SPACE & DEFENSE

Volume Ten Number One Spring 2017

EISENHOWER CENTER
FOR SPACE AND DEFENSE STUDIES

Space & Defense

Journal of the United States Air Force Academy
Eisenhower Center for Space and Defense Studies

Space & Defense is available at http://www.usafa.edu/df/dfe/dfer/centers/ecsds/defense_journal.cfm and indexed by ©EBSCO*host*.
United States Library of Congress, ISSN 2380-131X.

Editor, *Space & Defense*
Dept. of Political Science
2354 Fairchild Dr., Suite 6L-116
USAF Academy, CO 80840

Editor's Note

This issue of *Space & Defense* continues our effort to apply analytical tools from the field of political economy to emergent questions of defense policy. Many of the decision points relate to earth orbit as befits our heritage. Others expand the definition of space to include frontiers of conflict where new technology or novel actors present unresolved challenges for the United States and allied national security establishments.

We believe contributions for this issue on Russia's space sector; a prospective asteroid mining enterprise; criminalized power structures in fragile states; hypersonic weapons development; and the physics of financial markets are diverse manifestations of a single ethos. What unites them is our educated hunch that national security competition in new spaces will involve mixed actors—states, international organizations, sub-state agencies, and non-state entities; mixed motives encompassing geopolitical rivalry and global public goods attained through cooperation; and mixed domains as competitors bring assets to bear across land, sea, air, space, and cyber.

Dealing with this complexity, many of our analyses in *Space & Defense* run across four geopolitical chessboards—trade, finance, global security, and science & technology—reflecting late British political economist Susan Strange's four structures of power. Insightful contributions for our journal probe the multidimensional international security environment for patterns of political behavior that tie action and consequences across these chessboards. Doing so in coherent ways helps policy makers tackle problems of deterrence and international organization for the 21st century at the frontiers of defense policy. It also fulfills the charter of the U.S. Air force Academy's Eisenhower Center for Space and Defense Studies, which posits an inherent connection between strengthening intellectual foundations of the space policy community and fostering learning across communities—within the U.S. Government and beyond—interested in achieving a world more peaceful, prosperous, and just.

Our journal applauds several organizations within the U.S. Department of Defense that are acting upon a similar hunch about security challenges in new spaces. The Joint Chiefs of Staff (JCS), U.S. Special Operations Command (SOCOM), and U.S. Strategic Command (STRATCOM) among others are expanding their communities of interest (COI), initiating strategic multi-layer assessments (SMA), and in general finding creative ways to bridge *the gap*, a pernicious vacuum separating their policy responsibilities from historical scholarship and social science research.

Space & Defense, consistent with the goals of the Eisenhower Center, encourages participants in these burgeoning transnational communities of interest to try their hand at one or more of the important questions generated by these processes. This particular set of problems is growing as it becomes more refined, right at the nexus of policy-relevant scholarship.

Damon Coletta
USAFA
June 2017

The Russian Space Sector: Adaptation, Retrenchment, and Stagnation

Bruce McClintock

Since the collapse of the Soviet Union, Russia focused on its public space sector and consciously chose not to cultivate competitive, private space companies. Russia's overall space enterprise is now in systemic crisis due to multiple factors and, despite positive rhetoric from the government and with the partial exception of national security space capabilities, faces yet another generation of stagnation.

On October 4, 1957 the Soviet Union launched the first satellite into orbit from a site now known as Baikonur Cosmodrome.[1] The Sputnik surprise launched the Space Race and ushered in an era of rapid advancement in technological and scientific developments. Much has changed for both Russia and the United States in the last sixty years. On March 30, 2017 a private U.S. company successfully launched a commercial satellite into orbit with a previously used first stage booster—a feat never before accomplished and one that may launch a cheaper era of space travel.[2] The same day in Russia, an investigation into quality control issues in the Russian space industry reported that nearly every engine currently stockpiled for use in Russian Proton rockets is defective.[3] This investigation followed a catastrophic year for Russian space launch. In December 2016 a Russian Progress resupply craft burned up in the Earth's atmosphere shortly after liftoff from Baikonur, the twentieth malfunction of a Russian launcher since 2001, marking an inauspicious end to what many describe as a make-or-break year for Russian commercial space. Another potential indicator of the crisis in the Russian space sector is that last year Russia fell behind the United States *and* China in the number of space launches. Russia finished 2016 with just 18 launches, compared to China's 19 and America's 20 launches.[4]

The end of the Cold War and the collapse of the Soviet Union presented new opportunites for Russia to reinvent its government and economy, including its remarkable Soviet-era space program. The journey of the Russian space industry since the collapse of the Soviet Union offers a case study in how Russia, in spite of indications to do otherwise, chose not to break with previous models of behavior and organization. In addition, the history indicates that, without a significant change in direction, the Russian space industry likely faces more stagnation and even further decline.

