I Flew the U-2

One of Lockheed's former chief test pilots for high altitude reconnaissance describes the joys and terrors of the U-2.

(USAF)

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Marine Corps Reserve Major General Kenneth Weir (ret.) flew U-2s as a Lockheed test pilot between 1966 and 1993. A Marine aviator and graduate of the U.S. Naval Test Pilot School and the U.S. Air Force Aerospace Research Pilot School, Weir accumulated more than 19,500 hours in more than 200 types and models of aircraft.

Air & Space: **Once an airplane has been flying in service, as the U-2 had been when you started at Lockheed in 1966, what is the test pilot's job at that point?**

Ken Weir: The airplane's flight envelope had been expanded by the first pilots who flew the it. After it goes operational, most of the work done by the test pilots is developing electronic systems for the airplane—the sensors, the photographic equipment, the ELINT [Electronic Signals Intelligence] systems, modifications to the autopilots, flight control systems, and things of that sort.

The TR-1 was a production re-start of the U-2R with the addition of "Super Pods" on the wings to accommodate extensive

new airborne sensor systems. The Super Pods caused unforeseen structural dynamics at high Mach numbers at very high altitudes that had to be resolved. The U-2S airplane was the re-engining of all of the big U-2s with a new General Electric F118 turbofan engine. The initial flights were flown without any airstart capability until the incorporation of a hydrazine starter.

We verified the high-altitude performance of cameras that were to be used in satellites for reconnaissance. The manufacturer would develop the cameras, then we'd carry them as high as we could get them and check them out before they went into the satellite programs. Initially, the pilots weren't allowed to look at the pictures; they kept that compartmentalized, and we were shown only some of the tracker camera film. That was mostly unclassified. The pictures from the higher resolution cameras, they kept covert. We didn't get to enjoy what we called "our take."

So the pilots didn't get to see the pictures they were taking.

I've seen more of those pictures now in history books than I saw in the program. We did have a viewsight: There was a periscope that poked out of the bottom of the airplane, and you could get a look at where you were, so you could kind of imagine what the cameras or infrared or side-looking radars were getting.

What was it like flying missions that you couldn't tell anybody about?

Everybody was guessing, and you couldn't tell them, so you just let em keep on guessing. And that made it more intriguing.

You flew both the earlier, shorter-winged U-2 and the more modern variant with the very long, 105-foot wingspan.

I flew the little one and the big one. They modified the A model to put the bigger engine in it, and that was the C, the hot rod. That was a really fun airplane to fly. The Cs had a higher rate of climb; their thrust-to-weight ratio was a lot better.

They were a lot dicier airplane to fly because of the airfoil. In 1968, they built the big airplanes, and they had a much larger wing area and a different airfoil. They were a lot easier to handle at altitude; they had roll spoilers to go along with lift spoilers.

The G model was also a small airplane. That was the U-2C that was modified for carrier operations. They put a little different camber on the leading edge of the wing, and put lift spoilers on it, and a tailhook of course. And with the big engine—the J-75 non afterburning engine—it would just leap up. It would rocket to altitude. It was a fun airplane to fly also.

What was the challenge of flying the smaller airplane?

When the littler airplane got up to altitude, the margin between the climb speed and the critical Mach number and stall became very, very minor, and we were looking at plus or minus two-and-a-half knots at one particular point in the climb between the climb schedule and critical Mach and stall speed so that's very very small. When we got the bigger airplanes, we got up to plus or minus seven-and-a-half knots of margin.

But we were saddled with trying to maintain that climb schedule for long, long periods of time, so we would never go to altitude without an autopilot. You engaged the autopilot as you were climbing out, and then you got into the climb-Mach schedule, and you engaged "Mach hold,"; you had a small Mach trim wheel so you could tweak it just a little—more Mach or less Mach. And it maintained that climb schedule. It was almost impossible to "hand-fly" it—disengage the autopilot and try and fly it up through there with the yoke.

When Francis Gary Powers (we called him "Frank") got shot down, he was having trouble with the autopilot, and he had to descend to a lower altitude to hand fly it, and that's when the surface-to-air missiles were able to get him.

How did it help to descend?

