

## Practical Benefits for America

From its founding in 1917 until the beginning of the space race, every NACA project was intended to be of practical value. Goals flowed up from the engineers and in from industry. This era is well documented in James Hansen's book "Engineer in Charge". After Sputnik the situation changed radically; the space race was not a scientific quest, it was a substitute for a perilous nuclear arms race. The Apollo program was canceled simply because it achieved its goal, and continuing to fly people to the moon with expendable rockets was much too expensive.

The Shuttle was our first attempt to provide human spaceflight at a practical cost. It failed to achieve this goal because decisions were made on critical systems, such as the SRBs and heat shielding, without any prototypes to test them in actual flight. This resulted in highly inaccurate assessments of both maintenance cost and safety. But concluding on the basis of this one program that reusable spacecraft are impractical is like flying only the Wright Flyer until 1930 and then concluding that heavier-than-air flight is impractical and going back to balloons.

Just ten years ago NASA was well aware of this, and was developing a new series of unmanned "X-planes" that would provide flight experience on reusable spacecraft technologies, and thus enable a future generation of reusable spacecraft that would be both safe and practical. The X-33 was canceled because it was concluded that a composite LH2 tank was impractical, although the DC-X was already flying with just such a tank. The DC-X prototype was destroyed because the program was understaffed, leading to a maintenance error. The X-34 was canceled without explanation. When the airframe contractor offered to fly the X-34s at its own expense NASA inexplicably refused, even though sharing of public and private investment had been one of the goals of the program. The X-37 was transferred to DOD, but since DOD has no human spaceflight mission it is difficult to see how it can ever be used for its original purpose.

The fundamental deficiency of the Constellation program is the lack of a credible strategic goal that justifies its cost. Another race to the moon with China, a country as capitalist as the US and our major trading partner, would leave us further in debt and would serve no purpose for either country. Helium-3 has been proposed as a lunar resource so valuable it could be shipped back to earth at a profit, but the proton + boron-11 reaction has all the advantages of helium-3 fusion and the reactants are readily available on earth. Research and tourism in space are reasonable goals but are highly sensitive to cost. Constellation, like Apollo, is unaffordable for these purposes. At over \$1B for a lunar flight; it would be analogous to maintaining a permanent base at the South Pole using only dogsleds. Fully reusable launch vehicles and spacecraft remain the only prospect for practical human spaceflight, but because of the cost of the program, no resources will be available to develop such advanced technology.

The cost of human spaceflight is often justified to the public by the practical benefits of NASA-funded research, particularly through advances in medicine. Ostensibly these are free "spinoffs" of spaceflight that cost nothing in themselves. But in reality such cases are rare. There are a wealth of ideas but little institutional support for work that is not considered essential to the primary mission of returning Americans to the moon, even for research that could save many lives here on earth.

The space program continues to attract brilliant scientists, engineers, and students who can make air travel safer and less expensive, develop hydrogen-fueled airliners, protect the environment, improve communications and navigation, help US companies recapture a share of the commercial launch market, and make important advances in medical and life sciences. But to do these things NASA must once again produce science and technology of practical value to America, not as an accidental byproduct, but as its primary goal. It is time for the agency to return to its original mission, not the mission that was forgotten when the moon race ended, but rather the mission that was forgotten when the moon race began.