

The HAE UAV ACTD program was in aggregate a success. The program demonstrated the technical feasibility and operational utility of a new system concept. The Tier II+ program to a large extent developed and demonstrated an HAE UAV system capable of affordable, continuous, all-weather, wide-area surveillance in support of military operations. Given follow-on development, Global Hawk will provide ISR information to the warfighter.

The DarkStar effort was terminated fairly early in the overall development process. The DarkStar program accomplished most of what constitutes a traditional technology demonstration program along with some follow-on nonrecurring engineering to improve the system's configuration, as well as the manufacture of some additional developmental assets. The DarkStar program was canceled before a determination of its full operational capabilities could be made.

At the end of the HAE UAV ACTD, Global Hawk was not a fully developed system and did not demonstrate all that the ACTD had called for. However, the system was well along in development. Moreover, it showed the potential to be operationally suitable and militarily useful given a follow-on EMD program involving a small fraction of the time and funding normally required in a traditional EMD program.

ACTD EXECUTION

The HAE UAV programs were designated an ACTD in the first year that Congress authorized this acquisition strategy. Neither the gov-

ernment program management nor the participating contractors had any experience managing within this acquisition strategy. As no program had yet used the strategy, no prior experience could be drawn on. This put program management in the position of interpreting the minimal guidance it was given and literally making up the details of the process as they went along.

DARPA's management of the front end of this program was highly unusual. DARPA, an agency charged with technological innovation, is not in the business of developing new weapon system concepts. Nevertheless, DARPA was expected to complete the design and build of the first two examples of each system and to prove the basic flightworthiness of each. DARPA was then expected to transfer both development efforts to the Air Force. The Air Force, which initially had no stated requirement, budget, or interest in either system, was to complete the ACTD and pave the way for the future development or production of one or both HAE UAV concepts. This plan strikes us as high risk. Its success was therefore a substantial achievement on the part of both DARPA and the Air Force.

In the sense of what was envisioned at the beginning of the program compared to what occurred, the activity content of the ACTD was greatly curtailed while both the cost and schedule of the total effort grew only slightly. What occurred, in effect, was a continuous change in activity content throughout the ACTD in an attempt to stay within the original total cost and schedule constraints defined at its inception. While the ACTD construct largely defined those constraints, other elements of the HAE UAV program's approach enabled management to stay within those bounds while still developing a system with demonstrated military utility. In Global Hawk in particular, the collaborative working relationship established via the use of IPTs allowed for consensus building between the government and contractor; the inherent flexibility of OT provided a mechanism that made implementing change relatively easy; and early user involvement kept the program focused on its primary objective of demonstrating military utility.

The inherently uncertain and risky design, build, and basic testing of the first two aircraft ended up consuming a much larger portion of the allotted budget and calendar time than had been called for in the initial ACTD plan. To stay within these constraints, the planned de-

velopment and testing efforts were greatly curtailed. As a result, not all operational capabilities that the system might be capable of were given sufficient opportunity for demonstration.

When the Air Force took over the management of the ACTD in October 1998, DarkStar lagged far behind the developmental maturity of Global Hawk. Not enough time and resources were left to continue with the two programs through the conclusion of the ACTD. Given these circumstances, and given the apparent technical problems inherent in DarkStar's design, the Air Force decided to cancel DarkStar.

The success of Global Hawk in the D&E phase shows that reducing the activity content to cover increased costs for nonrecurring engineering activities was a wise course of action. The diminished activity content of the ACTD resulted from a serious underestimation of the complexity of the development effort required to create a minimally functional system with the desired HAE UAV capability. The unmanned nature of the air vehicle in some ways made it less challenging and costly to build than a manned air vehicle but in other ways made it more challenging. Had significantly more resources been made available, additional residual assets from the ACTD would be available today, and Global Hawk would be a more fully developed system.

The development efforts of the HAE UAV ACTD were not sufficient to field production-ready systems. The Air Force program office believes that had making the system production-ready by the completion of the ACTD been the overriding priority, this could have been accomplished. However, the overall objective of the acquisition strategy was to provide an enhancement to the warfighter's operational capabilities in a way that was deemed by the users to be worth the cost. Given this overriding objective, the path to success in the ACTD required that the system's military utility be proven via the execution of the D&E program.

