



RHODUS INTELLIGENCE REPORT

HOW DOES RUSSIA MAKE MISSILES?

INVESTIGATION SAMPLE:

THE VOTKINSK PLANT



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INTRODUCTION

The Rhodus Intelligence team documented the entire Russian missile manufacturing base. This includes 28 ballistic, cruise, anti-ship, and air defense production facilities belonging to or associated with the four key corporations – Roscosmos, Tactical Missiles, Almaz-Antey, and Rostec. This open-source intelligence sample demonstrates our investigation methodology using an example of the Votkinsk Plant, one of the relatively more secret facilities in Russia's missile industry.

Our investigation sheds light into the rationales of the Russian military industrial management, the logic of resource allocation, tradeoffs regarding the organization and optimization of production processes for the current and expected scale of output, as well as the existing chokepoints in the military industry's production chain.

HOW WE COLLECT OUR DATA IN RUSSIA

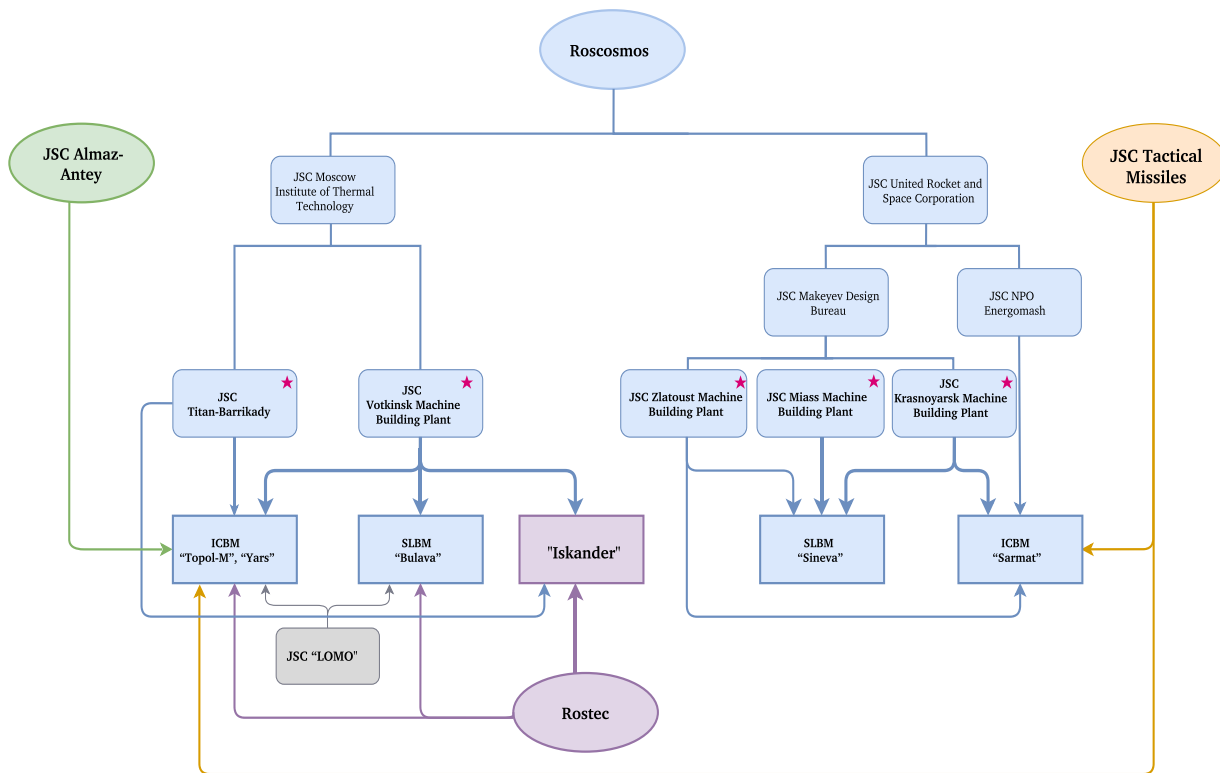
Although the Russian strategic missiles industry operates under the regime of secrecy, the secrecy considerations often come into conflict with other rationales which require the producer, its counteragents, or the state to disclose potentially sensitive information to public rather than to hide it.

First, it is the **propaganda needs**. The military buildup is the major source of national pride and, therefore, of the regime's legitimacy. The authorities and producers themselves feel pressured to convey the picture of a well-equipped, modernized military industry to the general audience. This makes federal and regional TV channels as well as producers' own video channels a principal source of visual evidence on the Russian military industry.

Second, it is the **market needs**. Since the fall of the USSR, military industry has been directly engaged in the competitive market, both as a seller and as a buyer. Whereas higher secrecy plants can be selective about the information they publish themselves, they are not always capable of censoring what their counteragents, including their employees, suppliers or service companies choose to publish.

Third, it is the **accountability needs**. The military plants' direct engagement into the market relations exacerbated the pre-existing principal-agent problem in relations between the state and state-owned enterprises. Aiming to check the managerial corruption, the state developed an extensive and transparent system of public procurements. As it developed, it became an invaluable tool both for the state controllers and for our investigation.

Figure 1: Roscosmos Structure



Source: Rhodus Intelligence

HOW IS PRODUCTION ORGANIZED?

Roscosmos is a state corporation responsible both for civilian aerospace programs and for maintaining the nuclear deterrence system. **It is the sole producer of intercontinental ballistic missiles in Russia, including strategic ICBMs and SLBMs.**

