The D-21 Tagboard: Its Life and Legacy

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(As prepared)

Building and operating a technological marvel like the D-21 drone in the early 1960s—not to mention doing it covertly so that the outside world knew nothing of its existence until more than a decade later—required a rather unique combination of engineering vision and talent, savvy program management, special authorities, and streamlined contracting practices, and, of course, a vital national security requirement. In short, the Tagboard program exemplified some of the best features of the then-newly established National Reconnaissance Office (NRO): 1) the drone's planned mission addressed the pressing need for deep penetration of denied areas to obtain timely imagery without risking pilot shoot-down and capture; 2) its design and construction pushed technological barriers to derive maximum capability—one of multiple examples where NRO aerospace developed a "next-generation" system; 3) the NRO's carefully guarded secret development and testing of the D-21 followed program management, contracting, and security practices that had succeeded on earlier and continuing covert reconnaissance satellite and overflight programs; 4) Execution of these practices on the Tagboard program required a successful, if sometimes uneasy, partnership among select segments of private industry, the Intelligence Community, and the Department of Defense; 5) and the Lockheed engineers and their Air Force support squadron partners overcame multiple technical issues and setbacks through rigorous testing and design adjustments to reach operational readiness.

Unfortunately, even well run programs sometimes do not yield completely successful systems. Though the D-21 was conceptually brilliant and proven mission capable when flying test courses, neither the initial M-21/D-21 nor the later D-21B operations ever recovered film of denied territory, and one too many mishaps resulted in program cancellation in July 1971. There is a tendency to dismiss cancelled programs as "failures," or a "mistake," but to do so overlooks the value derived from having attempted the program at all. At the NRO's Center for the Study of National Reconnaissance, when studying historical experiences to derive insight, we like to say that "there are no mistakes—only lessons." As with many cancelled programs, the experience gained by the D-21 investment taught valuable lessons that informed successful follow-on developments. Among the important contributions that justify our continued interest in this remarkable vehicle and cement its legacy are the following:

- Advanced low-observable technology, aka "Stealth," which culminated in vehicle designs like the F-117 and B-2 aircraft once computer software advanced to allow calculating for three-dimensional objects;
- Improved upon existing ramjet performance to allow for longer flight time, hence greater range, and increased rocket booster performance to enable the B52H/D-21B system
- Developed pilotless aircraft with sophisticated pre-programmed route (vs. remotely-piloted aircraft that required someone to fly the mission)
- Used same aerial recovery gear and technique as that employed for film capsule recoveries on Corona and Gambit, and the development of a unique parachute

configuration because of the additional weight of the O-21 "hatch" (@880 lbs.) and subsequent training by recovery crews provided the experience to air-catch the Hexagon satellite recovery vehicles

- The NRO learned lessons about transferring management of a program between Program Offices, from Program B to Program D, which it would later put to good use with transferring responsibility for Hexagon from Program B to Program A
- The design and testing for releasing D-21 drone from the A-12 no doubt contributed to later NASA developments, and was so ahead of its time that NASA in the late 1990s considered reactivating D-21s to flight test rocket-based combined-cycle engines, a propulsion system for reusable launch vehicles (eventually opting for a derivative of its own X-43A)

Lockheed lead engineer Kelly Johnson certainly never considered the D-21 a failure; he described the effort as a "program of the most difficult nature…[and yet] we were able to obtain such a high degree of performance with such low cost compared to any other system" (Miller, 1995, p. 141).

