THE OXCART STORY

One spring day in 1962 a test pilot named Louis Schalk, employed by the Lockheed Aircraft Corporation, took off in an aircraft the likes of which had never been seen before. A casual observer would have been startled by the appearance of this vehicle; he would perhaps have noticed especially its extremely long, slim, shape, its two enormous jet engines, its long, sharp, projecting nose, and its swept-back wings which appeared far too short to support the fuselage in flight. He might well have realized that this was a revolutionary airplane; he could not have known that it would be able to fly at three times the speed of sound for more than 3,000 miles without refueling, or that toward the end of its flight, when fuel began to run low, it could cruise at over 90,000 feet. Still less would he have known of the equipment it was to carry, or of the formidable problems attending its design and construction.

There was, of course, no casual observer present. The aircraft had been designed and built for reconnaissance; it was projected as a successor to the U-2. Its development had been carried out in profound secrecy. Despite the numerous designers, engineers, skilled and unskilled workers, administrators, and others who had been involved in the affair, no authentic accounts, and indeed scarcely any accounts at all, had leaked.

The official designation of the aircraft was A-12. By a sort of inspired perversity, however, it came to be called OXCART, a code word also applied to the program under which it was developed. The secrecy in which it was so long shrouded has lifted a bit, and the purpose of this article is to give some account of the inception, development, operation, and untimely demise of this remarkable airplane. The OXCART no longer flies, but it left a legacy of technological achievement which points the way to new projects. And it became the progenitor of a similar reconnaissance vehicle called the SR-71, whose existence is well known to press and public.

The U-2 dated from 1954, when its development began under the direction of a group headed by Richard M. Bissell of CIA. In June 1956, the aircraft became operational, but officials predicted that its useful lifetime over the USSR could hardly be much more than 18 months or two years. Its first flights over Soviet territory revealed that the air defense warning system not only detected but tracked it quite accurately. Yet it remained a unique and invaluable source of intelligence information for almost four years, until on 1 May 1960, Francis Gary Powers was shot down near Sverdlovsk.

Studies in Intelligence, Vol. 26, No. 2, Summer 1982

Meanwhile, even as the U-2 commenced its active career, efforts were under way to make it less vulnerable. The hope was to reduce the vehicle's radar cross-section, so that it would become less susceptible to detection. New developments in radar-absorbing materials were tried out and achieved considerable success, though not enough to solve the problem. Various far-out designs were explored, most of them seeking to create an aircraft capable of flying at extremely high altitudes, though still at relatively slow speed. None of them proved practicable.

Eventually, in the fall of 1957, Bissell arranged with a contractor for a job of operations analysis to determine how far the probability of shooting down an airplane varied respectively with the plane's speed, altitude, and radar cross-section. This analysis demonstrated that supersonic speed greatly reduced the chances of detection by radar. The probability of being shot down was not of course reduced to zero, but it was evident that the supersonic line of approach was worth serious consideration. Therefore, from this time on, attention focussed increasingly on the possibility of building a vehicle which could fly at extremely high speeds as well as at great altitudes, and which would also incorporate the best that could be attained in radar-absorbing capabilities. Lockheed Aircraft Corporation and Convair Division of General Dynamics were informed of the general requirement, and their designers set to work on the problem without as yet receiving any contract or funds from the government. From the fall of 1957 to late 1958 these designers constantly refined and adapted their respective schemes.

Bissell realized that development and production of such an aircraft would be exceedingly expensive, and that in the early stages at least it would be doubtful whether the project could succeed. To secure the necessary funds for such a program, high officials would have to receive the best and most authoritative presentation of whatever prospects might unfold. Accordingly, he got together a panel consisting of two distinguished authorities on aerodynamics and one physicist, with E. M. Land of the Polaroid Corporation as chairman. Between 1957 and 1959 this panel met about six times, usually in Land's office in Cambridge. Lockheed and Convair designers attended during parts of the sessions. So also did the Assistant Secretaries of the Air Force and Navy concerned with research and development, together with one or two of their technical advisors. One useful consequence of the participation of service representatives was that bureaucratic and jurisdictional feuds were reduced virtually to nil. Throughout the program both Air Force and Navy gave valuable assistance and cooperation.

As the months went by, the general outlines of what might be done took shape in the minds of those concerned. Late in November 1958, the members of the panel held a crucial meeting. They agreed that it now appeared feasible to build an aircraft of such speed and altitude as to be very difficult to track by radar. They recommended that the President be asked to approve in principle a further prosecution of the project, and to make funds available for further studies and tests. The President and his Scientific Advisor, Dr. James Killian, were already aware of what was going on, and when CIA officials went to them with the recommendation of the panel they received a favorable hearing. The President gave his approval. Lockheed and Convair were then asked to submit definite proposals, funds were made available to them, and the project took on the code name GUSTO.

Less than a year later the two proposals were essentially complete, and on 20 July 1959, the President was again briefed. This time he gave final approval, which signified that the program could get fully under way.

The next major step was to choose between the Lockheed and Convair designs. On 20 August 1959, specifications of the two proposals were submitted to a joint DOD/USAF/CIA selection panel:

	Lockheed	Convair
Speed	Mach 3.2	Mach 3.2
Range (total)	4,120 n.m.	4,000 n.m.
Range (at altitude)	3,800 n.m.	3,400 n.m.
Dimensions		
Length	102 ft.	79.5 ft.
Span	57 ft.	56.0 ft.
Gross Weight	110,000 lbs.	101,700 lbs.
Fuel Weight	64,600 lbs.	62,000 lbs.
First Flight	22 months	22 months

The Lockheed design was selected, Project GUSTO terminated, and the program to develop a new U-2 follow-on aircraft was named OXCART. On 3 September 1959, CIA authorized Lockheed to proceed with antiradar studies, aerodynamic structural tests, and engineering designs, and on 30 January 1960 gave the green light to produce 12 aircraft.

