Ural Iron Before the Industrial Revolution

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Background: Metallurgy in the Urals in the 17th Century

Small metallurgical enterprises—small peasant blast-furnaces which provided for internal needs of villages—first appeared in the Urals at the beginning of Russian colonisation. Peasants migrating to the Urals brought technical skills in metal processing from western Russia. They used uncomplicated methods to smelt iron ore, either through an indivisible bloomery process (where leather bellows provided needed air) or a process using small vertical furnaces.

At the end of the 17th century primitive methods of ore melting could be found on both slopes of the Middle Urals, where fusible bog ore was abundant on the land surface. The core mountain ridge with its magnetic iron ore was not yet exploited. Villages and towns in the Kungur and Verkhotursky districts, to the south-east of Ekaterinburg along the Zhelezenka river, and near the Bagaryatskaya and Aramilskaya settlements on the Sysert river were actively occupied in iron ore fusing.[1] Excavations have revealed the remains of a small production of iron near old Kungur on the Iren river on the western slope of the Urals and along the Neiva and Nitsa rivers on the eastern slope. Here a whole metallurgical settlement, Rudnaya Sloboda (The Ore Village), existed. The inhabitants of this settlement had been digging

[1] Kashintsev D. Istoriya metallurgii Urala (D. Kashintsev, A History of the Ural Metallurgy (Moscow-Leningrad 1939) p.22–23).

ore for a long period and melted iron in small blast-furnaces and bloomeries.[2]

In spite of the primitive nature of this iron-making process and its trifling output, iron production still demanded long seasonal work to procure firewood and burn charcoal in addition to digging ore and preparing it for charging. Any time peasant families could spare from agricultural work was spent on these duties. Prepared raw materials and fuel were used during the iron-making period, which lasted 3–4 winter months.

In relatively populous territories peasant production from small blast-furnaces was significant. In some places even some degree of labour division existed and special social relations arose. Thus, in the Kungursky *uezd*[3] more than 45 peasant manufactures existed at the end of the 17th century with an average production of more than 50 poods each.[4]

The craftsmen/melters sold their semi-products, pieces of iron loops, to peasants who possessed forges worked by river water. There they heated the iron loops and forged them into bar iron.[5] For several years the small production unit of Mazuevsky existed, where iron bought from peasants was refined.

At the beginning of the 18th century when exposed to competition from cheap iron of better quality from large-scale state works, the handicraft industry decayed. Production fell sharply: in the 1720s it was six to eight poods, and sometimes even as little as one pood per furnace a year.[6]

The first state-owned ironworks was built in 1630–1631 on the Nitsa river near the village of Rudnoe, where the inhabitants had long been occupied with iron-making. The choice of this village was caused

[2] Istoriya Urala s drevneyneyshikh vremen do 1861 g. (A History of the Urals from ancient times to 1861 (Moscow 1989) p. 189).

[3] Uezd: administrative, territorial unit equal to province, part of a gubernia, ruled by a voyevoda.

[4] Belousov. Istoricheskiy ocherk mednoy promyshlennosti na Urale // Permskiy kray (Belousov, "The Copper Industry of the Ural" in The Perm Region (Perm 1895) p. 12). 1 pood = 16.38 kg.

[5] Chupin N. K. Geograficheskiy i statisticheskiy slovar' Permskoy gubernii (N. K. Chupin, Geographical and statistical dictionary of the Perm Province (Perm 1973) p. 26).

[6] Kirilov I. K. Tsvetyshchee sostoyanie Vserossiyskogo gosudarstva (I. K. Kirilov, The prospering condition of the Russian state (Moscow 1977) p. 168).

by two factors. First, large deposits of high-quality marsh-ore were close at hand. Second, it was possible to connect the works with the main iron consumers. The colonised Siberian lands could be reached on the navigable Nitsa river leading further into Tura, Tobol, Irtysh and Ob.[7] In this case, the river was only considered to be an asset for transportation. Iron was made with bellows and water resources were not necessary for the works.

The Nitsinsky works had four small blast-furnaces, several bellows and warehouses. The annual production of the ironworks was approximately 2 700 poods.[8] The forced labour of 16 peasant families was used. These families were forced to resettle at the ironworks, thus forming the village of Rudnaya. They had to work during the entire industrial cycle which stretched from 1 September to 9 May.

Peasants of the village Rudnaya (later Nitsinskaya) were relinguished from taxes and other duties. They received a wage of five roubles (under condition that they executed their duty; smelting 400 poods of iron). But even this rather high payment did not satisfy the peasants who were not accustomed to the labour at the works. It was not uncommon for them to run away. However, the government forced "the walking people" to the ironworks.[9]

The works existed for more than half a century. In 1669, peasants from the village of Nitsinskaya worked as "ore peasants", i.e. they extracted ore.[10]

In 1634, the Pyskorsky state-owned copper-smelting works came into being. It was the first of its kind in Russia. Geographically it was situated like the Nitsinsky works on the European slope of the Ural mountain ridge. Through the Volga and the Oka, the Kama river connected these works with the main copper consumer: Moscow's state foundries. A more perfected technique was used here than in the peasant handicraft. The works used water power. It was built by voluntary peasants. Their wage was rather high: 12 kopecks per day for a man who came with a horse and 6 kopecks for others. Skilled labourers

[7] Kashintsev, op cit, p.26–27.

[8] Ibid, p.31–32.

[9] Istoriya Urala (A History of the Urals, p.189).

[10] Tsentral'ny Gosudarstvenny Arkhiv Drevnikh Aktov. F. 1111, op. 3, d. 13, ll. 57, 107 (Central State Archives of Ancient Documents, fund 1111, inventory 3, case 13, p.67, 107; Tam zhe. Op. 4, d. 40, l. 154 (Ibid, inventory 4, case 40, p.154).

were invited from Moscow and other towns. Russian masters ran the works and foreign advisors also came.[11]

In 1640 the works was transferred to a more convenient place along the Kama river, below the old place on the Kamgorka (Pyskorka) river, where a weir, a "melting shed", a smithy, mills and several warehouses were built. Along the Kama, there was a landing place, and beyond the Kama a meadow where turf was taken from to cover wood heaps which were burnt into coal. Near the works a small village was built. Combined, these constructions occupied a territory of 70 tithings.[12]

The work was led by melters who received high wages. Among them was Alexander Tumashev, one of the copper ore discoverers. Copper ore from two mines, Grigorovsky and Kuzhgorsky, was used at the Pyskorsky works.[13]

The average annual smelting of the works was 600 poods. Thus, the scale of production was very modest and quite insufficient to satisfy the requirements of the country. In the second half of the 17th century the works was let to the merchant family of Tumashev. The whole production of the works was taken to Solikamsk where it was handed over to the state treasury for two, and later for three, roubles per pood. In Solikamsk state copper was sold at a fixed price of 4.25 roubles per pood.

The works was soon shut down. In 1666, the lease-holders announced that "the ore is completely extracted" and that production had stopped long ago.

However, the brothers Tumashev continued their activity even after the closing of the Pyskorsky works. Dmitry Tumashev prospected iron ore in the Neiva river-head and in 1669 built a works there with an annual iron production of about 1200 poods. Only one-tenth of the iron produced was transferred to the state treasury as tax and the greater part was sold on the local market. Besides bar iron, tools were made which were sold to peasants. In the works there was a blast-furnace with three fineries and a forge. Only hired labour was used, consisting of the Verkhotursky *uezd's* peasants and free men. In 1671, 23 men worked here. The works functioned until 1680.

[11] Istoriya Urala (A History of the Urals, p. 189).

[12] Kashintsev, op cit, p. 35.

[13] Berkh V. Puteshestvie v goroda Cherdyn' i Solikamsk (V. Berkh, A Journey to the cities of Cherdyn and Solikamsk (St Petersburg 1821) p. 52).

Another ironworks, Krasnoborsky, was founded in 1640 but it was soon closed down. With only one blast-furnace and two fineries, its technical outfit was primitive.[14]

The iron-making industry of Dolmatov's monastery appeared in 1682 in the Verkhotursky *uezd* on the Zheleznyanka river (later called Kamenka), near its confluence with the Iset. The peasants of the monastery gained about 300 poods of iron annually, which they used for their own needs. The ironworks included a blast-furnace with two finery furnaces, a coal shed, a smithy and a mill.[15] The industry existed until the end of the 17th century.

Thus, in the 17th century several ironworks were founded. Yet, the very small and primitive works of this period can hardly be considered as precursors of the large-scale metallurgical ironworks of the 18th century. From the very beginning the latter appeared as big enterprises built to match European standards. However, 18th century mining was influenced by earlier local traditions regarding ore prospecting and the training of labour.

Legislation and State Administration

The first mining law appeared in Russia at the beginning of the 18th century. A general law on rights to prospect and exploit minerals did not exist before the establishment of large-scale mining enterprises, although several cases are known when tsars have chartered individuals with the right to search for minerals. Such charters normally included special conditions and did not limit prospecting to state-owned lands. The government obviously did not consider the entrails of the earth as the property of the landowners and sometimes even promised armed defence for prospectors against those who opposed their activity.

Peter the Great, who strove for the creation of a mining industry in Russia, issued a ukase (decree) on 10 December, 1719, known as *Berg-privilege*. Following German and Swedish models, he legalised the principles of free mining and of *ius regale*, i.e. royal prerogative to the entrails of the earth. Undertakers received the right to prospect ores

[14] Istoriya Urala (A History of the Urals, p. 190).

[15] Chupin, op cit, p. 490.

and to mine in any territory on the condition that 1/32 of the returns was set aside for the landowner. According to *Berg-privilege*, one-tenth of the returns had to be sent to the state treasury as a mining tax. However, administration was never adjusted accordingly and no principles were laid down concerning how to measure the returns. But the government soon clarified the tax system. The Senate ukase of 1724 ordered that the treasury should have "from every hand-blast furnace first one kopeck and then another den'ga per pood pig iron".[16]

Ore prospectors, who had intensified their search since free mining was put into operation, met opposition from the landowners. Already in 1722 the government had to issue a ukase directed against such practices, but this also seemed to be ineffective. The principle of free mining was then abolished for the Siberian territories by the ukase of 26 September, 1727. Those who wanted to found mines and metallurgical works in Siberia on territories belonging to private landowners had to reach agreements with them.

The principle of free mining for all Russian territories was taken up again by the *Bergregulation* of 1739. The regulation was valid until the manifesto of 30 June, 1782, issued by Katherine II who was influenced at the time by ideas of free economic relations. The manifesto of 1782 proclaimed the right of the landowner not only to the earth surface but also to its entrails. With free mining abolished, the manifesto guaranteed manufacturers freedom from a mining administration that meddled in their affairs, a freedom which at this time existed only in Great Britain. It was declared that anyone was free to set up a mining industry on his own land, to cede his rights to any other person or jointly build works on his own land. As a landowner, the state held the same rights. The right for anyone to exploit ore deposits found on state lands was abolished. Henceforward, the state could work such deposits under its own management or lease them on conditions which were not codified by law but were elaborated specifically for each case. Finally, the state acquired the possibility to establish rules according to which exploitation of entrails of state land could be given to entrepreneurs under conditions advantageous to the state treasury. This principle was valid in Russia during the entire 19th century.

[16] Pavlenko N. I. Razvitie metallurgicheskoy promyshlennosti Rossii (N. I. Pavlenko, The development of metallurgical industry in Russia 1700–1750. Industrial policy and administration (Moscow 1953) p. 407).

The abandoned principle of Peter I, i.e. that mining should be free, was, in fact, a logical outcome of his policy to encourage the mining industry, namely to favour big capital instead of capital in general. Already in the first quarter of the 18th century the small metallurgical industry in the Urals was attacked. In 1717, a ukase of the Siberian governor was issued which prohibited (punishable by death) "foreign people" from melting ore. In 1723, this ban was confirmed by the mining authorities. Small hand-blast furnaces and primitive copper furnaces were demolished in the Urals or subordinated to the administration of the mining districts.

The main question of the mining policy of the Russian empire, where nine-tenths of the territories belonged to the state treasury,[17] was not the problem of abuse by landowners but how to relate the rights of the government to the rights of the owners of works built on state land. The division of private works in two categories, *posessionnye* and *vladel'cheskiye* (patrimonial) must be connected with the manifesto of 1782. With the abolishment of *Berg-privilege* the government put in the *posessionnye* rank those owners, who had any kind of allowance (e.g. to work power, land, mines). *Posessionnye* rights limited owners in their business activity. They could not make independent decisions on extending, decreasing or shutting down the works, nor could they freely command the labour force appointed to the works or transfer it from one works to another. Further, an owner subjected to this legal form *had* to use land and forests attached to his works. In the case of three years of inactivity, he was liable to lose his *posessionnye* rights. Nor had he the right to sell or to change any part of his estate. It could only be sold as a whole. According to the ukase of 1794, owners of *posessionnye* works began to pay 6 kopecks per pood of smelted cast iron, as compared to 8 kopecks per pood payed by owners of *vladel'cheskiye* works.[18]

At the same time, the government never regarded lands under *posessionnye* rights as its own. These lands could be inherited, sold or transmitted to other persons, also on terms of *posessionnye* rights. Within his district an owner under such rights had a monopoly on iron

[17] Abamelek-Lazarev. Vopros o nedrakh i razvitie gornoy promyshlennosti s 1808 po 1908 g. (Abamelek-Lazarev, The mineral resources and the development of the mining industry from 1808 to 1908 (St Petersburg 1910) p. 15.)