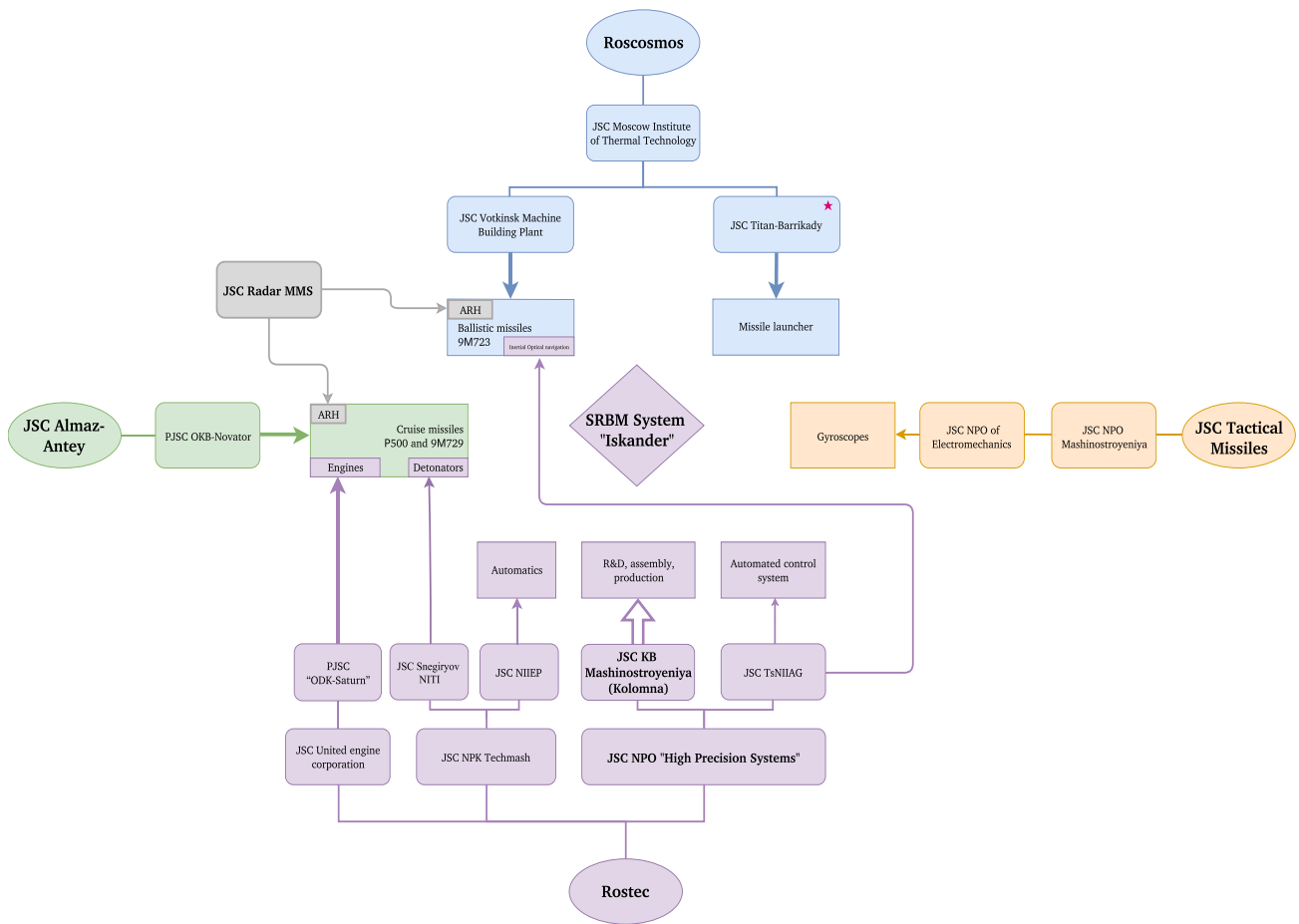
The military production of Roscosmos is concentrated within two defense holdings:

- JSC Makeyev Design Bureau (Makeyev) - liquid-propellant missiles
- JSC Moscow Institute of Thermal Technology (MITT) - solid-propellant missiles

Makeyev structure includes three missiles producing facilities – Krasnoyarsk Machine Building Plant (Krasmach), Zlatoust Machine Building Plant (Zlatmach) and Miass Machine Building

Plant, Krasmash being the most important one by far. Meanwhile, the MITT structure includes only one missile producing plant – Votkinsk, making it the sole producer of solid propellant ICBMs/SLBMs in Russia

Figure 2: The Votkinsk Plant and the SRBM «Iskander» production.



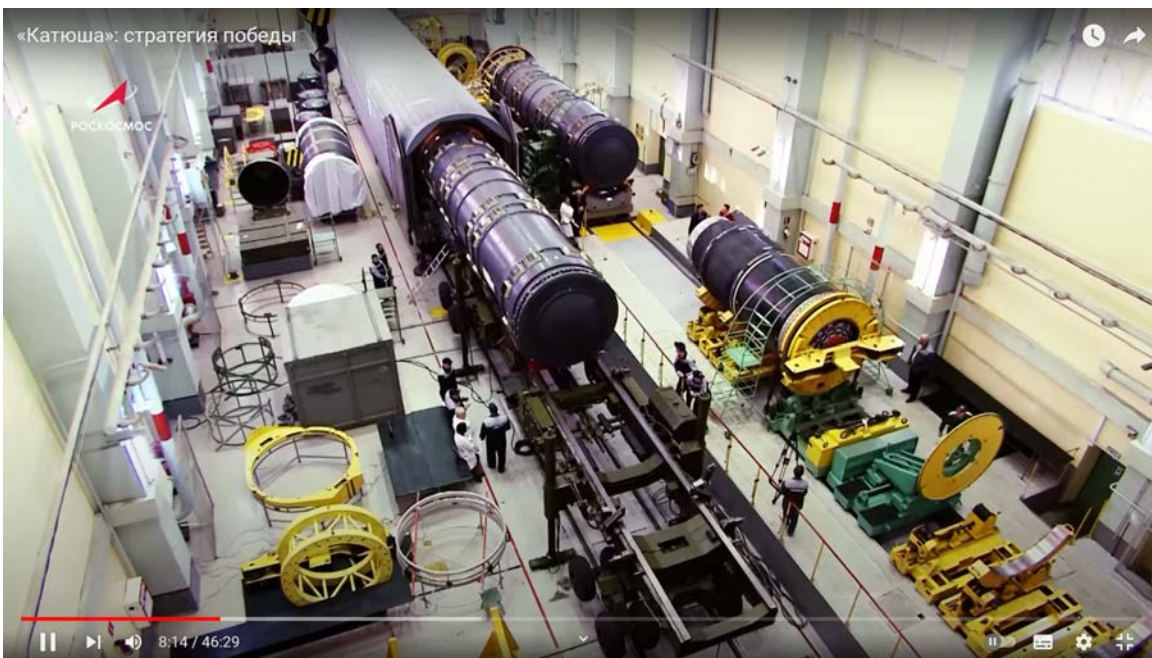
Source: Rhodus Intelligence

STEP 1: VOTKINSK PLANT IN STATE PROPAGANDA

Roscosmos official channel «Roscosmos TV», Video “«Катюша»: стратегия победы” [[Katyusha: strategy for victory](#)] from Dec 17, 2020 offers abundant visual information on machine tools used in the production of missiles:

8:01: “The Votkinsk plant is a gigantic, classified production facility...now the intercontinental heirs of Katyusha are being born here – Topol, Yars, Bulava missiles.”

Figure 3: ICBM «Yars» on the factory floor, Votkinsk Plant



Source: <https://www.youtube.com/watch?v=BkmqncBhkOw>

At 8:43 we can briefly see a screenshot of a laser machine tool.

