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Procedia Engineering 117 (2015) 696 – 705

Procedia Engineering

www.elsevier.com/locate/procedia

International Scientific Conference Urban Civil Engineering and Municipal Facilities, SPbUCEMF-2015

The History of Mills in Russia in the Context of Architectural Traditions

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Abstract

Interdependence of the architectural form with function is one of permanently open questions in the architectural theory. The paper describes the history of development mills in Russia in the context of architectural traditions. The use of wind and water engine was a real engineering breakthrough and by the end of the XIX century had been determining the nature of many types of industries. Architectural principles of the mills construction determined common European technological advances and development. The choice of the mill type depended only on the conditions of the building. Mills were built around by a project or likeness. Mill buildings were utilitarian and functional. Changing the architectural appearance of mills associated with the process and its improvement. The peculiar features of the mill buildings appeared only in connection with the characteristic of particular region general construction technologies, traditional building materials and the level of construction equipment.

Peer-review under responsibility of the organizing committee of SPbUCEMF-2015

Keywords: the history of architecture, architectural form, industrial architecture, mills, renewable energy sources

1. Introduction

Interdependence of the architectural form with function is one of permanently open questions in the architectural theory [1-17]. Speaking of the architecture of buildings, we can safely call the use of solar and wind energy as form design factor in architecture [18-27].

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Peer-review under responsibility of the organizing committee of SPbUCEMF-2015
doi:10.1016/j.proeng.2015.08.235

The history of culture and building technologies were directly related to the process that began at the end of the first millennium AD and had been continuing by the XVI c. It was named the second industrial revolution. The spiritual renewal of Renaissance revived interest in the ancient world and contributed to the gradual spread and improvement of technology that had changed social conditions and the mentality of people. Undoubtedly, European trends in the development of society's productive forces and the development of the sciences had an effect on similar processes in Russia. We can trace the characteristics and the relationship of building principles to create mills and technical equipment required for the mill production. Interdependence of the architectural form with function is one of permanently open questions in the architectural theory. Fig. 1 [28, 29].

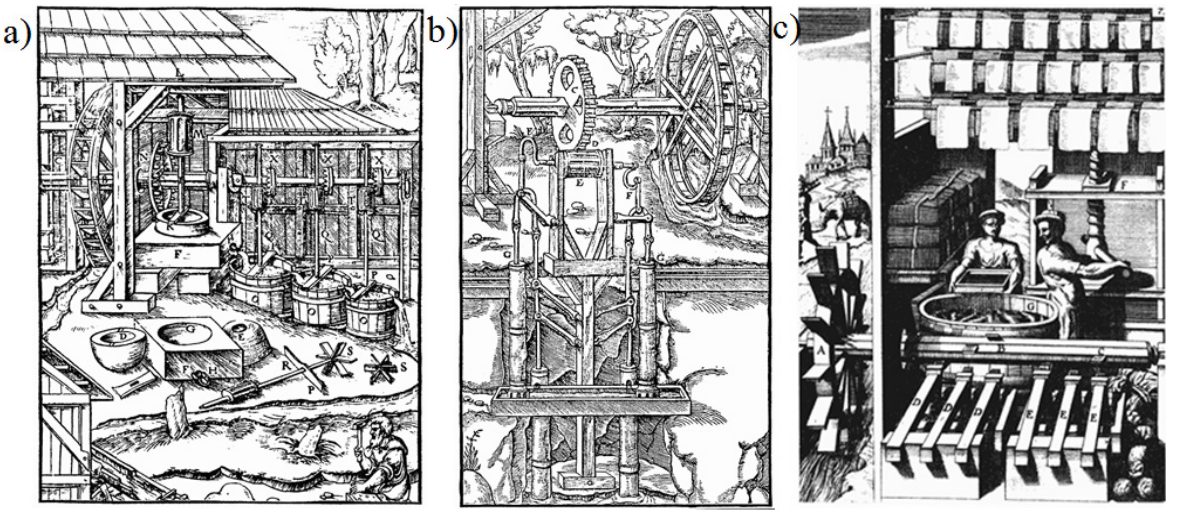

Fig. 1, a) An ore crushing mill in the book "De re metallica" XVI c., b) A mine pumps mechanism that used the water wheel force in the book "De re metallica", c) A paper machine running from the vertical undershot type wheel in the book by Andream Borkler "Theatrum machinarum novum" 1662

2. Mills building in Europe

From the XI century new sources of energy began to use to the needs of crafts and industry actively. Water Mill, which was already known to the Alexandrians in the first century BC, had been widely distributing in the West in various forms depending on local conditions. For example, there were working on the tides power in Venice, liquid in river areas. At the same time and windmill gained, introduced by the Arabs and had come to Europe through Morocco and Spain. Water- and windmills which are already in its original form in the XI and XII centuries had a capacity of 40-60 horsepower, had been determining the nature of technical installations by the end of the XVIII century. New sources of energy in the first decades of the XIII century gave a powerful impetus to the development of metallurgy, glass brightened skills, new weaving and fulling machine (Fig. 1, 2). Grand hydraulic works were undertaken in the Netherlands for the drainage areas, flooded waters of the sea, with the use of various types of pumps using of wind energy.