[18] Istoriya Urala (A History of the Urals (Perm 1963) vol. 1, p. 115).

and copper exploitation. In 1824, they received a similar right concerning gold deposits. Ores of other metals found on these lands were, however, regarded to be the property of the state treasury. In fact, if we do not take into consideration the conditional character of *posessionnye* estates, the owner can be said to have enjoyed the same rights as owners of strictly private domains. Moreover, state peasants were not transported to *posessionnye* lands. According to the regulation of 19 February, 1861, which abolished serfdom at the ironworks, the *posessionnye* owners obtained the right to decide which of their lands should be allotted to the workers and to ask for compensation to their own advantage.[19] During the period from the 18th to the first half of the 19th centuries not a single case of withdrawal of estates under *posessionnye* rights to the state treasury is known.

Direct or indirect government participation turned out to be decisive for the supply of labour to the mining works. The majority of labourers at the state works was enrolled in the work-force by means of extra-economic compulsion. At the beginning of the 18th century the workmen as well as the government regarded the work of the former as a state service. The legal position of state workmen approached the status of the lowest categories of servants. In the first half of the 19th century state workmen attained the status of the lowest military rank—recruits. After 35 years of compulsory service at an ironworks owned by the state treasury a workman could resign and had the right to a small pension.

Some of the governmental workmen were transferred to owners of private ironworks. To one of them (the Demidovs) the emperor gave (through a special ukase) state workmen when the works was founded. The other private owners (mainly noblemen) got their workmen in the same manner that state works were given to private owners in the 1750s. However, the work-force at the private works consisted mostly of released serfs and their standing was comparable to that of serf workmen.

The work-force of the private works at the beginning of the 18th century was mainly composed of "aliens"; peasants from villages under the state or private estates, with or without passports, escaping

[19] Ob usloviyakh posessionnogo vladeniya gornymi zavodami v Rossii (Conditions for possessionary ownership of the mining industries in Russia (St Petersburg 1863) p.36).

serfs, monastic peasants, traders, vagrants and people without relatives. A large part of the newcomers in the first half of the 18th century belonged to the religious sect known as the old-believers. In 1747, the private works employed more than 11,000 census souls. Among them, serfs who had belonged to the works from the start or who had been bought there later formed, on average, no more than 27 %. The others came to the works by their own will.[20]

However, people who came voluntarily often left their job, regarding themselves independent of the works. In 1736, after urgent demands from the owners of the works, a ukase was issued, which determined the fate of the engaged workers. All of them had to stay "forever" at the private works, in spite of the fact that they still paid their soul's tax at the place where they came from. The tax-paying provision somewhat limited the owners rights in relation to these workmen. But in 1755, the rights of "men given forever" were finally equalised with serf workmen and thereafter they had to pay their soul's tax directly at the works.

Noblemen owning ironworks transported serfs from their landed estates to their works, teaching them handicrafts. Children of serf workmen also became workmen. Nobles had the right to purchase peasants for their works from other noblemen. The same right was obtained by non-noble owners through the ukase of 18 January 1721. Serfs purchased by non-noble owners were regarded by the law as an integral part of the works. In case the works was transferred to somebody else, these people could not be separated. Non-noble owners lost the right to buy serfs for their works in 1762. They temporarily regained the right in 1798, only to have it abolished again in 1816. State workmen and serfs remained at the disposal of the owner according to his *posessionnye* rights. Thus, the owner possessed them conditionally since he would lose his right to be their master if he sold the works. He could use them only for tasks related to iron production and could not even transfer them to other works.

The ukases of 1721, 1736 and 1755 favoured the quick introduction of serfdom on the private Ural works. Serf workmen were essentially cheaper and hence more profitable than hired labourers for the owner.

[20] Cherkasova A. S. Masterovye i rabotnye l'udi Urala v XVIII veke (A. S. Cherkasova, Masters and workers in the Urals in the 18th century (Moscow 1985) p. 95).

Administration and technical duties were taken care of by serf workmen in the private works in the 18th and first half of the 19th centuries.

Consequently, the autocratic government, relying on serfdom, protected large-scale private capital with a policy which led to the reinforcement of feudal relations of production in industry. Striving to skip the period when big industrial capital was to grow naturally out of small capital, the reality of historical laws was violated. This led to paradoxical results. The monopoly of manufacturers, supported by the power of the state, became a feudal class-privilege. The preservation of serfdom prevented mining production from industrialising in the 19th century.

A system of huge mining districts—latifundia—was formed in the Urals. In 1861, there were 52 mining districts comprising 154 works and cottage industries. Among them 24 belonged to the state, 78 fell under *posessionnye* rights and 52 under patrimonial rights. The territories belonging to the works were vast. *Berg-privilege* of 1719 decreed that a quarter of a square *versta*[21] of land should be allotted for the private mines. The forest area attached to the works was defined separately in each case and depended greatly on the class and financial position of the landowner. In 1861, the total amount of land attached to the Ural works was 13,835,349 *desyatin.* [22] The owners of the mining districts/latifundia were given a monopoly on ore, fuel and labour force.

State interference in the metallurgical economy of the Urals was not limited to legislation. The economic management of industry, especially the state's own business undertakings, carried great importance in governmental policy. It is necessary to mention that in the 18th century the mining industry fell under the authority of *Bergcollegium,* the central administrative organ which had its own apparatus in the territories. Some reorganisation and administrative reforms of the mining management system corresponded to the changing political conjuncture but, in general, the governmental supervision with broad command rights on state mining works remained unimpaired.

The government executed its administrative functions especially

21 1 versta = 500 sazhens = 1.068 km.

22 Rutman R. E. Polozhenie i bor'ba rabochikh gornozavodskogo Urala nakanune otmeny krepostnogo prava (R. E. Rutman, The Ural miners' social conditions and class struggle shortly before the abolition of serfdom (1856–1860). Cand Diss (Leningrad 1954) p. 4).

regarding its own works. Organs of economic administration of these works (all levels included, from the separate workshop to the state industry as a whole) were regarded as a branch of the governmental apparatus. Mining engineers were not hired but continually appointed, getting a special rank according to the Table of Ranks.

Governmental works were instructed specially by the government; e.g. prices and norms of production output were ordered by the government. The administration was very bureaucratic. Large-scale metallurgy in the Urals originated, in fact, at the governmental works. 12 state works were built under Peter I but after his death their number increased. During the period 1725–1750 iron production of the state works in the Urals increased five fold, from 72,000 to 367,000 poods.[23]

The upsurge in market conditions lured the court nobility (Shuvalovs, Vorontsovs, Gollitsins, Sachovskies and others) into securing a large slice of the state-owned works in the 1750s. However, after a short time the major part of these works were returned to the state though in dysfunction and burdened with debts.

Up to the end of the 18th century production in general was rising but the industrial revolution in England had changed the situation of the world metal market. At the beginning of the 19th century the Russian government had to support a stable level of production through protective tariffs.

The formation of a ministerial system concentrated the highest governmental administration of the mining industry to the Ministry of Finance, specifically to its Mining Department. A local administration, the Urals Mining Board, headed by the main chief of the mining works in the Urals, was created. The state mining districts were headed by mining chiefs and the separate state works by managers. A corps of mining engineers with a semi-military organisation was created. The mining administration executed important civil functions. It was served by its own court, its own police and its own military troops, the Orenburgskie linear battalions. The mining administration ruled over the life and life-styles of all villages attached to the works, administered justice, meted out punishment and exercised guardianship. Essentially, it carried out all main functions of governmental bodies.

[23] Strumilin S. G. Istoriya chernoy metallurgii v SSSR (S. G. Strumilin, A History of the ferrous metallurgy in the USSR (Moscow 1954) vol. 1, p. 192–194).

The reform of 1861 which abolished serfdom marked a turning point in the history of metallurgy in the Urals. Through special statutes, mining workers were released from forced labour and a system of capitalist free employment began to take shape. Agricultural production also changed in the mining districts. Finally, under the pressure of private capital and of liberal opinion the government had to limit state business activities. In 1871 a law regarding the selling of a part of the state-owned works was approved.

Production and Consumption of Iron from circa 1700 to circa 1850

Until the 18th century demand for iron on the domestic market exceeded internal production. Therefore, iron was imported to Russia from abroad, mainly from Sweden. For example, in 1672 123,000 poods and in 1697 more than 41,000 poods of Swedish iron were imported into Russia.[24] The war with Sweden sharply increased the needs for iron. In this situation the government of course decided to encourage conceivably large-scale metal production in the country and to start an intensive phase of activity at the state-owned works. In the epoque of Peter I a new metallurgical region, with a power exceeding all the old ones, was created in the middle Urals.

The speed of construction was swift. First two state works, Kamenskii and Nevyanskii, were built. Both of them were put into operation in 1701. Already in 1702 the Kamenskii works produced 182 cannons and in 1703 the Ural works supplied a large amount of cannons, shells and iron to the army. In the first thirty years of the 18th century 33 works were built in the Urals. Thirteen of them belonged to the state, twelve to the big manufacturing family Demidov, two to the Stroganovs, and six to other private owners.[25]

In the second quarter of the 18th century, merchants (like the Osokins, Tverdyshev, Mjasnikov, Tochodjashin and others) began to invest capital in Ural metallurgy and the industrial development of the southern Urals began. During that time, more private works were

[24] Strumilin S. G. Istoriya chernoy metallurgii v SSSR (S. G. Strumilin, A History of the ferrous metallurgy in the USSR (Moscow 1954) p. 209).
[25] Istoriya Urala (A History of the Urals (Perm 1963) vol. 1, p. 99).

established than state-owned ones. Three times more private works than state works were built in this period. In sum, 71 units of metal-works were built in the Urals in the first half of the 18th century; 33 produced iron and 38 copper.

The Urals took the lead in the country's mining industry. In 1725, 0.6 million poods and in 1750, 1.4 million poods of cast iron were produced in the Urals.[26] The rapid development continued into the 1750s and 1760s. Then, the number of new works constructed decreased. In 1751–1770, 66 new works producing cast iron, iron and copper were put into operation and in the following 30 years only 35 new works arose, almost half the number. The state practically halted construction of new works. While in 1750 42 % of all blast-furnaces of the Urals belonged to the state, in 1800 only 12 % were state-owned. A total of 101 works were built in the second half of the 18th century and only five of them belonged to the state.[27]

In spite of the fact that fewer new units of production were added, metallurgical production in the Urals continued to grow in the second half of the 18th century. While in 1750 1.4 million poods of cast iron and 0.9 million poods of bar iron were produced there, in 1800 7.5 million poods of cast iron and 5.3 million poods of bar iron were produced.

Iron from the Urals was sold on the domestic market as well as on the foreign market. Already in 1724, Peter I ordered that all state iron should be sold abroad. The chief consumer of Russian iron was England. In 1716, in the period of the Great Nordic war, the first consignment of iron from Russia, more than 2000 poods, was received in England. In the period 1717–1719, annual iron export to England reached 35,000 poods on average. In the 1770s the English demand for iron increased considerably. In this decade the import of Siberian iron from Russia reached its maximum. The quantities left imports from Sweden far behind. In 1772, a total of 2,805,000 poods of iron were exported from Russia (in 1794, 3,885,000 poods).[28] However, in the end of the 18th century the situation changed. Foreign demand for Russian iron began to decrease. While in 1793 England imported

[26] Istoriya Urala s drevneyneyshikh vremen do 1861 g. (A History of the Urals from ancient times to 1861 (Moscow 1989) p.270, 274).
[27] Ibid, p.272.
[28] Strumilin, op cit p.229.

2,235,000 poods of Russian iron, in 1827 this import had fallen to 601,000 poods and in 1836 to 236,000 poods, i.e. a decrease of ninety percent compared with 1793.

The home market was satisfied with the private metallurgical production and internal sales of iron in the 18th century grew constantly. S. G. Strumilin has estimated that in the second half of the 18th century, iron export grew approximately by a factor of three, whereas the domestic market increased by a factor over seven.[29]

Iron and ironware were sold in the immediate proximity of the works. Further, consignments were delivered by merchants in the Ural towns and large quantities were sent to the Irbitskaya and Makarjevskaya fairs.

Up to the 19th century Russia was first in the world in iron production and the Urals produced 4/5 of all Russian cast iron and malleable iron. But in the ensuing decades the rise of the Ural metallurgy took a much slower pace. At the beginning of the century England had melted the same quantity of cast iron as Russia, about 10 million poods annually. In 1860, England had raised its production to 240 million poods a year whereas Russia (not including Poland and Finland) had only reached 18 million poods.

Although metal production in the Urals still increased during this period, the process was not as rapid as in the western countries. Within a half of a century it less than doubled. In the dynamics of the metallurgical production in the Urals two periods may be clearly distinguished: the period of economical difficulties and stagnation (1800–1835), and the period of slow rise (1835–1861).[30] The cause of the decrease and stagnation at the beginning of the century was that metal export declined. While in the beginning of the century Russia exported about 30 % of the produced metals, in the middle of the 1830s the export was only 20 % and at the end of the 1850s even only seven percent. The home market could not yet absorb the increasing quantity of metal. The transition from exporting to selling domestically provoked a necessary technical reconstruction. Since the home market demanded more specialised iron products (for instance roofing iron)

[29] Ibid, p. 233.

[30] Yatsunskiy V. K. Materialy po istorii ural'skoy metallurgii v pervoy polovine XIX v. // Istoricheskiy arkhiv (V. K. Yatsunsky, "Facts about the history of the Ural metallurgy 1800–1850" in Historical archives (Moscow 1953) vol. 9).

than bar iron, additional works had to be built and rolling and cutting mills and warming furnaces installed.