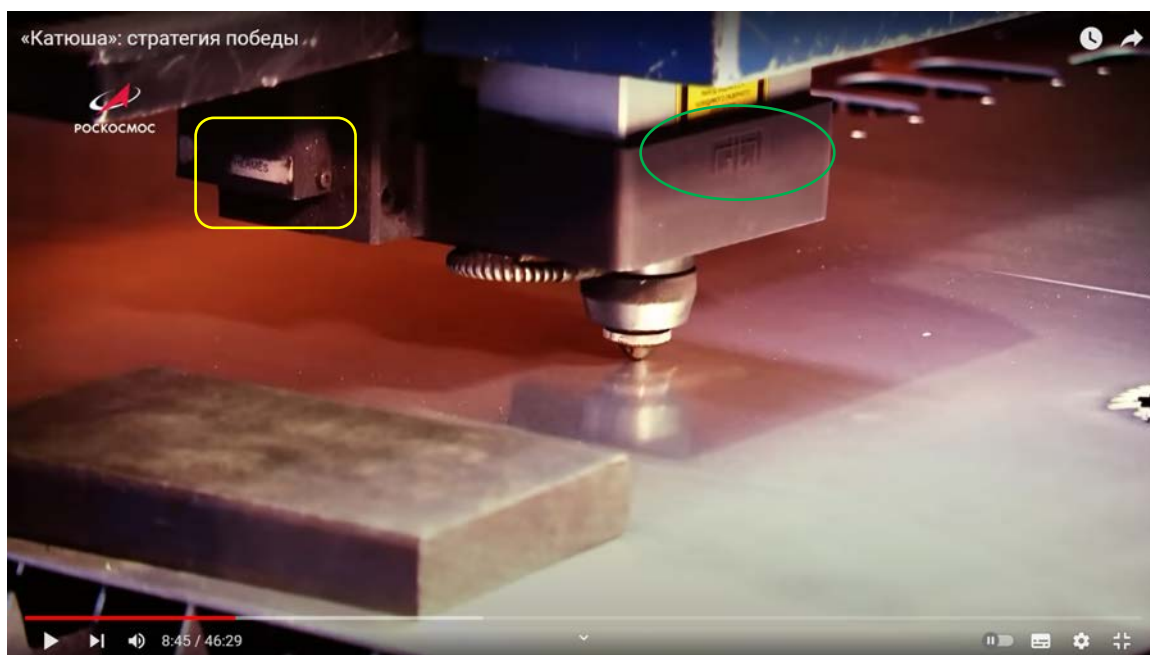
Figure 4: Laser Machine Tool



Source: <https://www.youtube.com/watch?v=BkmqnCBHkOw>

There is even a close-up at 8:45

Figure 5: Laser Machine Tool (Close-up)



Source: <https://www.youtube.com/watch?v=BkmqnCBHkOw>

We can safely assume that this video shows a punch laser machine produced by the [Italian company](#) Prima Power. This is indicated by a characteristic logo^{1 2}. On the left part of the screen you can notice the Hermes logo.



The next tool shown at 8:48 is a Primach-20l panel:

Figure 6: Laser Machine Tool (CNC panel)



Source: <https://www.youtube.com/watch?v=BkmqncBHK0w>

This is as far as propaganda videos can bring us. In order to establish the exact model of equipment, when it ended up on the Votkinsk Plant, and to trace back the supply chain, we need to resort to the public procurements data.

¹ <https://www.primapower.com/ru/technologies/2d-laser-cutting/2d-laser-cutting-machines/platino>

² <https://machineryline-au.com/-/laser-cutting-machines/Prima-Power---c3842tm10139>

STEP 2: USING PUBLIC PROCUREMENTS DATA

Public procurements are the most mass and the most informative source on the military industry's economic activities. Aiming to check the managerial corruption and to align activities of the individual producers with the broader policies of state, the state developed an extensive electronic system of public procurements. Procurement listings often include the information on the specific model of equipment acquired, its price, suppliers, technical specifications, and so on. **Overall, the public procurements are as close as we can get to the ultimate and exhaustive source on the Russian military manufacturing base.** Still, they have limitations.

First limitation is chronology. Functional electronic system of public procurements was not built until 2011, and it took until mid-to-late 2010s for most of the military industry to adopt it. Everything purchased through the 2000s is difficult to track and aggregate.

Second, transparency. The transparent and publicly accessible system of electronic procurements coexists with the untransparent, classified system of unknown size. As the secrecy regime is governed by the internal company regulations and the executive orders of state, we rarely know what they chose to classify

Third, unevenness. There is the significant variance between companies and plants regarding the procedures of procurements and the practical implementation of these procedures. Neither the track of a procurement, nor the content of the listings are necessarily standardized. Much of this unevenness seems to be arbitrary rather than based on the law or the formal executive regulations.

As a result, whereas public procurements constitute the most mass source on the Russian military industry's economic activities, **we have only a limited range of procurements concluded between 2011 and 2023.** Many purchases made within this interval and almost 100% of those made earlier are inaccessible. As the procedure, its implementation and the

content of listings are uneven, their analysis may require an investigation based on cross-comparison between different types of sources.

The Prima Power laser machine identified in the TV program is not reflected in the available procurements databases. Some of the possible explanations:

- It could have been bought until the early 2010s (chronology)
- It could have been bought through the classified procedure (transparency)
- The procurement could have been proceeded non-competitively or deleted from the database (unevenness)

However, even when we cannot find the procurement for the machine itself, as in this case, we can often find subsequent procurements for its spare parts. In certain cases, they allow us to identify the machine.

Let's look at the at this tender for the "*Spare parts for the Platino 1530-PRC2500 laser cutting machine*" of the Votkinsk plant published in January 2015. Spare parts listed on the p. 2 of the price listing in the attachment include CUTTING SENSOR HERMES II CONTROL BOARD 1SMPC4435/0C and I/O MODULE RSM101 board, 2SMPM3400/0M.

There are no published results for this tender. The absence of the published results can mean either that the tender was canceled, or (a more likely explanation) that the purchase was eventually made through a non-competitive procedure. The mention of Hermes cutting sensor indicates the plausible link between these spare parts and the machine represented in the video.