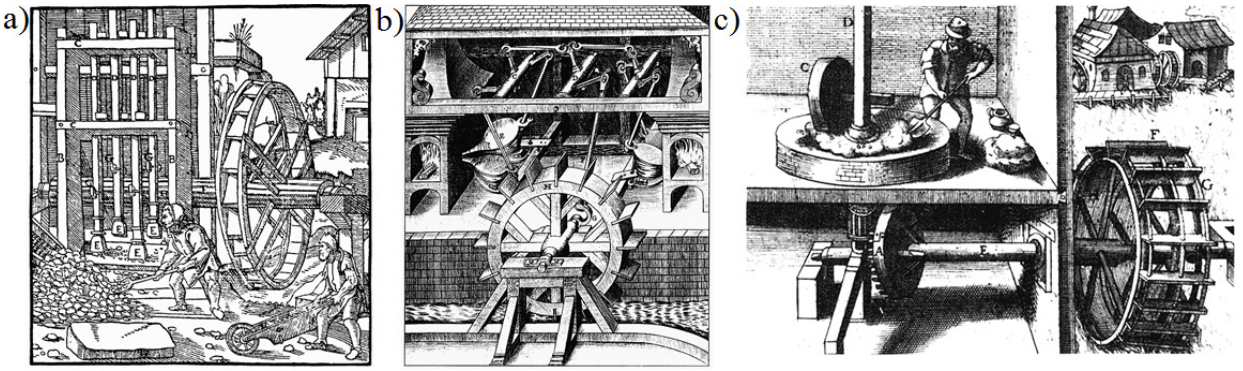

Fig. 2, a) The mill for crushing gold ore was driven by one water wheel, 1556 [28], b) The forge image using bellows actuated by undershot wheels [30], c) The mill with rolling millstone, 1607. Invented in the XI-XII centuries such mills were used for processing olives and making oil or sugarcane [31]

Such mechanisms which worked by a water and wind turbines are used for a variety of entertainment (Fig. 3). For example, the complex of 14 water wheels was built on the river Seine at Marly-le-Royer, 14 km to the west from Paris, in the 80 of the XVII century. The complex developed a power on a shaft from 300 to 500 hp, but useful was only 80-150 hp, the rest was losting in pumps and spent on mechanical transmission. Wheels pumped water, lifting it to the aqueduct located at an altitude of 153 m above the river. Water was delivered to several palace parks of Louis XIV [32].

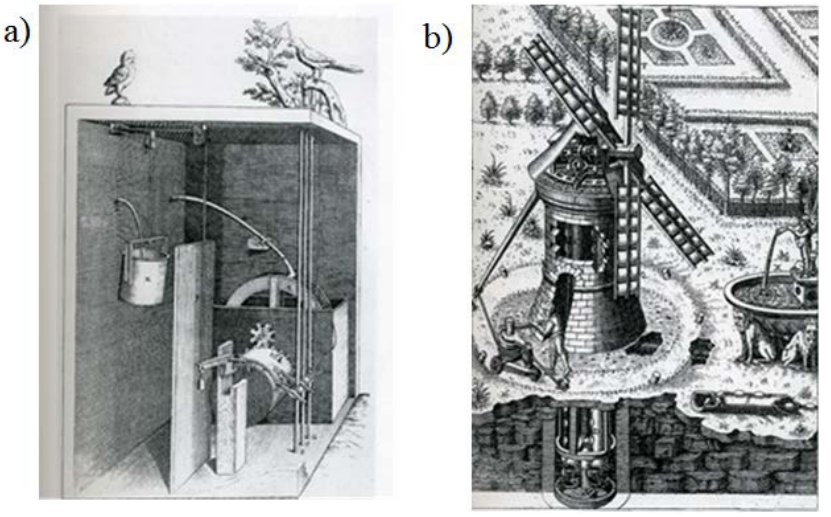

Fig. 3, a) Hydraulic machine Salomon de Cos, which drove the mechanical singing birds (the beginning of the XVII century) [33], b) Lifting water windmill for the work of fontain (1580) [33]

The use in all areas of their life activity windmills led to ways to improve smock-mills Dutch engineers. Changing the transmission system will increase the number of millstones revolutions, carry out a drive from one wind turbine to two, and later to more number of stone grinders. Respectively, an accommodate these millstones required more space, as a result, the wooden body of windmill transformed to a truncated multi-faceted prism, leading to greater stability of construction. The engineering breakthrough that occurred in the Netherlands especially related to improvements in wind mills and, of course, influenced the distribution of various types of mills in the countries of Western Europe and Russia.