Pratt and Whitney Division of United Aircraft Corporation had been involved in discussions of the project, and undertook to develop the propulsion system. Their J-58 engine, which was to be used in the A-12, had been sponsored originally by the US Navy for its own purposes, and was to be capable of a speed of

Mach 3.0. Navy interest in the development was diminishing, however, and the Secretary of Defense had decided to withdraw from the program at the end of 1959. CIA's requirement was that the engine and airframe be further developed and optimized for a speed of Mach 3.2. The new contract called for initial assembly of three advanced experimental engines for durability and reliability testing, and provision of three engines for experimental flight testing in early 1961.

Lockheed's designer was Clarence L. (Kelly) Johnson, creator of the U-2, and he called his new vehicle not A-12 but A-11. Its design exhibited many innovations. Supersonic airplanes, however, involve a multitude of extremely difficult design problems. Their payload-range performance is highly sensitive to engine weight, structural weight, fuel consumption, and aerodynamic efficiency. Small mistakes in predicting these values can lead to large errors in performance. Models of the A-11 were tested and retested, adjusted and readjusted, during thousands of hours in the wind tunnel. Johnson was confident of his design, but no one could say positively whether the bird would fly, still less whether it would fulfill the extremely demanding requirements laid down for it.

To make the drawings and test the model was one thing; to build the aircraft was another. The most numerous problems arose from the simple fact that in flying through the atmosphere at its designed speed the skin of the aircraft would be subjected to a temperature of more than 550 degrees Fahrenheit. For one thing, no metal hitherto commonly used in aircraft production would stand this temperature, and those which would do so were for the most part too heavy to be suitable for the purpose in hand.

During the design phase Lockheed evaluated many materials and finally chose an alloy of titanium B120, characterized by great strength, relatively light weight, and good resistance to high temperatures. Titanium was also scarce and very costly. Methods for milling it and controlling the quality of the product were not fully developed. Of the early deliveries from Titanium Metals Corporation some 80 percent had to be rejected, and it was not until 1961, when a delegation from headquarters visited the officials of that company, informed them of the objectives and high priority of the OXCART program, that the problems were solved.

But this only solved an initial problem. One of the virtues of titanium was its exceeding hardness, but this very virtue gave rise to immense difficulties in machining and shaping the material. Drills which worked well on aluminum soon broke into pieces; new ones had to be devised. Assembly-line production was impossible; each of the small OXCART fleet was, so to speak, turned out by hand. The cost of the program mounted well above original estimates, and it soon began to run behind schedule. One after another, however, the problems were solved, and their solution constituted the greatest single technological achievement of the entire enterprise. Henceforth it became practicable, if expensive, to build aircraft out of titanium.

Since every additional pound of weight was critical, adequate insulation was out of the question. The inside of the aircraft would be like a moderately hot oven. The pilot would have to wear a kind of space suit, with its own cooling apparatus, pressure control, oxygen supply, and other necessities for survival. The fuel tanks, which constituted by far the greater part of the aircraft, would heat up to about 350 degrees, so that special fuel had to be supplied and the tanks themselves rendered inert with nitrogen. Lubricating oil was formulated for operation at 600 degrees F., and contained a diluent in order to remain fluid at operation below 40 degrees. Insulation on the plane's intricate wiring soon became brittle and useless. During the lifetime of the OXCART no better insulation was found; the wiring and related connectors had to be given special attention and handling at great cost in labor and time.

Then there was the unique problem of the camera window. The OXCART was to carry a delicate and highly sophisticated camera, which would look out through a quartz glass window. The effectiveness of the whole system depended upon achieving complete freedom from optical distortion despite the great heat to which the window would be subjected. Thus the question was not simply one of providing equipment with resistance to high temperature, but of assuring that there should be no unevenness of temperature throughout the area of the window. It took three years and two million dollars to arrive at a satisfactory solution. The program scored one of its most remarkable successes when the quartz glass was successfully fused to its metal frame by an unprecedented process involving the use of high frequency sound waves.

Another major problem of different nature was to achieve the low radar cross-section desired. The airframe areas giving the greatest radar return were the vertical stabilizers, the engine inlet, and the forward side of the engine nacelles. Research in ferrites, high-temperature absorbing materials and high-temperature plastic structures was undertaken to find methods to reduce the return. Eventually the vertical tail section fins were constructed from a kind of laminated "plastic" material--the first time that such a material had been used for an important part of an aircraft's structure. With such changes in structural materials, the A-11 was redesignated A-12, and as such has never been publicly disclosed.

To test the effectiveness of antiradar devices a small-scale model is inadequate; only a full-size mock-up will do. Lockheed accordingly built one of these, and as early as November 1959, transported it in a specially designed trailer truck over hundreds of miles of highway from the Burbank plant to the test area. Here it was hoisted to the top of a pylon and looked at from various angles by radar. Tests and adjustments went on for a year and a half before the results were deemed satisfactory. In the course of the process it was found desirable to attach some sizable metallic constructions on each side of the fuselage, and Kelly Johnson worried a good deal about the effect of these protuberances on his design. In flight tests, however, it later developed that they imparted a useful aerodynamic lift to the vehicle, and years afterward Lockheed's design for a supersonic transport embodied similar structures.

