The following report will be published early in 2008 as a chapter in the National Defense University series on space power. See http://www.ndu.edu/inss/press/nduphp.html for details on availability of the entire volume. Meanwhile it is copyright @2007, James Oberg and the NDU.

Russia's Space Program at Fifty – An Assessment
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After half a century of space activities, Russia will be spending 2007 celebrating anniversaries of its space past, but with good reason will also be celebrating improving prospects for its space future. The past events include the 150th birth anniversary of Konstantin Tsiolkovsky, the birth centenary of Sergei Korolev, and 50 years since the world's first artificial satellite was launched in the Soviet Union. Lamentable hangovers from the more recent "space slump" have been fading away, although not entirely.

Not far from the main launch pad at the Baykonur cosmodrome, a pad that hosted the Sputnik blastoff on October 4, 1957, the Gagarin blast-off on April 12, 1961, and still hosts 'Soyuz' booster launches, stands a simple obelisk. It is surmounted by a full-size metal sculpture of the 'Sputnik', and supports a small plaque. "Here through the genius of Soviet man began the relentless assault on space," reads the plaque.

But the succeeding fifty years saw a mixture of relentless assault and single-minded perseverance with wasteful detours, dead-ended spectaculars, desperate gambles, and shriveling budgets. Interplanetary probes pioneered the routes to nearby planets, but could reach no further. Operating lifetimes of affordable satellites were so short that mass quantitites had to be successively launched into orbit – with the unintended benefit of providing a major surge (or casualty replacement) capability for military systems. Endurance marathons on manned space stations, and resolute repair missions in the face of daunting breakdowns, demonstrated the resilience of manned space flight – and the inability of the Soviet economy to industrially exploit the opportunities of the space frontier.

Many space strategies have evolved to keep pace with these changing circumstances. Where once the Soviet Union saw itself as a lone pioneer leading humanity into space, Russia now portrays itself as an essential partner of other spacefaring nations. Where once Soviet scientists foresaw national wealth from exploiting space conditions and space-based vantage points, Russian government planners now see their main space-related cash flow in sales of know-how, goods and services to other spacefaring powers. Where once fleets of military space systems were seen as force multipliers' for the Soviet armed forces on expansive missions, a much more constrained Russian military establishment now struggles not to be left hopelessly behind by U.S. and other national military space infrastructures, even as its fear of military confrontation ebbs.

Fifty years on, top Russian leaders have paid homage to the value of the country's space activities. "The industry is an integral part of the national defense industry and one of the flagship national industrial branches," Russian Deputy Prime Minister and Defense Minister Sergei Ivanov said recently while addressing Russia's "Defense Industry Commission" in Moscow.[1]. "Thus, space industry development is a must for ensuring Russia's independent space exploration."[2] At another event, he stressed the role of a nation's military-industrial complex as "a locomotive of high technology, economy and knowledge practically in all countries of the world," [3] and continued: "We are not an exception from this rule, because over half of the country's total scientific potential is still concentrated in the defense and industrial complex sphere."

Russian President Vladimir Putin has directed the head of the Federal Space Agency, Anatoliy Perminov, to work out a strategy for 30 years ahead, until about 2040 . "He wants the guidelines of the development of space exploration in the country determined," Perminov explains. "That includes above all the development of existing launching sites, the group of space assets in orbit in different departments -- communications, remote sensing, weather watch and so on. Naturally, some work is to be done for defense that includes new carrier rockets and the ground infrastructure and control of space systems in orbit." The strategy is due by the end of 2007, but its broad outlines are easy to scope out.

To examine the route from where Russia is in space, to where it wants to be, it is useful to survey the human and financial and administrative and technical resources at its disposal, and then extrapolate from there.

The human factor

The fundamental basis for any activity is the team of people who are to carry it out. Here, Russia is still struggling with personnel management issues that stretch back to the very beginning. A successful resolution of these issues – still in doubt – is fundamental to any hope of success in the coming decades.

To a far greater extent than in the United States, Russia created and then depended on a large cadre of specialists hired as young people in the Sputnik era. They worked together for decades and knew each others' specialties. Along the way, they brought in a few apprentices, but as a rule they relied on their own experience, memories, intuition and expertise, which were rarely documented in a form accessible to others. All-in-all they acted as if they all would live forever.

As a result, the average age of space workers in many key facilities in the 1990's was only a few years less than the average male life expectancy (59). If 20-year-old military draftees in the "Russian Space Forces" are counted, a lower value can be obtained ("47" is the current official average age), but there is no question this remains a critical challenge for the coming decade when half a century of expertise must be transferred or lost (and then slowly and painfully reacquired).

"Staffing is a painful problem for us," space chief Anatoliy Perminov told a news conference at the end of 2006. "It has always been a big problem and it is particularly an acute problem now.[5] "If there is no inflow of young specialists," Russian Prime minister Mikhail Fradkov had told reporters in July 2005, "everything could be lost, regardless of the money invested."[6]

Sergei Ivanov, widely considered a contender for successor to Vladimir Putin in 2008, had told newsmen much the same thing in late 2006. The chiefs of defense enterprises, he said, are concerned "not so much about financing as about who will work, where to get qualified personnel". One press report attributed to Ivanov the idea that “a shortfall of such cadre is increasingly apparent.”[7] Ivanov concluded: “The shortage of personnel is the main problem facing the rocket and space industry.”[8]

Anatoliy Perminov has directly addressed his strategy for finding such employees. They come from institutes such as Bauman University and the Moscow Aviation Institute, as well as experienced personnel who leave the military. “They mostly work at space launch sites, in particular, Baikonur,” Perminov noted. [9] But new employees in their late 40’s won’t help drive down the average age of the team.

Recruitment remains hit-or-miss, with some organizations showing large influxes of young people, as long as the cash flow remains healthy. But to a very large extent, every new employee is a potential ex-employee to a degree rarely seen in the previous generation. In those days, there were few other jobs with the prestige or intellectual stimulation or access to exclusive privileges, but today that’s all changed, and young people know it. Enthusiasts and loyalists there are – often the children of current or past workers – but there just aren’t enough of them to even replace the bodies, much less the experienced minds, now hemorrhaging irretrievably from the industry.