Social and Technical Organisation circa 1700 to circa 1850

Iron Production Within the Feudal Estate

Though the first profound historical studies and descriptions of the organisation and economic structures of the 18th and 19th century Ural mining industry were made as early as the end of the 19th and the beginning of the 20th centuries,[31] the general characteristics of the social organisation remained a much discussed problem over several decades not yielding, however, any common, universally recognised results. A certain theoretical sterility of this long debate was generated mainly by the fact that the mining works were considered as independent objects of investigation, and not as parts of a complex diversified mining economy. Only in the late 1960s, when the Ural historian V. V. Adamov attempted to identify the type of social organisation that prevailed in mining industry, the study was focused not on single works but on the district economy as a whole. Adamov's standpoint proved unpopular at the time but, nevertheless, at the close of the 1980s it was taken up by some Ural historians seeking to break the methodological deadlock. The first attempt to synthesise an interpretation from the studies made according to Adamov's conception has been made in a not yet published article by T. K. Guskova.[32]

[31] The works by V. D. Belov present a typical example of this kind of descriptions. See: Belov V. D. Istoricheskiy ocherk ural'skikh gornykh zavodov (V. D. Belov, An essay about the history of the Ural mining industry (St Petersburg 1896); Ego zhe. Krizis ural'skikh gornykh zavodov (The same author, Crisis in the Ural mining industry (St Petersburg 1910)).

[32] In order to get an idea about the key aspects and conclusions by V. V. Adamov and T. K. Guskova see: Adamov V. V. Ob original'nom stroe i nekotorykh osobennostyakh razvitiya gornozavodskoy promyshlennosti Urala // Voprosy istorii kapitalisticheskoy Rossii: problema mnogoukladnosti (V. V. Adamov, "The original system and some characteristics of the Ural mining industry. Aspects of the history of capitalist Russia: the 'mnogoukladnost'" (Sverdlovsk 1972) p.225–256); Ego zhe: Ob original'nom stroe Urala // Nauchnaya sessiya, posvyashennaya probleman mnogoukladnosti (The same author, "The original system of the Urals (terms, historiography)" in A scientific conference, devoted to the problems of "mnogoukladnost" of the Russian economy in the imperialistic period (Moscow 1969) p.71–108);

V. V. Adamov and T. K. Guskova regard the economic structure of a large-scale *votchina* (allodial land) to be the prime socio-economic "proto-structure" of the Ural mining industry. Characterising the socio-economic situation in Russia at the end of the 17th and the beginning of the 18th centuries, both scholars emphasise that there was no free manpower market in the country. The large-scale industrial production did not have sufficient economic outskirts and the potential entrepreneurs lacked the experience of organising more or less large-scale production. The experience of organising the *votchina* landholding was the only one available to the ironmasters in the early 18th century. T. K. Guskova distinguishes two major devices to utilise the above-mentioned proto-structure during the period when mining economies took shape. The simplest way, used for example by the Stroganovs, was to construct metallurgical works within the bounds of an existing *votchina,* as one further subdivision of a vast landholding. The *votchina* quite successfully carried out the functions of all the necessary auxiliary activities needed for the metallurgical production.

A much more complicated development took place in those mining economies, both *posessionnye* and state-owned, where the production complex was created on the basis of the metallurgical works, which gradually subordinated and adapted the economic outskirts to them. A major part of the Ural works belonged to this second group. Initially, a great number of operations at the enterprises was intended to be organised on the basis of hired labour. The ironmasters tried to attract contractors of various sorts who should supply the works with numerous articles indispensable to production (the so-called *pripasy*), raw materials and fuel. Nevertheless, as early as the mid-18th century the capitalist forms of organising production were pushed into the background and serf labour and the *votchina* organisation of production became the usual one.

In this light, T. Guskova conveys the idea that in Russia and in the Urals "the creation of a stable works economy, capable of sustaining the rapid pace of growth of the metallurgical works, had to be based

Gus'kova T. K. Okruzhnaya sistema kak forma organizatsii ural'skoy gornozavodskoy promyshlennosti // Sotsial'naya i proizvodstvennaya organizatsiya metallurgicheskoy promyshlennosti Urala v XVIII–XIX vv. V pechati (T. K. Guskova, "The system of regions as a way of organising the Ural mining industry in the prerevolutionary period" in Social and production organisation of the Ural metallurgical industry in the 18–19th centuries. To be printed).

exclusively on the serf principles". The return to the latter under the specific conditions of large-scale industrial production, differing substantially from those of large-scale agricultural production at the *votchina*, constituted the essence of the complex processes of "feudalisation" and "militarisation" experienced by the private and state-owned works at the end of the 18th and the beginning of the 19th centuries.

The processes of feudalisation and militarisation involved at least two important elements. First, the mining population became the main body of the permanent workers. Second, the ironmasters turned into owners of works *and* land. They, with support from the state, attained monopolistic ownership rights to exploit both the workers and the natural resources in their districts.[33]

These processes took place as a result of efforts to adapt the previous *votchina* to the demands of the works which grew up inside it in some regions. In others, efforts were made to form the necessary economic outskirts around the works in accordance with the principles of the *votchina* economy. Thus, during the 18th century peculiarly diversified economies termed mining districts (*gornozavodskiie okruga*) took their shape in the Urals.

In spite of the differences in their legal status, each of the mining districts—state, strictly private and *posessionnye*—presented a complex, diversified structure of production, which was based on the metallurgical production. All of them had much in common. Therefore, it is possible to identify some main features.

One trend was that every district tended to become a closed technological cycle of processing iron or copper, or even sometimes both metals, from ore extraction to rolling or forging metals of various sorts. As a rule, the equipment required for the closed technological cycle, i.e. blast-furnaces, copper-smelting furnaces, enlarged hammers and rolling-mills, was not located at the same place but was spread among several individual works, scattered all over the district territory and belonging to one and the same owner. Only a few copper-smelting works differed from this pattern due to their small size. This scattering of the production process imposed fairly considerable demands for transportation of semi-products, i.e. pig iron, black-copper or osmund

[33] Guskova, op cit.

iron, between the works within a district. Nonetheless, it was inevitable due to two reasons:

First, the water power of the relatively shallow rivers on which the dams of the Ural works were erected did not suffice to supply the whole metallurgical process with power. However, the construction technique had not reached a stage which allowed the erection of dams on full-flowing rivers. Moreover, the steam engines emerging in the Urals in the first half of the 19th century could not considerably increase the power of the works. Second, combining the system used to prepare fuel, ore and pig iron with transporting them made it impossible to commit a sufficient quantity of such materials to supply power for the closed technological cycle at one works or at several neighbouring ones. This generated a situation, where several blast-furnaces, forges and rolling-mills existing in the same district were essentially subdivisions of one and the same metallurgical enterprise instead of independent ones.

A second trend of development meant that each of the districts received vast landed property and tracts of woods which had either been possessed by the works' owner before the establishment of the works or been acquired by him on various legal grounds in order to provide the works with fuel, ore and other necessary natural resources.

A third trend was that many districts, especially those comparatively rich in natural resources and manpower, diversified their production and economic structures. Apart from metallurgical production proper and related activities characteristic to all districts, prospecting and mining of precious metals—gold and platinum—were carried out in many places. In some districts the metal was not only processed. To be sold it was further converted into more valuable goods. In the 18th century these were agricultural tools, such as scythes, sickles, iron mongery, armament and anchors. In the 1830s the production of far more complex machines, e.g. steam engines and metal ships, commenced.

A fourth trend of development led to proprietors of mining districts gaining a number of privileges, including the monopolistic right to exploit the natural resources of the Urals. When forced labour was used on their landed property, ironmasters profited not only by means of surplus value but by means of feudal rent as well.

The privileged status of the ironmasters also had an effect on their estate structure (*soslovny sostav*). Though merchants and rich gun-

smiths took an active part in the construction of works during the 18th century, by the close of the century 30 ironmasters' families, out of a total of 40, belonged to the nobility. The works owned by these 30 families produced 88.2 % of the aggregate output of cast iron and 84.9 % of the aggregate output of copper from all private metallurgical enterprises in the country. The structure of these 30 families is of great interest: ten of them belonged to the hereditary nobility, seven became owners of works due to marriage and thirteen were ennobled as industrialists and owing to their industrial activities. The estates and economic activities of these ennobled merchants and craftsmen were referred to as very large-scale. Their output of cast iron was 67.8 % and their output of copper 53.3 % of the total of all private works.[34]

A fifth line of development was that the dual nature of the mining economies (a large-scale industrial production with a feudal *votchina* as its proto-structure), with a variety of integrated branches and subdivisions, gave rise to an extremely complex social structure of the labour. Attention must be focused on the initially wide application of various forms of forced labour, for its share of total labour was continuously increasing during the 18th century and especially in the second half.[35]

Finally, the sixth notable feature, typical to some extent of all the Ural mining districts, was a certain "naturalness" of the district economy, i.e. a desire to produce everything required for the activity of the works and for other economic subdivisions within the same district. Apart from the metallurgical equipment proper, numerous small workshops grew up as a result, producing bricks, machines, tools, ropes, etc. Saw-mills and flour-mills were also situated within the territory of the Ural works. Consequently, the economies of the districts were closed and isolated from each other, while the whole of the Ural mining industry was related in exactly the same way to other regions of the country.

T. K. Guskova distinguishes the most important features of the

[34] Pavlenko N. I. Istoriya metallurgii v Rossii XVIII veka. Zavody i zavodovladel'tsy (N. I. Pavlenko, A History of the metallurgical production in Russia in the 18th century. Works and the works' owners (Moscow 1962) p. 516).

[35] Cherkasova A. S. Masterovye i rabotnye l'udi Urala v XVIII veke (A. S. Cherkasova, Masters and workers in the Urals in the 18th century (Moscow 1985) p. 98–113).

social organisation of the Ural mining industry (as cited above with a few additions) and determines the chronological bounds of the major stages of development:

1. The 18th century: the period when production started and the social structures of mining industry took shape.

2. The first half of the 19th century: the period of most rapid growth of the district system and of complete realisation of all its potentialities. The mining *votchinas* displayed a perfect flexibility and adaptability to the new conditions. When the technical outfit of the works had been considerably reconstructed, the assortment of produced metals expanded greatly. In branches outside the works proper (mining of ore, gold, platinum; fuel preparations, etc.) technical progress was less noticeable than at the works, but even there, the relations of production changed substantially. Serf labour made way for various forms of hired labour. The rate of economic development reached its peak, which allowed for the most fruitful utilisation of the natural resources. Separate auxiliary production developed into independent branches of the district economy. Moreover, a number of them started slipping away from the ironmasters' control. Petty entrepreneurs who, themselves, came from the mining population owned such production units. Thus, the feudal principle which had governed the works' economy was slowly broken.

Nevertheless, simultaneously with the growth of the mining industry, some signs of crisis became evident. The pace of technical progress was not the same in the different branches of the district economy; the technological backwardness of the Ural metallurgical works in comparison with those of England and some other Western European countries became more and more apparent. Introducing new technologies turned out not to be economically successful. Prime costs and overhead expenses tended to increase.

3. The second half of the 19th and up to the early 20th century: a period of general crisis for the district organisation of the Ural mining industry. Since the period exceeds the bounds of the joint research project, we will only point out that organising a mining economy according to the district system, which had its background in the mining *votchina*, became the main obstacle for the industrial revolution in general in the Urals, as well as for the industrial and capitalist reconstruction of mining industry in particular.

The social organisation of the district economy was intimately related to the technical organisation of production in the Ural iron industry. The closed technological cycle of metal processing and the whole system of subdivisions within every district brought about labour division not jointly for different districts but inside each of them.

The organisation of production in the Ural mining districts was based on the distinction between "works proper" and "non-works", i.e. auxiliary production. The two sectors differed substantially in the ways in which they attracted and structured the work-force, and they also used different technical equipment and different methods to raise productivity.

Organisation of Production in the Auxiliary Branches of the District Economy

With the auxiliary or "non-works" operations, one may refer to those tasks performed outside the works, such as mining and roasting ore, firewood preparation and charcoal burning, transportation to the works, mining gold, platinum, malachite and other minerals and delivering manufactured goods to the market places. Though only some of the auxiliary branches were somehow directly related to the metallurgical production proper, all of them may have been characterised by the same organisation of production.

The work-force was at the same time complex in its composition and shared important traits. The labour of serfs and ascribed peasants was in use but hiring workers was also more or less wide-spread. Hired workers included state peasants, the serf peasants of other landlords (permitted to work by hire) and even the serfs subject to the ironmaster himself, if they had fulfilled their obligations and had enough energy and a wish to increase their earnings. There is also evidence of cases of so-called "forced hire", i.e. a system where a landlord lent his serfs to another landlord for temporary use. The cash earned by the peasants fell into the hands of their proprietor. Almost all workers within the auxiliary branches retained close relations with agriculture, even in the mid-19th century. A great number of them not only possessed large farmsteads but continued to grow grain as well.[36]

[36] Nekl'udov Ye. G. Podsobnoe khozyaistvo gornozavodskikh rabochikh Urala v predreformennoy period // Sotsial'no-ekonomicheskoe polozhenie kadrov v gornoza-

The second common feature of almost all the auxiliary branches was the absence of any complex technical equipment. Tools and, especially, carts belonged to the workers themselves. The peasants' horses transported coal and pig iron, ore and osmund iron. The possibility to concentrate raw materials and fuel at the same locality and, consequently, the dimensions of the metallurgical works depended entirely on the number of peasants engaged and on their horses.