Pilots for the OXCART would obviously have to be of quite extraordinary competence, not only because of the unprecedented performance of the aircraft itself, but also because of the particular qualities needed in men who were to fly intelligence missions. Brigadier General Don Flickinger of the Air Force, was designated to draw up the criteria for selection, with advice from Kelly Johnson and from CIA Headquarters. Pilots had to be qualified in the latest high performance fighters, emotionally stable, and well motivated. They were to be between 25 and 40 years of age, and the size of the A-12 cockpit prescribed that they be under six feet tall and under 175 pounds in weight.

One thing to be decided in the earliest stages of the program was where to base and test the aircraft. Lockheed clearly could not do the business at Burbank, where the aircraft were being built, if for no other reason that its runway was too short. The ideal location ought to be remote from metropolitan areas; well away from civil and military airways to preclude observation; easily accessible by air; blessed with good weather the year round; capable of accommodating large numbers of personnel; equipped with fuel storage facilities; fairly close to an Air Force installation; and possessing at least an 8,000 foot runway. There was no such place to be found.

Ten Air Force bases programmed for closure were considered, but none provided the necessary security and annual operating costs at most of them would be unacceptable. Edwards Air Force Base in California seemed a more likely candidate, but in the end it also was passed over. Instead, a very secluded site was finally picked. It was deficient in personnel accommodations and POL storage, and its long-unused runway was inadequate, but security was good, or could be made so, and a moderate construction program could provide sufficient facilities. Lockheed estimated what would be needed in such respects as monthly fuel consumption, hangars and shop space, housing for personnel, and runway specifications. Armed with the list of major requirements, Headquarters came up with a construction and engineering plan.

Construction began in earnest in September 1960, and continued on a double-shift schedule until mid-1964. One of the most urgent tasks was to build the runway, which according to initial estimates of A-12 requirements must be 8,500 feet long. The existing asphalt runway was 5,000 feet long and incapable of supporting the weight of the A-12. The new one was built between 7 September and 15 November and involved pouring over 25,000 yards of concrete. Another major problem was to provide some 500,000 gallons of PF-1 aircraft fuel per month. Neither storage facilities nor means of transporting fuel existed. After considering airlift, pipeline, and truck transport, it was decided that the last-named was the most economical, and could be made feasible by resurfacing no more than eighteen miles of highway leading into the base.

Three surplus Navy hangars were obtained, dismantled, and erected on the north side of the base. Over 100 surplus Navy housing buildings were transported to the base and made ready for occupancy. By early 1962 a fuel tank farm was ready, with a capacity of 1,320,000 gallons. Warehousing and shop space was begun and repairs made to older buildings. All this, together with the many other facilities that had to be provided, took a long time to complete. Meanwhile, however, the really essential facilities were ready in time for the forecast delivery date of Aircraft No. 1 in August 1961.

The facilities were ready, but the aircraft were not. Originally promised for delivery at the end of May 1961, the date first slipped to August, largely because of Lockheed's difficulties in procuring and fabricating titanium. Moreover, Pratt & Whitney found unexpectedly great trouble in bringing the J-58 engine up to OXCART requirements. In March 1961, Kelly Johnson notified Headquarters:

> "Schedules are in jeopardy on two fronts. One is the assembly of the wing and the other is in satisfactory development of the engine. Our evaluation shows that each of these programs is from three to four months behind the current schedule."

To this Bissell replied:

> "I have learned of your expected additional delay in first flight from 30 August to 1 December 1961. This news is extremely shocking on top of our previous slippage from May to August and my understanding as of our meeting 19 December that the titanium extrusion problems were essentially overcome. I trust this is the last of such disappointments short of a severe earthquake in Burbank."

Realizing that delays were causing the cost of the program to soar, Headquarters decided to place a top-level aeronautical engineer in residence at Lockheed to monitor the program and submit progress reports.

Delays nevertheless persisted. On 11 September, Pratt & Whitney informed Lockheed of their continuing difficulties with the J-58 engine in terms of weight, delivery, and performance. Completion date for Aircraft No. 1 by now had slipped to 22 December 1961, and the first flight to 27 February 1962. Even on this last date the J-58 would not be ready, and it was therefore decided that a Pratt & Whitney J-75 engine, designed for the F-105 and flown in the U-2, should be used for early flights. The engine, along with other components, could be fitted to the A-12 airframe, and it could power the aircraft safely to altitudes up to 50,000 feet and at speeds up to Mach 1.6.

When this decision had been made, final preparations were begun for the testing phase. Support aircraft began arriving in the spring of 1962. These included eight F-101's for training, two T-33's for proficiency flying, a C-130 for cargo transport, a U-3A for administrative purposes, a helicopter for search and rescue, and a Cessna-180 for liaison use. In addition, Lockheed provided an F-104 to act as chase aircraft during the A-12 flight test period.

Meanwhile in January 1962, an agreement was reached with the Civil Aeronautics Board that expanded the restricted airspace in the vicinity of the test area. Certain CAB air traffic controllers were cleared for the OXCART Project; their function was to insure that aircraft did not violate the order. The North American Air Defense Command established procedures to prevent their radar stations from reporting the appearance of high performance aircraft on their radar scopes.

Refueling concepts required prepositioning of vast quantities of fuel at certain points outside the United States. Special tank farms were programmed in California, Eielson AFB Alaska, and at strategic locations overseas. Since the A-12 used specially refined low vapor pressure fuel, these tank farms were reserved exclusively for use by the OXCART Program. Very small detachments of technicians at these locations maintained the fuel storage facility and arranged for periodic quality control fuel tests.