EARLY OPTIMISM AND PUBLIC SPACE SUCCESSES

While the picture looks less positive now, in the early 1990s there was plenty of optimism and cooperation between Russia and the West that looked likely to benefit the Russian space sector. President Clinton reflected the optimism of the

---

[1] Brig Gen (ret) Bruce McClintock is the CEO of Zenith Advisors Group and an adjunct policy analyst at the RAND Corporation. Prior to retiring, he was special assistant to the commander of AF Space Command. Until July 2016 he was the Senior Defense Official and U.S. Defense Attaché in the U.S. Embassy in Moscow, Russia.

[2] Kenneth Chang, "SpaceX Launches a Satellite with a Partly Used Rocket," *New York Times*, 30 March 2017, https://www.nytimes.com/2017/03/30/science/spacex-launches-a-satellite-with-a-partly-used-rocket.html?emc=edit_nn_20170331&nl=morning-briefing&nlid=70171243&te=1.

[3] Matthew Bodner, "Defects Found in Almost Every Russian Proton Rocket Engine," *Moscow Times*, 30 March 2017, https://themoscowtimes.com/articles/defects-found-in-almost-every-russian-proton-rocket-engine-57584.

[4] Matthew Bodner, "Russia Falls Behind the U.S. and China in Annual Space Launches," *Moscow Times*, 29 November 2016, https://themoscowtimes.com/articles/russia-falls-behind-us-and-china-in-annual-space-launches-for-first-time-ever-56344.

time in his remarks at the U.S. Naval Academy graduation in 1993: "President Yeltsin and his fellow reformers throughout Russia are courageously leading three modern Russian revolutions, to transform their country from a totalitarian state into a democracy; from a command economy into a market; and from an empire into a modern nation-state." Budget constraints, system failures (such as the Challenger disaster in 1986) and a desire to continue human space exploration futher motivated the United States to assist with Russian integration into the space enterprise supply chain. The signing of a bilateral trade liberalization treaty on commercial satellite launch services did pave the way for "public-public (International Space Station), public-private (NASA and Russian Space Agency subcontracting) cooperation, and for major private joint ventures between U.S. and Russian firms in the aerospace sector."[5]

This cooperation was most apparent in the public-public sector. Russia and the United States agreed to place U.S. astronauts on the Mir space station and Russian cosmonauts on the U.S. shuttle. Both countries agreed to an ambitious International Space Station (ISS) plan that made Russia a major partner. The Russian Space Agency also agreed to provide resupply for the ISS using Soyuz-launched Progress cargo vehicles and crew transportation to and from the station.[6] The zenith of the public-public cooperation for Russia was the eventual exclusive use of Soyuz to resupply and staff the ISS following the second shuttle accident in 2002. Overall, the Soyuz System has been remarkably successful over its lifetime.

Russia also had its own internal public sector space successes, independent of the international community. GLONASS, Russia's Global Navigation Satellite System, is fully operational and an accepted international system for navigation and timing. This system, originally designed for use by the Russian Aerospace Forces, has grown in popularity as a commercial system for public use, due in no small part to guidance from President Putin. There are other examples, including the Public-Private Partnership between Gazprom Space Systems and Roscosmos. This operator has its own communications satellite constellation, providing services to both institutional and private players.[7]

SIMILAR OPTIMISM FOR RUSSIAN PRIVATIZATION AND COMMERCIALIZATION, DIFFERENT RESULTS

The end of the Cold War accelerated an overall shift in U.S. space policy—inspiring the commercialization of space and encouraging the private sector to take on as much space development work as was commercially feasible.[8] From a U.S. perspective, many assumed that the combination of bilateral agreements and public-public cooperation would pave the way for similar commercialization in the Russian space industry. In fact, Russia never truly intended to commercialize its industry. Russia's true intent was to make its space sector more competitive while retaining government control.[9]

Both United States and Russian firms had to adjust their business models from primarily defense work to accommodate commercial work. However, Russian firms faced challenges that U.S. firms did not. Most importantly, Russian firms all came from a Soviet model that centralized control

[5] Jeffrey Pigman, "The New Aerospace Diplomacy: Reconstructing Post-Cold War U.S.-Russian Economic Relations," *Diplomacy and Statecraft* 15(4), 2004, pp. 683–723.