The complex structure of the work-force in the auxiliary branches was combined with diverse ways of organising production. In the larger mines and gold fields, work was supervised by the district administration. In such places, as a rule, serf peasants were widely used. In comparatively small mines, the organisation of transportation inside a district was frequently carried out by contractors (*podriadchiki*). They made contracts with the works administration and hired workers. The precise structure of the work-force and the ways of organising production in every individual economic unit were determined by a compound of local conditions and traditions, of potentialities and means of each ironmaster.

Below follows a brief sketch of the organisation of production in the auxiliary branch most closely related to the metallurgical works, i.e. the mines.

Each of the mining districts possessed sufficient ore desposits for long-term operation. Instances when the same ore fields were explored by representatives of different districts were usually caused by the fact that these districts had been constituted one economy earlier. This was, for instance, the case with the well-known iron ore field of Vysokogorsk. After the middle of the 18th century, such districts had been divided as a result of inheritance. The vast area of the fields was divided into plots, and each of the owners conducted their work independently.

Iron fields were explored mainly by open pit mining. In all operations, such as e.g. removing the upper layer of the earth, mining in the proper sense and storing ore, manual labour was used. Only the hardest ores were blasted with gunpowder. Various machines, such as

vodskoy promyshlennosti (Ye. G. Nekl'udov, "Subsidiary small-holdings of the workers of the Ural mining and metallurgical industry before 1861" in Socio-economic conditions of the Ural mining and metallurgical workers (Sverdlovsk 1989) p. 40–54).

pumps to drain the water and mechanical devices to lift the ore out of the mines, were not applied until the mid-19th century. The first evidence that a steam excavator and a steam machine for pumping water were being used in the Vysokogorsky mines is from the early 1850s.[37] The excavated ore was burned in large heaps within the mines. Special furnaces to burn the ore, kilns, made their first appearance in the Urals only in the late 1830s or early 1840s. They were only used in two mines, Goroblagodatsky and Vysokogorsky.[38]

The copper mines of the Urals, the largest of them at least, were equipped with more complicated machinery than the iron mines. The richest deposits of copper ore, such as Mednorudnianskoie, were quite deep. To exploit them, shaft mining was used and special lifts for ore and pumps were constructed. The latter were driven by manpower or horse-power in the 18th century. In the first half of the 19th century, especially from the 1830s on, steam engines appeared in the copper mines.

The district administration exercised control over methods and equipment used in mining and over quality in ore preparation for smelting, irrespective of whether the mines were organised by the administration itself or by special agents appointed by contracts. In the early 18th century one of the founders of the Ural mining works, Wilhelm de Gennin, considered it necessary to have special experts on the staff of a blast-furnace. When ore was brought up according to contracts they should "prospect and supervise the iron ore for the blast-furnaces and explain to the peasants how the ore should be mined according to the mining rules".[39] The blast-furnace workers' duty was to control whether the ore from the mine was fit to be charged into the furnace or not.

[37] Mozel' Kh. Materialy dl'a geografii i statistiki Rossi. Permskaya gubernia (Kh. Mozel, Geographical and statistical facts about Russia. Province of Perm, vol.2 (St Petersburg 1864) p.222); Tsentral'ny Gosudarstvenny Arkhiv Drevnikh Aktov. F. 1267, op. 8, d. 1819, l. 6 (Central State Archives of Ancient Documents, fund 1267, inventory 8, case 1819, p.6).

[38] Karminskiy. Ob obzhege zheleznykh rud v pechakh na Nizhnetagil'skom zavode // Gorny zhurnal (Karminsky, "Burning of iron ore in the stoves of the Niznetagil works" in Journal of Mining (1836), no. 5, p.361, 364–368); D'yakonov. Ob obzhiganii goroblagodatskikh rud // Gorny zhurnal (Dyakonov, "Burning of goroblagodatskie ore" in Journal of Mining (1852) no.9, p.479–484).

[39] Genin V. Opisanie ural'skikh i sibirskikh zavodov (V. Genin, A description of the Ural and Siberian works (Moscow 1937) p. 166).

Organisation of Production in the Metallurgical Shops

Organisation of production in the metallurgical shops, as well as in other activities located on the ironworks territory, such as those performed in the blacksmithy, joinery, etc., had the following common features:

A) All means of production (constructions, machines, implements, etc.) were the property of the ironmaster.
B) Most workers were serfs and belonged to the ironmaster.

In the early 18th century hired workers were widely used at the ironworks, but during the course of the century the ironmasters substituted this category with serfs. Towards the end of the century and during the first half of the 19th century hired workers, often foreigners, were used with the purpose of assimilating new technologies and techniques.

Workers connected to the industrial part of the production process were, as Ye. G. Nekl'udov has pointed out, engaged in the iron industry for a much longer period than those working in the auxiliary branches. They were therefore associated with agriculture to a lesser degree, had smaller households, and never practised grain-growing.[40]

The separation of the production process into a blast-furnace branch, a finery and forging shop was purely technical. The social organisation of production was essentially the same. The technical organisation in each of these shops may be described briefly as follows.

Pig Iron Production

Most blast-furnace units in the Urals during the 18th century and first half of the 19th century consisted of one or two furnaces placed inside the stone constructed furnace building. Only a few ironworks had three or four furnaces. The construction of the blast-furnaces hardly changed during this period. In the beginning of the 19th century, however, furnaces of an improved and advanced type, that is with a hearth with a circular horizontal section, were erected.[41] The average output of the furnaces nearly doubled over this century, from 60,000 poods in 1725 to 115,700 poods in 1851.[42] There were also some alterations in the

[40] Nekl'udov, op cit. p. 40–54.
[41] Strumilin S. G. Istoriya chernoy metallurgii v SSSR (S. G. Strumilin, A History of the ferrous metallurgy in the USSR (Moscow 1954) vol. 1, p. 150).
[42] Ibid, p. 425, 429.

construction of the bellows around the turn of the century. This made it possible to construct taller blast-furnaces.[43] During this period the length of the blast-furnaces' campaign increased. In 1718, the average length in production was 185 days, in 1827 it was 251 days.[44]

The serf workers at the blast-furnaces were attached to their works. By smelting ore from the same mine during a long period they gradually adapted their furnace and equipment to blow with an exact combination of ore and fuel, although the overall construction of the furnace remained unaltered. Empirically, without any chemical analysis, they found the most suitable charge for a given ore. This experience of the blast-furnace workers became one of the preliminary conditions upon which much of the success of pig iron production in the Urals depended.

Bar Iron Production

The German finery process was the only method of bar iron production used in the Urals throughout the period until the late 1830s. This meant that the forges remained even more unadaptable than the blast-furnaces. The only significant innovation, as in the blast-furnaces, was the introduction of box bellows. Nevertheless, the annual output per hearth and hammer increased considerably from 5400 poods of bar and special iron in 1725 to 8600 poods in 1835. This happened almost exclusively by means of adapting manual labour skills and forge equipment to the local peculiarities of the pig iron and the charcoal of every specific forge. It may be inferred, that the enserfing of workers in the bar iron production amended the technology to a great extent. As a result, about 90 variants of the German finery process were used in the Urals in the early 19th century. This was the case despite the fact that the equipment remained unaltered.[45] All ironworks in the Urals had their own variant of the process.

[43] Ibid, p. 422.

[44] The calculations have been made according to figures in: Strumilin, op cit, p. 180; Knauf A. A. Obozrenie chugunoplavilennogo deystviya i zheleznogo proizvodstva zavodov khrebta Ural'skogo v 1827 g. // Gorny zhurnal (A. A. Knauf, "A review of the iron foundries and iron production of the Ural mountain range" in Journal of Mining (1830), no. 11, p. 237).

[45] Kozlov A. G. Ob osobennostyakh razvitiya tekniki na kazennikh zavodakh Urala // Voprosy istorii Urala (A. G. Kozlov, "Characteristic features of the technological development of the Ural state-owned works in the end of the 18th and the beginning of the 19th centuries" in Aspects of the Ural history (Sverdlovsk 1964) no. 5, p. 13).

In the late 1830s new ways of making bar iron were introduced in the Urals. Foremost it was the Wallon and the French Comtois finery processes and the puddling method. This change was necessitated not only by an increase in demand for iron, but also by the introduction of new kinds of iron. The latter was the result of a change in the market situation, whereby production no longer aimed at the international market but almost exclusively at domestic markets. This occurred in the early 19th century. Different iron was used for different purposes. Puddled iron was converted into mass and rough sorts, rails and special metal. Ingots from the Comtois method were rolled into sheet iron, and at the state works they were manufactured into armament. Bar iron obtained from the German finery was processed into cementation steel. Applying a certain technology in each specific district, therefore, depended on the sort of metal the whole district or individual works within the district specialised in. The most wide-spread of the new technologies was puddling. Towards the end of the 1850s about half of the total iron production in the Urals came from puddling.[46]

The forges were scattered throughout the mining districs with at least one connected to each blast-furnace, but there were also specialised finery works. This may be considered a major peculiarity of locating forges in the Ural mining districts. When pig iron could not be refined in the same works, it had to be transported to other forges within the same district. Only a few ironworks, owned by the Treasury, consisted of only blast-furnaces. These works specialised in manufacturing castings for the army. The proportion of the blast-furnace works to fineries varied, but was on average one to one.

Concerning wrought iron production, ironmasters tried to use pig iron from their own blast-furnace only. Purchasing from outside the district occurred exclusively after breakdowns in their own pig iron production. Some state-owned works, though, sold pig iron. To a certain extent this protected the private industry against production troubles depending on temporary scarcity of pig iron.

[46] O deystvii gornykh zavodov za 1860 i 1861 (Ironworks 1860–1861 (St Petersburg without year), p.39–40).

The Rolling Process

The first evidence of rolling technology being used in the Urals comes from the early 18th century. It was not, however, until the first half of the 19th century that it became widely used. This was in part due to the augmentation of output. By mid-century rolling-mills of various constructions were operating in every Ural district. Rolled sheet iron for roofs proved to be a succes.

The new rolling production was located in every district in accordance with its local conditions. The new mills were often built in connection with already existing blast-furnaces and forges. Sometimes special dams of small dimensions were built on shallow rivers. Towards the mid-19th century, rolling-mills emerged in the structure of some Ural mining districts separate from blast-furnace and finery works.

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The principles of locating production in the Urals up to the mid-19th century can now be summarised. It may be asserted that in every district blast-furnaces, finery works and rolling-mills constituted, in aggregate, a closed technological cycle of iron-making, from melting pig iron to rolling iron and steel of various sorts. Towards the end of the 18th century, and during the first half of the 19th century, mining districts in the Urals consisted of an average of three to four separate ironworks, including one or two blast-furnaces and two units for bar iron production. The largest mining district had ten ironworks.

To locate an ironworks within a district's territory, a number of factors had to be considered, concerning either the appropriate site or the specialisation of the planned works. The general principles of choosing a site for an ironworks in the Urals were the same as in Western Europe. These included the river banks which had to be appropriate for dam constructions, the proximity of mines and woods, and the existence of waterways for transports of manufactured goods to market places. A difference existed in locating blast-furnaces and forges. They were erected on the same river, but blast-furnaces were most often found up-streams and forges down-streams. With this structure it was possible to use the river not only as a source of power, but also as a means for pig iron carriers. However, this was not followed too strictly in the Urals, as the ironmasters could dispose their very cheap labour,

the ascribed and serf peasants, to transport semi-products. Not many forges, therefore, got pig iron via rivers. The majority were supplied with pig iron by means of cartage on specially built mining roads, *trakty*.

Ironworks within the mining districts were, as a rule, scattered all over the territory. The distance between them was very seldom less than ten kilometres. This dispersion of the technological cycle was created in order to obtain maximum possible utilisation of the natural resources of the area, but it led to a lot of pulling and carrying. Transports of pig iron and blooms proved to be smaller than those of ore and fuel from the mines and the woods.

The distribution of the technological cycle between several blast-furnaces and forges also required coordination of production relations among them, determining the demand for equipment in every works. In the 18th century this was achieved in a fairly simple way. A district was to contain the number of forges needed to refine the production of pig iron. In the first half of the 19th century the problem became a bit more complicated as a result of the enlargement of the commodity assortment. It was no longer just pig iron, but also various kinds of blooms (for special iron rolling) that were transported between the works.

Rationalisation of production relations inside the mining districts were brought about in the Urals mainly by means of specialisation. Each ironworks limited its production range, and fixed the number of semi-products or metal sorts. Two variants of this specialisation were in existence. In larger mining districts, each works was equipped to produce only one or two sorts of iron and steel. Market fluctuations, though, induced a reduction of production of some and increased output of others. Division of labour among the works within the Urals was, therefore, continuously being adapted throughout the 19th century.

The second variant of ironworks specialisation was fulfilled only in some districts in the Western Urals and in economies possessing works in both the Western and Eastern Urals. Their technological cycle was spread along the transport route, so that pig iron was melted in the Ural Mountains and forging and rolling of iron took place in Prikamie, the plain area around the Kama river to the west of the Urals, close to the centre of the country. This geographical structure offered an advantage

to these mining districts. In the Western Urals iron ore was in abundance, and Prikamie was rich in woodlands for fuel preparation.