At the Lockheed Burbank plant, Aircraft No. 1 (serially numbered 121) received its final tests and checkout during January and February 1962, and was partially disassembled for shipment to the site. It became clear very early in OXCART planning that because of security problems and the inadequate runway, the A-12 could not fly from Burbank. Movement of the full-scale radar test model had been successfully accomplished in November 1959, as described above. A thorough survey of the route in June 1961, ascertained the hazards and problems of moving the actual aircraft, and showed that a package measuring 35 feet wide and 105 feet long could be transported without major difficulty. Obstructing road signs had to be removed, trees trimmed, and some roadsides leveled. Appropriate arrangements were made with police authorities and local officials to accomplish the safe transport of the aircraft. The entire fuselage, minus wings, was crated, covered, and loaded on the special-design trailer, which cost about $100,000. On 26 February 1962, it departed Burbank, and arrived at the base according to plan.

First Flights

Upon arrival reassembly of the aircraft and installation of the J-75 engines began. Soon it was found that aircraft tank sealing compounds had failed to adhere to the metals, and when fuel was put into the tanks numerous leaks occurred. It was necessary to strip the tanks of the faulty sealing compounds and reline them with new materials. Thus occurred one more unexpected and exasperating delay in the program.

Finally, on 26 April 1962, Aircraft 121 was ready. On that day, in accordance with Kelly Johnson's custom, Louis Schalk took it for an unofficial, unannounced, maiden flight lasting some 40 minutes. As in all maiden flights minor problems were detected, but it took only four more days to ready the aircraft for its first official flight.

On 30 April 1962, just under one year later than originally planned, the A-12 officially lifted her wheels from the runway. Piloted again by Louis Schalk, it took off at 170 knots, with a gross weight of 72,000 pounds, and climbed to 30,000 feet. Top speed was 340 knots and the flight lasted 59 minutes. The pilot reported that the aircraft responded well and was extremely stable. Kelly Johnson declared it to be the smoothest official first flight of any aircraft he had designed or tested. The aircraft broke the sound barrier on its second official flight, 4 May 1962, reaching Mach 1.1. Again, only minor problems were reported.

With these flights accomplished, jubilation was the order of the day. The new Director of Central Intelligence, Mr. John McCone, sent a telegram of congratulation to Kelly Johnson. A critical phase had been triumphantly passed, but there remained the long, difficult, and sometimes discouraging process of working the aircraft up to full operational performance.

Aircraft No. 122 arrived at base on 26 June, and spent three months in radar testing before engine installations and final assembly. Aircraft No. 123 arrived in August and flew in October. Aircraft No. 124, a two-seated version intended for use in training project pilots, was delivered in November. It was to be powered by the J-58 engines, but delivery delays and a desire to begin pilot training prompted a decision to install the smaller J-75's. The trainer flew initially in January 1963. The fifth aircraft, No. 125, arrived at the area on 17 December.

Meanwhile the OXCART program received a shot in the arm from the Cuban missile crisis. U-2's had been maintaining a regular reconnaissance vigil over the island, and it was on one of these missions in October that the presence of offensive missiles was discovered. Overflights thereafter became more frequent, but on 27 October a U-2, flown by a Strategic Air Force pilot on a SAC-directed mission, was shot down by a surface-to-air missile. This raised the dismaying possibility that continued manned, high-altitude surveillance of Cuba might become out of the question. The OXCART program suddenly assumed greater significance than ever, and its achievement of operational status became one of the highest national priorities.

At the end of 1962 there were two A-12 aircraft engaged in flight tests. A speed of Mach 2.16 and altitude of 60,000 feet had been achieved. Progress was still slow, however, because of delays in the delivery of engines and shortcomings in the performance of those delivered. One of the two test aircraft was still flying with two J-75 engines, and the other with one J-75 and one J-58. It had long since become clear that Pratt & Whitney had been too optimistic in their forecast; the problem of developing the J-58 up to OXCART specifications had proved a good deal more recalcitrant than expected. Mr. McCone judged the situation to be truly serious, and on 3 December he wrote to the President of United Aircraft Corporation:

> "I have been advised that J-58 engine deliveries have been delayed again due to engine control production problems.....By the end of the year it appears we will have barely enough J-58 engines to support the flight test program adequately.....Furthermore, due to various engine difficulties we have not yet reached design speed and altitude. Engine thrust and fuel consumption deficiencies at present prevent sustained flight at design conditions which is so necessary to complete development."

By the end of January 1963, ten engines were available, and the first flight with two of them installed occurred on 15 January. Thenceforth all A-12 aircraft were fitted with their intended propulsion system. Flight testing accelerated and contractor personnel went to a three-shift work day.

With each succeeding step into a high Mach regime new problems presented themselves. The worst of all these difficulties--indeed one of the most formidable in the entire history of the program--was revealed when flight testing moved into speeds between Mach 2.4 and 2.8, and the aircraft experienced such severe roughness as to make its operation virtually out of the question. The trouble was diagnosed as being in the air inlet system, which with its controls admitted air to the engine. At the higher speeds the flow of air was uneven, and the engine therefore could not function properly. Only after a long period of experimentation, often highly frustrating and irritating, was a solution reached. This further postponed the day when the A-12 could be declared operationally ready.

Among more mundane troubles was the discovery that various nuts, bolts, clamps, and other debris of the manufacturing process had not been cleared away, and upon engine run up or take off were sucked into the engine. The engine parts were machined to such close tolerances that they could be ruined in this fashion. Obviously the fault was due to sheer carelessness. Inspection procedures were revised, and it was also found prudent at Burbank to hoist the engine nacelles into the air, rock them back and forth, listen for loose objects, and then remove them by hand.