[6] NASA, the other ISS partners, and the RSA agreed to incorporate major Russian contributions to the new space station totaling one third of the mass of the completed station and almost half of the volume of the station's pressurized area (Pigman 2004: 703).

[7] Email exchange with Ivan Kosenkov, 5 December 2016.

[8] Pigman 2004: 700, 706. National Space Policy Directive 2, issued in September 1990, actively promoted creation of an international marketplace in commercial space launch services, while still maintaining heavy Cold War-era restrictions on technology transfer and limiting U.S. Government satellite launches to U.S.-built launch vehicles.

[9] Ivan Kosenkov, "Re: Questions regarding your article," received by Bruce McClintock, 5 December 2016.

of decision-making and resource distribution. Russian firms, whether fully or partially privatized on paper, still had to develop their functional autonomy as enterprises. This legacy meant that, while Russian companies did gain market share and formed joint ventures with others in the United States and elsewhere, their companies still behaved like state-run entities. Arguably, this behavior was conscious and not a failure on the part of the companies to adapt to Western models.

For example, International Launch Services (ILS), formed in 1995 as a joint venture between Lockheed, Khrunichev and Energia, is today a subsidiary of Roscosmos, the State Corporation for Space. So, while Lockheed and Boeing currently operate United Launch Alliance as a truly private entity operating Atlas launchers, ILS operates Proton launchers as a state-owned monopoly in Russia. Sea Launch provided another well-known example of integration between Boeing, the Russian firm RSC Energia and others.

Other joint ventures occurred at the component level. The most well-known is the Lockheed Martin selection of an Energomash RD-180 for use as a booster on the Atlas V. In 2000 the RD-180 became the first Russian-designed and built propulsion system on a U.S.-designed launch vehicle. The RD-180 remains in use by customers, including the United States even though Energomash is also largely owned by the Russian government.

In general, Russian firms used joint ventures to gain market share without truly privatizing their companies. While not apparent to the West twenty-five years ago, it now seems clear that the Russian government never intended to privatize their industry in the same way the West did.

FACTORS LEADING TO OVERALL DECLINE OF RUSSIA'S SPACE INDUSTRY

In the post-WWII Soviet era, the space sector attracted the best and brightest of Russian talent and significant infrastructure investment. Conversely, severe government funding shortages in the 1990s created early and long-lasting impacts to the Russian space sector.[10] The lack of funding caused degradation to national constellations, infrastructure, and personnel. Observers visiting Russian rocket facilities in the 1990s reported design, manufacturing, and test facilities in a state of decay. Possibly more telling was the lack of a cadre of young professionals and middle managers ready to take the place of the early Soviet space leaders.[11]

The immediate impact of the reduced funding was delays in accomplishing new projects. For example, the Russian strategy from the 1990s envisioned a Proton replacement, called Angara, which should have already been fielded. As one analyst put it, "like many things in Russia's history, the Angara's path toward the market has not been straightforward or easy." In 2014, the Angara did have two successful test launches but is still years away from replacing the Proton.[12]

Existing system reliability is also faltering over time. Since 2001, Russia has had anomalies on twelve Proton and eight Soyuz launches, the most recent being the loss of a Progress resupply mission on December 1st, 2016. Some of the launch failures have been directly attributed to quality control lapses. For example, in 2009, a communications satellite was placed in incorrect orbit due to a mission software error. In 2010, a Proton rocket failed because it was loaded with too much propellant. In 2013, another Proton crashed because it had flight control sensors installed upside-down.[13]

Besides the shock of the lack of funding in the 1990s, the troubling trend of reduced reliability and slow progress on new projects is routinely attributed to several factors.

Brain Drain—Russia's space specialist population is aging, and their competence is waning due to

---

[10] Ibid.
[11] Jim Marshall, "Questions on Space and Russia," received by Bruce McClintock, 5 December 2016.
[12] Anatoly Zak, "Getting Its Space Mojo Back," aerospaceamerica.aiaa.org, November 2016, https://aerospaceamerica.aiaa.org/features/getting-its-space-mojo-back/.
[13] Zak 2016.

the low attractiveness of space careers. This is due in part to reportedly low pay in the space sector. Also, some claim that, to comply with the Russian state secrets law, space workers are not allowed to travel outside of Russia—a big disincentive for young Russians.