At lower altitudes, the airplane was more stable and there was more margin between the stall buffet and critical Mach number

buffet. During the cruise phase of the mission, as you burned off fuel and the aircraft got lighter, you had a little more margin even as it gained more altitude. The envelope expanded as you got higher and higher and lighter and lighter. Then you got more margin between the Mach buffet and stall buffet. If you encountered buffet, the first thing you did was go faster. You'd assume it was stall buffet, and you wanted to go faster because if you guessed wrong and slowed down, then it would stall and quit flying altogether. It would flip over on its back, and that's how we lost a lot of the airplanes. It stalled at altitude, it would head straight down, and the tail would snap off.

Is that why the change was made to the longer wing?

No, I think the reason they went to a larger airplane was that they wanted more range and a larger payload—more capability. They wanted the same altitude, but we never got to the same altitude in the bigger airplane that we could in the little one. The smaller airplane was lighter and had a higher thrust-to-weight ratio, and it would get up there. We could get up to 74, 75,000.

How would it tell you that you couldn't get any higher?

We'd have it at maximum EGT [exhaust gas temperature], so you were getting everything you could out of the engine and it didn't have any more thrust to overcome the drag to give you what you needed to go higher. If you increased you angle of attack to generate more lift, it would generate more drag, and airspeed or Mach wouldn't hold up.

You flew two aircraft that were structurally damaged, and you were advised to eject both times. Why did you keep flying?

We went back and pulled a lot of U-2Cs out of storage, and we had to verify that they had them all back together right. What happened on one of the airplanes was that on the hot section of the engine, they used a Teflon fairlead [a fitting mounted on a bracket to guide a cable]; that's what control cables went through—these Teflon fairleads on the inside of the fuselage near the hot section of the engine. They had small holes, just so that the control cables could slide back and forth.

It's interesting that these sophisticated airplanes had manual control with cables.

Oh yeah, the U-2, both the little one and the big one, did not have boosted flight controls. It was all pushrods, bell cranks, and pulleys and cables. We did not have boosted ailerons in either airplane. That's why it had a yoke in it rather than a stick—to provide you with the leverage that you needed to move the control surfaces.

Why were there no hydraulics for boost?

To keep it light. The lighter it was the higher it would go. Every pound that the airplane weighed was a foot of altitude that you lost, so you wanted to keep it as light as you possibly could to get it as high as you could. When they added a new system, a new camera, a new radar that weighed 'x' pounds, that was altitude that you were going to give up.

And you'd have to fly that new camera or system to find out what impact it had on the altitude.

Yes.

But back to the fairleads holding the control cables in place.

They used Teflon. But someone mistakenly selected nylon. Well, I went smoking off and the hot section of the engine melted the fairleads, and when I got to altitude and it was really cold, the fairlead that had melted congealed, and it had congealed around the control cable. And so I had trouble with it during the flight, and I couldn't understand why it wasn't maintaining climb schedule, and why I was having so much difficulty with it. At one point, the autopilot just couldn't deal with it and it got real slow, and I attempted a programmed turn, and it stalled out. The airplane flipped over on its back, and I laid into the ailerons to keep it rolling because I didn't want to wind up upside down. I got it right side up, and …

This is all happening in a matter of seconds, right?

Oh yeah. In five seconds or less. I was at about 60,000 feet when this happened. And I got it wings level, and it was heading downhill, so I pulled the throttle back and threw everything out—the gear out, the speed brakes out, flaps raised to the gust

position—I was going straight down, but I managed to get it out of the dive, and recovered. I cleaned the configuration up, added power, and flew it back up to altitude not knowing what was going on. Then I took it back home, and I realized when I got down lower and tried to hand fly the airplane that I didn't have any elevator control. And so I was just barely able to keep it straight and level, descending very slowly and finally made an approach to a landing and didn't like it, so added power, and the airplane climbed back out, and then I came back around and tried it again, and my boss told me I oughta seriously consider jumping out of it because the airplanes were so fragile. They built them so light that they didn't sustain damage very well when you impacted the ground. He thought I should jump out, but I had never ejected and I really wasn't seriously considering that.

That's a good record to preserve, never having ejected.

[laughter] I got through all of it without ever having to eject. When I got close to the runway, I pushed very hard on the rudder pedals and pulled very hard on the yoke, and it snapped the fairlead off its fitting, and all of the sudden, I had all of the elevator authority that I needed. The tail went down and the nose went up and it stalled and plunked on the runway, and that was it. When they got in it and found out what was going on, they had to go back and re-examine all of the airplanes that had gone through remanufacture and make sure that we didn't have any more of those.