Global Hawk is prepared to enter the acquisition process with a greatly abbreviated EMD and concurrent serial production. As a result, the ACTD was sufficient as an acquisition strategy for one of the more desirable post-ACTD paths to be followed. The proposed spiral development represents the logical extension for further acquisition

in this program. Spiral development is essentially what was practiced throughout the ACTD in Phases II, IIB, and III. The spiral development process also accurately describes the phases being used to bridge the ACTD and EMD efforts—that is, Phase IIC and the pre-EMD.

The Unit Flyaway Price

The single program requirement, the UFP, will not be attained in the Global Hawk program and would not have been attainable in the DarkStar program. Yet the HAE UAV program office does not view this failure to meet the UFP as constituting failure on the part of the DoD's HAE efforts. We agree with this assessment.

The reasons the program's sole requirement was not met were as follows:

- **Little or no analytical basis in support of the UFP.** This was the result of a deliberate philosophy of *setting the price* at what was believed the customer was willing to pay rather than at what actual costs would be.
- **Rationalization of the UFP through extremely optimistic and essentially *unrealistic assumptions*.** The result of these assumptions not materializing were direct cost increases for components that make up the air vehicles themselves and direct cost increases of running the manufacturing and engineering organizations executing the program.
- **The unwillingness of government program management to mandate the *cost control philosophy* defined at the program's inception.** The DARPA program office was unwilling to give up major system capability to meet the UFP requirement.

The UFP constraint shaped the system in both positive and negative ways. Its invocation successfully kept additional requirements from being imposed on the program. It put continuous pressure on the contractor to control costs, with both positive and negative results. It could be held over the contractor as paramount and credibly referred to as potentially causing program cancellation if not met. Its continued existence instilled a cost consciousness at the contractor that almost certainly would not otherwise have prevailed.

On the other hand, the UFP forced design compromises that actually increased costs in the long run. Government program engineers believe that total life-cycle costs will increase as a result of the UFP. The setting of a firm price requirement on just one segment of the larger system also created the potential for the nonoptimal allocation of airborne and ground-based capabilities. In addition, it is believed that in the long run, the UFP inhibited systemwide cost control by discouraging investment in more costly basic system design solutions that would more than pay for themselves later, when the system incurs operating and support costs.

In future programs, objectives should be stated as goals, and management must retain the authority to modify the balance among these goals as the program evolves. An acquisition strategy providing for the balancing of and willingness to trade cost, schedule, and system performance will provide the flexibility needed to ensure the best possible overall outcome.

Comparative Success

In many respects, the Global Hawk and DarkStar programs were at least as complex as similar efforts in typical manned aircraft development. Despite this inherent complexity in technology development, integration, and software development, the HAE UAV efforts compare favorably with traditional manned aircraft programs in terms of both cost and schedule. Global Hawk also compares favorably with such programs in terms of performance.

The DarkStar Phase II effort can best be compared to the Have Blue and Tacit Blue programs. The final cost of DarkStar Phase II was roughly what one would expect given the costs and accomplishments of these historical programs. The Global Hawk Phase II effort can best be compared to the two prototype development efforts of the LWF program. These three programs cost about the same once each is adjusted for known definitional differences in estimates. This is a favorable outcome given that conventional wisdom views the LWF prototype program as one of the most successful such programs in Air Force history.

The Global Hawk equivalent EMD is defined as Phases IIB and III of the ACTD, plus Phase IIC and the pre-EMD that bridge the ACTD to

formal EMD, plus Spirals 1 and 2 of EMD. The cumulative actual and projected costs of these six phases are compared to EMD expenditures in the F-16, F/A-18, and F-117 programs. The projected cost of Global Hawk's equivalent EMD is about \$1.1 billion in FY 2001 dollars. This is only slightly more than half the inflation-adjusted EMD costs in the least expensive of the comparison programs, the F-16. It is slightly more than one-third more than the inflation-adjusted expense of the most appropriate EMD comparison program, that which developed the F-117.

A large band of uncertainty surrounds the future of Global Hawk development expenditures. After the definition of realistic upper and lower bounds, however, and regardless of which developmental path is taken, Global Hawk development costs will be considerably less than what one might expect given historical programs of roughly similar technological challenge and system complexity.