

How much of a good thing is enough?

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During the last decade, the Hubble Space Telescope created much of NASA's good news. ~~Its rate of major discoveries has been twice that of its sister Great Observatory, Chandra. In total,~~ Hubble has already produced nearly three times the number of discoveries as the two Voyager spacecraft, NASA's second most productive science mission overall. Another indicator, the demand for Hubble time continues to outstrip the supply by more than a factor of six. Meanwhile, Hubble's observational capabilities improve with the installation of each new instrument; they are now ten to one hundred times more powerful than they were at launch, and their capability will increase by another factor of ten after the next servicing mission, following the installation of the Cosmic Origins Spectrograph and Wide Field Camera 3.

For NASA, astronomers, and the public, Hubble has been a very good thing. The question is: How much of a good thing is enough?

Hubble's long run of great performance cannot last forever. Even champions eventually lose their edge, as younger competitors overtake the old masters. When will Hubble's time have come? This question sparks strong emotions—and some oversimplification—on both sides of the debate. One side compares Hubble to an old jalopy, ready to fall apart at the next bump in the road; it says NASA should end the Hubble mission, freeing-up money to pay for new projects. The other side likens Hubble to a classic car; it can continue to perform at a high level indefinitely, if kept up by regular servicing.

Neither analogy captures the complexity of the issue facing NASA. Far from an old jalopy, Hubble is at the peak of its performance, continuing to outpace everything else in NASA's lineup. It is still unsurpassed in its ability to produce new scientific discoveries and should remain so for many years to come. Competitive new telescopes will eventually overtake even Hubble's great power, and then we should stop paying the bills to keep it running. The only telescope on the horizon that can come close to Hubble's capabilities is the James Webb Space Telescope, not scheduled for launch until late 2011.

One difficulty for NASA is that when Hubble is no longer able to compete, they cannot just leave it floating in space. They will have to remove it from orbit, an undertaking nearly as expensive as launching it in the first place. This need to de-orbit Hubble suggests that there will be at least one more opportunity to visit and upgrade Hubble, effectively a final servicing mission, after the last one currently planned, which for now is still booked in 2004. The mission to prepare Hubble for controlled de-orbiting is an important chance to keep Hubble productive beyond its currently planned lifetime. The opportunity cost may of the shuttle launch might be paid for largely from the shuttle program, but the money to cover the costs of maintaining the telescope may have to come from somewhere else in NASA's ambitious program.

Understanding the difficulty of setting science priorities, the stewards of our space science program acted in NASA's best tradition and put the issue to a panel of experts who would provide unimpeachable advice: John Bahcall (chair), Barry Barrish, Jacqueline Hewitt, Christopher McKee, Martin Reese, and Charles Townes. The panel quickly achieved consensus and gave NASA its recommendations in August, six weeks ahead of schedule. The panel stated that NASA's first priority should be to keep Hubble in service after 2010 if shuttle servicing is possible (which the Columbia accident ~~in~~ February 2003 calls into question.)

In the preparation of Hubble for its 'final tow'—a mission in 2010, say, to install rockets that can take it safely out of low earth orbit—the panel discerned the important science opportunity. Because this final mission is imperative—but the final de-orbit can be delayed—it could be scientifically advantageous and cost-beneficial to service Hubble and even upgrade its science capabilities, to add several more years to its wonderfully productive life. To assess the scientific benefits against the programmatic costs, the panel recommended that the proposal to extend Hubble's life should compete in a scientific peer review panel against proposals for other NASA projects seeking the same money.

The panel left to the Office of Space Science the difficult task of deciding which program elements should compete against Hubble and on what terms. They may consider Hubble's value to the overall space enterprise and how Hubble helps justify space exploration. Because Hubble's value cuts across programmatic boundaries, the competition could be across those boundaries as well.

The Hubble project uniquely marries superlative science with human spaceflight, providing one of today's best reasons to send humans into space. Servicing Hubble demands a blend of dexterity and decision-making that no robots possess. The four Hubble servicing missions to date demonstrate the enormous returns possible from repairing, maintaining, and improving an expensive scientific facility. As NASA continues to launch people into space for scientific discovery, its top managers should not overlook Hubble's great popularity and value as a showcase of human spaceflight success.

The cost of maintenance, upgrades, and five additional years of Hubble operation is about three quarters of a billion dollars, exclusive of launch costs. The cost of visiting Hubble simply to install rockets for a controlled de-orbit ~~would~~might cost a similar amount but offer no science benefit. These are, indeed, large sums, yet the two costs combined represent only a few percent of NASA's total budget for five years. By comparison, the returns in science and public acclaim that we can expect from five extra years of Hubble will far exceed those from any other few percent of everything else NASA does. By Greg Davidson's 'Science News metric,' which is NASA's own measurement, in 2002 often cited by NASA officials and known to be of interest to Congress and the Office of Management and Budget, Hubble returned one third of NASA's 'good news' and that in 2002. That high return should continue for years to come.

Astronomy does not feed people, cure disease, provide military security, or contribute directly to the material well-being of the nation. Its benefits lie elsewhere. Astronomy inspires us to think about our origins and destiny and to find our place in a larger cosmos. It helps educate new generations of young thinkers and gives meaning to life. In these ways, astronomy shares with the whole space program the purpose of exploring the universe. Hubble plays a central role in astronomical exploration. It is appropriate to judge Hubble's continued operation against other reasons we send people into space. Only then will we really find out how much of a good thing is enough.