What about the second time you were told to eject?

Something was wrong with the lower Q-bay [where the camera was installed] hatch. One of the crew chiefs had failed to notice that the lower Q-bay hatch had not been properly locked on one side. So when I went to altitude and the Q-bay pressurized, the hatch blew partially open. Then I lost all the pressurization in the airplane, and the pressure suit squeezed me down tight. I was at altitude and trying to come down. And one of the procedures for descending was to lower the landing gear to increase the drag, so I put the gear handle down and kept waiting for the indication that the gear was down and locked, and nothing happened.

So I looked through the viewsight on the airplane at the landing gear to see what was going on, and there I saw that the Q-bay hatch in the partially open position was blocking the landing gear. It wouldn't let it go down. So that's when the guys on the ground said I better get out. The Q-bay hatch was part of the structure and necessary to maintaining the structural integrity, so a belly landing would probably have been disastrous. But I said, well, we got a lot of fuel here, let's see what we can do. So I got it down to 15,000, 12,000 feet, and put all the G on the airplane that was permissible and went as fast as I could, and got that Q-bay hatch to flutter. While it was fluttering and the airplane is shaking and bouncing around. But every time it would flutter a little bit open, the gear would go down a half an inch or so. Eventually, by continuing the maximum G and maximum speed, getting the bay hatch to flutter, the gear eventually cleared the hatch, and went down into the down and locked position.

So I went home with a dangling Q bay hatch, but I landed the airplane, and I was pretty proud of both of those recoveries.

When you're flying one airplane after another of the same type in a test program, can you tell any differences in the handling among them? Is one different from another?

They built so few of these airplanes that they were really considered to be hand made, and they all had idiosyncrasies. If one of these airplanes had its wing attached at a slightly different angle than the other, that caused the airplane to have lateral trim difficulties. It caused the airplane to have peculiar stall characteristics; it might roll off to the right or roll off to the left, or it wouldn't stall straight through, and there was always something like that that you had to be conscious of.
And it was mainly by word of mouth that you learned of the difference between these airplanes. One pilot would tell you, well be careful of this. This plane's going to do such and such.

Would that characteristic simply follow the airplane or would Lockheed try to remedy it?

Lockheed did everything it possibly could to eliminate those differences. They added stall strips eventually to the airplanes. They would alter the wing attachment points a very, very small amount to make them exactly the same. They would change the flap settings with minor adjustments to actuator rods, and they could lower or raise the flap maybe a fraction of a degree, and that would give you a little more, or a little less lift, depending on what was called for.

We had one that was really a nightmare, and they put a lot of Bondo on the leading edge of one wing to change the airfoil and the lift characteristics of the wing. And they eventually found out that the wing had been attached at a higher angle than it

should have been, and they peeled all the Bondo off, and changed the attachment angle, and the airplane started flying about right.
The little airplanes were more susceptible to those idiosyncrasies than the big ones were. The big airplanes were a little more uniform in their construction than the little ones.

When you were flying above 70,000 feet, could you enjoy the view? Could you take time from testing sensors to take a few seconds and just look?

Oh, yeah, you were always looking out up there. You could make out the curvature of the Earth very slightly; nothing like in spacecraft, but you could. And the sky is getting darker as you get up higher. And then looking at all the various landmarks: You can see all the Great Lakes in one shot. And that was very impressive, and down the Florida Keys, or up along the Aleutian Islands, and places like that, it was spectacular. And I remember on one flight up near the Canadian border going northeast, the planet looked like a great big golf ball because they had had an enormous snow storm, and everything was just snow white.

And is the air smooth up there?

Usually the air is very smooth above 60,000 feet. Once in a great while we would encounter sever clear air turbulence and were along for a very rough ride with the wings flexing a great deal. We were above the clouds most of the time. When you get down near the equator, the cumulonimbus and the thunderstorms are the highest down there, but we were usually above all that. And watching those big buildups was something. We didn't pull any contrails at altitude. Occasionally, you got some, but usually when you got up above 60,000 feet, the contrails were very small or disappeared altogether. And you looked down and you could see the weather patterns—hurricanes, and the eye of the hurricanes, or something that was just a tropical storm, the counterclockwise storm system.