Corruption—Generally considered organic to the Russian economic system, corruption has become evident over the last few years in various aspects of the space sector. The most famous example of corruption is the construction of the Vostochny Space Launch center. Russians envisioned Vostochny in the 1990s as a replacement for the Russian reliance on Baikonur. Over the last few years there have been numerous public delays associated with the construction of the launch facility and several cases of managers and workers arrested for corruption. Separately, in January 2017, Roscosmos announced it was withdrawing all second and third-stage engines for the Proton-M rocket, citing "technical reasons." At the same time, Russian media reported that factory bosses manufacturing engines for Russia's Proton-M rocket may have swapped precious metals for cheaper alternatives, possibly leading to the failure of the Proton in December 2016.[14] Elsewhere, there are reports of substantial percentages of state budgets siphoned from major programs and projects as a part of "overhead."

Reduced Budgets—While Russia has improved upon its desultory budgets from the 1990s, this decade it had to reduce government funding for space. As recently as 2014, Russia promised $70 billion for a ten-year space program. In 2016, struggling economically due to reduced oil prices and international sanctions, the government approved only $20.5 billion.[15] Not only does reduced funding reduce or delay marquee projects such as lunar exploration; reduced funding further contributes to decay of the space infrastructure.[16] Indeed, the Russian government publicly acknowledged the crisis in the space industry and has taken actions in an attempt to reverse the slide, not all of them helpful.[17]

Multiple Reorganizations—Russia attempted several variations on organizational models for the space industry. Between 2012 and 2015, Russia formed United Rocket and Space Corporation, using leaders from the Russian automobile industry. URSC was granted property rights over space enterprise assets and separated from the state space agency. Uncertainty about responsibility sharing and control, accompanied by additional delays, cancellations, and hardware failures, led to another reorganization in 2015. Effective January 1, 2016, Russia made Roscosmos a state corporation rather than a government agency. This is a return to the previous model—all space industry united in one framework—making the policy and procurement decisions. Roscosmos is now responsible for oversight and business development of most key organizations in the Russian aerospace industry, including Energia, Khrunichev, and Energomash. The Kremlin's stated goal at the time was to make the industry more competitive and profit oriented. Most observers agree that in practice there has been little change in management and organization of such core programs as the Soyuz, Progress, and International Space Station.

Master Plans—Russia's latest Federal Space Program for 2016-2025 (FKP 2025) illuminates the long-term crisis faced by the Russian space

[14] "Russian Police Investigate Alleged Substitution Scam at Rocket Engine Factory," *Moscow Times*, 25 January 2017, https://themoscowtimes.com/news/experts-check-russian-rocket-engines-for-low-quality-metal-56918.

[15] Matthew Bodner, "Grounded: Economic Crisis Hobbles Russian Space Program," *Moscow Times*, 24 March 2016, https://themoscowtimes.com/articles/grounded-economic-crisis-hobbles-russian-space-program-52257.

[16] In 2016, for example, Igor Komarov, the head of Roscosmos, publicly noted a "considerable lag in the use of modern development methods, low productivity, and worn machinery" (Zak 2016).

[17] In March 2016, the Roscosomos communications director said, "It's no secret that the reforms that are underway now might not have occurred if the state had not acknowledged that the Russian space industry is in a systemic crisis." Shura Collinson, "Experts Look to Space X Phenomenon in Quest to Develop Russia's Private Space Industry." 4 March 2016, http://sk.ru/news/b/articles/archive/2016/03/04/experts-look-to-spacex-phenomenon-in-quest-to-develop-russia_1920_s-private-space-industry.aspx, accessed December 1, 2016.

sector since it is the latest plan that promises progress but ultimately decreases the scope of effort. FKP 2025 effectively prioritizes preservation of Russia's existing satellite constellation, consolidation and streamlining of the decaying space industry, and minimizing delays in the Russian program for lunar exploration.[18]

Leadership Changes and Reprimands—The current head of Roscosmos, Igor Komarov, is the fourth Russian space agency director since 2009.[19] More recently, following the 24-hour delay of the inaugural launch from Vostochny, President Putin officially reprimanded Deputy Prime Minister Rogozin, Roscosmos head Komarov, and the head of the manufacturing firm responsible for the problematic component. Leadership changes have done little to improve the current situation.