On 24 May 1963, while on a routine training flight, one of the detachment pilots recognized an erroneous and confusing air speed indication and decided to eject from the aircraft, which crashed 14 miles south of Wendover, Utah. The pilot was unhurt. The wreckage was recovered in two days, and persons at the scene were identified and requested to sign secrecy agreements. All A-12 aircraft were grounded for a week during investigation of the accident. A plugged pilot static tube in icing conditions turned out to be responsible for the faulty cockpit instrument indications--it was not something which would hold things up for long.

Loss of this aircraft nevertheless precipitated a policy problem which had been troubling the Agency for some time. With the growing number of A-12's, how much longer could the project remain secret? The program had gone through development, construction, and a year of flight testing without attracting public attention. There was also a realization that the technological data would be extremely valuable in connection with feasibility studies for the SST. Finally, there was a growing awareness in the higher reaches of the aircraft industry that something new and remarkable was going on. Rumors spread, and gossip flew about. Commercial airline crews sighted the OXCART in flight. The editor of Aviation Week indicated his knowledge of developments at Burbank. The secrecy was thinning out.

The President's Announcement

In spite of all this, 1963 went by without any public revelation. President Johnson was brought up to date on the project a week after taking office, and directed that a paper be prepared for an announcement in the spring of 1964. Then at his press conference on 24 February 1964, he read a statement of which the first paragraph was as follows:

> The United States has successfully developed an advanced experimental jet aircraft, the A-11, which has been tested in sustained flight at more than 2,000 miles per hour and at altitudes in excess of 70,000 feet. The performance of the A-11 far exceeds that of any other aircraft in the world today. The development of this aircraft has been made possible by major advances in aircraft technology of great significance for both military and commercial applications. Several A-11 aircraft are now being flight tested at Edwards Air Force Base in California. The existence of this program is being disclosed today to permit the orderly exploitation of this advance technology in our military and commercial program."

The President went on to mention the "mastery of the metallurgy and fabrication of titanium metal" which has been achieved, gave credit to Lockheed and to Pratt & Whitney, remarked that appropriate members of the Senate and House had been kept fully informed, and prescribed that the detailed performance of the A-11 would be kept strictly classified.

The President's reference to the "A-11" was of course deliberate. "A-11" had been the original design designation for the all-metal aircraft first proposed by Lockheed; subsequently it became the design designation for the Air Force YF-12A interceptor which differed from its parent mainly in that it carried a second man for launching air-to-air missiles. To preserve the distinction between the A-11 and the A-12 Security had briefed practically all witting personnel in government and industry on the impending announcement. OXCART secrecy continued in effect. There was considerable speculation about an Agency role in the A-11 development, but it was never acknowledged by the government. News headlines ranged from "US has dozen A-11 jets already flying" to "Secret of sizzling new plane probably history's best kept."

The President also said that "the A-11 aircraft now at Edwards Air Force Base are undergoing extensive tests to determine their capabilities as long-range interceptors." It was true that the Air Force in October 1960, had contracted for three interceptor versions of the A-12, and they were by this time available. But at the moment when the President spoke, there were no A-11's at Edwards and there never had been. Project officials had known that the public announcement was about to be made, but they had not been told exactly when. Caught by surprise, they hastily flew two Air Force YF-12A's to Edwards to support the President's statement. So rushed was this operation, so speedily were the aircraft put into hangars upon arrival, that heat from them activated the hangar sprinkler system, dousing the reception team which awaited them.

Thenceforth, while the OXCART continued its secret career at its own site, the A-11 performed at Edwards Air Force Base in a considerable glare of publicity. Pictures of the aircraft appeared in the press, correspondents could look at it and marvel, stories could be written. Virtually no details were made available, but the technical journals nevertheless had a field day. The unclassified Air Force and Space Digest, for example, published a long article in its issue of April 1964, commencing: "The official pictures and statements tell very little about the A-11. But the technical literature from open sources, when carefully interpreted, tells a good deal about what it could and, more importantly, what it could not be. Here's the story....."

Going Operational

Three years and seven months after first flight in April 1962 the OXCART was declared ready for operational use at design specifications. The period thus devoted to flight tests was remarkably short, considering the new fields of aircraft performance which were being explored. As each higher Mach number was reached exhaustive tests were carried out in accordance with standard procedures to ensure that the aircraft functioned properly and safely. Defects were corrected and improvements made. All concerned gained experience with the particular characteristics and idiosyncrasies of the vehicle.

The aircraft inlet and related control continued for a long time to present the most troublesome and refractory problem. Numerous attempts failed to find a remedy, even though a special task force concentrated on the task. For a time there was something approaching despair, and the solution when finally achieved was greeted with enormous relief. After all, not every experimental aircraft of advanced performance has survived its flight testing period. The possibility existed that OXCART also would fail, despite the great cost and effort expended upon it.

The main burden of test flights fell upon Lockheed pilots, and some of the aircraft that became available at the site were reserved for the most advanced testing. At the same time, however, the detachment pilots were receiving training and familiarizing themselves with the new vehicle. In the course of doing so, they contributed a good many suggestions for improvements, and their own numerous flights shortened the time required for the test program as a whole. Indeed, one feature of OXCART development was this intimate collaboration between designer, test pilots, operational pilots, and CIA officials, all of whom worked together with great effectiveness.

