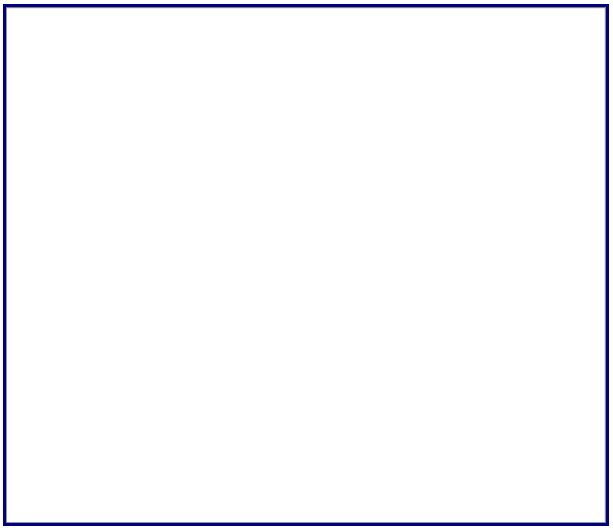
Back in the late 90s I was fortunate to work for a company that did consulting with NASA Dryden (now Armstrong) at Edwards AFB. At that time NASA was involved with a program named REVCON, or Revolutionary Concepts. My assignment was the X-33.

REVCON was to advance several concepts, of which the X-33 was one of many. That program was to test the feasibility of a single stage to orbit vehicle, mostly of composite materials, including the fuel and liquid oxygen tank. The X-33 was to employ a Rocketdyne engine referred to as an aerospike engine, or in this case a linear aerospike engine. Strangely enough, this type of rocket had been around since the early 60s.



Working with NASA Dryden meant working with interesting technology like a linear aerospike engine.

My immediate focus at this time was lunch, so I wandered into the cafeteria to see what was on the menu. As I was standing in the check out line, I noticed the chief test pilot having an earnest, in-depth discussion with one of the test pilots—who was not happy with his assignment. With the opportunity to fly NASA's F-18s, highly modified F-15 (NASA 837), the SR-71, and other fun toys available for their amusement, spending time conducting flight test in a simulator… well, let's just say there was no long line waiting to do that.

It was at this time I was noticed by the chief test pilot: "Hey, you're a driver, aren't you?" He got my attention and most everyone else in the checkout line too.

I think I answered with something clever, but I can only report I said something like, "what? Hum, yes why?" (Translation: Driver, in military aviation slang, is a fellow pilot of equal respect. The opposite would be Nugget, FNG, an new flying officer)

"Look," he said, "we need someone to pilot the 71 simulator while the engineers and sim operator conduct some conditions on stability for the 33 programs. Any interest?"

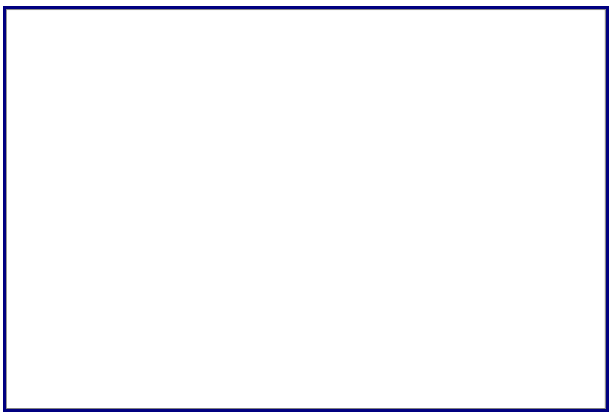
"Sure," I said, "happy to help out." (I refrained from screaming "hell yes!" while turning a few handsprings.)

"Great, I will tell the principal investigator you be there after lunch; I think you already know him."

This phase of the 33 program involving the SR-71 was called LASRE, or Lockheed Martin Liner Aerospike SR-71 Experiment. LASRE was a half scale model of a lifting body, referred to as a canoe. The aerospike engine, with eight thrust cells, was mounted on top of the canoe, which was placed on the back of the SR-71. This was to function as a "flying wind tunnel," to study flow dynamics and interaction of the aero spike with the lifting body, aka canoe.

The liner aerospike engine differs from existing rocket engines as it does not employ a bell-shaped rocket nozzle. Instead, it is made up of a “spike” or a tapered, wedge-shaped plate, allowing a stacking smaller engine—making one large engine. These increase thrust efficiency and lower fuel burn rate by an estimated 30 percent.

As the aerospike rocket engine had never been flown before, one of NASA’s SR-71 was pressed into service. Placing any structure of the back of an SR-71 would definitely affect the stability and control on this and any other high performance aircraft. If you really want to get a test pilot’s attention, tell him you are going to change the stability and control of a very high performance aircraft, or any aircraft he might be flying.



The SR-71 featured a “canoe” on top for this experiment.