SKOLKOVO: RECENT EFFORTS TO ENCOURAGE SPACE COMPANIES WITH SPORADIC RESULTS

One effort that has shown some signs of promise for helping form a true private Russian space sector is the Skolkovo initiative. In 2010, Russian President Medvedev launched the Skolkovo Innovation Center, which included a Space and Telecommunications "cluster" among the five core clusters. There is some sign of hope for the private sector via the Skolkovo cluster. As of October 2016, there were more than 180 participants at Skolkovo in various technological domains related to space activities.[20] Skolkovo allows these participants to find investment, partners, and clients on world markets."[21] Thus far, the Russian private space sector supported by Skolkovo can claim some modest victories. For example, Dauria Aerospace won a contract in 2012 to create two small space vehicles for Roscosmos. Dauria eventually launched two Perseus-M microsatellites in the United States in 2014. Dauria is still active—working on two smallsats for Roscosmos and developing an earth observation platform named Auriga. Other companies with successes include: SPUTNIX (ground equipment and test facilities for small satellites), Spectralaser (laser ignition modules for Soyuz engines), Kosmokurs (a reusable suborbital launch vehicle for space tourism and scientific experiments) and Lin Industrial (family of light launch vehicles for small satellite launches).

Still, advocates of Skolkovo acknowledge that the number of private space endeavors in Russia is relatively small and the pace of growth could be better. Many blame Roscosmos for the short list of successes to date. In March 2016, representatives from Russian private space companies and Roscosmos debated the level of cooperation between Roscosmos and private companies in Russia. Only last year did Roscosmos say it would allow private companies access to the space services market, and not before 2020.[22] Others report passive resistance from Roscosmos against private companies, for example, demanding detailed designs and models of proposed systems before discussing funding. This is not surprising since as a state corporation, Roscosmos does not have much reason to support private start-ups that become competitors.

There are impediments to private space business in Russia other than Roscosmos and the systemic factors already listed. Besides decreasing state funding, Russian firms also lack adequate private investment. In addition, some point out that Russians, often capable of great technological innovation, are not as steeped in the capitalist

[18] There is still some progress on the lunar base plan but at a much lower level. For example, NPO Lavochkin intends to launch one lunar probe every year or two for the next seven years. There are also successes such as the Radioastron mission and preparation of next space observatories—Spektr RG and Millimetron. Kosenkov email, 5 December 2016.

[19] Marcia Smith, "Russia Downscales Lunar Program as Roscosmos Morphs into State Corporation." 29 Dec 2015, spacepolicyonline, http://www.spacepolicyonline.com/news/russia-downscales-lunar-program-as-roscosmos-morphs-into-state-corporation.

[20] Skolkovo Space Cluster briefing, October 2016, courtesy of Ivan Kosenkov.

[21] Ivan Kosenkov, "Role of Skolokovo in the Development of the Russian Private Space Industry," May 2015, IASP 2015 32nd World Conference Proceedings, Beijing, http://iasp2015beijing.csp.escience.cn/dct/page/70085.

[22] Collinson, 4 March 2016.

ethos of recognizing and addressing needs of the market.

CONCLUSION

Since the collapse of the Soviet Union, Russia focused on forming an internationally competitive public space sector and consciously chose not to establish a competitive private space sector. Skolkovo's space cluster does provide support for private Russian companies, but numerous institutional factors in the Russian Federation will continue to challenge space entrepreneurs, and Roscosmos will likely gobble up those that show any promise. The one likely exception to this stagnation turns out to be in national security space capabilities.

More broadly, the overall Russian space enterprise wallows in a systemic crisis due to multiple factors and, despite positive rhetoric from the government, likely faces yet another generation of stagnation and decreasing market share. In the best case, which seems unlikely, Russia's space industry will survive and protect its own systems while slowly rebuilding its once great national space capability. Even under this best-case scenario, it would likely take a generation to address the many systemic issues facing Russia. The worst-case scenario is a complete collapse of the Russian space sector except for military capabilities. This also seems unlikely given the numerous, albeit modest, attempts to generate a private space sector in Russia and the government's clear priority on national security and public organizations.

The most probable path for the Russian space sector is enduring stagnation with the odd success outside of critical national security missions, but nothing akin to its former glory. Sadly, following twenty-five years of opportunity, Russia space is a poster child for how *not* to evolve for the next century of space challenges.