December 2014

AEROSPACE AMERICA

2014 IN REVIEW

TWO BAD DAYS
Questioning conventional wisdom after Antares, Virgin Galactic/Page 4

A PUBLICATION OF THE AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

With the industry eager to understand and move beyond two launch failures in a matter of days, Teal Group analyst Marco Cáceres examines the strategies that brought the industry to this point.

TWO BAD DAYS

The risks of minimalist flight testing

The deadly SpaceShipTwo crash raises fresh questions over how much testing is enough before sending people up.

The failed flight of Virgin Galactic's SpaceShipTwo Enterprise was the 54th test flight of the suborbital space plane, although only four of these were rocket powered. The flights began in 2010 and had been scheduled to continue into next year. A total of 140 test flights were planned before commencing commercial operations, which means that had Enterprise not failed, it would have flown another 86 times before being qualified to begin carrying paying passengers. As Virgin Galactic founder Richard Branson told talk show host David Letterman a few weeks before the accident, "From now until March [2015] there will be many test flights. There will be many test flights actually into space." The indication was that there would be an intense period of test flights over the next seven months.

National Transportation Safety Board

What is sometimes compromised whenever one accelerates the development of rockets is flight testing. It is possible to field safe and dependable vehicles with a minimal number of test flights, but now, with the advent of the commercial space tourism industry, the risks of this minimalist flight testing culture are much greater because human lives are at stake. If an Antares rocket blows up, you lose the rocket, the satellite payload and the space station cargo. If a Virgin Galactic space plane goes down, it's an entirely different level of loss.

At first glance, the plan for 140 flights seemed adequate. It showed seriousness on the part of Branson and his company, and was reminiscent of 1959-1968 when NASA conducted 199 test flights of its X-15 rocket-powered aircraft. Like the Enterprise, the X-15 was also piloted and air-launched. Unlike the Enterprise, though, nearly all of the X-15 test flights were powered, meaning the rocket engine was turned on and the vehicle flew of its own

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ANALYSIS
BY MARCO CÁCERES

The SpaceX effect

In the the wake of the Antares failure, SpaceX's approach of developing all-new engines contrasts sharply with the strategy of using old Russian engines.

The failed launch of Orbital Sciences Antares 130 rocket in late October has again raised concerns about the use of Russian-made engines by U.S. launch companies.

Although we don't yet know what went wrong, we know that the first stage of an Antares is powered by two engines built by the Kuznetsov Design Bureau in the 1960s. The engines, designated NK-33, were purchased by Aerojet during the 1990s, refurbished, and sold to Orbital Sciences as the AJ26 in 2010 for use on Antares. Another U.S. company, United Launch Alliance, uses the Russian Energomash RD-180 engine on the first stage of the Atlas 5 rocket.

NASA

The reliance on Russian engines has raised concerns about their continued availability. After the U.S. and Europe imposed sanctions against Russia over the conflict in Ukraine, Russian Deputy Prime Minister Dmitryi Rogozin threatened to ban exports of the RD-180 to RD AMROSS, the Florida-based company that sells the engines to ULA, which launches many U.S. government military and scientific payloads. That has fueled a push in Congress for a U.S.-made alternative to the RD-180.

But the more fundamental question that keeps popping up is, "Why are we even buying Russian engines to begin with?" The answer is simple: The engines are among the most powerful in the world, and they're much less expensive than anything available in the U.S. The NK-33 and RD-180 have exceedingly high thrust-to-weight ratios and they can be bought at bargain prices. Aerojet Rocketdyne reportedly paid $1 million for each NK-33, while the RD-180s have been sold by Energomash to the U.S. for $6 million. The underlying assumption in the Atlas 5 and Antares programs was that the fastest and most cost-effective way to develop rockets with the lift capacities required by the U.S. Air Force and NASA was to go with readily available Russian liquid-fuel engines for the first stage. The established U.S. launch companies saw little reason to consider using homegrown engines.