Were you ever able to snap any photographs for yourself?

Well, I took a picture of my home, and I took a picture of my parents place down in Texas. I never had an onboard hand-held camera in the cockpit.

So you used the U-2 camera to take a picture of your house?

[laughter] Well, we had a little camera that they called a tracking camera, and you'd turn that on and it would take a picture every few seconds. And that would document exactly where you had been. It was a hard copy record of the flight path. And so I would deviate slightly and come over my house, so the house was right in the viewsight. I had that picture hanging on my wall for a long time, but I don't know where it may be right now.

You've called the U-2 a difficult airplane to land.

I have flown over 200 different types and models of airplanes and helicopters, and the U-2 was far and beyond the most difficult airplane to land I have ever tried.

Did anyone warn you about the landing characteristics before your first flight?

Oh, you bet. Everybody told me that. From Tony LeVier on down, everybody said you gotta be careful. And I had a lot of tailwheel experience before flying the U-2. And I thought I knew something about it. But in actuality, I didn't know anything about how to land the U-2. But I learned pretty fast because these guys were there briefing me before and debriefing me afterwards, telling me exactly what should be done.

The really difficult thing about the airplane…everybody makes a big deal about it being a powered glider, but the difference between the U-2 and the everyday glider is the center of gravity in the U-2 is behind the main landing gear. And so what that does is that when you just barely touch the main gear on the runway, the weight of the engine and the CG [center of gravity] aft of that will make the tail go down, and immediately you generate an enormous amount of lift with those big wings and the airplane wants to get back in the air. So that's what you're not really prepared for. You may have a lot of glider experience where the CG is always forward of the main gear, but in this airplane the landing gear—because it had to have that big engine in there—had to be forward of the engine in the space that was available.

So the gear touches down and the nose comes up?

The nose comes up, the angle of attack immediately increases, the lift increases, and you're back in the air. The tendency is to push the yoke forward to change the angle of attack, decrease the lift and put it back on the runway. Well, you're always a day late and a dollar short when you do that, and you're behind it, and the airplane is going down when you think it should be going up, and it's going up when you think it should be going down, and you get a big porpoise going. Then it bounces down the runway and it stalls out, and it crashes. And that's where so many guys got in trouble and beat up the airplane.

When Tony LeVier flew the first flight on the airplane, that's what he encountered. He had been told by Kelly Johnson "now this is the way I want you to land it," and he had told Kelly, "No, Kelly. That's not the way you do it. This is a taildragger, and you land it tailwheel first." Kelly said no, I want it done this way. You bring it in and land it on the main gear.

Well, Tony had a terrible time. The first few attempts doing it Kelly's way didn't work, and he'd bounce back up in the air, and he was about to get the porpoise going and he had to add power to it and take it around. So he got tired of listening to Kelly he was there, flying alongside of him in the C-47 with [test pilot] Ray Goudey, so he yanked the cord on his headset so he didn't have to listen to Kelly or anybody else tell him how to land it. He went back to his way of landing it tailwheel first, got it on the dry lake bed runway, and then when he jumped out, the story went that Kelly came over to him and was barking at him, and Tony flipped him the bird. And Kelly Johnson said "U-2." So now you have a designator for the airplane. I don't know how true that is, I wasn't there. But that's the story I got.

How did you get to fly in the Century Series jets?

I was assigned to the Aerospace Research Pilot's School. When I went to Navy test pilot school at Patuxent, I knew about the astronaut program and never dreamed that I'd have a chance to do it. Shortly after I graduated from Navy test pilot school and was at Flight Test at Pax River, NASA opened up the program for the second astronaut selection. I applied and went through that process and got into the 32 finalists, along with Neil Armstrong and Jim Lovell and Tom Stafford, and whole bunch of other incredible guys. I failed the selection; I was one of the 23 NASA rejects from that group; they picked nine. I analyzed it and tried to find what shortcomings caused me to fail, and it came to be really apparent to me that this nine they had selected were absolutely gifted academics. They all were in the top 10 of their classes. Intellectual giants. So I went to headquarters, Marine Corps, and said, "Look, if you want to get any more Marines in this program, you're going to need to get them some serious education. You ought to start by getting a billet for a Marine out there at that Aerospace Research Pilot School. Well, they had a selection process, and I get a phone call. I was thrilled. And I went out to Edwards, and that's were I got to fly the F-100, the -101, the -106, and spent an awful lot of time in the -104. And I got my first flight in the U-2, and the first flight in a B-52, of all things.