A few dates and figures will serve to mark the progress of events. By the end of 1963 there had been 573 flights totalling 765 hours. Nine aircraft were in the inventory. On 20 July 1963 test aircraft flew for the first time at Mach 3; in November Mach 3.2 (the design speed) was reached. The longest sustained flight at design conditions occurred on 3 February 1964; it lasted for ten minutes at Mach 3.2. By the end of 1964 there had been 1,160 flights, totalling 1,616 hours. Eleven aircraft were then available, four of them reserved for testing and seven assigned to the operational detachment.

The record may be put in another way. Mach 2 was reached after six months of flying; Mach 3 after 15 months. Two years after the first flight the aircraft had flown a total of 38 hours at Mach 2, three hours at Mach 2.6, and less than one hour at Mach 3. After three years, Mach 2 time had increased to 60 hours, Mach 2.6 time to 33 hours, and Mach 3 time to nine hours; all Mach 3 time, however, was by test aircraft, and detachment aircraft were still restricted to Mach 2.9.

As may be seen from the figures, most flights were of short duration, averaging little more than an hour each. Primarily this was because longer flights were unnecessary at this stage of testing. It was also true, however, that the less seen of OXCART the better, and short flights helped to preserve the secrecy of the proceedings. Yet it was virtually impossible for an aircraft of such dimensions and capabilities to remain inconspicuous. At its full speed OXCART had a turning radius of no less than 86 miles. There was no question of staying close to the airfield; its shortest possible flights took it over a very large expanse of territory.

The first long-range, high-speed flight occurred on 27 January 1965, when one of the test aircraft flew for an hour and forty minutes, with an hour and fifteen minutes above Mach 3.1. Its total range was 2,580 nautical miles, with altitudes between 75,600 and 80,000 feet.

Two more aircraft were lost during this phase of the program. On 9 July 1964 Aircraft No. 133 was making its final approach to the runway when at altitude of 500 feet and airspeed of 200 knots it began a smooth steady roll to the left. Lockheed test pilot Bill Parks could not overcome the roll. At about a 45 degree bank angle and 200 foot altitude he ejected. As he swung down to the vertical in the parachute his feet touched the ground, for what must have been one of the narrower escapes in the perilous history of test piloting. The primary cause of the accident was that the servo for the right outboard roll and pitch control froze. No news of the accident filtered out.

On 28 December 1965 Aircraft No. 126 crashed immediately after take-off and was totally destroyed. The detachment pilot ejected safely at an altitude of 150 feet. The accident investigation board determined that a flight line electrician had improperly connected the yaw and pitch gyros--had in effect reversed the controls. This time Mr. McCone directed the Office of Security to conduct an investigation into the possibility of sabotage. While nothing of the sort was discovered, there were indications of negligence, as the manufacturer of the gyro had earlier warned of the possibility that the mechanism could be connected in reverse. No action had been taken, however, even by such an elementary precaution as painting the contacts different colors. Again there was no publicity connected with the accident.

The year 1965 saw the test site reach the high point of activity. Completion of construction brought it to full physical size. All detachment pilots were Mach 3.0 qualified. Site population reached over 1,800. Contractors were working three shifts a day. Lockheed Constellations made daily flights between the factory at Burbank and the site. And officials were considering how and when and where to use OXCART in its appointed role.

Targeting the OX

By early 1964 Project Headquarters began planning for the contingency of flights over Cuba under a program designated SKYLARK. Bill Parks' accident in early July held this program up for a time, but on 5 August it was directed that SKYLARK achieve emergency operational readiness by 5 November. This involved preparing a small detachment which should be able to do the job over Cuba, though at something less than the full design capability of the OXCART. The goal was to operate at Mach 2.8 and 80,000 feet altitude.

In order to meet the deadline set, camera performance would have to be validated, pilots qualified for Mach 2.8 flight, and coordination with supporting elements arranged. Only one of several equipments for electronic countermeasures (ECM) would be ready by November, and a senior intra-governmental group, including representation from the President's Scientific Advisor Committee, examined the problem of operating over Cuba without the full complement of defensive systems. This panel decided that the first few overflights could safely be conducted without them, but the ECM would be necessary thereafter. The delivery schedule of ECM equipment was compatible with this course of action.

After considerable modifications to aircraft, the detachment simulated Cuban missions on training flights, and a limited emergency SKYLARK capability was announced. With two weeks notice the OXCART detachment could accomplish a Cuban overflight, though with fewer ready aircraft and pilots than had been planned.

During the following weeks the detachment concentrated on developing SKYLARK into a sustained capability, with five ready pilots and five operational aircraft. The main tasks were to determine aircraft range and fuel consumption, attain repeatable reliable operation, finish pilot training, prepare a family of SKYLARK missions, and coordinate routes with North American Air Defense, Continental Air Defense, and the Federal Aviation Authority. All this was accomplished without substantially hindering the main task of working up OXCART to full design capability. We may anticipate the story, however, by remarking that despite all this preparation the OXCART was never used over Cuba. U-2's proved adequate, and the A-12 was reserved for more critical situations.

In 1965 a more critical situation did indeed emerge in Asia, and interest in using the aircraft there began to be manifest. The Director of the Office of Special Activities briefed senior officials on a scheme which had been drawn up for operations in the Far East. The project was called BLACK SHIELD, and it called for the OXCART to operate out of the Kadena Air Force Base in Okinawa. In the first phase, three aircraft would stage to Okinawa for 60-day periods, twice a year, with about 225 personnel involved. After this was in good order, BLACK SHIELD would advance to the point of maintaining a permanent detachment at Kadena. Secretary Vance made $3.7 million available to be spent in providing support facilities on the island, which were to be available by early fall of 1965.