The second-guessing of this strategy has been intensified by the emergence of SpaceX as a major provider of launch services. SpaceX has managed to break into a market that is technologically and financially demanding and extremely competitive. Yet it has done so relatively quickly with reliable rockets that it produces entirely at its facilities in California. SpaceX has demonstrated that it is possible for a vertically integrated company to be a

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The risks of minimalist flight testing
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accord. For Enterprise, 50 of the 54 tests involved takeoffs of the WhiteKnightTwo carrier aircraft with the Enterprise attached to it. WhiteKnightTwo would fly to an altitude of about 50,000 feet and then release Enterprise, after which the space plane would glide down and land on a runway.

This raises the issue of how many of the remaining 86 flights of the Enterprise were planned to be powered, particularly in light of preliminary findings by the National Transportation Safety Board that a pilot's actions may have contributed to the early deployment of the space plane's "feathering" descent system — a mechanism that rotates the aircraft's tail booms upward — which could have caused the crash of the vehicle.

The Enterprise made its first powered test flight on April 29, 2013; its second on Sept. 13, 2013; its third on Jan. 10, 2014; and its fourth on Oct. 31. Realistically, you have to wonder how many powered flights Virgin Galactic could have conducted through March 2015 before it would have felt compelled to announce that start of commercial operations. The Virgin Galactic plan seemed more than reasonable to establish the reliability and safety of a rocket vehicle, especially given the current tendency by space launch companies to test fly their new rockets once or twice before declaring them ready for operations. An example of this is Orbital Sciences and its Antares, which was first test flown carrying a dummy payload on April 21, 2013. That was followed by a demonstration flight carrying the Cygnus capsule on Sept. 18, 2013, to show that the capsule could dock with the International Space Station, and its first operational flight on Jan. 9, 2014, with Cygnus delivering cargo to the ISS. The rocket flew a second Cygnus resupply mission to the ISS on July 13, 2014, before the failed launch on Oct. 28. So, there was one test flight before Antares was considered fit for active service.

In the 1990s, Arianespace conducted three test flights of its new Ariane 5 rocket, but even those missions were really more operational flights, because they carried actual satellites, not dummy payloads. However, at least those satellites were relatively small and inexpensive ones for the European Space Agency, which had a vested financial interest in the development of the Ariane 5. In the case of the doomed Delta 3, Boeing didn't even bother with test flights.

The Delta 3's inaugural mission on August 26, 1998, carried the Galaxy 10 spacecraft — a $225 million, 8,543-pound commercial TV broadcasting satellite for PanAmSat. The launch failed, but Boeing wasn't deterred. Instead of pausing and trying a couple of test flights, the company attempted a second Delta 3 commercial launch on May 4, 1999, and again failed. That time it involved a $145 million, 9,400-pound telecommunications satellite for Orion Network Systems.

Ultimately, Boeing did opt for a test flight. On Aug. 23, 2000, a Delta 3 launched a dummy payload designated the DM-F3, designed to simulate the Hughes Space and Communications HS-601 satellite. By then, it was too late. The Delta 3 had lost the market's confidence, and Boeing terminated the program.

The obvious question is: Why was Boeing in such a hurry? Answer: The commercial satellite market was perceived as being at the cusp of a boom period. The demand for commercial launch services was growing, and Boeing wanted to be a major player with its Delta 3. The company was under pressure to introduce the vehicle and commence operations as quickly as possible. It was working under a $1.5 billion contract from Hughes to provide 10 firm Delta 3 launches, plus options for 10 or more launches. By 1996, the Delta 3 program already had an order backlog of 20 launches through 2002. Arianespace was also facing pressure to introduce its Ariane 5 to take advantage of the coming boom in satellite launch orders.

As to Orbital Sciences, it may have felt the need to speed up development of its Antares to take advantage of an opportunity that presented itself on Oct. 18, 2007, when NASA canceled its Commercial Orbital Transportation Services contract with Rocketplane Kistler. The contract was recompeted under the Commercial Resupply Services program, and Orbital won a $1.9 billion contract on Dec. 23, 2008, to provide eight cargo supply flights to the International Space Station using its Taurus 2 (subsequently renamed Antares) and Cygnus capsule combo.