The Peasantry and Iron Production in the 18th Century

Like the Swedish one, the Russian metallurgical industry was closely related to the agrarian sector of society, even though the actual links differed between the two countries. Pre-industrial metal production in Sweden was based partly on the small-scale pig iron production of free and independent peasants/*bergsmän*. True, a considerable part of manpower within Russian metallurgical enterprises also consisted of peasants. However, they only served as auxiliary labourers and not as owners of independent production units. We may distinguish the following categories of peasants engaged in metal production in the Urals: peasants from ascribed villages (*pripisnoy*), possessory peasants, *votchina* peasants and hired labourers.

Peasants from Ascribed Villages

Russian mining industry relied heavily upon the forced labour of the tax-paying population, which was attached/*ascribed* to state-owned and private enterprises. In this way the government pursued two objects: 1) to raise production despite the fact that labour for hire was scarce; 2) to protect the ascribed villages from impoverishment. Initially, the state policy accentuated the first goal.

The first villages to be ascribed were situated in Central Russia, Solomenskaya *volost*[47], ascribed to the Tula works of Vinnius in 1632, and Vyshegorodskaya *volost*, ascribed to the Ugodsky works of Marselis and Akema in 1657.

Around 1700, many large-scale works were started in the Urals, accompanied by mass ascription of peasant villages. By the tsar's enactment of 23 April, 1699, 15 *slobodas* [48] were ascribed in order to build the Neviansky works. Later, these works were given to Nikita Demidov and the state *slobodas* of Ayatskaya and Krasnopolskaya

[47] Volost: a local administrative territorial unit, a part of the uezd.

[48] Sloboda (in this context): a large peasants' and artisans' settlement and also the adjacent territory with several villages.

and the monastery village of Pokrovskoye (Verkhotursky *uezd*) were ascribed through the enactment of 9 January, 1703. For the construction of the very first Ural works, Alapayevsky, Kamensky, Neviansky and Uktussky, peasants from almost all Ural *slobodas*[49] were generally engaged. In the middle of the 18th century 15,000 male subjects were ascribed to state-owned works and about 10,000 to the private ones (according to Vasily Semevsky).[50] At the beginning of the 19th century there were 252,000 ascribed peasants in the Urals.[51]

Having been ascribed, a state peasant remained a subject of civil and public laws. For example, he was not deprived of the right to swear the state oath. He had the right to trade, to perform various crafts, and to conclude contracts. He also had the right to acquire immovables, to move into another estate, and to migrate within the ascription area. But unlike an ordinary state peasant the ascribed one had to pay poll-tax (or a part of it) by working at the works.

The amount of compulsory work was determined by: 1) the total sum of poll-tax expected from a peasant settlement (according to census data); 2) the official prices of different kinds of work; 3) the demand for manpower of a works.

At first the compulsory work of ascribed peasants was equivalent to a poll-tax of one rouble and ten kopecks. After the Senate enactment of 12 October, 1760, the poll-tax was increased by 60 kopecks. The manifesto of 21 May, 1779, confirmed that the compulsory work should amount to one rouble and 70 kopecks.

According to our research, the payment for forced labour in the period 1700–1720 was determined both by contract relations with the ironmasters and by orders given by the local authorities. Thus, the ukase of 1713 from the Sibirian governor prescribed that daily payment to a mounted labourer be two altyns[52] and to an unmounted

[49] Genin V.I. Opisanie ural'skikh i sibirskikh zavodov. 1735 (V.I. Genin, A description of the Ural and Siberian works 1735 (Moscow 1937) p.475, 478, 611); Strumilin S. G. Istoriya chernoy metallurgii v SSSR (S. G. Strumilin, A History of the ferrous metallurgy in the USSR (Moscow 1954) vol. 1, p.437).

[50] Semëvskiy V.I. Krest'yane v tsarstvovanie imperatritsy Ekateriny II (V.I. Semyovsky, Peasants during the reign of Empress Catherine II (St Petersburg 1901) vol.2, p.304).

[51] Istoriya Urala s drevneyneyshikh vremen do 1861 g. (A History of the Urals from ancient times to 1861 (Moscow 1989) p.248).

[52] 1 altyn = 3 kopecks; 1 denga = 1/2 kopeck.

labourer one altyn and two dengas.[53] In 1721, as dam buildings were being prepared on the Iset river (the future Ekaterinburg works), the daily payments were: for a grown-up, mounted labourer six kopecks, for a juvenile four kopecks, to a grown-up, unmounted labourer four kopecks, and to a juvenile two kopecks.[54] The strictly fixed state payment, called "placard", was introduced by the tsar's enactment of 13 January, 1724. In the summer, a mounted labourer received ten kopecks and an unmounted one received five kopecks. In the winter, they received six and four kopecks respectively.[55] In the period 1741–1761 the ascribed peasants received six kopecks for each six *verstas* (so-called "passing money"). Through the Senate enactment of 27 May, 1769, the following principle was laid down; if a labourer had passed 25 *verstas* in a day he would receive three kopecks. By the same enactment a mounted labourer was to receive twelve kopecks in the summer and an unmounted one six kopecks. In the winter, they got eight and five kopecks a day respectively. By the manifesto of 21 May, 1779, the "placard payment" exceeded twice the level of 1724; in the summer twenty or ten kopecks, in the winter twelve or eight kopecks per day.[56]

Table 1: Payment per day for peasant labour. Kopecks.

Year		Mounted	Unmounted
1724	(summer)	10	5
	(winter)	6	4
1769	(summer)	12	6
	(winter)	8	5
1779	(summer)	20	10
	(winter)	12	8

But according to the legislation of the first quarter of the 18th century, ascribed peasants could be forced to do compulsory work beyond the poll-tax level for an extra payment in accordance with the official

[53] Pikhoya R. G. K istorii pripisnoy derevni Urala v nachale XVIII v. // Krest'yanstvo Urala v epokhu feodalizma (R. G. Pikhoya, "The History of registered villages of the Urals in the early 18th century. A Prelude to the Introduction of a Poll Tax" in The Ural Peasants during feudalism (Sverdlovsk 1988) p. 63).

[54] Semëvskiy, op cit, p. 307.

[55] Polnoe sobranie zakonov (Code of laws, vol. VII, no. 4425).

[56] Polnoe sobranie zakonov (Code of laws, vol. XVIII, no. 13303 and 14878).

work prices. This possibility was widely used by the works administration, especially in the private ones. The Senate enactment of 20 November, 1756, permitted nobles, who had recently acquired state works, to use ascribed peasants without any restrictions. Thereafter this right was transferred to other owners.[57] This innovation greatly aggravated the life of the peasantry and caused protests in the period 1750–1760.[58] A consequence of the unrest was a special issue of the enactment of 9 April, 1763, "Regulations for the ascribed peasants of the Izhevsky and Votkinsky works of the late feldmarshal-general Shuvalov" by prince A. A. Vjazemsky. The regulations stated in particular: "However, a works manager can not give peasants more work than they ought to do for the poll-tax". Payment was to be given directly to the peasants by the works' office, and they paid the poll-tax to the state bodies themselves.[59] Still, the regulations had been initiated by the ironmasters and can be considered as mere recommendations.

Step by step, the state regulated in detail how the compulsory work should be carried out. The first orders were rather obscure. The yearly cycle of the works had been regulated by special orders and instructions in 1725, 1726 and 1727, according to which the peasants were free from 1 May to 10 September and from 16 November to 1 December. During the rest of the year the administration was free to take them for felling and chopping, for burning charcoal, for transporting ore, coal, lime, etc.[60] Nevertheless, it was stipulated that in case of an "extraordinary emergency" and especially "if a dam gets damaged or if anything else does not function then there is no excuse for not appearing at the works".[61] Similar stipulations as well as the arbitrari-

[57] Pavlenko N.I. Naemny trud v metallurgicheskoy promyshlennosti Rossii // Voprosy istorii (N.I. Pavlenko, "Hired labour in Russia's metallurgical industry 1750–1800" in Problems of History (1958) no. 6, p. 44).

[58] Semëvskiy, op cit, p. 323–433; Orlov A. S. Volneniya na Urale v seredine XVIII veka (A. S. Orlov, Unrest in the Urals in the middle of the 18th century (Moscow 1979)).

[59] Semëvskiy, op cit, p. 405–08.

[60] Pavlenko N. I. Razvitie metallurgicheskoy promyshlennosti Rossii (N. I. Pavlenko, The development of metallurgical industry in Russia 1700–1750. Industrial policy and administration (Moscow 1953) p. 474).

[61] Nauchnoe nasledstvo (A scientific heritage, vol. 14); Tatishchev V. N. Zapiski. Pis'ma. 1717–1750 gg. (V. N. Tatishchev, Reports. Letters, 1717–1750 (Moscow 1990) p. 81); Pikhoya R. G. Obshchestvenno-politicheskaya mysl' trudyashchikhsya Urala (R. G. Pikhoya, Socio-political views among the Ural workers in the end of the 16th through the 17th centuries (Sverdlovsk 1987) p. 74).

ness of the administration often made peasants work more than that demanded by the poll-tax.

In the "Work regulation at the mining enterprises" from 23 October, 1741, the Ural Mining Board defined more precisely the annual cycle of work at the state enterprises (later on it applied to the private ones as well). According to this, ascribed peasants had to work at the enterprises from March to the beginning of May, from 25 May (or 1 June) to 25 July (before haymaking and harvest) and from the middle of September to November. They mainly had to perform auxiliary work such as chopping wood, burning charcoal, extracting ore and lime, transporting materials to the works and to the river wharves, and finally erecting dams.[62] The manifesto of 1779 set an end to duties like burning charcoal and extracting ore. Repairing dams remained an extraordinary duty in case of fire or flood. Fines were stipulated for making extra work compulsory for the peasants.

In theory, compulsory work was not too burdensome. An unmounted labourer could fulfil his duty in 22 days and a mounted one in 11 days. But in reality, the duties of able-bodied peasants were much greater. Firstly, the number of peasants registered for work was two and a half times as great as the able-bodied population. Secondly, the censuses reflected the tax-paying population in the year of the original calculation. This number might have been reduced further due to escapes, recruiting and deaths. As a result, peasants actually had to work a lot. According to V. Semevsky, the ascribed peasants of the Kamsky works had to work 216 days a year and even more in the middle of the 18th century.[63]

The status of an ascribed peasant could vary. At the private works, exploitation was harsher than at the state-owned ones and abuses of administration were more common. Since the larger part of the metallurgical products was purchased by the state at fixed prices in the first part of the 18th century, the only way for the ironmasters to raise their incomes was to reduce costs by increasing exploitation, first and foremost of the non-qualified manpower, i.e. the ascribed peasants. It is not mere coincidence that disturbances were more frequent at the private works than at the state-owned ones. Moreover, the conditions

[62] Orlov, op cit, p.56–57; Pavlenko, Razvitie (The development) p.480–81).
[63] Semëvskiy, op cit, p.364.

of the peasants differed according to whether they lived near the iron-works or not.

An independent group among the ascribed peasants was the so-called "slobodian blacksmiths". They also worked for their poll-tax at the works, but according to their individual specialities they forged tools and machinery details from iron made at the works. At the beginning of the 18th century their number was rather considerable. At the Kamensky works 72 out of 161 were blacksmiths. At the Uktussky works the ratio was 87 to 156 and at the Alapayevsky works 10 to 71. All of them lived in *slobodas* which had each been ascribed to a works.[64] The slobodian blacksmiths took part in the mining industry throughout the 18th century and remained there in the 19th century even after the abolishment of the institution of peasant ascription.

Already in 1763 a Senate enactment (15 September) forbade the ascription of 9000 peasants from the province of Isetskaya to the Ekaterinburg gold fields. In spite of the fact that this act had no general relevance but applied to one specific works, it put an end to the ascription of state peasants to the metallurgical enterprises due to the following reasons:

1) all the settlements near the works had already been ascribed;
2) mass disturbances had occurred among the ascribed peasants in the middle of the 18th century;
3) ascription had led to a decline of grain cultivation. This was serious, since the population of the works and the garrisons on the southern frontier needed bread from the rural province of Isetian.[65]

The institution of peasant ascription was finally abolished in the Urals at the beginning of the 19th century (through the enactment of 9 November, 1800, confirmed by a report to the tsar from the Ministers for Internal Affairs and Finance on 23 June, 1803, and through the enactment of 15 March 1807). The labour of 217,000 ascribed peasants was substituted by 17,850 so-called "indispensable labourers" recruited from the peasantry.[66]

[64] GASO, F. 24, op. 1, d. 17, ll. 116–25, 128–32 (Fund 24, inventory 1, case 17, p. 116–25, 128–32).

[65] Pavlenko, Naemny trud (Hired labour, p. 43).

[66] Gorlovskiy M. A, Pyatnitskiy A. N. Iz istorii rabochego dvizheniya na Urale (M. A. Gorlovsky, A. N. Pyatnitsky, Workers' movement in the Urals (Sverdlovsk 1954) p. 30–38).

Possessory Peasants

By different means another category of worker was created, called (in 1797) "possessory peasant".[67] These persons were so-called "eternally given" workers (*vechnootdannyie*); in other words, some had been given together with the works to the ironmaster; others had been bought for the works by non-noble ironmasters on *posessionnye* rights according to the ukase of 18 January, 1721 (and its later versions).