How interesting that was. I'd been flying the F-4 at Pax River. When I got to Edwards and was flying the F-104, that was a whole different thing. I didn't get to fly the -105; they didn't have one available there at the school. Well, anyway, I failed the selection the second time, while I was in the school out there. And when I graduated from that, the Marine Corps said, "We had enough of you." and sent me overseas to be a staff secretary at the First Marine Aircraft Wing.

How did you like that?

Aw, I thought that was terrible. It was awful. It was one of the worst jobs ever. To go from being a big fanny test pilot to a staff secretary was just awful.

Of the airplanes that you flew at Edwards, which did you like the best?

The -104 by far. It went fast, it looked great. Sitting on the runway, it looked like it would go a million miles an hour. And it was fun to fly. It had a great cockpit. The control system was spectacular; it was so much better than the F-4.

Was the F-104 a difficult airplane to fly?

I didn't feel that way. It had very tiny wings and a very high landing speed. You were smokin' all the time, but it wasn't difficult. If you got it into a stall or into a pitch-up, then you had a handful. You were in trouble. Chuck Yeager [who ran the Aerospace Research Pilot School] had to jump out of it because he got one into a pitch-up, and he recovered from the pitch-up and the spin by using the drag chute, but he jettisoned the drag chute after he recovered, and he pulled too hard on the recovery from

that, and got it into the pitch-up again, and then he was too low to recover, and he had to eject.

He wasn't much of a pilot, was he?

[laughter] He was a terrific pilot. I really had a great deal of admiration for him. He was our boss there at the Aerospace Research Pilot's School. He really treated me awful good. There are a lot of folks who disagree, but he treated me awfully good as one of his employees out there. But there's a funny story. He was waving at a busload of school kids one day, as he taxied in, in a B-57, and ran into the bus. And they got that on film.

Did you always know you wanted to fly?

Oh, yeah. My dad was a Marine aviator. My earliest memories are Marine airplanes at North Island, and I always wanted to fly, and the first airplane I flew was an N3N floatplane at the Naval Academy, when I was all of 16 years old. I remember watching my dad and a whole bunch of Marine pilots taking off in formation of maybe 12 airplanes abreast at North Island, and I thought that was pretty spectacular. I was under 5 years old, and I still remember it.

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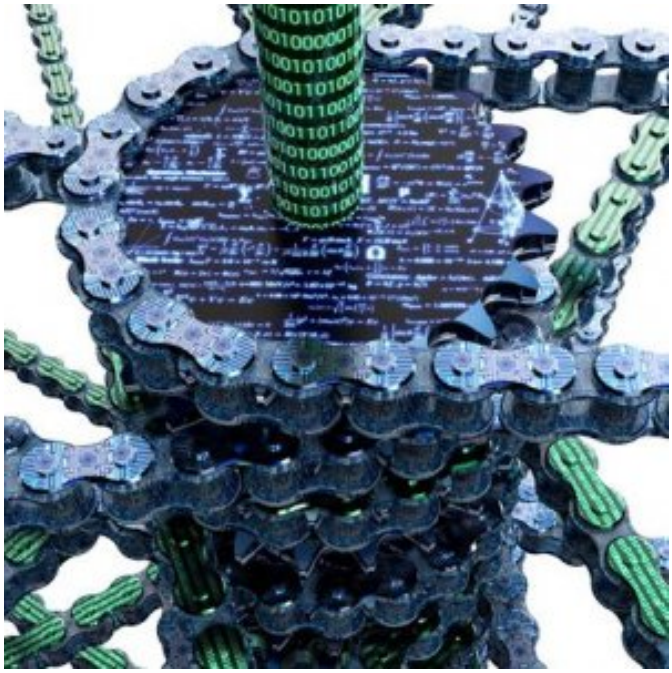

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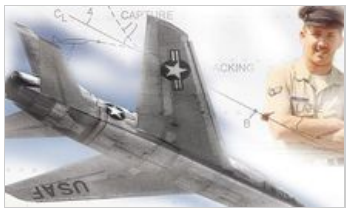

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