Figure 7: Procurement for the Platino laser spare parts (2015)

★ Добавить в избранное
👁 Скрыть закупку

Размещение завершено

[Протоколы](#)

Запчасти для установки лазерной резки Platino 1530-PRC2500

Закупка иного способа размещения № 31501913869 опубликован 14.01.2015 09:31 (мск) на ЕИС

Начальная цена контракта сумма не задана

[Контактные данные](#)
[Получить гарантию](#)
[Помощь в участии](#)

Порядок размещения время МСК

223-ФЗ, запрос цен открытый, площадка [ЕЭТП](#)

Окончание подачи заявок 21.01.2015 08:00

Рассмотрение заявок 21.01.2015 11:00

Подведение итогов 21.01.2015 15:00

Документы

[Запрос о предоставлении цен - запчасти TAV \(5\).doc](#)

Заказчик

Акционерное общество «Воткинский Завод»

ИНН-КПП 1828020110 – 182801001

Место поставки Отгрузка товара производится в адрес Покупателя за счет Поставщика по адресу: Российская Федерация, Удмуртская республика, город Воткинский, ул.Кирова, 2, территория ОАО «Воткинский Завод»

[Анализ заказчика](#)
[Все закупки заказчика](#)

Объекты закупки

ОКДП	ОКВЭД	Кол-во	Доп. информация
5150710 Услуги по оптовой торговле комплектующими изделиями для машин и оборудования	51.65.2 Оптовая торговля эксплуатационными материалами и принадлежностями машин и оборудования	2Штука	Запрос о предоставлении ценовой информации

Протоколы

Протокола по запросу цен от 04.02.2015

[31501913869.docx](#)

Source: Kontur database

While we cannot track the supply chain for the machine, we have seen on the video based on the procurement data, we can do this for another Prima Power laser cutting tool purchased in 2018. This tender published in June, 2018 had two participants:

- [Prima Power LLC \(official distributor³ in Russia\)](#)
- OJSC Trading House Votkinsk Plant

The OJSC Trading House Votkinsk Plant, outbided the Prima Power LLC by less than 2 000 euro. Considering the very insignificant price difference compared with the cost of the tool itself, we can hypothesize this is a corruption scheme. The well-connected participant was quite plausibly notified of the Prima Power bidding, so it could offer a slightly lower price and win.

Figure 8: Procurement for the Platino laser spare parts (2018)

The screenshot displays a procurement page with the following details:

- Star icon:** Добавить в избранное
- Status:** Размещение завершено, Заключен договор, with a button for [Участники и результаты](#).
- Title:** Открытый запрос предложений в единой информационной системе и на электронной торговой площадке <https://com.roseltorg.ru> (далее Система), на поставку в в АО «Воткинский завод» установки лазерной резки с иттербиевым лазерным резонатором, в количестве 1 шт., в соответствии с техническим заданием (приложение №1 к закупочной документации), с проведением сборочных, пуско-наладочных работ и инструктажа персонала заказчика
- Publication Info:** Закупка иного способа размещения № [redacted] опубликован 27.06.2018 11:51 (мск) [перейти на ЭТП](#)
- Description:** Поставка в АО «Воткинский завод» установки лазерной резки с иттербиевым лазерным резонатором, в количестве 1 шт., в соответствии с техническим заданием (приложение №1 к закупочной документации), с проведением сборочных, пуско-наладочных работ и инструктажа персонала заказчика.
- Price:** Начальная цена контракта 806 884,00 €
- Results Section:** Результаты от 18.07.2018

Участник	Цена, €	Рассмотрение заявок
ОАО «ТД «Воткинский завод»	804 999,00 €	Допущена
ООО «Прима Пауэр»	806 884,00 €	Отклонена

Source: Kontur database

The sanction regime does not necessarily hinder the maintenance of the existing equipment. A tender on the Prima Power laser cutting tool maintenance published on March 21, 2023, has no official results, yet. As in other cases, the absence of results may suggest the tender being redirected to the non-competitive track rather than being cancelled.

³ <https://www.primapower.com/ru/kompaniya/prima-power-v-mire>

STEP 3: INTEGRATING PROFESSIONAL SOURCES

Going back to the video, at 8:56 we find a laudatory remark that “*there is a Yars missile inside this transport and launch container [pause] [Some] say it is beautiful. But only some details are allowed to be filmed.*”

Figure 9: ICBM «Yars», Votkinsk Plant



Source: <https://www.youtube.com/watch?v=BkmqncBhkOw>

Despite trying to be secretive, at 9:09 – 10:07, the narrator is commenting on the welding processes conducted in an argon-filled chamber and says that “*this is the only process where the manual labor is still required. All other operations are automated*”.

At 10:14 we get a clear view of HELITRONIC VISION 400 L five-axes grinding machine manufactured by a German producer WALTER⁴ and equipped by a Japanese FANUC computer numerical control system

⁴ https://www.walter-machines.com/fileadmin/content_live_2019/www.walter-machines.com/01_pdf/01_brochures/1_Grinding/HELITRONIC_VISION_400_L/292_WALTER_HELITRONIC_VISION_400_L_EN.pdf


Figure 10: Walter precision grinding machine



Source: <https://www.youtube.com/watch?v=BkmqnCBHkOw>

An article in the professional metalworking magazine gives some context on the specific purpose of the Walter tools on the Votkinsk plant.

Figure 11. Instrumental workshop equipped with Walter machines (article with translation)

<p>Режущий инструмент будут делать на Воткинском заводе</p>	<p>“Votkinsk Plant” will be producing the cutting instruments</p>
	<p>The “Votkinsk Machine Building Plant” in Udmurtia has launched a new workshop for producing the advanced cutting instruments.</p>
<p>На Воткинском заводе в Удмуртии открыли новый цех по производству прогрессивного режущего инструмента.</p>	<p>According to the CEO Victor Tolmachev, this is the first and the only workshop of its kind in Russia. The “Votkinsk Machine Building Plant” has 525 CNC machine tools, including more than 100 machining centers, and 52 high-speed centers.</p>
<p>По словам руководителя предприятия Виктора Толмачева, этот цех первый и пока единственный в России. На ОАО «Воткинский завод» работают 525 станков с ЧПУ, из них более 100 обрабатывающих центров, в том числе 52 высокоскоростных.</p>	<p>The new workshop will fully cover the plant’s needs in the metal-cutting instruments, significantly increase the cutting speed and the productivity. The estimated production volume is 50 000 pieces per year.</p>
<p>Новый цех позволит полностью обеспечить потребности этого оборудования, значительно увеличить скорость резания и повысить производительность. Предполагаемый объем выпуска инструмента – 50 000 штук в год.</p>	

Source: https://issuu.com/zolotstrof/docs/rm_6_18_2013_block_prew

This article⁵ was dedicated to the "first and only in Russia" workshop for producing the modern metal cutting instruments on JSC Votkinsk. The authors estimated its output at 50 000 instruments per year. We can clearly see at least two Walter grinding machines on the illustration to this article. As we will see in the chapter on the JSC Tactical Missiles Corporation, the use of Walter HELITRONIC VISION machines to produce cutting instruments by the missile producing plants is not limited to the Votkinsk Plant.