The first labourers at the Ural works included a considerable number of newly arrived peasants, among them those who had run away from their landlord. The tsar's ukase of 18 August, 1722, permitted N. Demidov to retain many fugitives at his works. This act later developed into a resolution of the Empress Anna (12 November 1736) which said that state, synodal and monastery peasants studying craftsmanship at Akinfy Demidov's works should stay there: he could thus "ascribe them to *slobodas* within his lands and pay poll-tax for them".[68]

In 1750, the twelve Ural works of A. Demidov had 6728 male subjects who had arrived there or had been given by decree. The ascribed peasants were only 3630.[69] The empress' decree of 13 May, 1754, confirmed the ascription of peasants, who had been attached to the works through previous legislation. But newly arrived men and women had to be returned to their former residence. To allow fugitives to stay was a punishable act with a fine of 200 roubles per man and 100 roubles per woman.

The Senate decree of 30 November, 1755, in response to a petition from the ironmasters Procopy, Grigory, Nikita and Yevdokim Demidov, S. Stroganov, Peter and Pavel Osokin, was of great significance. According to it, the ironmasters were allowed to take from state *slobodas* all newly arrived state peasants and have them registered for poll-tax together with their own serfs.[70] Those given eternally to Demidov's works struggled persistenly against being subjected to private feudal law. But in spite of the adverse conditions the migration of peasants into the Urals did not cease.

[67] Polnoe sobranie zakonov (Code of laws, vol. XXIV, no. 18211).

[68] Kafengauz B. B. Istoriya khozyaystva Demidovykh v XVIII–XIX vv. (B. B. Kafengauz, A history of the Demidov works in the 17th and 18th centuries (Moscow-Leningrad 1949) vol. 1, p. 173).

[69] Op cit, p. 204.

[70] Polnoe sobranie zakonov (Code of laws, vol. XIV, no. 10494).

Votchina Peasants

The serf system in the Urals expanded by means of *votchina* peasants being moved by the ironmasters and by purchasing new serfs (on noble or *posessionnye* rights depending on social status of the ironmaster). Thus, Nikita Demidov used his own *votchina* peasants at his works after their migration from Central Russia, temporarily or permanently. This policy was continued by his son Akinfy. In 1745, at the Suksunsky works there were 408 labourers with 342 serfs among them, all taken from Akinfy's own *votchinas*. In 1747–1749, the twelve Ural works of Akinfy Demidov included 3248 serfs.[71] All the private Ural works had over 11,000 "revision" (census) serf subjects in 1747. Five years later, the *Bergskollegium* allowed ironmasters to acquire serfs, quite apart from the ascribed peasants. From 1762 to 1798 a decree existed which prohibited non-nobles from buying serfs.[72] However, the Ural ironmasters ignored it and continued purchasing serfs during the following period.[73]

Eternally given men and serfs lived directly at the works, studied a profession and became skilled specialists. Thus, the main means of their living was the work performed within iron production. Having visited the Simsky works in 1770, the Russian academician P. S. Pallas wrote: "The labourers of this as well as of the other Tverdyshev works are serfs, but receive such a payment as seems sufficient to prevent their families from living miserably".[74] It should be noticed that these persons were regarded and referred to as peasants from the point of view of their estate status, even though their only agricultural occupations were market-oriented horticulture and cattle-breeding.[75]

[71] Kafengauz, op cit, p.339–66.

[72] Polnoe sobranie zakonov (Code of laws, vol.XV, no.11490).

[73] Pankratova A. M. Formirovanie proletariata v Rossii, XVII–XVIII vv. (A. M. Pankratova, The formation of the proletariat in Russia in the 17th and 18th centuries (Moscow 1963) p.458–59); Chudinovskikh V. A. Komplektovanie rabochey sily na Bogoslovskikh zavodakh // Voprosy istorii Urala (V. A. Chudinovskikh, "Completion of the working force in the Bogoslovsky works 1750–1800" in Problems of Ural history (Sverdlovsk 1975) vol.13, p.16–17).

[74] Pallas P. S. Puteshestvie po raznym mestam Rossiyskogo gosudarstva (P. S. Pallas, A Journey to different places in the Russian empire (St Petersburg 1786) vol.2:1, p.34).

[75] Cherkasova A. S. Masterovye i rabotnye l'udi Urala v XVIII veke (A. S. Cherkasova, Masters and workers in the Urals in the 18th century (Moscow 1985) p.152).

The absolute growth of forced labour took place in the second half of the 18th century. This was a consequence of the natural increase of the population of the possessory villages and of a more intensive application of the labour of possessory peasants, whose family members chose to follow them. Finally, it was caused by illegal bargains, breaking the enactment of 1762.[76] But at the same time the tendency to hire labour came to light.

Hired Labour

Hired labour with various degrees of personal freedom had always been employed in the mining manufacturies of the Urals, though on various scales. The main portion of the hired labourers were peasants having the right to sell their labour, ensured through documents/ passports and "feeding letters".

A rather wide-spread form of hiring used by the administration of the works was the so-called "task-giving": a contract payment partly on account, which proved to be lower than the market price for labourers. This form frequently led to the enslavement of the labourer. As a rule, only the poorest peasants who could not pay poll-tax themselves chose to enter a "task-giving" contract. The rate of deposit was five roubles and 20 kopecks. Task-giving had both advantages and disadvantages for the ironmaster. On the one hand, he could suffer damage, as a "task-given" worker would sometimes deviate from the works, run away before the advance was worked off, fall ill or die. Task-giving decelerated the circulation of capital and gave rise to unrealisable capital. On the other hand, task-giving permitted ironmasters to maintain extremely low wage levels and to hold "task-given men" at the works for a long time. A "task-given" was allowed to take out some food and clothes, which made him an even greater debtor. Of course, such a "free labourer" was subjected to extra-economic coercion on a large scale.[77] The hiring of poll-tax debtors through *volost* bodies also had an unfree character.[78]

[76] Pavlenko, Naemny trud (Hired labour, p.44).

[77] Ibid, p.46–58.

[78] Krivonogov V. Ya. Formirovanie postoyannykh kadrov na'emnogo truda na zavodakh // Iz istorii rabochego klassa Urala (V. Ya. Krivonogov, "The formation of a permanent core of hired labour in the works within the jurisdiction of the Ural mining administration 1700–1850" in A history of the Ural working class (Perm 1961) p.39).

Besides, there were other forms of hired labour. Thus, the ascribed peasants could engage labourers to do their job at the works. In order to get someone to perform one's compulsory work, the peasant would have to pay another village member a fixed sum which was four to five times that of the poll-tax. Thus, the latter left the agricultural occupations, the allotment of land losing its significance as a main means of subsistence. Having sold his cattle and chattels and let his land, the peasant moved closer to the works and turned into a permanent labourer. In this way peasants freed themselves from other state obligations, which laid an additional burden on their former neighbours. Ruined peasants (10 % of all the Ural peasantry) was a source of hired manpower for the works *and* for the more prosperous part of the peasantry.[79]

The Influence of Mining Industry on the Peasantry

Contracts to prepare raw and auxiliary materials (like ore, leather, tar, pitch, timber, building materials, hemp, cord, clothes, greasy candles, etc.) were of great importance to the works. The establishment of the works stimulated peasant trades, which had previously existed only within the bounds of the household economy, to become market oriented. Making bricks, ropes, strings, bast mats, distilling tar and pitch were common tasks according to Anastasia Cherkasova.[80] Peasants also supplied the works with a considerable amount of ore. For example, they supplied the Pyskorsky works with 14–15,000 poods annually. In 1724 the ore contractors who were peasants of the Aramilskaya, Beloyarskaya and Pyshminskaya *slobodas*, and Shartash village, provided 419,000 poods of iron ore to the Uktussky state works.

The Tatar and Bashkir population also engaged in ore trade. After the Yagoshihinsky state works had been built, the inhabitants of the neighbouring village of Koyanova began supplying this unit with copper ore and later also the Yugovsky and Motovilikhinsky units.

[79] Krest'yanstvo Sibiri v epokhu feodalizma (Peasants in Siberia during feodalism (Novosibirsk 1982) p. 274–75).

[80] Cherkasova A. S. Sotsial'no-ekonomichiskie svyazi gorno-zavodskikh tsentrov i dereven' Urala v seredine XVIII v. // Derevnya i gorod Urala v epokhu feodalizma (A. S. Cherkasova, "Socio-economical relations between the mining and metallurgical centres and the countryside of the Urals in the middle of the 18th century" in Ural country and town during feodalism. Problems of interrelations (Sverdlovsk 1986) p. 24).

Since ore-producers had no big capital they united into companies on share principles. According to a register of the Perm mining department, showing the suppliers of copper ore at the private mines in 1754, the shares of those companies of the aggregate supplies were as follows:[81]

Table 2: Ore coming from small-scale production companies as compared to total supply. Percentages.

Pyskorsky works	33.4 %
Yugovsky works	80.3 %
Visimisky works	79.6 %
Motovilikhinsky works	99.5 %
Yagoshihinsky works	86.8 %

But with assistance from the authorities, the large-scale mining industry dealt a tangible blow to peasant petty-commodity iron production. In 1717, a decree of the Siberian governor M. P. Gagarin stringently prohibited domestic peasant production. However, ore smelting and metal processing were means of subsistence for many peasants, who would not leave this handicraft because of such orders.[82] In 1720, in the Kungur *uezd* there were still small water-driven works in peasant possession or owned by small towns' people (*posadskie*). These owners paid a special fee.[83] For some years they apparently met the internal requirements of the countryside, until cheaper and better metals finally forced them out of the market in the 1730s–1740s. But during the entire 18th century the Ural peasants continued prospecting and mining ore. Private ore trade also attracted hired labour. In the patrimony of the Stroganovs there was a whole village of ore producers (Subbotina). Its inhabitants exploited the copper fields.

Mining industry influenced the development of the productive forces of agrarian production in many ways. On the one hand, peasants who worked at the metallurgical enterprises were prevented from

[81] The Perm works with its centre, the Yagoshinsky works (today's city of Perm), were situated in the Western Urals.

[82] Chernoukhov A. V. Istoriya medeplavil'noy promyshlennosti v Rossii XVII–XIX vv. (A. V. Chernoukhov, A history of the copper-smelting works in Russia in the 17th, 18th and 19th centuries (Sverdlovsk 1988) p. 40).

[83] GASO, F. 40, op. 1, d. 4a, ll. 119–22 (Fund 40, inventory 1, case 4a, p. 119–22.

engaging more fully in agriculture and trades. In 1761, ascribed peasants from N. N. Demidov's works Kaslinsky and Kyshtymsky wrote a petition stating that in their long absence only wives with infants and decrepit old men were left in the village. They were not able to plough land and sow spring and winter crops, not to mention the arduous harvest. Many of the poor and middle peasants could not work off their poll-tax when they had lived at the works from year to year without taking absence from work.[84] These peasants who "from year to year" were living at the works had actually broken their ties with the countryside. Archive sources witness that the process of forced mass migration to the works developed rapidly.[85] And even those still living in a village were affected by the enterprises. In 1770, P. S. Pallas wrote: "The inhabitants of Kosoy Brod and of other villages ascribed to the Sysertsky and Polevskoy works are so burdened that one can hardly find any sign of agriculture there."[86] Finally, the works occupied a large part of the land of the peasantry. For example, in 1771 four state-owned and twelve private iron and copper-smelting works were operating in the Verkhotursky *uezd*. According to the words of governor D. I. Tchicherin, the shortage of land made it impossible to increase the tillage.[87] Peasants from the Verkhotursky *uezd* instead moved to other agricultural areas to make a living. A document from 1767 says about the Siberian districts of Krasnoslobodsky, Ishimsky and Ialutorovsky: "In these three districts hired men from the Verkhotursky uezd are kept for ploughing".[88] At the beginning of the 19th century those who left the Verkhotursky *uezd* to make a living (*otkhodniki*) changed their routes. The Russian historian N. Popov wrote about the inhabitants of this *uezd* in the period 1802–1803: "If they are not supported with agricultural products and cattle-breeding, they have a chance to go to the mining works or to apply anywhere for various transportation jobs".[89]

[84] Orlov, op cit, appendix 2, p. 196.
[85] Ibid, p. 207, 209.
[86] Pallas, op cit, vol. 26:1, p. 183.
[87] Tsentral'ny Gosudarstvenny Arkhiv Drevnikh aktov. F. 84, op. 1, d. 4a, l. 130; (Central State Archives of Ancient Documents, fund 84, inventory 1, case 4a, p. 130); Tam zhe, d. 606, ll. 1, 15–17 (ibid, case 606, p. 1, 15–17).
[88] Tam zhe, d. 356, l. 130 (ibid, case 356, p. 130).
[89] Popov N. Khozyaystvennoe opisanie (N. Popov, Household accounting, vol. 1, p. 259, 275, 331).

On the other hand, the industrial development stimulated and commercialised the agrarian sector of the economy. As a result, agricultural products turned into a commodity. The Ural ironmasters were interested in a steady supply of bread and actively organised bread commerce in the eastern Urals. Thus, N. Demidov organised a fair at the Neviansky works to supply the workers with the necessary food. Peasants were permitted to conduct a duty-free trade, albeit only on a small scale.