The way in which Russian space workers are organized into teams has also evolved. Under the Soviet regime, federal agencies and industrial enterprises were often arbitrarily yoked together on projects that operated by fiat, not by budget (there was no quantitative ‘cash flow’ to gauge levels of effort). Conflicts and alliances developed on an almost literally Byzantine (i.e., personal intrigue) style (some mergers were actually sealed by marriages, or even what looked like exchanges of hostages). Operating as quasi-autonomous satrapies, space and rocket firms were vertically integrated, often possessing their own support industries, hospitals, and even their own food supplies,

Only in 1993, in response to negotiations with the United States, did Moscow convert an administrative ministry into an executive agency with its own budget – the ‘Russian Space Agency’, or ‘Roskosmos’ (the name has evolved over the years). A parallel military command, usually called some variation of the “Russian military space forces” and transferred among major branches of the armed forces every few years, handled infrastructure operations and military-related space vehicles. Both agencies dealt with a Holy Roman Empire crazy quilt array of academic and industrial entities

The most important ‘firms’ are:

“Energiya Rocket and Space Corporation” (named after Sergey Korolev), located in a Moscow northern suburb now called ‘Korolev’, manufactures human spacecraft, ‘Progress’ freighters, ‘Block-D’ upper stages, and communications satellites, and operates Mission Control Center. Management replaced recently in ‘hostile takeover’ by Russian Space Agency.

“Khrunichev State Research and Production Space Center” in Moscow, manufactures Proton rockets, space station large modules, ‘Rokot’ ICBM-derived small launchers, and small satellites. Developer of ‘Angara’ booster family. Finances are shaky.

“Progress State Research and Production Rocket Space Center“, Samara, ‘Soyuz’ booster fabrication, reconnaissance satellites.

“Applied Mechanics Scientific and Production Organization” (NPO Prikhladnaya Mekhanika), named after Mikhail Reshetnev, Krasnoyarsk, communications and navigation satellites.

Lavochkin Design Bureau, Moscow-Khimki, specializes in lunar and planetary probes, military reconnaissance satellites, other small satellites.

Moscow Institute of Thermal Technologies (MIT), sole remaining active ICBM/SLBM manufacturer (Topol, Bulava missiles, START-1 small satellite launcher)

“Production Association Polyot” (Omsk), ‘Kosmos’ satellite launcher, ‘GLONASS’ navsats, production of ‘Angara’ booster elements

Gagarin Cosmonaut Training Center, Zvyozdniy (“Star City”) NE of Moscow – cosmonaut training.

Krasnoznamensk (Golytsino-2), southwest of Moscow, central space communications and control hub, operated by military space forces

Other smaller entities build weather and earth resources satellites, perform basic research, provide support services, etc.

A major challenge today is the consolidation of hundreds of these groups, large and small, that make up the Russian space industrial base. Perminov recently put the total at “about 112 spearhead enterprises,” and it’s his job to reduce this to a dozen. Specific skills are to be retained, while duplication in support technologies is to be eliminated.

But outside observers are less optimistic. Andrey Kislyakov, a retired space official who now writes for the ‘Novosti’ news agency, has described the lack of progress towards this goal over the past five years: “On October 11, 2001, the Russian government approved the federal target program ‘Overhauling and Expanding the Defense Industry in 2002-2006.’ A conference on July 6 [2006] that discussed the same issue indicated there had been no achievements in this sphere…. Anatoly Perminov said Russia's 100-plus space-rocket companies will be merged into 10 integrated companies, and the entire industry will have just three or four corporations by 2015. It is a tried and tested way. Unfortunately, they are only now starting to implement this plan, rather than in 2001.” [13]

These enterprises and their overseeing bureaucracies had been operating on dwindling funds since the late 1980’s – an impoverishment that grew even worse with the collapse of the Soviet Union and the loss of many industrial elements to newly independent nations. But the twenty-year-long spectre of poverty has faded. According to Perminov, "this year [2006] for the first time the entire sum allocated for the federal space program, as far as the Federal Space Agency is concerned, has been disbursed." [14]

This financial well-being is largely based on reliance on what is euphemistically called "extra-budget sources" (in reality, sales to Western customers). "This year [2006] 23 billion rubles has been provided for the federal space program," Perminov explained. "Next year it will be 24.4 billion rubles, with no account of extra revenues. Combined with other programs, this makes a total of 35 billion-36 billion rubles."[15] That means that about twelve billion rubles, or a third of the total space budget, has to be raised commercially.

This fraction has remained fairly constant in recent years. In 2006, for the period 2006 to 2015, 305 billion rubles (about $10 billion) had been allocated, with the expectation that an additional 130 billion rubles will come from "off-budget sources." That's about $400 million per year of foreign funding, or about 30% of the operating funds (by comparison, in 1996-2000, 60% of the space budget was foreign funding, and in the first half of this decade, the figure has been about 30%).[16]

At least, at last, the space industry can again pay its workers. "As for salaries, we have done away with this problem," Perminov declared. "This year [2006] there are no enterprises with arrears of wages." Salaries range from 11,000 rubles to 20,000 rubles, not generous in Russian terms by any means – but a living wage, especially in two-income families.[17]

Infrastructure: Launch sites

Baykonur – The primary Russian space launch facility at Baykonur is undergoing profound transition as operating elements of the Russian 'Military Space Forces' hand over facilities to the civilian 'Federal Space Agency'. Progressive infrastructure collapse has been locally reversed through investments by commercial satellite launch groups. Political arrangements with the Kazakhstan government have stabilized, although both Russian and Kazakh officials have begun expressing anxiety about signs of Islamic extremist activities among the local population.

"A lot of work has been done to transfer Baikonur facilities from the Defense Ministry to Roskosmos," Perminov noted in December 2006. "A total of 62 facilities were handed over this year and the remaining ones will be handed over by the end of 2007. All the facilities have been accepted, and operational units have been appointed." [18]

Management and maintenance of decaying structures has been a challenge. When the massive 'Building 254', built in the late 1970's to house the Buran shuttle, was converted to processing modules and spacecraft for the International Space Station, the Buran orbiter that had made the programs single orbital flight in late 1988 was moved to Building 112 next door (it was built in the mid-1960's for the abortive Soviet man-to-the-moon program). A low bay of that building had already been converted to house payload processing for the STARSEM commercial Soyuz launch company, and an adjoining medium bay was modified to process Soyuz booster processing after the condition of the original assembly hall (built in 1956) deteriorated dangerously. But then the high bay area where the Buran lay collapsed (in 2001), killing six workers and destroying the flown shuttle. Yet the pressing need for booster processing facilities – and the availability of investment funds – led to the decision to repair and reopen one of the two collapsed high bays [construction is now in progress].