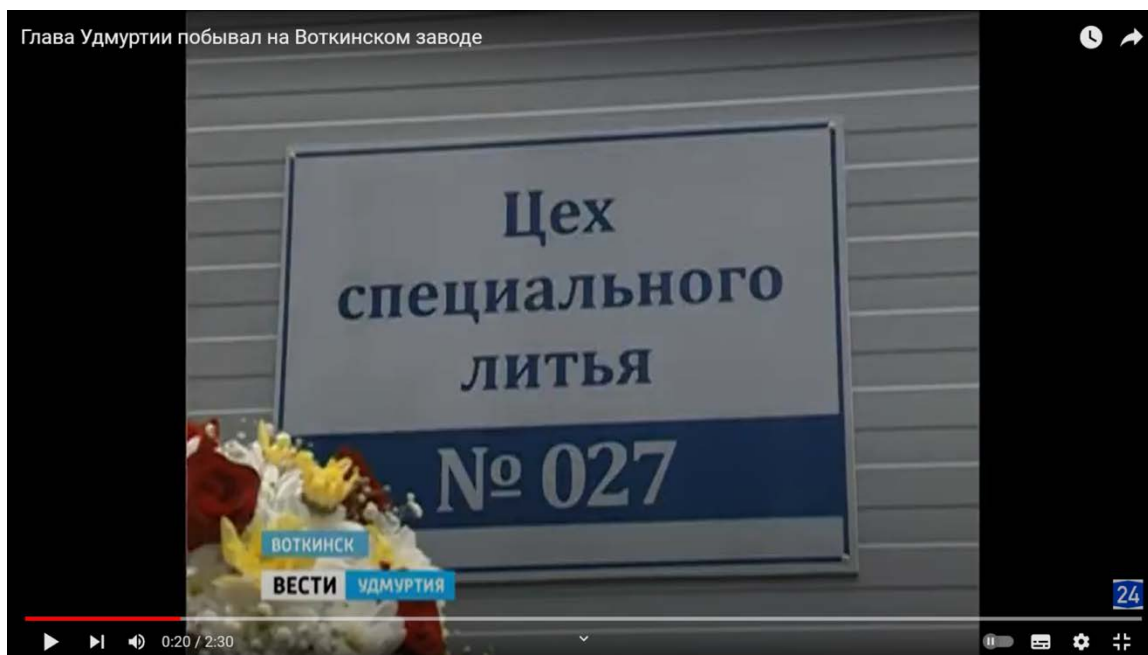
⁵ https://issuu.com/zolotstrof/docs/rm_6_18_2013_block_prew

STEP 4: TRACKING THE SUPPLY CHAIN

Regional TV channels from Udmurtia, where the Votkinsk Plant is located, offer supplementary evidence about the equipment and production lines. During the boost of military production following the annexation of Crimea, they often boasted new acquisitions and the expansion of production facilities, such as in this Sep 27, 2016 video from Vesti.Udmurtia TV channel. [[Head of Udmurtia visited the Votkinsk plant – Special Casting Workshop №027](#)]

At the beginning of a report on the governor's visit to the plant, it mentions "*a new section of the Special Casting Shop opened at the "Votkinsk plant...This foundry is unique in the Russian industry"*

Figure 12: Special Casting Workshop №027, Votkinsk Plant



Source: <https://www.youtube.com/watch?v=0wUCbORZZwY>

At 0:29 we can see the first footage with the robotic equipment.

Figure 13: Robot in the Casting Workshop



Source: <https://www.youtube.com/watch?v=0wUCbORZZwY>

Unblurred at 0:32 we can see that this is an industrial robot produced by the Swedish-Swiss company “ABB”. ASEA Brown Boveri has an extensive network of suppliers⁶ and service centers⁷ in Russia. By 2023 their withdrawal from Russia has not been completed yet.

⁶ <https://new.abb.com/ru/partnery/robotics>

⁷ <https://new.abb.com/ru/servis/servisnye-centry-abb-v-rossii>

Figure 14: ABB Robot at the Special Casting Workshop



Source: <https://www.youtube.com/watch?v=0wUCb0RZZwY>

In the same month, local channel Moya Udmurtia releases a video specifying that these industrial robots are used to produce the molds for the missile parts: [\[Votkinsk machine tools builders celebrated their professional holiday\]](#)

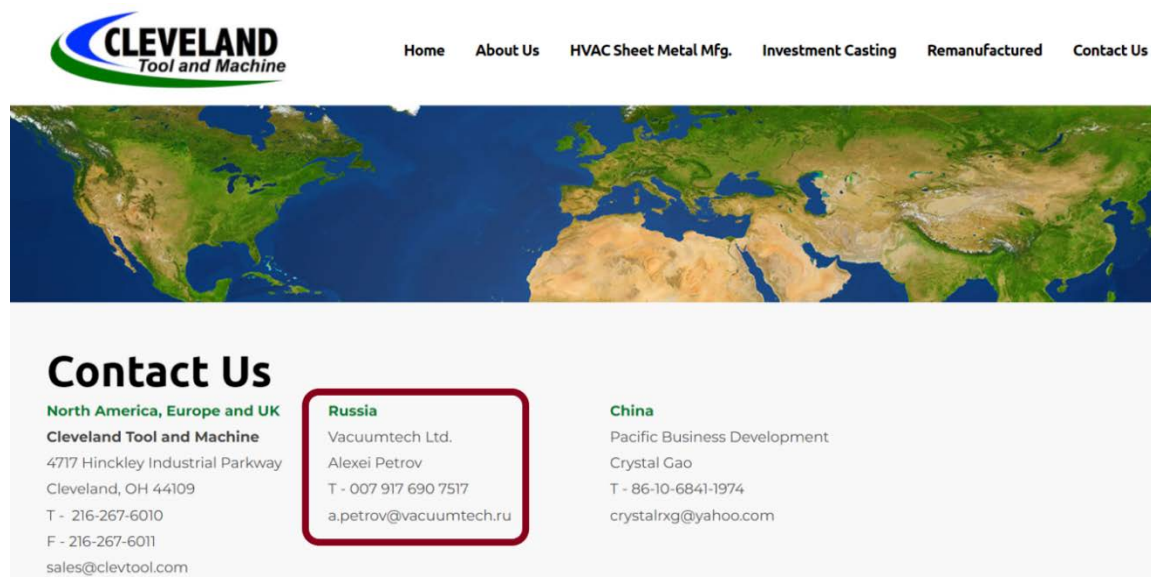
Procurements data suggests that the equipment for this casting facility was supplied under two contracts: under Procurement Notice No. 31603451269⁸ and Procurement Notice No. 31603450785⁹ (Contract No. 1118187400052020105000078/112-161957 of 04.06.2016) between the “Votkinsk plant” and “Vacuumtech” LLC, importer of similar equipment. Also “Vacuumtech” is the distributor¹⁰ of American “Cleveland Tool and Machine Inc” in Russia.