Beside annual fairs, peasants and town dwellers arrived every Sunday. Fairs and Sunday markets at the works of Neviansk and Nizhny Tagil provided the population of Verkh-Neivinsky, Verkhne-Tagilsky, Shuralinsky, Visimoutkinsky, Verkhne-Saldinsky, Verkhne- and Nizhne Laysky, Tchernoistochinsky and Goroblagodatsky with food and goods. Peasant commerce also existed at the Yagoshikhinsky, Kamensky, Alapayevsky, Irginsky and other Ural works. In this manner, peasants supplied the works with bread, oats, meat, fish, fat, honey, etc.[90]

In the second half of the 18th century the contacts between the grain-growing *uezds* and the mining ones took on a steady character. Thus, the peasants of the Shadrinsk, Kamyshlov and Krasnoufimsk *uezds* supplied the works of the Ekaterinburg *uezd* with bread. Likewise, the peasantry of the Kungur, Sarapul and Glazov *uezds* served the works of Tcherdyn and Solikamsk. The peasants of Orenburgs' *gubernia* came to mining and distillery works within the same area.[91]

Agriculture in eastern Urals and western Siberia succeeded economically in the 18th century thanks to the influence of the mining industry. Peasants increased their crop yields by means of the three-field system, by manuring the lands and through new agricultural tools: plough, iron harrow, and big scythe (instead of the little scythe, *gorbusha*). This was all under the impact of a wish to sell more bread. Some of the peasants even carried out experiments to cultivate wheat, rye and buckwheat. They also investigated the quality of the soils, determined sowing standards, verified corn germination and searched for methods to exterminate weeds. In particular *uezds* of the Siberian *gubernia* 50 % of the gross harvest was sold as bread. In the Shadrinsk

[90] Cherkasova, Sotsial'no-ekonomichiskie svyazi (Socio-economic relations, p.26–35).

[91] Istoriya Urala (A History of the Urals, p.282).

uezd winter rye was ousted by spring crops, to be sold as a commodity.[92]

The industrial centres not only raised demand for agricultural products. They also offered goods for sale in the countryside. In Neviansk scythes of two types, frying-pans, spades, padlocks, smithy tools, nails, horse shoes, iron mongery and weights were sold. In Nizhny Tagil (1763) different kinds of iron (bar, rafter, flatter, carved, roofing and so on), welded steel, smithy anvils, anchors, saws, wire, iron boilers, soap-boiling coppers, scoops, candlesticks, braziers, frying-pans, oven-doors, cramp-irons, shovels, axes, scythes, padlocks, horse shoes, nails, pots, trivets, bushes, basins and saucepans were sold. This assortment shows the orientation of the peasants. Thus, they contributed substantially to the functioning of large-scale mining industry in the Urals. They built the first Ural works. They fulfilled a major part of the hard and non-qualified labour at the works. They supplied the works with food and raw materials. Finally, they must be regarded as an important part of the market to which iron production was geared. The iron industry, in its turn, exerted both constructive and destructive influences upon agriculture and upon the rural population.

The Workers and the Iron Industry

There are two main principles of great significance in the iron workers' way of life in the Urals during the first part of the 19th century: 1) industrial production, including auxiliary tasks, and 2) domestic duties, including work on their small allotments. Work connected with iron-making was, from the beginning, the most important occupation and the main source of income for masters and workers who did not have their own farmsteads. This situation was established even in the sphere of auxiliary work towards the beginning of the 19th century when ascribed peasants, with their peasant way of life and consciousness, were turned into permanent workers. In accordance to the law, permanent workers had rights to both haymaking and tilling. However, the scantiness of arable land did not allow this. Even in the southern Ural region, where the opportunities for agriculture were better, bread for workers had to be purchased from other regions.[93]

[92] Krest'yanstvo Sibiri (Peasants in Siberia, p.256–66).

[93] Nekl'udov Ye. G. Gornozavodskie rabochie Urala v period krizisa feodalizma

Sons of free workers started to work at an age of twelve or thirteen years, while the serfs' children began at an even younger age. Wages were paid in money or in foodstuff. The workmen were allowed to leave the ironworks during the idle periods in the summer in order to deal with their haymaking at home. Masters were permitted an absence of 20–30 days, while permanent workers' leave could last up to two months, from the beginning of July to the beginning of September.

There were no strictly determined terms of work. Masters could be released after 25 years in the trade. Permanent workers had to work at least 30 years, but often 40 years before they were allowed to go back home permanently. Masters, or their widows, had the right to a pension under the condition of a faultless service. Permanent workers had no such privilege. The serfs were wholly and utterly in the hands of the ironmasters who did, however, give them temporary vacancies and pensions, sometimes even more generously than to the masters. The ironmasters also had to support disabled serfs.[94]

Workers' households were not very large.[95] Their size and structure were determined by the opportunities to work for all household members and by the need for a monetary income. The life-cycle of the household was constantly moving between a complex state, meaning a simultaneous co-existence of three generations, and a simple form with just parents and their children. In the second half of the 18th century and the first half of the 19th century both men and women married in their late teens, often between eighteen and twenty. The eldest son remained at home while all the other children moved away. The daughters left to join their husbands' families.

In most households the parents lived with a married son. After a period of about ten to fifteen years, when the parents had died, the

(Ye. G. Nekl'udov, Mining and metallurgical workers in the Urals during the crises of feodalism 1830–1850. Diss cand (Sverdlovsk 1989) p. 176–81).

[94] Pavlovsky N. G. Gornozavodskie rabochie Urala v pervoy treti XIX v. (N. G. Pavlovsky, Mining and metallurgical workers in the Urals 1800–1830. Diss cand (Sverdlovsk 1990) p. 90–94, 114–15, 128–29, 151–85).

[95] Arsentev N. M, Nechaeva M. Yu, Cherkasova A. S. Sem'ya rabochikh v pervoy polovine // Demograficheskie protsessy na Urale (N. M. Arsentyev, M. Yu. Nechayeva, A. S. Cherkasova, "Workers' families 1800–1850 according to material about works around Moscow and in the Urals (typology and structure)" in Demographical processes in the Urals during feodalism (Sverdlovsk 1990) p. 126).

household was reduced to one couple with children. Another ten to fifteen years later, after the children had grown up, the phase with a complex structure returned. This phase was longer within communities of old-believers.

A typical worker family included two to four adults and two to three children. This demographically balanced optimum was supported either through second marriages and adoption of orphans or through family division. On the farmsteads property and other belongings were held in common. The wages were distributed by the elders, with the father having priority. Rights and duties of family members were strictly regulated, e.g. the children had to show total obedience to the elders, and so did the wives to their husbands.[96]

Living conditions of the workers' families were determined by strong connections with industry. The interior schedule within the family depended on work conditions, that is working day duration, relief alternation, etc. It was also regulated by division of labour according to sex and age.

The duties of men, women and children were strictly structured. The men worked at the ironworks. The ironmasters also tried to use women at the works, but with no success. Their main duties were attached to the domestic sphere, including housekeeping, cooking, cattle-breeding, laundry, gardening, etc. Within a three generation household it was the duty of the mother-in-law to cook, while the daughter-in-law had to do the other tasks. Men's only jobs at home were wood cutting, fodder storing, horse-keeping, and shed-cleaning.[97]

Children started to help out with domestic duties at age six or seven. This was crucial because the standard of living for each family depended, to a high degree, on the relationship between dependent and independent members. When children began to do auxiliary work at about age twelve, it brought in extra income. This was an important addition to the family budget.

Since the master mainly worked outside the household, the role of the housewife became important, especially during the children's infancy. This can be seen in the fact that no widowers existed under

[96] Krupyanskaya V. Yu, Polishchuk N. S. Kul'tura i byt rabochikh gornozavodskogo Urala (V. Yu. Krupyanskaya, N. S. Polishchuk, Workers' culture and way of life in the mining Urals, around the last turn of the century (Moscow 1971) p.64).
[97] Ibid, p.68–72.

the age of forty. If the wife died the husband had to remarry in order to keep the household working. This was the case even when grandmothers were present. The household could not survive without the mother and wife.

Each household had its own house. When the size grew and the complex, three generation structure emerged, new lodgements were attached to the house or a new house was built. Apart from the dwelling, a stable and a bath were the only other buildings. Most households had horses and cows of their own, and also often a kitchen garden.[98]

The strategy of the household aimed at self-sufficiency, and everything that was produced inside the domestic sphere was consumed by its members. Nothing was sold. This also meant that the household structure governed the material structure existing in connection to the household. The number of cows was, for instance, dependent on the number of members, and the number of horses was correlated to tasks at the ironworks. The workers used their horses at work. This was especially true for the permanent workers since their horses were regarded as the ironworks' property and used in the important transport operations.

The ironmasters and the administration of the state-owned ironworks could not profit from the domestic sphere of the workers' households. But the existence of this sphere enabled them to pay lower wages and also made it possible to reduce maintenance costs for horses and tools.

The first half of the 19th century was the crest of social development in the feudal iron industry in the Urals. This also applies to the consciousness of the workers. The formation of dynasties of workers, storing and developing systems of ideology corresponding to interests of the group, had been going on for the past century. The turning point in this process was the peasant war of 1773 to 1775.

The main focus of the workers' life was their work in the iron industry. During the first half of the 18th century this was not considered by

[98] Cherkasova A. S. Demograficheskaya kharakteristika masterovykh i rabotnykh l'udey Zlatoustovskogo i Miasskogo zavodov Urala // Demografischeskie protsessy na Urale (A. S. Cherkasova, "Demographical characteristics of artisans and workers in the Zlatoust and Miassk works in the Urals in the end of the 18th and the beginning of the 19th century" in Demographical processes in the Urals during feudalism (Sverdlovsk 1990) p. 107).

workers to be an exceptionally hard duty, breaking their normal peasant mode of life. When labour at the ironworks became the main source of monetary income this situation changed. In the course of several generations this led to a recognition of the value of industrial labour. At the same time agricultural work began to be considered as a subsidiary matter.

The workers' identification of a common situation with total dependence upon industrial labour, and the influence of work upon all sides of life led to a recognition of common interests and aims. The mining districts became the social and territorial region of this process. Each district represented an integrated economic, administrative and social system, independent of other districts. Social conflicts were localised inside regional borders, and exceptions from this patter were few.

Participation in industrial production was seen by the workers as a fulfilment of their social destiny and it was also regarded as their duty to the ironmaster or to the state. An impeccable performance of these tasks ensured workers of their rights. Workers saw their relations with the ironmaster as an unwritten contract, according to which the parties were obliged to carry out their mutual duties honestly.

In the workers view, it was the administration who was the oppressor, guilty of all misfortunes. From time to time, ironmasters and higher district officers had to intervene in direct conflicts and thereby also became enemies to the workers. But the fact that most ironmasters lived far away explains why they were reputed as being benevolent, unfortunately entrusting their works to cruel managers and dishonest administration.

The emperor was a central figure in the workers' political hierarchy as a sacred person. In spite of his faults and mistakes, the workers were not interested in reforming the emperor's power. Workers at state-owned ironworks saw their work as service for the emperor. He embodied the State and his higher officers played the role of his assistants whose goodwill was only a derivation from the emperor's will. Neither state workers nor private workers completely realised the system of their total suppression.

Thus, the political hierarchy as imagined by the iron workers in the Urals had three distinct social layers: 1) The emperor and higher state administration, being in consent with God's will; 2) The local admini-

stration (both state and private); 3) The workers themselves. The ironmasters were included in either of the two first groups, depending on their relations with the workers.

Workers directly involved in the production process were more apt to understand events in the outer world than peasants. This was so because iron production was less dependent upon the forces of nature than agricultural production. This allowed workers to understand causes and consequences in a way which people in the villages could not. A belief in demons was something the auxiliary workers, like miners, charcoal burners, floaters, etc., had inherited from their peasant ancestors, but it was strengthened and enriched by new myths and legends. The auxiliary workers could not explain their fate in a rational way. Instead, it was perceived by them as bad luck.[99]

Development After 1861: Technology and Social Organisation

The abolition of serfdom in 1861 changed the conditions for a metallurgical industry in the Urals to a high degree. A new era commenced. The socio-economic consequences of this were great. Most important was the breakdown of the old feudal structure and the introduction of capitalist relations, creating opportunities for a faster technical revolution and a new form of social organisation.

The technical progress of the metallurgical enterprises in the Urals during the first half of the 19th century was very slow and inconsistent. Towards the end of the 1850s most of the wrought iron was manufactured either by the puddling process or by the backward German finery process. Thus, the industry, as a whole, was still based upon old traditional methods. Most of the bar iron was hammer-forged, whereas Western Europe had moved on to the more rational method of rolling.[100]

[99] Pikhoya R. G. Obshchestvenno-politicheskaya mysl' trudyashchikhsya Urala (R. G. Pikhoya, Socio-political views among the Ural workers in the end of the 16th through the 17th centuries (Sverdlovsk 1987) p.234–35).

[100] Strumilin S. G. Istoriya chernoy metallurgii v SSSR (S. G Strumilin, A History of the ferrous metallurgy in the USSR (Moscow 1954) vol. 1, p. 420–26); Krivonogov V. Ya. Vnedrenie fabrichnoy tekhniki v gornozavodskoy promyshlennost Urala v XIX v. // Voprosy narodnogo khozyaystva SSSR (V. Ya. Krivonogov, Introduction of

After the reform of 1861, the ironmasters were deprived of cheap serf labour and had to rely on free workers only. In order to ensure their profits and improve the economic results they had to speed up the introduction of various technical innovations.[101] Total technical reinforcement of the iron industry in the Urals was spreading gradually but at an accelerating rate.

