Eye in the Sky

The Space Telescope. A Study of NASA, Science, Technology, and Politics. ROBERT W. SMITH. With contributions by Paul A. Hanle, Robert H. Kargon, and Joseph N. Tatarewicz. Cambridge University Press, New York, 1989. xviii, 469 pp., illus. $39.50.

The Space Telescope. Eyes above the Atmosphere. GEORGE FIELD and DONALD GOLDSMITH. Contemporary Books, Chicago, IL, 1989. 166 pp. $18.95.

In April of this year, NASA is yet again scheduled to launch the Hubble Space Telescope (HST) into orbit some 600 kilometers above the earth. The size of a highway tanker-truck, the telescope satellite contains a 2.4-meter-diameter diffraction-limited mirror that will feed signals of unprecedented stability and intensity to its two spectrometers, two imaging systems, and photometer. As was pointed out by Lyman Spitzer as early as 1946, the lack of atmospheric turbulence and scattering alone would make the venture worthwhile. This, coupled with the telescope's ability as now configured to fix at about 0.01 arc-second on its targets, will make it 50 to 100 times better than the best ground-based observing. This will increase our viewing range by a factor of at least 7, raising the possibility of finding some 350 times as many new space objects as are known at present. Although at launch the five main instruments are to concentrate on the visible and ultraviolet regions, provisions for infrared instruments exist for later in its expected 15-year life. Being married to the Space Shuttle program, which has been both blessing and curse, makes periodic maintenance and upgrading of the telescope possible. Among the major "crown jewels" expected of this two-gigadollar satellite are vastly improved study of Cepheid variable stars and consequent redefinition of distance scales in the universe.

From Robert Smith's book—the result of a project carried out under NASA, Smithsonian, and other sponsorship—it seems even more a miracle that the HST might be launched at all. Smith traces the tortuous path that its proponents pursued from Spitzer's early proposal to the disaster of the Challenger explosion in 1986, basing his tale on extensive published data, letters, and memoranda and on interviews with many participants. It is not a tale for the faint-hearted. Many astronomers, fearful that the "Large Space Telescope," as it was first called, would sap resources from their ground-based work, had to be cajoled into support; next, an increasingly parsimonious Congress had to be convinced after several denials to appropriate the 500 million dollars that, in 1977, was thought sufficient. This was only possible after the European Space Agency had been convinced to contribute 15% of the cost in exchange for 15% of the observing time and the size of the mirror had been decreased from 3 meters. Then NASA, desperate in post-Apollo, pre-Shuttle days to save its Marshall Space Flight Center, gave the project to that center rather than to the seemingly more appropriate Goddard Center, creating internal hostility that contributed to early failures to stay on schedule and within budget. Twice, in 1980 and again in 1983, serious cuts to the program had to be ordered. Most of this "descoping" affected backup equipment and maintenance, but some threatened the scientific instruments and viability of the telescope. The assigned launch in 1983, barely a year after the Shuttle began flying, gradually receded and eventually ended up as October 1986. When the Shuttle program went on hold following Challenger, the HST disappeared into clean-room storage at Lockheed in Sunnyvale, still not fully ready for flight yet costing seven million dollars a month.

"Even Superman was enlisted to help sell the Large Space Telescope." In this 1972 comic book, produced with "technical assistance" from Grumman Aerospace's director of space astronomy, Superman applied his "heat vision" to remove "trouble-making [cosmic] dust" from the telescope's lens. [From *The Space Telescope: A Study*; courtesy of D.C. Comics]

Here is a stark portrayal of what big science has become in the post-war period. As the author frequently points out, what may appear from the outside to be a straightforward technical accomplishment is actually the end-product of a frightening mixture of political, financial, technical, social, industrial, scientific, and ethical concerns that mesh in a sometimes violently confrontational manner. Examples abound: Constrained by Defense Department concerns, Marshall's staff involvement at major subcontractor (and reconnaissance satellite manufacturer) Perkin-Elmer was too small, and NASA management lost control over both budget and schedule for the 70-million-dollar optical system. To correct this without seriously impairing the scientific capability of the HST required NASA to go back to Congress for additional money from a House committee whose chair had strongly opposed the telescope in the first place. Or this: Thermal effects of the HST cycling between direct sun and earth shadow every 90 minutes produce instabilities on the order of 10,000 times the intended stability of the optical system; this necessitated development by Lockheed of a decoupling mechanism between substructures at increased cost and delay. The planetary astronomers' need for sensitivity in red light led to the use of unproven Charge-Coupled Device videcons, which very late in the testing revealed that what had been looked at before would degrade what was looked at later unless the videcon was periodically flooded with ultraviolet light; a special tube had to be introduced long after the camera design was fixed to avoid having to point the entire HST directly at the sun.

