons are what had been used in traditional scientific ballooning, explains Lally. Most range from 1 million cubic feet to 6 million cubic feet and carry very heavy instruments, such as telescopes, to altitudes of 100,000 to 130,000 feet. Such flights usually last only 12 to 24 hours—until the instruments get beyond the range of the launch site — but some scientific balloons have been able to tread the ballasting-venting tightrope as long as eight days.

With another type of balloon, however, scientists have achieved flights of up to 744 days — 34 global circuits. Called super-pressure balloons, these are made of stronger plastics than zero-pressure balloons and are inflated with an excess of gas and sealed. When they are released, they rise to and stay at a level in the atmosphere where the pressure inside the balloon is more than the outside pressure. Unlike zero-pressure balloons, super-pressure balloons can fly for long periods of time at altitudes of about 30,000 to 40,000 feet, although they can carry loads of only a few ounces.

Such payloads and altitudes are quite different from those required by sports balloonists. In Anderson and Ida's most recent attempt, for example, the *Jules*

Below: proposed path of the Jules Verne. *Right: Details of gondola suspended below the balloon. Pilot Maxie Anderson and co-pilot Don Ida took off Feb. 12, developed problems and aborted on Feb. 14.*





Verne weighed — including crew, ballast, gondola and balloon—10,500 to 11,500 lbs. at liftoff and was planned to drift at a maximum altitude of 30,000 feet. In duration and distance records, sports balloonists also lag behind their scientific counterparts. The records to beat are an estimated 600 miles for a hot air balloon, set March 6 by Kris Anderson, Maxie Anderson's son, and 3,314 miles for a helium balloon, set by the two Andersons in May 1980. The *Double Eagle II* set the manned balloon flight duration record of 137 hours.

Anderson and Ida hoped to break both duration and distance records in the *Jules Verne*. At 390,000 cubic feet, it was significantly larger than the 160,000-cubic-foot *Double Eagle II*. Like the *Kitty Hawk* in which the Andersons made their 1980 transcontinental crossing, the *Jules Verne* carried a liquid ballast of antifreeze and water. (Sand, the traditional ballast, freezes at the cold upper atmosphere.) Unlike the *Double Eagle II*, which was made of coated nylon, the envelope of the *Jules Verne* was translucent polyethylene, which absorbed less solar heat and diminished the roller-coaster effect. Even with all these improvements, says Lally, the aeronauts were still defeated before they started because of the daily "balance penalty."

Other global hopefuls are attacking the problem differently. A British team, led by balloon manufacturing company owner Donald Cameron, plans an April launch in a "hot-helium" balloon. In this scheme, the helium in the balloon will be heated by liquid fuel whenever necessary to maintain altitudes. While this is a promising system, says Lally, with whom Cameron consulted last fall, it is also limited by fuel supplies to a 12-day flight time. About two weeks, he said, will be necessary for a round-the-world journey at the altitude Cameron plans to fly.

Lally contends that there are only two ways to successfully circle the globe using current technology, and both are the offspring of recent developments in long duration scientific ballooning. The first is to fly a zero-pressure balloon of about 10-million-cubic-feet capacity in the tropical stratosphere. Like the troposphere—that part of the atmosphere from the ground to about 50,000 feet — the stratosphere becomes warmer with increasing altitudes. To take advantage of this inverted temperature structure, a balloon could be inflated to fly at 130,000 feet during the day where it is warm, and at night it would only fall to about 70,000 feet, where it would be buoyed by the colder air and continue to fly. The aeronauts would need a pressurized capsule but would not need to ballast. Sailing on the stratospheric winds during the summer months, such a balloon could circle the earth in about 14 days, Lally says.

The second strategy Lally suggests uses a super-pressure balloon. Scientists that use super-pressure balloons can carry only lightweight instruments because heavier loads require bigger balloons and stronger and more expensive materials to withstand the added stresses. With a pressurized gondola and a 500,000-cubic-foot envelope of extremely strong material such as Kevlar—the tradename for a fiber used in some bulletproof vests — and a metalized outer surface to reflect solar radiation, this balloon could fly at about 40,000 feet and circle the earth in 10 to 14 days, says Lally.