Plesetsk – The mainly military space and missile launch facility north of Moscow has also been undergoing significant infrastructure enhancement, both in space operations and in worker living conditions. In particular, launch pads for Russia's first new booster in more than twenty years, the 'Angara' family, are nearing completion.

Sergey Ivanov has described the Angara launch site as a "task of state importance," and asserted that the new pads will give Russia "a guaranteed, and independent from any political or economic circumstances, access to outer space." Once operational, the pads will allow the transfer of military and dual-purpose spacecraft launches from Baikonur to Plesetsk.[19] This will involve launchings into all operational orbits including geosynchronous (24-hour equatorial), either through use of a larger plane change during direct ascent or via fuel-efficient but operationally complex orbital plane change maneuvers utilizing lunar fly-by [currently, such orbits can only be reached from Baykonur].

Kapustin Yar – Russia's original missile launch facility on the lower Volga continues in operation for military missile (including anti-aircraft) testing, and spartan living conditions have slightly improved according to press reports in 2006. It retains the capability for small satellite launchings.

Svobodniy – The far east launch site for small commercial satellites, once touted as a replacement for major Baykonur operations but recently threatened with closure, faces an uncertain future. Regional governor Leonid Korotkov told reporters in December 2006 that he had attended a meeting of the Russia Security Council in Moscow where it was decided not to "liquidate" the center. One of its decisions was to propose to the government and the Defence Ministry "to find forms of the rational use of the cosmodrome in the interests of defence, security and the economy of the country," Korotkov said. "This decision gives certain hopes for the preservation of the cosmodrome's infrastructure," he said.[20] Start-1 satellite launchers (converted ICBMs) operate from "Pad 5" at 51.79N, 128.19E.

Kourou – Development of a Soyuz launch vehicle capability at the French launch site in French Guyana is proceeding. In a formal ceremony in February 2007, Russian officials laid a stone from the sputnik pad in Baikonur to the Kourou space launch site. [21] The pad location is near Malmanoury (5.30 N, 52.83W), about six kilometers west of the Ariane-5 pads. The Russian side is investing 121 million Euros of its own money build the Kourou facility. The total cost, shared with the European Space Agency, is more than 300 million Euros, with a first launch expected in early 2009 and more than five launches per year [including potentially human launchings] subsequently.[22]

Dombarovskiy – A new satellite launch site was introduced in mid-2006 with the orbiting of a commercial payload (Bigelow Aerospace's "Genesis-1" inflatable habitat prototype) aboard a modified 'Satan' SS-18 ICBM (called 'Dnepr' with the addition of a third stage) from the missile field in southwest Siberia. A special hotel and payload processing hangar has been built in the support town of 'Yasniy' for foreign customers, and more launchings are planned. Use of the military base simplifies launch preparations and eliminates issues of environmental concerns by the Kazakh government, especially useful in light of the mid-2006 launch failure of the same category of booster from Baykonur that resulted in significant contamination issues in a sparsely-populated region downrange to the south of Baykonur. The silo used, designated “1-1” in official START negotiation documents, is at 51.06N, 59.71E.

Sea-Launch – The international consortium that launches Ukrainian-built Zenit rockets from a floating platform based in California continues in operation despite a lift-off booster explosion in early 2007 that damaged the platform. The project had already been facing a major cash flow problems due to the inability to perform a critical originally-intended mission function, to wit, reload the launch platform with a second launch vehicle and payload, while at sea. With launches limited to a single shot per time-consuming cruise, earnings are severely constrained.

Russia’s interest is with the use of a Russian-built upper stage, the ‘D’ block, a booster that has been phased out of most other Russian launches (on Proton it has mostly been replaced with a competing vendor’s upper stage, called ‘Briz’), resulting in significant income loss to its manufacturer, the Energia Rocket and Space Corporation.

Rumors persist that Ukraine, eager to establish a Zenit launch capability at the Brazilian Alcantara launch site, is considering moving ‘Sea Launch’ operations permanently to Brazil, where the existing floating launch platform could be anchored just offshore of Alcantara and could be rapidly reloaded after each commercial launch. In late 2006, Ukraine completed fabrication of a launch platform for the smaller ‘Tsyklon-4’ booster, intended for installation at Alcantara to allow commercial launchings on behalf of the two-nation “Alcantara-Cyclone-Space” corporation.[23]

Submarine-launched boosters – A converted SLBM booster, renamed ‘Shtil’, carried a small German science satellite into orbit most recently on May 26, 2006, launched from the submarine ‘Ekaterinberg’ in the Barents Sea. But launch failures have bedeviled this attempted conversion of rockets from the Makeyev Bureau. The old rocket factory had been the manufacturer of all but the most recent submarine missiles, but is now facing bankruptcy after transfer of all future military missile contracts to another vendor. Operational advantages of this submarine option appear dubious, and cost advantages are far outweighed by the daunting failure rate, arguably a consequence of the financial collapse of the missile firm that is desperately seeking to avoid dissolution.

Launch vehicles -- Russia’s family of satellite launch vehicles has been undergoing significant upgrading, but plans to shift to a new generation of launchers – the ‘Angara’ series – continue to recede into the indefinite future.

Soyuz-2 -- This is the biggest recent success story for Russian space rocketry. Three very successful missions with this upgraded booster occurred in 2006, and more are planned (including from Kourou). The upgrades include a digital control system (that flies a more efficient ascent profile and allows a reduction in unburned propellant), a new telemetry system, addition of wider and longer payload farings, replacement of non-Russian vendors, more efficient main stage engines, and an entirely new third stage rocket engine. Combined, these improvements increase the payload of the vehicle by 1,200 kilograms (almost 20%). The booster is designed for human launches as well.

