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Personal stories from quality professionals

MY QUALITY STORY

The transfer of the integrated launch vehicle, Zenit-3SL rocket, to a launch platform.

RELIABILITY

My First Steps In Quality and Reliability

Lessons from the Russian space program

by Alexey Glazachev and Ray Harkins

"Reliability is a pseudoscience, akin to astrology!" With these words, I was greeted by the operations manager for the Soyuz ILV Complex in Moscow when I asked him for his last five years of missile failure data. This was my first day on the job as a reliability engineer.

Although it was early in my career, this wasn't my first experience with reliability or integrated launch vehicles (ILV)—the high-velocity, dispensable rockets designed for placing satellites into low earth orbit. In fact, it seems that reliability and rockets have always been part of my life.

As I toddler, I remember all my favorite toys—they were plastic rockets and airplanes. I used to dream of going to the Baikonur Cosmodrome in southern Kazakhstan (the world's first and largest operational space launch facility). Math and science always came easy to me. When I had to decide what I would do "when I grew up," there was only one answer: I would work in Russia's space program.

I graduated from the Moscow Aviation Institute with my master's degree in aeronautical and astronautical engineering, where I studied rocket and space system operation. In my fourth year of studies, I took an elective course on reliability engineering. I remember a lot of math and graphs in that class, but how I might apply those concepts in my career was entirely unclear to me.

While still at university, I interned at the Moscow Design Bureau of Transport Machinery (MDBT), which is now part of TsENKI-Roscosmos. MDBT is well known throughout Russia's space program for its design and manufacturing of launch support equipment for the Sea Launch space complex. After I graduated—to my great delight—Sea Launch offered me a position with the team of engineers working in Long Beach, CA, assembling rocket stages and docking telecommunication satellites to the rockets in their Zenit-3SL ILV program.

The Zenit-3SL ILV is a rocket designed to deliver satellites into near-earth orbits. In California, the ILV and its payload were fully assembled and transferred by crane to the Odyssey, a semi-submersible mobile launch platform. After completion, the Odyssey was driven into the Pacific Ocean near the equator, where the launches took place. For the safety of the crew, everyone evacuated the platform and the ILV launch sequence was conducted remotely.

Those were amazing times. I had the privilege of working on four of the 36 Zenit-3SL launch missions. It was on these missions where I first began to see the value of reliability engineering.

On the day before transferring the assembled ILV to the launch platform, the full team of engineers simulated the entire transfer sequence. At each simulation, the cranes worked smoothly. But the next day, when working with a real rocket, the cranes failed, leaving the rocket suspended in midair for costly durations.

Following my fourth ILV launch mission, Sea Launch offered me the reliability engineering position back in Moscow, which I graciously accepted. That is where I met the skeptical and cantankerous operations manager. Although I knew little about reliability, it was a welcome change for me—a chance to return home and dive into an entirely new discipline.

The entire field of reliability is based on probability theory. The reliability of any system—from kitchen toasters to rocket ships—is described by a random, probabilistic value ranging from zero to one. But because most engineers deal with specific, nonrandom numbers such as pressure, mass and load, applications of probability remain difficult to grasp.

Nassim Nicholas Taleb, the author of *Fooled by Randomness*, contends that our brain is poorly adapted to work with chance and probability. To demonstrate his point, compare these two statements:

1. Humans have 10 fingers.
2. Humans have 10 fingers with a probability of 0.999.

Which one is clearer for you? Most people are more comfortable with the first statement, even though the second statement is more accurate.

I soon learned that this difficulty with probably also extends to many engineers and managers in the Russian aerospace industry. For many of them, reliability is a senseless "game of nines" in which they see little difference or meaning between 0.99 and 0.999.

It turns out that reliability engineering not only saves money, but more importantly, it also saves lives. Arguably, it's the most important aspect of technology. No matter how fast and beautiful a plane is, you're not stepping on board unless it's reliable.

Intuitively, we all have basic ideas about reliability. We know that two kidneys are better than one, for example. So it makes sense to us that two computers on a spaceship are better than one, and three are better than two. But engineers don't use words such as "better" or "worse." We use the language of numbers. Three onboard computers are three times heavier, consume three times the electricity and cost three times as much as one onboard computer.

The question for the engineering team, then, is what is the optimal compromise between high reliability and low weight, energy consumption and cost? It's a tough puzzle to solve. Trying to answer that question led me to deepen my knowledge of reliability and quality engineering.

Today, I manage a reliability engineering team for an organization in Moscow, examining the safety, security and regulatory issues of unmanned aerial vehicles. And I love every minute of it! I also teach young (and sometimes not so young) engineers about the great value of quality and reliability engineering, and other lessons I've learned in the Russian space program. QP

EDITOR'S NOTE
This column was written by Alexey Glazachev with the assistance of Ray Harkins.

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