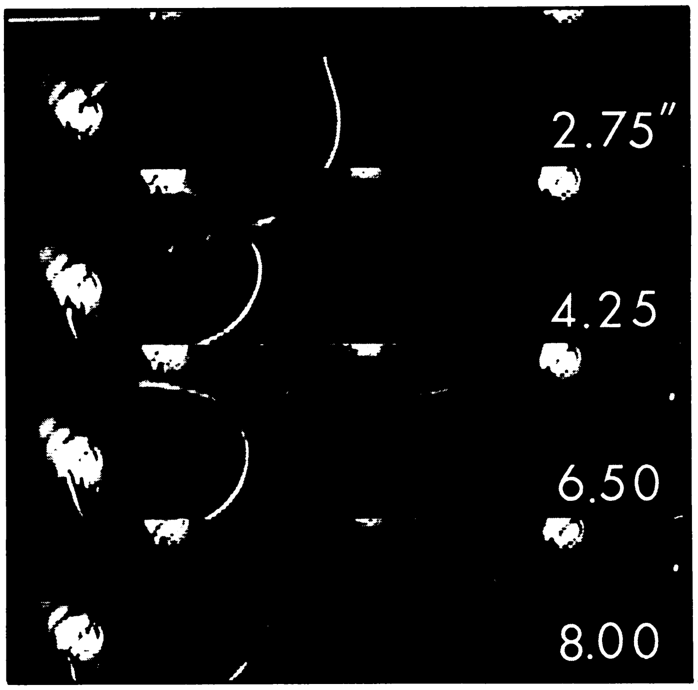
Both of these schemes are currently being used by scientific balloonists. In January, for example, using the first type of system, which is called a radiation-controlled balloon, or RACOON, Lally and co-workers launched a balloon on a successful 14-day global journey from Brazil. Such balloons can be used to carry telescopes for cosmic studies or heavy analytical chemistry equipment. One project proposed for December by Glen Frye of Case Western Reserve University in Cleveland, Ohio, would send a telescope via balloon to study neutrons on the sun.

While Lally's interest in ballooning remains scientific — "people on balloons just get in the way"—he sees no problem applying the same principles to manned flights. With a little more science, the flight of the *Jules Verne* might be more than science fiction. □

... Microscope

The video equipment can make any microscope give better images, without very fancy (or expensive) systems of lenses, Allen says. "I have a pile of letters on my desk from people who want to do the technique with the microscopes they already have in their labs," he reports. "Everyone who has a decent microscope can now get first-rate images."

The video system is not only impressive when attached to a standard research microscope, but also when it is combined with the "Cadillac" of microscopes, as Allen terms Inoué's system. Inoué first addressed the problem of background and contrast years ago by inventing optical devices, called rectifiers, to produce better images at high magnification. But even his luxury microscope is improved with the addition of an inexpensive ($1,700) television camera. The "off-the-shelf" camera, monitor and tape recorder altogether cost $10,000, only a few percent of the value of the microscope, and Inoué says with newer equipment the cost could be as low as $5,000.



Video captures a process shooting out of sea cucumber sperm after an artificial stimulus mimicking contact with an egg. At its most slender portion, the process is 50 nanometers in diameter.

In addition to the clearer images and ability to view smaller structures, the biologists are enthusiastic about other aspects of the technique. Allen estimates it is possible to record images 1,000 times faster and 100 times more cheaply than with photographic methods now in wide use. Because there is no wait for film to be developed, scientists can be certain their data are sufficient and successfully recorded during the experiment. Allen says, "Immediate replay and analysis ensures peace of mind." Another advantage of video is that pictures can be slowed down or sped up for convenient study, or several can be combined to bring out more detail. The system can also feed into a computer for more elaborate data analysis.

In their eagerness, biologists can hardly decide where to turn their new video-vision. According to Allen, "We can now expect a number of important breakthroughs to follow in many different kinds of processes in living cells." □