This upgrade will allow years of future use for a booster that has, in its basic form, been launched almost 1800 times in the past 50 years. One of its anticipated future missions, using a ‘Fregat’ fourth stage, will be to carry a pair of replacements of improved Glonass-K navigation satellites in 2010, a significant cost reduction of the three-per-launch Proton missions now needed.[24]

Proton – Russia’s most powerful launch vehicle (approx 20 tons in LEO) continues in use, in recent years exclusively for geosynchronous-bound missions. The “Proton-M” upgrade is now entering service, and as with the Soyuz-2, uses a digital flight control system and upgraded first stage engines, resulting in a 6% payload performance improvement.

The next major upgrade in development is a cryogenic upper stage.[25] Once operational, it will make the Proton competitive with Ariane-V for GEO missions.

Angara – The long-anticipated “ecologically friendly” booster family called ‘Angara’ had been held up for years as Russia sought Western funding. “This system has been in development for more than a decade,” Russian Space Forces Cdr Col. Gen. Vladimir Popovkin told reporters recently. “Eventually, an understanding has been reached on how it should be funded and when it should be created," he added.[26]

Russia will spend 1.8 billion rubles ($75 million) on space center development in 2007, most of it at Plesetsk, and most of that for the Angara launch support complex. This money is coming from the Defense Ministry budget, not the RSA.[27]

Angara is being built by the Khrunichev company, the builders of the Proton system – but unlike the military-derived missiles that use highly-toxic hypergolic propellants, Angara is to use more benign kerosene and liquid oxygen. Depending on the number of engines and strap-on stages, the system will offer small, medium, and large (“Angara-5”) versions[28], and will replace the ‘Proton’ rocket (and ‘Soyuz’ as well, perhaps) about ten years from now. A special Angara-5 version called ‘Baiterek’ will operate under Kazakh auspices from Baykonur and one Proton launch pad is already undergoing modifications.

These delays are more than merely inconvenient – they threaten the very financial rationale for the project. Roskosmos official Aleksandr Chulkov had told ‘Izvestia’ in August 2005 that funding problems continued to delay the new launch vehicle family. “The Angara rocket, however promising it may be, will not be ready in the next three years,” he admitted. By then, he warned, competition from comparable boosters in China, India, and Ukraine may have locked up the international market. “Ukrainian rockets are serious competitors for Russian cosmonautics,” he pointed out with irony, “and it will be very difficult to take away the leading position which we ensured for them.” As a result of the delays, paying customers such as Panamsat have cancelled launch contracts worth in aggregate up to $700 million in the past two years. They have switched to other rockets and may never come back to ‘Angara’, if it ever appears at all.

URAL – A joint Russo-French project called 'URAL' aims at a fully-reusable advanced launch vehicle burning liquid hydrogen and methane. Whether it is an actual hardware development project or a foreign-subsidized hobby shop for under-employed Russian space engineers is impossible to tell.

"Air Launch" – A project involving an Antonov-124 aircraft and a two-stage satellite launcher called "Polyot" has been in the works for a number of years, but moved closer to reality in 2006 with the beginning of construction of ground facilities on Biak Island in Indonesia. Flight tests are promised for 2009 with an operational launch the following year.

Satellite deployments

Russia's collection of operational satellites – about one hundred, on average – displays some striking features which are consequences of the severe budget constraints of the past twenty years. The number of science satellites, or the number of specific applications satellites, is seriously deficient. Networks of military satellites – such as early warning and navigation systems – have also been severely degraded.

In the late 1990's, as orbiting payloads broke down or exhausted their control propellants, gaps appeared in the applications networks ("constellations" in US terminology, "groupings" in Russian). Despite new launches after 2000, failure rates exceeded replacement rates. "Two years ago, it was our understanding that it was simply going to collapse," Perminov told a journalist in November 2006. Now that failure has been stalled."[29] And speaking in December 2006, Perminov claimed that the situation had stopped deteriorating and was turning around. "Regarding the composition of space assets in orbit -- the composition has improved, but mainly in terms of quality. As of today, 53 percent of space vehicles are operating within their design life spans. Last year that parameter was not so good." [30]

Figures released by Perminov indicate that currently the existing Russian deployment of satellite constellations (involving 96 spacecraft, a quarter the size of the US contingent) meets only 26% of the defined needs of Russia. Funding of future replacement vehicles is supposed to raise that level to 51% by 2010 and to 90% by 2015. Anther Russian space official said that only 39 of 99 existing spacecraft were "fully operational," while the rest were operating in degraded mode well beyond their design lifetimes.

It is astonishing to note that currently Russia does not have a single functioning weather satellite in orbit. Russian meteorologists have had to purchase their images from foreign satellites. At last, a new-model "Meteor" payload was to be launched later in 2007. Ultimately, three will be placed in polar orbit and two in geosynchronous orbit.[31]

In terms of civilian remote sensing satellites, the dearth of payloads is finally being remedied. Perminov boasted of a remote Earth sensing Resurs-DK with a resolution of within 1 meter, launched in 2006. "We faced a systemic crisis last year [2005]", he admitted. "At the start of last year we didn't have a single remote Earth sensing probe. And the launching of that probe -- and it is now in operation and bringing good results and provides a high quality of pictures." [32]

Russia has also continued to operate the experimental small-size Monitor-E optoelectronic surveillance satellite, which uses panchromatic cameras (with a resolution of about 10 meters) and spectral-zone cameras (with a resolution of 22-24 meters) to fill commercial orders, according to Novosti commentator Yuriy Zaitsev.[33]

For military photoreconnaissance satellites, recent years have been very hard, with long gaps when no observation satellites of any kind were in orbit: Russia "periodically launches the Yenisey, Araks, Neman, and Oko heavy and medium optical reconnaissance satellites," noted journalist Viktor Myasnikov. "But they were all developed in the last century and are distinguished by a short period of operation in orbit. And even then do not always make it to the end. It is believed that all Russia's spacecraft, regardless of purpose--reconnaissance, meteorological, communications, and so forth--trail their American and European counterparts by two or three generations. And it is not a question of a lack of money but of backward scientific policy oriented toward instant impact, not the long-term development of new ideas."[34]

Russia intends to remedy that backwardness by promoting its GPS-equivalent, GLONASS. But when it comes to commercial applications of an originally all-military project, they are running into structural hurdles. One basic problem were espionage laws which until January 1, 2007, made it illegal for Russian citizens to even KNOW their true latitude/longitude to the accuracy that GLONASS can provide.