One of the chief proponents of what became HST, and a savvy lobbyist when needed, has been George Field, a student of Spitzer's and sometime director of the Harvard-Smithsonian Center for Astrophysics. Realizing from his experience that publicly funded efforts require an informed and supportive public, Field has teamed with astronomer-popularist Goldsmith to laud the program in time for the launch. What emerges is a remarkably clear, non-condescending, and reasonably complete description of the HST, its value and its mission, and a good deal of modern astronomy, aimed at an interested lay audience like the readership of *Scientific American*. It is definitely not history, being quite a different story from that emphasized by Smith; it downplays the problems (after initial funding "the next seven years were good ones for the Space Telescope and led to its completion") and includes many more of the technical matters. Of particular interest are the discussions of possible serious damaging

"NASA administrator James Fletcher explains a model of the Space Shuttle to President Ford," 1976. "In contrast to the previous year, in 1976 the Space Telescope sailed through its [Office of Management and Budget] reviews. There are even stories of meetings—unusual, certainly, by OMB standards—that were brought to a halt as staff members pondered what it meant to peer back many millions of years." [From *The Space Telescope: A Study*; courtesy of Gerald R. Ford Library]

effects of the four years in storage; of concerns about launching during a period of increased solar flaring; of how a necessary 55-meter focal length could be fit into the 12-meter Shuttle bay; and of how the new Space Telescope Science Institute will coordinate use of the satellite. For readers unfamiliar with the immense changes in how science is done in modern times, this last chapter alone will be an eye-opener.

There does seem to be an essential factor that is given short shrift in both books. In light of recent revelations of how important reconnaissance satellites have been in preventing arms proliferation in the last 30 years, this reader finds the consideration of their relevance surprisingly brief. Perkin-Elmer had been in the earth-directed optical reconnaissance satellite business for at least a decade before NASA selected them as the prime contractor for the optical subassembly of the HST, and the same can be said of Lockheed, selected for the rest. Indeed, we even know from a public statement by President Carter in 1979 just what the optical resolution of the latest KH satellites was at about the time the HST was funded. One book questions whether reconnaissance was going on at all, the other barely mentions its role though does emphasize the influence of the Department of Defense in limiting NASA's oversight ability in the early years of HST fabrication.

Notwithstanding this perhaps over-inquisitive reader's desire to understand more fully the evident influence of prior defense reconnaissance work on the HST's origins, possible emergency uses, and contractual difficulties, we have here two immensely useful books on the eve of the HST launch. They address quite different audiences, but both are well deserving of praise from their respective readerships.

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A Rise and Fall

Gene Dreams. Wall Street, Academia, and the Rise of Biotechnology. ROBERT TEITELMAN. Basic Books, New York, 1989. xii, 237 pp. $19.95.

Robert Teitelman's *Gene Dreams* is a book about the biotechnology "revolution" that began more than a decade ago. Teitelman argues that this "revolution," as it was initially promoted by entrepreneurs, the press, and the financial community, has failed. According to Teitelman, "Biotechnology sold itself on the belief that it could remedy the most profound economic and medical ills of the age, and please Wall Street as well." More than ten years later, in comparing the promises to the results, Teitelman concludes: "Although biotechnology has changed the way the drug business works, it has not sparked anything approaching a Schumpeterian economic revolution."

Why has the "revolution" failed? For Teitelman, the answer lies not in the failures of a particular body of science but with the institutions and people who promised miracles in the first place and who underestimated and intentionally minimized the difficulties of transforming science into technology. There are three villains in this story: the biotechnology entrepreneurs, the press, and the financial community. Their respective roles in feeding the biotechnology mania in the early 1980s are examined in detail through the case of Genetic Systems, a biotechnology company "assembled by a pair of Wall Street deal makers and run by a young scientific entrepreneur."

The entrepreneur lies at the heart of what Teitelman calls "the mythos of biotechnology":

> The industry, of course, has a much grander image of itself than just another industrial enterprise. Particularly in its early days, biotech entrepreneurs talked as if they were assembling academic laboratories that happened to be funded by Wall Street instead of some nonprofit or govern-