⁸ <https://zakupki.gov.ru/epz/contractfz223/card/contract-info.html?id=3191445>

⁹ <https://zakupki.gov.ru/epz/contractfz223/card/contract-info.html?id=3191229>

¹⁰ <https://www.clevtool.com/contact-us.html>

Figure 15: «Cleveland Tool & Machine» Distributor in Russia



Source: <https://www.clevtool.com/contact-us.html>

We have every reason to believe that it was Vacuumtech that supplied such equipment from Europe, Canada and the USA to other Russian military enterprises. **In the upcoming full report on Russian missile industry, we will show the entire supply chain involving JSC “Tactical Missiles Corporation”.**

The Votkinsk Plant continued to acquire new cutting tools in the years and months preceding the invasion in Ukraine. On 15 Dec, 2020 a local propaganda video [[Alexander Brechalov visited the Votkinskiy zavod](#)], once again, shows the governor Alexander Brechalov’s visit to the plant. On the background, to the right of the plant’s deputy director, you can see a sign SP430.

Figure 16: Governor visits the Votkinsk Plant



Source: <https://www.youtube.com/watch?v=V1sW-x7llll&t=59s>

That is a Czech-produced CNC lathe SP430/1100¹¹, manufactured by the Kovošvit Mas Company. According to the company booklet, it has Siemens-Sinumerik 840Dsl control system with SINAMICS and FANUC drivers. On customer's request it can be equipped with the Heidenhain CNC PILOT 640 line.

Figure 17: Kovošvit Mas SP430 CNC Lathe



Source: https://kovosvit.com/wp-content/uploads/2021/08/1540315079_cs_1_111_sp430en-de-web.pdf

¹¹ https://kovosvit.com/wp-content/uploads/2021/08/1540315079_cs_1_111_sp430en-de-web.pdf

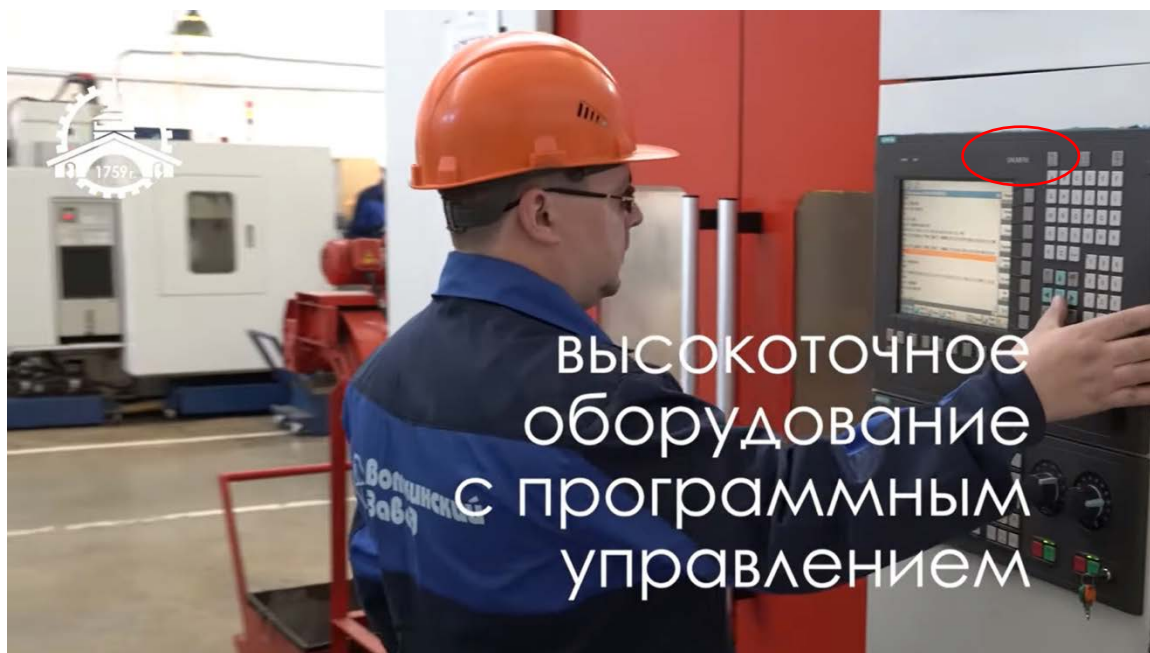
This specific machine may have been imported or assembled in Russia within the localization program. Since 2011-2013 the Russian government started incentivizing foreign producers to localize their production within Russia. As a result, foreign industrial equipment producers established a number of joint ventures (JV) and special investment contracts (SPIC) enterprises. Czech enterprises such as “TOS Varnsdorf”, “Kovosvit MAS”, and TDZ Turn s.r.o. were some of the first to occupy this niche. At 0:59 of the same video we see what is most likely a TOS Varnsdorf horizontal boring machine. Like the previous machine tool, this one is also Czech-produced.

Finally, in April 2022 “PARUS» IT company, published a corporate video [[Votkinsk Machine Building Plant is on the road to digital transformation](#)]. In this video, we can clearly see the HELITRONIC VISION 400 grinding machine again (0:25) as well a Japanese-produced MAZAK machine, probably the 1980s-produced MAZAK H-22- 80 tools Horizontal machining center¹² (1:00).

Most machine tool logos and CNC control panels in this video are not blurred. See this SIEMENS-produced SINUMERIK CNC panel at 0:40

¹² <https://www.machtechnica.com/en/metalworking-machinery/machining-centers/168-mazak-h-22-80-tools-horizontal-machining-center>