Reporter Yuriy Gavrilov described the spacecraft-specific problem in December 2006: "The collapse of defense enterprises in the middle of the last decade and the relatively short lifespan of domestic satellites -- around 3 years -- have turned into serious problems in space. Today only 14 GLONASS satellites fly around the Earth; moreover, only four of them are new-generation satellites with an operating endurance of 7 years. Every satellite costs more than $10 million; its launch and operation require another $35 million. It is clear that the military will not be able to cope with this task alone."[35]

"We hope we will have 18 spacecraft in orbit by late 2007 - early 2008, and there will be a whole orbital group of 24 spacecraft by late 2009," he went on. Perminov said the main task now is "to create ground equipment for ordinary people so that they could enjoy the fruit of this space system." [36]

On November 29, Vice-Premier Sergei Ivanov brought this theme up at a conference at the St Petersburg Institute of Radio-Navigation and Time. He was there to consult with specialists on how to carry out the President's directive: to accelerate the bringing of the dual-use navigation system online. According to the new program, both military and civilian users should have access to GLONASS by the end of 2007. Civilian users are supposed to make up 80 percent of the users in the country.

"Without being able to enter the market and provide citizens and their children with the opportunity of navigational support, as is already done, the system will not function as we want," he told reporters "The very main thing is the influence of GLONASS on the socio-economic development of the country and providing it with greater transparency and less corruption."[37]

Space analyst Yuriy Zaitsev of Novosti, along others, has pointed out the flaw in the commercialization strategy – nobody in Russia is really making GLONASS receivers for public purchase: “Unfortunately, the system's ground segment still leaves a lot to be desired. Starting on January 1, 2007, all restrictions on the purchase and use of GPS receivers will be lifted all over Russia, but batch production of them has not yet been launched. Moreover, electronic maps of all of Russian territory will only be compiled by late 2007. Consequently, commercial use of the global positioning system for civilian purposes is still out of the question.”[38]

Zaitsev has pointed out another reason for skepticism that Moscow’s top-down approach to motivating potential private GLONASS users will ever work. Two decades earlier, the USSR teamed up with Western countries in deploying orbital transponders to enable search and rescue for downed aircraft [called SARSAT for ‘Search and rescue Satellite] as small hitch-hikers on Soviet military navigation satellites [the Russians still claim disingenuously that these satellites are ONLY carrying out the ‘SARSAT’ missions]. Hundreds of thousands of such beacons have been installed on Western aircraft and boats, but as recently as 2006, Zaitsev notes, only “a few hundred” SARSAT-compatible beacons have ever been installed on Russian vehicles of all types, and many of them probably are no longer functioning. Russian aircraft continue to crash – and few if any are ever found through use of SARSAT-relayed signals.

Resumption of Science Missions

Writing for Novosti in 2006, Yuriy Zaitsev pointed out that although “unfortunately, no full-fledged scientific satellites have been launched in Russia this year,” Russian scientist still were able to utilize science date from their instruments aboard other space probes. Also, in exchange for providing a launch vehicle, “they have priority rights for the use of 25% of observation time aboard the International Gamma Ray Astrophysics Laboratory (INTEGRAL), which has enabled them to find out the nature of the cosmic microwave background radiation spread evenly throughout the Milky Way galaxy.”[39] Still, this led to widespread complaints from within Russia’s space science community.

But this may soon change, since the Russian Space Agency has actually added budget line items for future missions. Russia’s ‘Lavochkin Bureau’, which built the Soviet lunar and planetary probes of the early space age, now has government contracts for nine deep-space probes.

In 2007 the first of these, a ‘Spektr’ observatory with a 12-meter diameter dish antenna, is to be launched into high earth orbit. Russia is also dusting off (and replacing lifetime-expired components in) an already mostly-built payload called ‘RadioAstron’. It will be followed by “Spektr-UF”, planned for 2010, that will carry a UV telescope with 20 times the sensitivity of Hubble’s instruments into a very high orbit that allows continuous observations with much-reduced Earth interference. A space infrared observatory named ‘Millemetron’ has also been approved for launch by 2015. It will use a cryogenically-cooled 12-meter diameter mirror that will be deployed after launch into a high Earth orbit.

A Spektr payload devoted to X-Ray astronomy, formerly called Spektr-Roentgen-Gamma, has now been folded in with similar European projects, and now carries the ungainly title Spektr-RG/eRosita/Lobster. The payload will be carried into a low equatorial orbit by a Soyuz-2 booster to be launched from Kourou.

Several planetary missions have been funded, the first in more than a decade. The Fobos-Grunt [‘grunt’ is Russian for ‘soil’] 3-year round trip mission, now scheduled to begin in 2009, will leave a long-lived Russian-built science orbiter near Mars, along with a Chinese hitch-hiker beacon. The probe is now expected to be followed in 2011-2012 by a set of small Mars surface landers. And a moon orbiter called ‘Luna-Glob’ (‘glob’ is Russian for ‘globe’) has been contracted with a Moscow geochemistry institute that has been out of the lunar science business for almost thirty years. The probe will search for lunar polar ice[40] and will detect gravitational irregularities to help map the moon’s internal structure.

A probe named ‘Intergeliozond’ (‘Inter-’ for international, ‘gelio-‘ for sun, and ‘zond’ for probe) has also been approved for an attempt to reach nearer the Sun’s surface than any previous space mission. After a Venus swing-by, the probe’s perihelion would be 42,000,000 km, and further fly-by maneuvers will cut that distance in half, and ultimately even far lower. An ion drive will also twist the orbital plane until it passes over the solar polar regions.

The USSR’s greatest deep-space successes were with its missions to Venus, and they will be resumed by a probe called ‘Venera-D’ that will orbit the planet conducting remote observations. Serious studies have resumed for a long-lifetime Venus surface mission but no formal project has been approved so far.