Meanwhile the Communists began to deploy surface-to-air missiles around Hanoi, thereby threatening our current military reconnaissance capabilities. Secretary McNamara called this to the attention of the Under Secretary of the Air Force on 3 June 1965, and inquired about the practicability of substituting OXCART aircraft for U-2's. He was told that BLACK SHIELD could operate over Vietnam as soon as adequate aircraft performance was achieved.

With deployment overseas thus apparently impending in the fall, the detachment went into the final stages of its program for validating the reliability of aircraft and aircraft systems. It set out to demonstrate complete systems reliability at Mach 3.05 and at 2,300 nautical miles range, with penetration altitude of 76,000 feet. A demonstrated capability for three aerial refuelings was also part of the validation process.

By this time the OXCART was well along in performance. The inlet, camera, hydraulic, navigation, and flight control systems all demonstrated acceptable reliability. Nevertheless, as longer flights were conducted at high speeds and high temperatures, new problems came to the surface, the most serious being with the electrical wiring system. Wiring connectors and components had to withstand temperatures of more than 800 degrees Fahrenheit, together with structural flexing, vibration, and shock. Continuing malfunctions in the inlet controls, communications equipment, ECM systems, and cockpit instruments were in many cases attributable to wiring failures. There was also disturbing evidence that careless handling was contributing to electrical connector failures. Difficulties persisted in the sealing of fuel tanks. What with one thing and another, officials soon began to fear that the scheduled date for BLACK SHIELD readiness would not be met. Prompt corrective action on the part of Lockheed was in order. The quality of maintenance needed drastic improvement. The responsibility for delivering an aircraft system with acceptable reliability to meet an operational commitment lay in Lockheed's hands.

In this uncomfortable situation, OSA's Deputy for Technology went to the Lockheed plant to see Kelly Johnson on 3 August 1965. A frank discussion ensued on the measures necessary to insure that BLACK SHIELD commitments would be met, and Johnson concluded that he himself spend full time at the site in order to get the job done expeditiously. Lockheed President Daniel Haughton offered the full support of the corporation, and Johnson began duty at the site next day. His firm and effective management got Project BLACK SHIELD back on schedule.

Four primary BLACK SHIELD aircraft were selected and final validation flights conducted. During these tests the OXCART achieved a maximum speed of Mach 3.29, altitude of 90,000 feet, and sustained flight time above Mach 3.2 of one hour and fourteen minutes. The maximum endurance flight lasted six hours and twenty minutes. The last stage was reached on 20 November 1965, and two days later Kelly Johnson wrote Headquarters:

> "Overall, my considered opinion is that the aircraft can be successfully deployed for the BLACK SHIELD mission with what I would consider to be at least as low a degree of risk as in the early U-2 deployment days. Actually, considering our performance level of more than four times the U-2 speed and three miles more operating altitude, it is probably much less risky than our first U-2 deployments. I think the time has come when the bird should leave its nest."

An impressive demonstration of the OXCART's capability occurred on 21 December 1966 when Lockheed test pilot Bill Parks flew 10,198 statue miles in six hours. This flight established a record unapproachable by any other aircraft.

With the readiness of the aircraft confirmed, a formal proposal was made that OXCART be deployed to the Far East. After examining the matter, the proposal was not approved. It was agreed, however, that short of actually moving aircraft to Kadena all steps should be taken to develop and maintain a quick reaction capability, ready to deploy within a 21-day period at any time after 1 January 1966. There the matter remained, for more than a year. During 1966 there were frequent renewals of the request for authorization to deploy OXCART to Okinawa and conduct reconnaissance missions over North Vietnam. All were turned down.

Meanwhile, of course, flight testing and crew proficiency training continued. There was plenty of time to improve mission plans and flight tactics, as well as to prepare the forward area at Kadena. New plans shortened deployment time from the 21 days first specified. Personnel and cargo were to be airlifted to Kadena the day deployment was approved. On the fifth day the first OXCART would depart and travel the 6,673 miles in five hours and 34 minutes. The second would go on the seventh and third on the ninth day. The first two would be ready for an emergency mission on the eleventh day, and for a normal mission on the fifteenth day.

BLACK SHIELD

About May of 1967 prospects for deployment took a new turn. A good deal of apprehension was evident in Washington about the possibility that the Communists might introduce surface-to-surface missiles into North Vietnam, and concern was aggravated by doubts as to whether we could detect such a development if it occurred. The President asked for a proposal on the matter and once again CIA suggested that the OXCART be used. Its camera was far superior to the U-2 and its vulnerability was far less. The State and Defense members of the Committee decided to re-examine the requirement and the political risks involved. While they were engaged in their deliberations, the Director of Central Intelligence, Mr. Helms, submitted another formal proposal to deploy the OXCART. In addition, he raised the matter at President Johnson's "Tuesday lunch" on 16 May, and received the President's approval to "go." Walt Rostow later in the day formally conveyed the President's decision, and the BLACK SHIELD deployment plan was forthwith put into effect.

On 17 May airlift to Kadena began. On 22 May the first A-12 (Serial No. 131) flew nonstop to Kadena in six hours and six minutes. Aircraft No. 127 departed on 24 May and arrived at Kadena five hours and 55 minutes later. The third, No. 129, left according to plan on 26 May 1967 and proceeded normally until in the vicinity of Wake Island the pilot experienced difficulties with the inertial navigation and communications systems. Under the circumstances, he decided to make a precautionary landing at Wake Island. The prepositioned emergency recovery team secured the aircraft without incident and the flight to Kadena resumed next day.