I would love to report that the cockpit was something wonderful, akin to Luke Skywalker’s X-wing, as fantastic and advanced as the aircraft itself. I was expecting a mainyard of advanced technology that only a favored few could understand. Wow, was I surprised. The aircraft was built in the early 60s and the cockpit layout and instrument arrangement showed that. Other than a Mach meter without a “barber pole,” which indicated Mach critical, or Mach limits, I could report that it was not that much different from other high performance jet aircraft, from that time. It was all steam gauges; the only difference was there were a lot more of them.

The principal engineer invited me to slide into the pilot’s cockpit (the rear cockpit is in another section of the simulator room). Nothing unusual here so far. I thought it was curious that the simulator had a seat belt with shoulder harness… There were no visuals out of the front, but he said I might want to use the seat belt as the simulator had two degrees of motion: pitch and roll.

Of more interest was a two by four-inch red light that said UNSTART at the top right corner of the simulator’s instrument panel. I had heard that referenced before, both in rumor and several times in aerodynamic classes I had taken. However, what that would mean not in theory but in this airplane simulator, I was about to find out.

OK, so just what is an UNSTART? The term was first coined when early wind tunnels first reached supersonic. UNSTART is where the airflow is in reverse. In supersonic aerodynamics, a violent breakdown of the supersonic airflow at about Mach 2.2 is when the mass flow rate changes within an intake duct. This will cause violent, sometimes temporary, loss of control until the intake is restarted.

“So, if you’re ready I’ll set you up for the first run,” said the engineer. “We will start you at Mach 3 at 80,000 for awhile to let you get the feel for this one—do not make any corrective control inputs.”

Control inputs… in my experience having flown various high performance and not-so-high performance aircraft, handling qualities can and do vary a lot between aircraft types. Describing this to another pilot is easier than to someone who has no flight experience. To that end, the Cooper-Harper

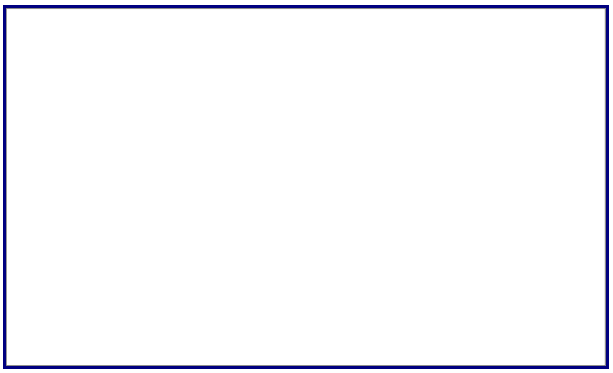
Rating Scale was developed. On that scale the type and intended use of the aircraft are the first consideration in handling qualities—i.e., you do not build airplanes that are hard to fly, if you do, they are not around long. Transports handle different that fighters, trainers are forgiving but tactical fighters are not. With respect to the SR-71 simulator, the designers had done a fantastic job.

In this case I could say: it was as one would expect for any jet aircraft employing a stick, but that does not help as a point of reference is needed. I found the stick and rudder control inputs to be light yet firm in roll and pitch inputs were light and not as responsive as I expected. My first impression was that of a high performance sailplane: light but firm, responsive yet stable in control feedback.

Here's where the fun begins.

Just when I was getting the feel, BAM—a hard right roll followed by a sharp nose down! Then the simulator froze. I had failed to notice the UNSTART light was on; I would be seeing more of that light during the flights to come. "That is a good run, we will reset and collect some data," the engineer said.

I responded, "OK, I think I will need a minute." I took this time to get back off the cockpit floor and locate my headset. "I think I will use the seat belt now."



The height of technology—in the 60s at least.

"Ready?" the sim operator said.

"Sure," I responded.

"OK, this time do make corrective control inputs." After about another minute, BAM again—the same violent roll and nose down pitch. I applied hard left rudder and pulled the stick back and to the left and fought the pitch and roll, but found the same result. Only this time the seat belt saved me from embarrassment and having to get back off the cockpit floor. That warning light, I decided, was not of much help.

This exercise continued the remainder of the day The engineer and sim operator varied the test conditions, control inputs and CN beta conditions. It took longer each time for the UNSTART condition to present itself, and I got much better at correcting the results—well, I thought so anyway. Sometimes they wanted me to make corrective actions, followed by just allowing the UNSTART to occur without taking any action.

The test ran the rest of the week, and each test run ended with the same results: that of me being bounced and slammed around in the seat. Several times I had to ask they turn off the motion base of the simulator.

Tests continued until finally enough data was collected to resolve any instability problems from the payload mounted on the actual SR-71 aircraft. By the end, I had logged about 40 hours in the simulator. Several things became clear: I began to suspect the chief test pilot had not done me a favor. Also, I can understand the test pilot complaining about his assignment. The second thing was the benefit of having

a light lunch before riding this beast.

I am please to report the SR-71 completed seven research flights. This phase validated the aerospike and “canoe” configuration mounted on the back of the aircraft. The primary area of focus was the flow dynamics of the aero spike engine. I am proud to have provided a small contribution to these test flights. I was available to view the flights from my usual position in the control room at NASA.