Manned program and vehicles

Soyuz manned spacecraft – Introduced forty years ago, the ‘Soyuz’ has undergone numerous modifications and upgrades. Most significantly, an entirely new generation of ‘Soyuz’ has now been officially approved for introduction in 2011-12. This project clearly indicates that follow-on human space vehicles (e.g., the “Kliper” project) are much farther away.

The new Soyuz will be designed with a flight control system making one-man operation the norm so that two non-professional passengers can safely be carried. Major hardware changes will be made in the craft’s Service Module and other systems in the Command Module. It will have a 360-day versus the current 180-day on-orbit dwell capability. It will also be capable of being manufactured in a lunar variant, including a stronger heat shield, thermal control system, and longer-range communications capabilities. These options are nominally in support of a serious offer to make a commercial circumlunar mission for space tourists – but at a price of $400 million for two seats.

Sharing many basic systems with ‘Soyuz’ is the robotic supply craft called ‘Progress’. Introduced 30 years ago for use with Salyut and Mir space stations, the vehicle has seen more than 100 missions, every one of which has succeeded (occasionally on the second, and once on the third, docking attempt). It delivers about 2300 kg of payload to the space station.

ISS utilization and expansion -- Russia plans to double production of Soyuz and Progress vehicles in 2009 to support a six-person crew on the ISS and to transport US personnel in the period after shuttle retirement but prior to the beginning of 'Orion' missions – perhaps four years or longer. NASA has agreed to a Soyuz launch price of $65,000,000 (three seats), and will purchase seats for cash during this period. A contract for more than $800,000,000 worth of services was signed early in 2007.

In late 2006 the design for Russia's next add-on ISS module, called the Multipurpose Laboratory Module (MLM), was finalized. Originally to be basically a rebuilt spare 'FGB' module in storage at the Khrunichev plant (like the unit that served as the base of the initial ISS orbital assembly), it now will utilize more control systems provided by Energia-RCC (based on their 'Yamal' bus) in order to reduce the space allocated to equipment that is applicable only to the initial rendezvous and docking phase. This will double the available volume for scientific equipment.[41] The unit will be docked to one of the side-facing Service Module ports sometime in 2009-2010. Another module will provide a fourth docking port to support the higher traffic rates.

Russia plans to support and help operate the ISS through at least 2020. But it remains to be seen whether the scientific returns from its participation will have any more impact on Russian industrial technology than did the ambitious program of orbital research in the 1980's, that is, zero.

It is just as likely that Russia sees its ISS role as "dues" for membership in the high-status club of top world spaceflight players. It is also relatively cheap insurance that the massively profitable foreign space sales activities will continue without interference by the governments of the US and the EU.

Kliper -- Support for the theory that Russia's main space efforts are aimed at securing additional foreign funds is the recent history of the much-touted 'Kliper' [Russian for "Clipper"] six-person spacecraft. Officials have stated that it has been "approved for development" in the years after the Soyuz upgrade becomes operational, but significant design work is now being redone, and the hoped-for European and Japanese funding has not yet materialized.

The deputy chief of Roskosmos, Viktor Remishevskiy acknowledged in October 2006 that "this is the next stage in developing a manned space ship, and that Roskosmos had issued an RFP for the spacecraft, but then withdrew it." He added that the Russian Space Agency had concluded that the budgetary funds allocated (about nine billion rubles through the year 2015, of which 500 million are available by the year 2010) would not be sufficient to create a six-seat space ship that can fly to the Moon, to a space station, fly from Plesetsk, land on runways, and perform other required functions. Additional non-budgeted funds are needed to realize the project -- tens of billions of rubles – and there were no longer any credible sources of such financing.

In addition, the design teams had settled on a spacecraft that would weigh between 13 and 14 tons, and there is no man-rated booster available. The 'Angara-3' could do it in theory but it has been so often delayed that officials were unwilling to fund and develop a manned spacecraft in the hope that the new booster would be done on time. [42]

Ground Simulations -- Another human space flight project that looks more like a foreign funding magnet than a serious scientific effort is a planned 500-day isolation study with six volunteers simulating a Mars mission. In 2007, facilities were developed at the Institute for Medical and Biological Problems (IMBP) in Moscow for an exercise to begin late in 2007, pending the receipt of enough European money (and crew volunteers). Past isolation studies have had mixed results (at best) and produced no significantly usable operational or medical insights beyond the insight that people still don't understand how to handle long-term spaceflight psychological stresses – actually, a highly valuable discovery if program managers come to believe it and act on it.

The "Parom" Ferry -- There are also some commercially feasible proposed Russian spacecraft that might well be worthy of outside funding. Probably the most attractive is the small "space tug" called "Parom" that has been designed based on existing space hardware to substitute for one of the major capabilities of the soon-to-grounded NASA space shuttle – its ability to bring large cargoes (structural elements, supplies, etc) gently to the space station.

It is useful to do a more detailed treatment of the 'Parom' project because it is a good example of Russian space engineers "playing to their strengths" and providing specific, critical services to international space activities. As such it is an illustrative case study in the ways that Russia can successfully exploit its existing strengths, and build upon them.

With the approaching irrevocable grounding of the space shuttle fleet, space planners must face the need to replace piecemeal as many of its capabilities as possible. And as the construction of the International Space Station has demonstrated, a key ability is not just to carry payloads into orbit, but also to accurately bring them to a desired point in space and attach them gently to a structure already there.

Without the shuttle acting as such a carrier, each payload designed to visit a space station must have its own navigation, guidance, control, and mating hardware. That hardware, and the power systems and propellant tanks to feed it, often can outweigh the deliverable payload on every launch and then often get in the way of operations once the delivery has been performed.

Now the Russians have proposed building the 'Parom', a specific spacecraft that promises to perform these tasks efficiently (and to use another critical word again, "gently" – a trait that makes building the payloads much easier). Functionally, it is the full equivalent of the harbor tugs in major earthside ports. Cargos without their own propulsion are towed to locations where they are wanted. The tugboat then moves on to another cargo, stopping once and awhile for refueling and maintenance.

The 'Parom' that the Energia Rocket and Space Corporation (Russia's manufacturer and operator of most human-related space vehicles) wants to build is a Soyuz-sized flying docking tunnel surrounded by propellant tanks, thrusters, solar cells, and avionics bays. It can dock in either direction, can thrust in either direction, and can be refueled repeatedly. Its components are to be designed for a 15 year lifetime involving up to 60 round trips between low orbit and the space station.