On 29 May 1967, the unit at Kadena was ready to fly an operational mission. Two hundred and sixty personnel had deployed to the BLACK SHIELD facility. Except for hangars, which were a month short of completion, everything was in shape for sustained operations. Next day the detachment was alerted for a mission on 31 May, and the moment arrived which would see the culmination of ten years of effort, worry, and cost. As fate would have it, on the morning of the 31st heavy rain fell at Kadena. Since weather over the target area was clear, preparations continued in hopes that the local weather would clear. When the time for take-off approached, the OXCART, which had never operated in heavy rain, taxied to the runway, and took off while the rain continued.

The first BLACK SHIELD mission followed one flight line over North Vietnam and one over the Demilitarized Zone. It lasted three hours and 39 minutes, and the cruise legs were flown at Mach 3.1. Results were satisfactory. Seventy of the 190 known SAM sites in North Vietnam were photographed, as were nine other priority targets. There were no radar signals detected, indicating that the first mission had gone completely unnoticed.

Fifteen BLACK SHIELD missions were alerted during the period from 31 May to 15 August 1967. Seven of the fifteen were flown and of these four detected radar tracking signals, but no hostile action was taken against any of them. By mid-July it had been determined with a high degree of confidence that there were no surface-to-surface missiles in North Vietnam.

Operations and maintenance at Kadena began with the receipt of alert notification. Both a primary aircraft and pilot and a backup aircraft and pilot were selected. The aircraft were given thorough inspection and ser- vicing, all systems were checked, and the cameras loaded into the aircraft. Pilots received a detailed route briefing in the early evening prior to the day of flight. On the morning of the flight a final briefing occurred, at which time the condition of the aircraft and its systems was reported, last-minute weather forecasts reviewed, and other relevant intelligence communicated, together with any amendments or changes in the flight plan. Two hours prior to take-off the primary pilot had a medical examination, got into his suit, and was taken to the aircraft. If any malfunctions developed on the primary aircraft, the back-up could execute the mission one hour later.

A typical route profile for a BLACK SHIELD mission over North Vietnam included a refueling shortly after takeoff, south of Okinawa, the planned photographic pass or passes, withdrawal to a second aerial refueling in the Thailand area, and return to Kadena. So great was the OXCART's speed that it spent only 12 1/2 minutes over North Vietnam in a typical "single pass" mission, or a total of 21 1/2 minutes on two passes.

Once landed back at Kadena, the camera film was removed from the aircraft, boxed, and sent by special plane to the processing facilities. By late summer an Air Force Center in Japan carried out the processing in order to place the photointelligence in the hands of American commanders in Vietnam within 24 hours of completion of a BLACK SHIELD mission.

Between 16 August and 31 December 1967, twenty-six missions were alerted. Fifteen were flown. On 17 September one SAM site traced the vehicle with its acquisition radar but was unsuccessful with its Fan Song guidance radar. On 28 October a North Vietnamese SAM site for the first time launched a single, albeit unsuccessful, missile at the OXCART. Photography from this mission documented the event with photographs of missile smoke above the SAM firing site, and with pictures of the missile and of its contrail. Electronic countermeasures equipment appeared to perform well against the missile firing.

During the flight of 30 October 1967, two sites prepared to launch missiles but neither did. During the second pass at least six missiles were fired at the OXCART, each confirmed by missile vapor trails on mission photography. The pilot saw these vapor trails and witnessed three missile detonations. Post-flight inspection of the aircraft revealed that a piece of metal had penetrated the lower right wing fillet area and lodged against the support structure of the wing tank. The fragment was not a warhead pellet but may have been a part of the debris from one of the missile detonations observed by the pilot.

The SR-71

In late 1962, the Air Force ordered a fleet of A-11's from Lockheed, which upon being finished as two-seated reconnaissance aircraft would be named SR-71. The first flight was made in December 1964 and the SR-71 became operation in 1967. The fact that these aircraft were ordered eased the path of OXCART development, since it meant that the financial burden was shared with the Air Force, and the cost per aircraft was somewhat reduced by producing greater numbers. In the longer run, however, the existence of SR-71 spelled the doom of OXCART.

Ending

In spite of all the efforts to save the program, the Secretary of Defense on 16 May 1968 reaffirmed the original decision to terminate the OXCART Program and store the aircraft. This decision was confirmed by the President on 21 May 1968 during his weekly luncheon meeting with his principal advisers.

Early in March 1968, USAF SR-71 aircraft began to arrive at Kadena to take over the BLACK SHIELD commitment, and by gradual stages the A-12 was placed on standby to back up the SR-71. Project Headquarters selected 8 June 1968 as the earliest possible date to begin redeployment, and in the meantime flights of A-12 aircraft were to be limited to those essential for maintaining flying safety and pilot proficiency. After BLACK SHIELD aircraft arrived in the US they would proceed to storage. Those already at base were placed in storage by 7 June.

Postscript

In summary: the OXCART Program lasted just over ten years, from its inception in 1957 through first flights in 1962 to termination in 1968. During this period a total of 22 operational missions had been flown over hostile territory.

Lockheed produced 15 OXCARTS, three YF-12-A's, and 31 SR-71's. Five OXCARTs were lost in accidents; two pilots were killed, and two had narrow escapes. In addition, two F-101 chase planes were lost with their Air Force pilots during OXCART's testing phase.

The main objective of the program--to create a reconnaissance aircraft of unprecedented speed, range, and altitude capability--was triumphantly achieved. It may well be, however, that the most important aspects of the effort lay in its by-products--the notable advances in aerodynamic design, engine performance, cameras, electronic countermeasures, pilot life support systems, antiradar devices, and above all in milling, machining, and shaping titanium. Altogether it was a pioneering accomplishment.