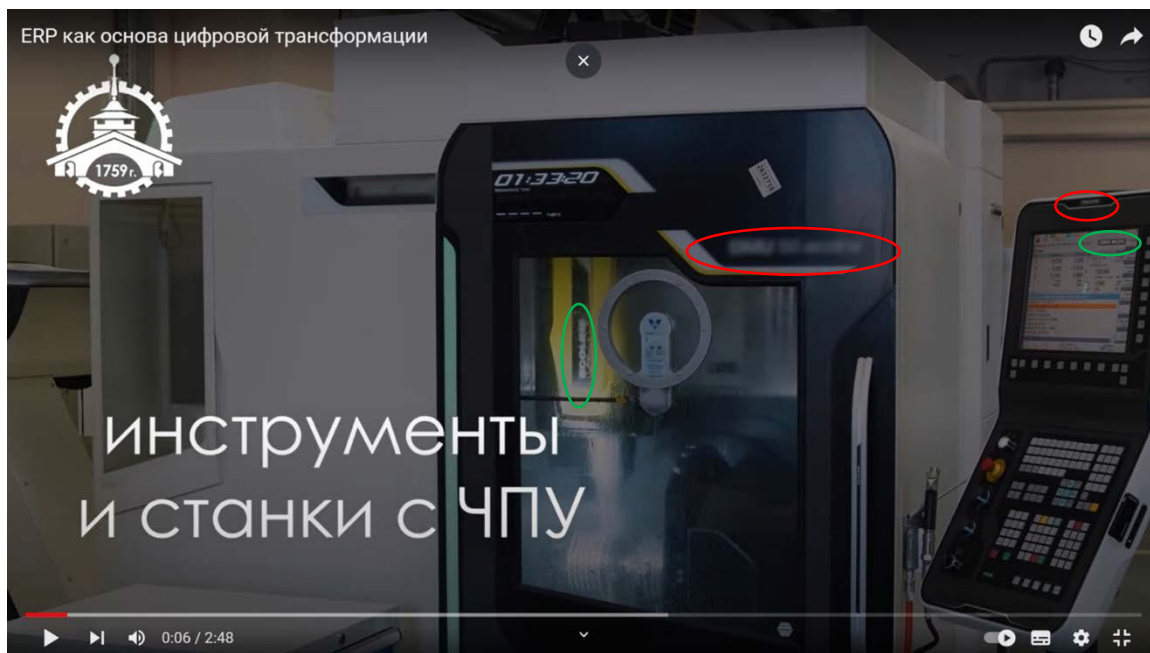
Figure 18: Siemens CNC Panel



Source: <https://www.youtube.com/embed/G1p1tperBZQ>

There is just one exception where they blurred the company logo both on the machine itself and on the control panel. And yet, they forgot to blur the «Ecoline» label and the «DMG Mori» sign on CNC screen, which allows us to identify the producer: DMG MORI Seiki AG.

Figure 19: Machine Tool with Blurred Labels (still, identifiable)



Source: <https://www.youtube.com/embed/G1p1tperBZQ>

German Gildemeister AG signed a cooperation agreement with Japanese Mori Seiki in 2009, and since 2013 they have been acting under a common brand: DMG Mori. To improve their branding, Mori Seiki was renamed to the DMG MORI Seiki Company, Ltd. and Gildemeister AG – into the DMG MORI Seiki AG.

In 2011, even before two companies developed a common brand, the German Gildemeister AG signed an agreement with the OJSC "Development Corporation of Ulyanovsk region" to localize the production of its ECOLINE models in Ulyanovsk¹³. In 2015, the DMG MORI Seiki AG launched the Ulyanovsk Machine Building Plant (USZ) - the first new machine tools building facility constructed in Russia since the collapse of the USSR. In September 2016 it was officially recognized¹⁴ as a Russian domestic manufacturer.

Note that this machine is shown twice, and its logo is blurred in both cases. **This makes us conclude that the military management considers the fact of the widespread use of *localized* Western production as the more sensitive information than the direct imports.** Most probably the production team obliged to their demands, but since they don't know what they can and cannot share, they forgot to blur the ECOLINE label and the DMG MORI label on the CNC panel. The mass blurring or covering the DMG Mori labels on the Russian nuclear warheads producing plants supports our assumption.

¹³ V.A.Zaitsevsky "Foreign direct investment in domestic machine tool building" // Izvestia MGTU "MAMI" № 3(21), 2014, t. 5. P. 69

¹⁴ <https://vestnikprom.by/stanki-ecoline-koncerna-dmg-mori/>

STEP 5: SURVEYING THE HR DATA

Russian military industry is integrated into a competitive job market. Military plants compete for workforce, and workers compete for the jobs. Optimizing for this competition, both sides disclose potentially sensitive information online, in vacancy postings and on Russian job search websites.

Vacancy listings posted by the military producers picture their generalized expectations of the prospective workers, including their qualification, education, work experience and skills. They also specify the paygrade.

Resumes posted by workers describe their individual work experience, employment history, education, skills, achievements, and the expected paygrade. **Combined together, HR sources produce a comprehensive picture of the Russian military industry's workforce structure, qualifications as well as individual and generalized career tracks.** They also indirectly produce a representative picture of the military industry's machine tool park, hardware, software and the technological solutions implemented.

The secrecy regime affects vacancy and resumes listings asymmetrically. Highly classified producers such as the Votkinsk Plant may be selective about the information they post themselves. Consequently, their vacancy listings are very uninformative. At the same time, they are often unable to censure the resumes their employees choose to publish. This makes job search websites such as the SuperJob.ru a major source of information on the most classified enterprises of the Russian military industrial complex.

Based on the vacancy and resume listings, we can classify the bulk of the military industry's machinists into two categories: CNC operators and set-up operators.

Table 1: CNC Operator vs Setup Operator

CNC OPERATOR	SETUP OPERATOR
<p>Below \$ 1 thousand/month (before 2022). Education: vocational school or short-term courses, sometimes a distance university degree. Semi-skilled, quick to train, low paid labor. If necessary, a janitor or a stunt actor can be retrained into a CNC operator in three to four months.</p>	<p>Over \$ 1 thousand/month (before 2022). Education: in most cases includes an offline university degree, typically in engineering. Highly skilled, highly paid workforce combining mechanical engineering and programming competences. The salary premium explains the abundance of setup operators with quality engineering degrees (the premium compensates for harder work conditions and a certain downgrade in status)</p>


Source: Rhodus Intelligence

We can look at an example of this 42-year-old CNC operator who has been working on machines equipped with Siemens-produced CNC controllers: SINUMERIK 840D, 802D, and on the Soviet CNC systems. These skills are directly listed on his resume:

Figure 20: CNC Operator Resume (example)


№ 1997913 Обновлено 11 июня 2021 • Был(а) больше месяца назад

[Показать контакты](#) [Пригласить](#) [Отправить письмо специалисту](#)

 41 год (родился 25 апреля 1981), состоит в браке, есть дети
Воткинск, готов к переезду, готов к командировкам

Инженер-технолог

Полная занятость
70 000 ₽

 **Опыт работы** 21 год и 5 месяцев

Сентябрь 2018 – работает сейчас 4 года и 5 месяцев	Инженер-технолог АО "Воткинский завод" Отладка технологии, внедрение управляющих программ, внедрение нового режущего инструмента, разработка оснастки.
Сентябрь 2001 – работает сейчас 21 год и 5 месяцев	Оператор с ЧПУ ФГУП "Воткинский завод"

Обязанности:

Изготовление деталей для технически сложных узлов механических конструкций.
4й разряд оператор ЧПУ
работа на токарных станках с ЧПУ и кранусельно-фрезерном с ЧПУ.
системы Siemens SUNUMERIK 840D, 802D также советские системы

Source: <https://russia.superjob.ru/resume/inzhener-programmist-po-stankam-s-chpu-2185798.html>

In contrast, here is an example of a resume belonging to a setup operator who had continuously worked on the Votkinsk plant since 1982. He worked as a machine operator, as a setup operator, programmed the CNC controllers, managed the workers. Most importantly, he was thrice awarded as the best “rationalizator” of the JSC Votkinsk Plant¹⁵.