The basic mission profile is simplicity itself. Based at a docking bay at the ISS (perhaps only an attach point with minimal interface with the station), it departs for a lower orbit when a station-bound cargo canister (or assembly component) is placed into a parking orbit by any of a number of launch vehicles. The cargo vehicle must have a simple end-mounted mechanism for mechanical attachment and for short-term stabilization and power – nothing more sophisticated is needed. Parom approaches and docks to the cargo vehicle, and then pushes it up to the space station where it docks its free end to a fully-functional port.

At that point, Parom’s hatches can be opened and crewmembers can enter the cargo canister, if that’s the mission. Or propellant can be fed through transfer lines into the station (and into Parom’s own tanks, whenever needed).

Alternately, the station’s robot arm can grapple the payload, detach it from Parom, and place it where needed – perhaps in an assembly area, or perhaps over a ‘common berthing mechanism’ on the US side that allows transfer of full-size science racks or other large cargoes. Or perhaps the payload can be delivered to applications not yet even imagined. Parom is to have the flexibility to accommodate practically anything that anyone can get into a parking orbit, up to a mass of 12 metric tons and possibly more than twice that.

The space delivery options made available by such a spacecraft are as wide as space itself. Parom could visit free-flying materials processing modules co-orbiting with the ISS, bringing them in for annual servicing and then redeploying them on its way out for a parking orbit pickup. Some Russian designs have Parom providing the space-to-space transport for the proposed ‘Kliper’ follow-on human spacecraft, also still on the drawing board (and also awaiting funding from foreign partners).

Parom-class tugs could carry satellites into higher orbits for deployment, or emplace and then retrieve co-orbiting science and industrial satellites near the ISS. They could operate autonomously in geosynchronous orbit and even around the Moon, carrying cargo canisters that include additional propellant supplies. In another application, ISS-based Paroms (and more than one may be stationed there, once the Russians install additional docking ports) might be able to serve as emergency crew refuges, with portable consumables packages for life support..

Practically all of the components of this ‘Parom’ design have already been flight tested. The structural framework is easy to build, and the power, control, approach and docking systems would be outgrowths of existing Soyuz and Progress systems. Those avionics boxes that couldn’t last 15 years can be designed for in-space change-out.

And Russia has twice used tugboat-style vehicles to bring components to a space station. Both for the ‘Kvant’ module (Mir, 1987) and the ‘Pirs’ airlock module (ISS, 2001), the component was mounted atop a detachable ‘propulsion module’ that later departed. In both cases, however, rendezvous guidance gear was installed on the station-bound component, not on the proto-tugboat that was the ancestor of the Parom design.

In October 2006, Energiya president Nikolay Sevastyanov told a space conference. "We want to lower the cost of cargo supplies by a factor of four.” His deputy chief designer, Nikolai

Bryukhanov, had recently told reporters that "with consideration for the cost of the development and manufacture of the tug, the system will repay in less than two years of use" – clearly implying that customers would be expected to pay for the service. Once funding was approved, Bryukhanov promised the spacecraft could be ready in five years.

The following month, Energiya's plan received the blessing of Russian Federal Space Agency head Anatoly Perminov, who touted its benefits at a press conference and announced plans to conduct its first flight within three years (it wasn't clear if this would be a test flight and 'proof of concept' or the first fully-operational vehicle).

The plans are to phase out Progress flights soon afterwards, although cargo canisters carrying four tons of supplies (instead of the 2.5 tons carried inside each Progress) would then be launched regularly for pick-up by the operational 'Parom' tug. How many would eventually be deployed remains unclear – but in the case of logistical support for a post-shuttle space station, 'Parom' could well be the answer to a worrisome problem. And the way that the spacecraft is developed, funded, and operated could be the general operating concept for Russia's expanded successes in space in years to come.

Conclusion

For the foreseeable future, Russia appears committed to internationalization of its main non-military space activities, mainly as a crutch in obtaining services disproportionate to contributed resources ("For 5% of the investment we get 30% of the resources" is a frequent comment in justification of the space station partnership) and as a badge of 'major player' status in the world.

At the same time, Russia shows no signs of developing a capability for major innovation in spacecraft engineering or of demonstrating more than lip-service interest in quantum advances in space operations capabilities. Incremental progress has been the watchword for decades, usually not by choice but out of necessity because all previous attempts at break-out projects (human lunar flight, advanced robotic Mars probes, the 'Buran' shuttle, the Polyus-Skif family of orbital battle stations) ended in humiliating frustration.

Providing commercial launch services for foreign customers has provided multi-dimensional benefits to Russia. Beyond the significant cash flow, such activities fund booster upgrades and, in the case of converted military missiles, fund validation of lifetime extension efforts for still-deployed missile weapons.

Military applications of space systems remain uninspired, with critical constellations (such as the missile early warning net) still significantly degraded and likely to remain so for many years. Russian officials have evidently decided that, despite any public posturings over US military threats, there is essentially no prospect of actual hostilities in the foreseeable future and hence little pressure to reconstitute military space assets to a Soviet-era level. Russia retains an operational anti-missile system around Moscow that, with hit-to-kill guidance, could provide significant anti-satellite capability; it is also developing small robotic rendezvous spacecraft similar to US projects that have potential anti-satellite capabilities at any altitude they can be launched into.

Attempts at domestic commercialization of space-related services, including communications, navigation, and mapping, remain seriously – perhaps irremediably – hamstrung by the recent resurgence of a traditional Russian top-down structure of authority. Bureaucrats are being ordered to implement wider use of space infrastructure, and after many years of rosy reports of progress, Moscow may realize that it is almost all, as usual, a sham.

There is still little indication of successful exploitation of space discoveries and space-developed technologies (what NASA and the Europeans call "spin-offs") as a means of improving the technological skills of Russian industry. The space industry, as a component of the national defense industry, remains strictly compartmentalized from Russia's civil economy, and the resurgence of broad espionage laws (and several recent highly-publicized convictions) will keep this ghettoization in force. This in turn may require other government measures, from patent purchase to industrial espionage, to acquire technologies that some Russian industries may already possess but are in practice forbidden to share internally.