The old blast-furnaces (i.e. low, thick-walled, open-grilled, square-mouthed) were replaced at most sites by more sophisticated ones which were taller, had thinner walls and no outer lining. They also had closed grills and round mouths. Cold blasting which dominated in 1861 was replaced by hot blasting towards the end of the 19th century. Kauper machines were also introduced during that period, along with more powerful blowing machines. Sloping wooden grill bridges were replaced by mechanic vertical lifts.[102] As a result of this, pig iron output in the Urals increased from 14.5 million poods in 1860 to 50.2 million poods in 1900, i.e. an enlargement by 3.4 times in 40 years. Output per furnace rose from 145,000 poods in 1860 to 259,000 poods in 1890, 363,000 poods in 1900, and 507,000 poods in 1916.[103]

The same development occurred in the finery sections of the mills as the older, unprofitable finery process and puddling began to be replaced by the more yielding Bessemer and Open-Hearth processes. The Bessemer method was first tried in the Urals in 1856 at Zlatoust and also on a smaller scale at the Votkinsk and Nizhny Tagil mills in the 1860s. Production of Bessemer steel on a larger scale, though, only took place at the Nizhnaya Salda and Katav-Ivanovsk mills.

An experimental type of Open-Hearth production was set up in

factory techniques in the mining and metallurgical production in the Urals in the 19th century" in Aspects of the national economy in the USSR (Moscow 1962) p.311–27).

[101] Kotlyarevsky I. P. Eshche o vol'nom trude i prochee // Gorny zhurnal (I. P. Kotlyarevsky, "Once more on the free labour and other things" in Journal on mining (St Petersburg 1864) No. 1, p. 120–21); Popov R. S. Gornozavodskiy Ural // Otechestvennye zapiski (R. S. Popov, "Mining and metallurgical Urals" in Reports from Russia (St Petersburg 1874) No. 12, p. 348).

[102] Ocherki istorii tekhniki v Rossii. Gornoe delo. Metallurgiya. Energetika. Elektrotekhnika. Mashinostroenie (Essays on the history of technology in Russia. Mining. Metallurgy. Power engineering. Electrotechnics. Machine-building. 1861–1917 (Moscow 1973) p. 128–135).

[103] Sigov S. P. Ocherki po istorii gornozavodskoy promyshlennosti Urala (S. P. Sigov, Essays on the history of mining and metallurgical industry of the Urals (Sverdlovsk 1936) p. 96); Strumilin, op cit, p. 425.

Zlatoust in 1866–67 and the first Open-Hearth furnace in the Urals was launched at Votkinsk in 1871. By 1893 this method was used in eleven mills and seven years later in eighteen mills.[104]

The introduction of the new steel processes drastically increased productivity and thereby gave higher priority to steel production. In 1860, 11.9 million poods of wrought iron were produced and only 0.1 million poods of steel. As a percentage this was 99.2 % iron and 0.8 % steel. For 1890 the figures are 18.3 million poods of iron (87.1 %) and 2.7 million poods of steel (12.9 %). The decisive breakthrough came around the turn of the century. In 1900 the combined production of the Open-Hearth and Bessemer methods almost equalled iron production, 48.9 % compared with 51.1 %.[105] In 1913, iron production had declined to 1.5 million poods of puddled iron and 63,000 poods of finery iron.[106] This was the dilemma of the two archaic ways of metal production.

Water-driven hammers were replaced by steam hammers, and "home-made", low-speed rolling-mills were replaced by more powerful ones. Blooms were launched at rail production mills at Alapaevsk and Nizhny Tagil in 1856–60, and later at Nizhnaya Salda, Katav-Ivanovsk and Nadezhdinsk.[107] By the end of the 19th century and beginning of the 20th century huge workshops made of brick, stone, iron, steel and glass were erected at many works replacing old wooden ones.[108]

104 Ocherki istorii tekhniki (Essays on the history of technology, p. 158–63.)

105 Strumilin, op cit, p.426; Sbornik statisticheskikh svedeniy o gornozavodskoy promyshlennosti Rossii 1890 (Collected statistics about the mining and metallurgical industry in Russia 1890 (St Petersburg 1892) p.203, 210–11); Sbornik statisticheskikh svedeniy 1900 (Collected statistics 1900 (St Petersburg 1903) p.326, 348); Sbornik statisticheskikh svedeniy 1910 (Collected statistics 1910 (St Petersburg 1913) p.308, 321).

106 Sigov, op cit, p.92.

107 Ocherki istorii tekhniki (Essays on the history of technology, p.169–72).

108 Time I. A. "Kratkiy otchet po komandirovke na Ural'skie zavody letom 1894 g. // Gorny zhurnal (I. A. Time, "A short report about an official journey to the Ural works in the summer of 1894" in Journal on mining (St Petersburg 1896) No. 1, p. 17–18).

Table 3: Number of iron and steel mills, 1860 to 1910.

Years	Furnace			Bessemers	Martins	Fineries	Puddlings
		Cold-blast	Hot-blast				
1860	100	100	–		–	1064	337
1885	102	59	43	7	21	453	332
1890	105	43	62	4	12	337	364
1900	138	15	123	4	42	217	312
1910	77	4	73	2	58	12	46

Sources: Strumilin S. G. Istoriya chernoy metallurgii v SSSR (S. G. Strumilin, A History of the ferrous metallurgy in the USSR (Moscow 1954) vol. 1, p. 425); Gornozavodskaya proizvoditel'nost' Rossii v 1885 g. (Mining and metallurgical productivity in Russia 1885 (St Petersburg 1888), vol. 2, p. 42, 60, 74); Sbornik statisticheskikh svedeniy o gornozavodskoy promyshlennosti Rossii 1890 (Collected statistics about the mining and metallurgical industry in Russia 1890 (St Petersburg 1892) p. 173–84, 202, 210); Sbornik statisticheskikh svedeniy 1900 (Collected statistics 1900 (St Petersburg 1903) p. 296, 326, 348); Sbornik statisticheskikh svedeniy 1910 (Collected statistics 1910 (St Petersburg 1913) p. 292, 308, 320).

Water wheels and turbines were gradually replaced by steam engines towards the end of the 19th century. Total power used in all iron mills in the Urals was divided as follows: in 1860, 92.4 % used water engines and 7.6 % used steam engines; in 1880, 72.6 % versus 27.4 %; in 1890, 66.5 % versus 33.5 %, and lastly in 1900, 50.2 % versus 49.8 %.[109]

Steam engine output increased by 2.7 times from 1880 to 1900, and by 4.1 times from 1900 to 1917. At the end of the 19th century most iron and steel mills used steam and water power only but they gradually started to use electric energy for both lighting and production purposes.[110] At the beginning of the 20th century inner combustion

[109] Pamyatnaya knizhka dl'a russkikh gornykh l'udey na 1863 g. (A Memorandum book of 1863 for Russians dealing with mining (St Petersburg 1863) p. 25, 109); Gornozavodskaya proizvoditel'nost' Rossii v 1880 g. (Mining and metallurgical productivity in Russia in 1880 (St Petersburg 1882) p. 118–19); Sbornik statisticheskikh svedeniy 1890 (Collected statistics 1890, p. 152–53); Sbornik statisticheskikh svedeniy 1900 (Collected statistics 1900, p. 236–37); Sigov, op cit, p. 257. The calculations have been made by the author.

[110] Fedorov M. M. Ocherk sostoyaniya elektricheskikh sooruzheniy na Ural'skikh zavodakh i rudnikakh v 1906 g. // Gorny zhurnal (M. M. Fyodorov, "About the condition of electrical equipment at the Ural factories and mines in 1906" in Journal on mining (St Petersburg 1910) vol. 4, No. 10, p. 58–94); Sigov, op cit, p. 256–57.

engines had spread significantly.[111] Total power of all engines in the Urals increased by 5.4 times from 1850 to 1916.

Certain mills in the Urals were technically advanced even compared with European standards but the iron industry in general remained technically backward.[112]

The technical change was visible in other branches of the iron industry as well and the change turned into a full-scale industrial venture. The significant breakthrough took place during the 1890s and in the years preceding World War I. Before the industrial revolution most of the total iron produced in the Urals was sold at the Nizhny Novgorod fair. By the turn of the century many of the private enterprises had established trading companies of their own.[113]

The development of a railway network played an important role for the Ural metallurgy during this period. In 1878, Gornozavodskaya became connected with Perm, Nizhny Tagil and Ekaterinburg. This connection process continued with new railways, for example Ekaterinburg–Tyumen in 1885, Samare–Zlatoust in 1892, Chelyabinsk–Ekaterinburg in 1896, and Lysva–Berdaush in 1916. The Urals also became connected with other major industrial regions.[114]

After the reform of 1861 certain elements of serfdom in the iron industry still prevailed. Ironmasters remained major landowners. This was clearly the case in the province of Perm. In 1891, the group of combined ironworks owners and landlords included P. O. Demidov, Prince of San-Donato, who owned 755,000 tithings of land; further, the Countess N. A. Stenbock-Fermor, who claimed 704,000 tithings, and the Princess E. H. Abameleck-Lazareva, who held 691,000 tithings.[115]

111 Sheftel' A. Teplovoe i silovoe oborudovanie Urala // Gorny zhurnal (A. Sheftel, "Thermal and power equipment in the Urals" in Journal on mining (St Petersburg 1925) No. 7, p. 560). The calculations have been made by the author.

112 Mitinskiy A. N. Gornozavodskoy Ural (A. N. Mitinsky, Mining and metallurgical Urals (St Petersburg 1909) p. 138–39, 141–42).

113 Yatsunskiy V. K. Geografiya rynka zheleza v doreformennoy Rossii // Voprosy geografii (V. K. Yatsunsky, "The geography of the iron market in Russia before 1861" in Problems of Geography (Moscow 1960), no. 50, Historical Geography, p. 111–17); Matveev A. A. Ural'skie metally 1897 g. (A. A. Matveyev, Ural metals in 1897 (St Petersburg 1898) p. 95–106); Ragozin E. I. Zhelezo i ugol' na Urale (Ye. I. Ragozin, Iron and coal in the Urals (St Petersburg 1902) p. 25–35).

114 Sigov, op cit, p. 146–59.

115 Gavrilov D. V. Sotsial'no-ekonomicheskaya struktura gornozavodskoy promy-

In the post-reform period the group of old aristocratic ironmasters like Paul Demidov, Count Stroganov, Prince Beloselsky-Belozersky and others, was extended to include bourgeois elements. Included in this new group of entrepreneurs were the banker S. P. von Derviz, the higher officer A. A. Polovtsev, and merchants like P. S. Kondurin and N. D. Shamov.[116]

Vast landholdings and a monopoly in mining business allowed the owners to heavily exploit local workers. Long after the reform, labour was secured through indebtedness; a payback for land, tillage, wood, timber, etc. All this led to special socio-economic relations retaining certain features of serfdom. Thus, the evolution of a capitalist structure in the iron industry in the Urals was a gradual process and remains of the pre-reform archaic structure existed long after 1861. This was manifested in both the industrial sphere and everyday life.

In the development of the socio-economic structure, the creation of an advanced class structure and the formation of a modern working class was of utmost importance. In the beginning of the 20th century, 50 % of workers had no disposal of land and no other means of making a living than their own hands and, as a rule, iron workers did not work the soil.

The concentration of workers at major iron and steel plants in the Urals was high at the end of the 19th century. In the Motovilikhinsky cannon factory 10,900 workers were employed, in the Chermossky plant 9500, in Nadezhdinsky 9200, and in Beloretsky 7800 workers, etc.[117] By 1917 this tendency became even more pronounced. In the Izhevsky gun factory there were 34,200 workers, in the Motovilikhinsky cannon factory 22,700, in the Lysvensky plant 19,500, and in the Zlatoustovsky plant 16,800 were employed, etc.[118]

shlennosti Urala v period kapitalizma (D. V. Gavrilov, "Socio-economic structure of the Ural mining and metallurgical industry during capitalism (1861–1917): Methodological aspects" in Ural industry and workers during capitalism. Collected works (Sverdlovsk 1991) p. 55–56).

[116] Buranov Yu. A. Aktsionirovanie gornozavodskoy promyshlennosti Urala (Yu. A. Buranov, The turning of the Ural mining and metallurgical industry into joint-stock companies, 1861–1917 (Moscow 1982) p. 43).

[117] Gavrilov D. V. Rabochie Urala v period domonopolisticheskogo kapitalizma (D. V. Gavrilov, Ural workers during premonopolistic capitalism, 1861–1900. Number, structure, social status (Moscow 1985) p. 51).

[118] Rafikov I. K. Chislennost' rabochikh gornozavodskoy i fabrichno-zavodskoy promyshlennosti Urala // Aktual'nye voprosy razvitiya promyshlennosti i rabochego

At both mills and mines a core of permanent qualified workers was created and the number of literate workers increased significantly from 7–10 % in the 1860s to 42 % in 1897 and 60–70 % before 1917.[119]

Major breakthroughs had taken place in the social consciousness among the workers. Although a worker from the Urals had retained, at the turn of the century, certain features reflecting his serf roots, his position in the production system and the class structure of society, his outlook and social consciousness distinguished him from the serfs. As the industrial revolution proceeded, the workers of the Urals gradually lost their specific style and increasingly approached the general type of Russian proletarian.

klassa Urala v perekhodny period (I. K. Rafikov, "The number of workers in the mining and metallurgical as well as other manufacturing industries of the Urals, 1917–1918" in Aspects of industrial development and the working class in the Urals in a transitional period (Sverdlovsk 1988) p. 33–34).

[119] Narodnoe obrazovanie na Urale v XVIII-nachale XX vv. (Public education in the Urals from the 18th century to the early 20th century (Sverdlovsk 1990) p. 50, 74); Gavrilov, Rabochie Urala (Ural workers, p. 126, 129).