The SpaceX effect
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launch industry leader. That is starting to unnerve large launch companies that have seldom felt threatened by newcomers.

Other private companies have tried — and failed — to introduce new launch vehicles. That's why when SpaceX was founded in 2002, it wasn't taken seriously by the industry.

SpaceX initially offered a small-lift rocket called the Falcon 1, priced at $5.9 million per launch, less than half the going rate for other small U.S. launch vehicles at the time. The industry viewed the price as a marketing gimmick. The first three Falcon 1 launch attempts — in 2006, 2007 and 2008 — failed and SpaceX raised its launch price by 30 percent. Three consecutive failures should have meant the end of a new launch company, but SpaceX kept at it. Less than two months after Falcon 1's third failure, SpaceX tried again and succeeded. The company conducted another good launch before deciding to retire the Falcon 1 and move on to its heavy-lift Falcon 9, which began launching in 2010. Through the end of October 2014, the Falcon 9 has launched 13 missions.

SpaceX is currently working under a $1.6 billion contract to provide cargo resupply services to the International Space Station using its newer, larger Falcon 9 v1.1 and Dragon cargo capsule. In September, NASA awarded a $2.6 billion contract to SpaceX to develop a system, using the Falcon 9 and a manned version of Dragon, for transporting crews to and from ISS. The company is also on the verge of having the Falcon 9 certified by the Air Force as a potential launch provider for Evolved Expendable Launch Vehicle payloads.

Additionally, SpaceX has been competing successfully in the commercial launch market. Over the past year, the company has launched four commercial communications satellites destined for geostationary orbits, plus a batch of Orbcomm mobile comsats to low-Earth orbit. It has won contracts to launch more than two dozen commercial satellites for companies around the world, as well as contracts to launch satellites for the Air Force, NASA, the German armed forces, and the space agencies of Argentina, Canada, Taiwan and Turkmenistan.

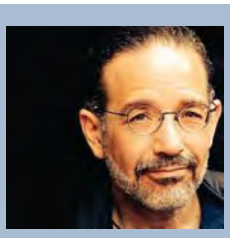
SpaceX has been winning contracts in every segment of the launch market. The company has a reliable rocket priced at half, or less, the prevailing prices of comparable vehicles, and it has been around long enough that it is now viewed as part of the mainstream of the industry, giving it the credibility that it may have lacked just a few years ago. This presents a potential nightmare for traditional players in the launch market.

There is increased pressure on companies like ULA and Orbital Sciences to reduce the cost of their rocket programs so that they can be competitive with SpaceX. One way to do this is to increase launch volume by more aggressively marketing the vehicles commercially. Lockheed Martin has moved in this direction with its Atlas 5 during the past year. Another way is to shake up corporate leadership to come up with new ideas. That would explain ULA's move in August to replace CEO Michael Gass with Tory Bruno, former president of Lockheed Martin Strategic and Missile Defense Systems. ULA is a joint venture of Lockheed and Boeing.

Europe's Arianespace is also starting to feel pressure to reduce its costs. The consortium is struggling to decide how to proceed with development of the Ariane 6 rocket. One of the drivers of the debate is the question of how to dramatically reduce launch costs compared with its Ariane 5 ECA. The Europeans are even considering a fundamental industrial restructuring of Arianespace to make it more competitive.

It's almost impossible to get anyone within the European space industry to admit that they underestimated SpaceX and its impact on the market. But the Europeans are clearly concerned. France's space minister, Geneviève Fioraso, has criticized SpaceX for "dumping" its rockets on the commercial market. She and others in Europe also believe SpaceX has been unfairly bolstered by U.S. government contracts. The fact remains: The Europeans are reacting to SpaceX.

Perhaps the best indicator of the "SpaceX effect" can be found in comments made shortly after the Antares failure by Chris Chadwick, the president and CEO of Boeing Defense, Space & Security. In a Bloomberg News article, Chadwick was quoted as saying that SpaceX founder and president Elon Musk and others are bringing "disruptive ideas" to the space industry. "It ensures that we stay on our toes," Chadwick said.



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