Russian space-related scientific and exploratory research, after hitting rock bottom a decade ago, is showing signs of a modest rebound. Russian space scientists may be able to resume making respectable contributions to the world scientific literature in the coming decade, another ticket to world-class status that spreads prestige to all of Russia's science reputation..

But even if the main values of the Russian space program remain symbolic, these symbols have computable value to the nation's self-confidence and to the reputation of its technology – either for commercial export or as a reflection of the efficacy of its weapons. The modest but steady resource commitment to the space program reflects the government's assessment of the degree of value, now and in the foreseeable future.

However, none of these intentions have much chance of success unless the Russians find a way out of the looming demographic crisis that mass mortality is confronting them with. In a society and an industry where monopolization of knowledge was power, and sharing it often led to legal prosecution, behavior must change, and fast. This must be done so that space workers a decade from now, without the in-the-flesh guidance and advice of the old-timers, will be able to draw on their 'team knowledge' that survived the passing of its original owners and was preserved in an accessible, durable form. The alternative is a return to the 'learning curve' of more frequent oversights, mistakes, and inadequate problem solving of the dawn of the Space Age – with its daunting costs in time, treasure, prestige, and even human lives.

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1 Defense Industry Commission Discussing Space Industry Development Until 2015, MOSCOW. Dec 11 1430 GMT (Interfax-AVN)
2 Defense Industry Commission Discussing Space Industry Development Until 2015, MOSCOW. Dec 11 1430 GMT (Interfax-AVN)
3 ITAR-TASS 1818 GMT 23 Dec 06

4 PRESS CONFERENCE WITH FEDERAL SPACE AGENCY DIRECTOR ANATOLY PERMINOV, ROSKOSMOS, DECEMBER 26, 2006
5 Perminov, December 26, 2006, op. cit.
6 Fradkiv July 2005 quote
7 Development Of Space Rocket Industry Important - Ivanov
MOSCOW, December 11 1457 GMT (Itar-Tass)
8 Govt Commission Approves Rocket And Space Strategy Up To 2015
MOSCOW, December 11 1800 GMT (Itar-Tass)
9 Perminov, December 26, 2006, op. cit
10 Russia faces problems in developing space technology, Dec 11, 2006, MOSCOW. (RIA Novosti political commentator Andrei Kislyakov)
11 Perminov, December 26, 2006, op. cit.
12 Govt Commission Approves Rocket And Space Strategy Up To 2015
MOSCOW, December 11 1800 GMT (Itar-Tass)
13 Russia faces problems in developing space technology, Dec 11, 2006, MOSCOW. (RIA Novosti political commentator Andrei Kislyakov)
14 Perminov, December 26, 2006, op. cit.
15 Perminov, December 26, 2006, op. cit.
16 Five-year plan budget citation, TBS
17 Perminov on pay TBS
18 Perminov, December 26, 2006, op. cit.
19 Russia's Angara Carrier Rocket To Be Flight Tested In 2010, Moscow ITAR-TASS in English 1816 GMT 11 Dec 06
20 Russia Far Eastern Cosmodrome To Remain In Place - Governor
Moscow ITAR-TASS in English 0842 GMT 29 Dec 06
21 Perminov, December 26, 2006, op. cit.
22 Moscow Voyenno-Promyshlennyy Kuryer in Russian 01 Nov 06
["State Priority: Fleet of "Klipers" to be Created in Russia," by Gennadiy Pulin
23 Itar-TASS, Kiev, Oct 16, 2006, "Ukraine Makes Platform for Brazlian Launch Center".
24 Russian Launch Activity Ups A Gear, Sergi Manstov, nasaspaceflight.com, Dec 24, 2006.
25 Anatoliy Zak. Russianspace.web.com
26 Flight Tests Of Angara System To Start In 2010 - Popovkin
MOSCOW. Dec 11 1616 GMT (Interfax)
27 Interfax-AVN, Moscow, September 19, 2006
28 "Strategy of Space Independence", Krasnaya Zvezda, Dec 13, 2006.
29 Argumenty i Fakty in Russian 29 Nov 06
[Interview by Nikolay Zyatkov, editor-in-chief of Argumenty i Fakty, with Anatoliy Nikolayevich Perminov, director of the Federal Space Agency: "Space is Not Just for Tourists"]
30 Perminov, December 26, 2006, op. cit.
31 "Russia to have own weather satellites in two years – Chief meteorologist", Interfax, Moscow, November 23, 2006.
32 Perminov, December 26, 2006, op. cit.
33 Russia set to implement ambitious space program, 19/ 12/ 2006 // 21:41
MOSCOW. (Yury Zaitsev for RIA Novosti)
34 Moscow Nezavisimoye Voyennoye Obozreniye in Russian 01 Dec 06
[Viktor Myasnikov report: "A Satellite Is Now Space Junk"]

35 Moscow Rossiyskaya Gazeta in Russian 30 Nov 06 p17
[Report by Yuriy Gavrilov: "Dual-Use Navigation"]
36 Russia holds talks on GLONASS with US, Europe, India, others
MOSCOW, December 5 (Itar-Tass)
37 Moscow Rossiyskaya Gazeta in Russian 30 Nov 06 p17
[Report by Yuriy Gavrilov: "Dual-Use Navigation"]
38 Russia set to implement ambitious space program, 19/ 12/ 2006 // 21:41
MOSCOW. (Yury Zaitsev for RIA Novosti)
39 Russia set to implement ambitious space program, 19/ 12/ 2006 // 21:41
MOSCOW. (Yury Zaitsev for RIA Novosti)
40 Russia set to implement ambitious space program part 2, 20/ 12/ 2006 //
MOSCOW. (Yury Zaitsev for RIA Novosti)
41 Moscow ITAR-TASS December 4, 2006, "Two Russian companies to build new ISS module to do more research".
42 Moscow Voyenno-Promyshlennyy Kuryer in Russian 01 Nov 06
["State Priority: Fleet of "Klipers" to be Created in Russia," by Gennadiy Pulin.
43 Perminov, December 26, 2006, op. cit.
44 Perminov, December 26, 2006, op. cit.