Tagboard also exemplified an era of reconnaissance aircraft design—starting with the U-2 and ending with the SR-71—where design requirements strove for that perfect balance of speed, altitude, low visibility, and operating range. In all these areas, the D-21 excelled: an unpiloted aerial vehicle with a miniscule radar cross section that achieved Mach 3.3 cruising speed, operated at hitherto unreachable altitudes of 95,000 feet, and that could traverse 3,000 nautical miles on its outward and return journey, executing pre-programmed maneuvers using a fully automated guidance system—had the public heard of the program in 1962, it might have suspected that it came from the imagination of a science fiction author. Resembling a mini-A-12—Lockheed's Ben Rich described it as "the flat triangular shape of a manta ray" (Rich & Janos, 1994, p. 264), the D-21 was composed of high-strength titanium alloy and high-temperature plastic materials. It was 43 feet long, with a 19-foot wingspan, weighed 10,300 pounds fully fueled, and was fitted with a recoverable payload "hatch" weighing 880 pounds designed to be ejected over the ocean at mission completion and then caught mid-air by a specially adapted JC-130B Hercules aircraft. The hatch contained among other items the camera, camera electronics, the inertial navigation system computer, electronics, and power supply, command receiver, the recovery beacon and beacon antennas, and the "aerodynamic decelerator system," i.e., the parachute recovery system. All but the parachute were mounted on the hatch within a watertight cover in case the hatch was not air caught.

The drone's incredible performance owed to the Marquardt Ramjet engine, but by choosing this means of propulsion, Lockheed was forcing the need to mount the D-21 on and launch from its Mach 3-capable A-12, which was just beginning testing in 1962. As covert as the A-12 development program was, if possible, the D-21 was held even closer to the vest: In re-assigning management responsibility for the Tagboard program from NRO Program B to the Director, NRO Program D in 1963, then DNRO Brockway McMillan affirmed "This project will remain within the purview of the NRO and be considered a covert, clandestine, and completely black activity throughout the construction, test, and operational phases." Only those with the strictest need-to-know were even aware of it, which amounted to fewer than one hundred people. A recovery aircraft commander that I corresponded with recalled that no one ever mentioned the word "Tagboard," and that initially only three squadron aircrews were granted access and dedicated to recovery missions (emails to author).

After the tragic July 1966 mid-air crash of the D-21 and M-21, resulting in the death of Launch Control Officer Ray Torick, the program was reconfigured to launch a now re-designated D-21B drone from adapted B52H aircraft. This required the addition of a solid fuel booster, and here again, Lockheed excelled, developing a booster capable of burning for 87 seconds that lifted the drone from 40,000 ft to 80,000 ft, and then was jettisoned as the ramjet took over. The drone on display here at the museum, which NRO Chief of Recognition, Exhibits, and Outreach Ms. Trisha Aquintey, will be discussing shortly, was one of these second generation, if you will, D-21Bs. It was in this configuration that the Tagboard or "Senior Bowl" as the Air Force called it, came closest to operational success. On several test missions—called "Captain Hook—the drone flew its designed range at altitudes over 90,000 ft. and the recovery crews successfully recovered the payload hatch and film. Alas, as I mentioned earlier, none of the operational missions conducted over China between November 1969 and March 1971 succeeded in recovering film—though they were tantalizingly close on the third mission, on which the drone completed its flight and ejected the payload, but damage to the parachute resulted in the package falling in the water, and Naval vessels standing by were unable to retrieve it before it sank. At the recommendation of the ExCom, the program was cancelled on 15 July 1971.

In the final analysis, the D-21 remains a remarkable achievement and we should appreciate it as an historical artifact, and a great example of technological innovation by the Lockheed Skunk Works and the NRO. As Dr. McDonald said in his introduction, perhaps the program cancellation owed as much to NRO's satellite development successes as it did to the drone's operational setbacks; it was not coincidental that just a month before the decision to cancel, the NRO had successfully launched its newest imagery satellite, Hexagon, destined to become its most capable and dependable film-recovery system ever. Like the A-12 and SR-71, the D-21B was audacious, bold technology, well ahead of its time, and perhaps the lesson that we can take away from the experience is that, while risk taking development often pays off, it sometimes doesn't happen in the needed time frame, and is overcome by other events, made expendable by higher funding priorities. The Director NRO, John McLucas, by 1971 was already considering eliminating Program D, as the organization was fully committing to focusing on upgrading its satellite constellation. This consigned unpiloted aerial vehicles to a subsidiary role, at best, and it would some time before the U.S. would exploit this capability to anywhere near the level that had been envisioned for the D-21, Lockheed's "twice unsuccessful success."

References

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