¹⁵ <https://russia.superjob.ru/resume/inzhener-programmist-po-stankam-s-chpu-2185798.html>

Figure 21: Setup Operator Resume (example)

Опыт работы 37 лет и 5 месяцев

Декабрь 1986 – работает сейчас
36 лет и 2 месяца

Инженер-программист по станкам с ЧПУ
ФГУП Воткинский завод

Обязанности:
Разработка технологий и управляющих программ для станков с ЧПУ (ОЦ), отладка их на станке, сдача тестовой детали, профессиональное консультирование по техническим вопросам рабочих и технологов, проведение обучения рабочих-операторов работе на станках с ЧПУ.
В течение нескольких лет, являюсь, лучшим рационализатором ФГУП «Воткинский машиностроительный завод», имею заявку на изобретение.
Разработка пакета подпрограмм для систем ЧПУ FANUC.
Преодоление японской блокировки трех-координатного перемещения, на системах ЧПУ FANUC 6M, что привело к значительному повышению производительности станков IP-500 и IC800.
Инженер 1-й категории.

Январь 1984 – август 1984
8 месяцев

Наладчик станков с программным управлением
ФГУП Воткинский завод, Воткинск

Обязанности:
Работа на станках с ЧПУ, составление программ ЧПУ, отладка программ на станке, подбор инструмента, сдача тестовой детали, консультирование по техническим вопросам рабочих-операторов, руководство рабочими.
Имею самый высокий 6-ой разряд.

Январь 1982 – июль 1982
7 месяцев

Оператор станков с ЧПУ
ФГУП Воткинский завод

Обязанности:
6 разряд квалификации.

Обо мне

Профессиональные навыки:

Три раза присуждалось звание - "Лучший рационализатор объединения Воткинский завод".
Два раза побеждал на обще-заводской научно-технической конференции.

Компьютерные навыки:

Составление программ для для станков с ЧПУ. Интернет. И другое.

Source: <https://russia.superjob.ru/resume/inzhener-programmist-po-stankam-s-chpu-2185798.html>

In the Russian manufacturing slang, «rationalization» often means the implementation of Western solutions in the domestic production. In this specific case, the setup operator was

awarded for hacking the Japanese Fanuc 6M CNCs installed on the Soviet IP-500¹⁶ and IC-800 drilling-milling-boring machines. Imported Japanese CNC controllers had a blocked axis, limiting the range of geometries they could produce (apparently due to the export restrictions). This setup operator unblocked it, thus bypassing the export control for the military grade equipment.

Hybridization of the Soviet machines and the modern Western computer control is not an isolated case, but a common practice. We can reconstruct the modernization process on the Votkinsk Plant due to a leaked document from their service company. This document is a report¹⁷ by an Udmurt group of companies «KAM-Engineering». This company is modernizing Soviet-era tools, equipping them with modern CNCs and servo drives. Since 2002, KAM-Engineering performed extensive modernization projects in their home region of Udmurtia, including the JSC Votkinsk Machine Building Plant. Between 2003-2016 the KAM-Engineering modernized 74 obsolete machine tools on the JSC Votkinsk Machine Building Plant. 53 of them were produced in the USSR, 19 – in Germany (including DDR), 2 in Japan, 1 in Hungary and 1 in Taiwan. This reflects the mixed structure of the Soviet machine tool stock, with the disproportionately large role of the Eastern Block, especially East German production. These machines were equipped with modern CNC controllers and the servo drives:

Table 2: Modernization of Soviet Equipment on Votkinsk Plant

CNC	Servo drives
41 Siemens Sinumerik (Germany)	30 Yaskawa (Japan)
31 Balt-System (Russia)	23 SINAMICS (Germany)
2 Mitsubishi (Japan)	18 SIMODRIVE (Germany)
	2 Mitsubishi (Japan)
	1 Izhprest (Russia)

Source: Rhodus Intelligence based on http://kamstanko.ru/pdf/completed_projects.pdf

¹⁶ http://stanki-katalog.ru/sprav_ir500.htm

¹⁷ http://kamstanko.ru/pdf/completed_projects.pdf

Judging by these figures, modernization of the Soviet-era stock depended upon the supply of critical components from Japan and Germany. It is noteworthy that while the import dependency in servo drives was absolute, more than 40% of CNC controllers were home-made, all produced by the Balt-System company. The offshoot of Gorbachev's industrial policy, Balt-System is the only CNC controller manufacturer in Russia whose products are widely used in the military industry. It is producing the low end 2-3 axes controllers based on Taiwanese/Chinese components base. Its product is deemed as obsolete: in 2016, German CNC-producers compared the quality of Balt-System production to what Germany had been producing 20 years earlier. As a result, Russian machine tool producers/assemblers choose not to use the Balt-System product, preferring the imported Siemens, Fanuc or Heidenhain CNC controllers instead. And yet, as we see Balt-System found itself a relatively narrow niche of modernizing the Soviet tools with new computer controls.

The case of KAM-Engineering reflects how the interrupted continuity between the Soviet and the Russian military manufacturing base determined the current Russian import dependency. The Soviet Union collapsed at a very early stage of its transition from the mechanic (conventional) to mechatronic manufacturing. As Russia lost the Soviet machine tool industry in the 1990s, and chose not to revive it in the 2000s, its transition from mechanics to mechatronics was based on importing industrial equipment rather than on its domestic production. **Consequently, even the operability of the remaining Soviet stock depends on the continuous flow of machines, components, and expendables from the U.S. allies.**

CONCLUSION

As Russia lost the Soviet manufacturing base, it has effectively outsourced production of industrial equipment abroad. Putin's military buildup of the 2000s-2010s was based on mass import of computerized manufacturing equipment from the U.S. allies in Western Europe and in East Asia. As these supplies formed the Russian missiles manufacturing base, production was hooked on a permanent needle of spare parts, expendables and software support from the U.S. allies.

The mass replacement of manually controlled Soviet machines with the automated CNC equipment has radically expanded the Russian machining capacity. This allowed Russia to reboot the production of sophisticated weaponry, compensating for the consequences of post-Soviet collapse. This came at the cost of an almost full dependency on the Western machinery, software and, most importantly, the integrated manufacturing solutions provided by only a handful of companies in the world.

Contrary to the popular view, China has played a very limited role in the Russian military buildup until recently. Being a catching development producer, it could rarely provide the Russian missiles industry with the higher-end equipment it needed. These limitations of Chinese capabilities explain the otherwise puzzling absence of Chinese tools on the Russian missile plants. As of 2024, China is only capable of providing the lower end non-integrated products which cannot and will not substitute the Western European integrated solutions in the short to medium term perspective.