A strong impetus to the development of the mill machinery America had given where along with the improvement of machinery, in 1783 the American engineer Oliver Evans was invented automatic water mill. These achievements were recommended in Russia for simple rural mills:

«Nowadays, all knowledgeable and experienced millers in Western Europe according to give preference to the North American mills цршрс ерун imitate more or less, depending on local circumstances and means ... The main attention is paid by Americans to the choice and the preparation of grinding stones ... Then they came up with two types of machines for cleaning grinding grain: one of them is like a genus sieves or harp, and the other that replaces the cumbersome and require large force of a float.

They had invented a special shell for raising grain and flour from the lower tier to the upper ... Finally, the most significant benefits of the American mills devices are that they have one ... waterwheel which drive from 2 to 4 and even more stone grinders, while we have, for the most part, is still required for each stone its own wheel...

However, a main care is the choice of millstones, which the best is still considered to be French …. The advantages of these stones are in the excellent hardness, porous and sharp rash, from which during the grinding grain grains are worn without a significant loss surface of the stone, which during using becomes polished and coated by glaze. Most of the other stones are always somewhat rough and do not get a smooth surface such as French, (off maybe the Rhine consisting of a very solid, clincer basalt mass, very similar to the components of French stones).

The consequence of this lack is that grain only crumble and not disintegrate into fine flour; and it is impossible to avert another as wetting grain by water. No less attention is required installation of stones, which depends on the best possible device any details of burmill, as well as by careful alignment of a spirit level on all supplies flour to deliver" [34].

In the Scandinavian countries all types of mills had also been distributed such as water and wind. There were similar mill in Germany.

3. Mills spread in Russia

Active dissemination watermill through Europe to Russia probably began at the end of the XIIIth century. Water mills were documented, at least, from that time. But researchers suggest their existence earlier (Fig. 9). In the sixteenth century Russian industrial enterprises with water wheel spread quite rapidly. Approximately from the XVI century (according to some other sources from the XV c.) windmills were more popular because a strong householder or some farmers paying to one's footing had a power to build it. By the beginning of the XVIII century according to few sources only post-mills had been builting in the Moscow state

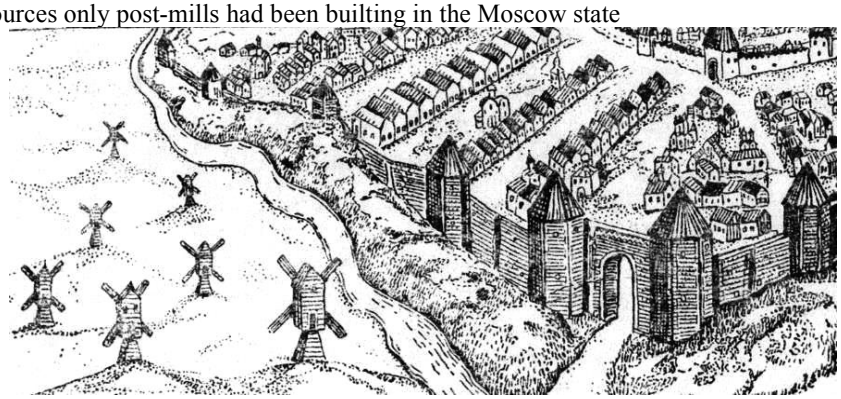

Fig. 3. Seven post-windmills from the book about the election of Mikhail Fedorovich by writer Boyar Artamon Sergeevich Matveev [36]

In 1547 on the orders of Ivan the Terrible different masters were invited from abroad, the Dutch were among them too, who quite possibly could build the first post-mills [32].

In 1583 Arkhangelsk began to build, where "in the city, above the Musketeers District, on the river Dvina, 2 windmills were", as cadastres book mentioned in the 1622 by scrivener Myron Veliaminov. 23 February 1694 in

order to unsubscribe Dvinsk voivod attached drawings, which show the part of Arkhangelsk in the end of the XVII century with 2 post-mills. There were seven windmills in another book by Boyar Artamon Matveev [35]. We have the concise message by Reytenfels who visited the capital in 1670 about the windmills existence in Moscow in the XVII century. He wrote that "every man for his own benefit has a wind-, water- or handmill" [36].

Start a broad construction of the Dutch mills in Russia was initiated by Peter I. By his edicts mills were built in St. Petersburg, Kronstadt and other Russian cities. Peter I strongly encouraged the construction of mills. For example, 12 August 1692 "on the petition" by interpreter Ambassadors order Andrew Kreft he received the royal patent letter about "water and wind for bread and grinding, beams and planks sawing mills, where at the water and windmills to grind a bread and rub rails and boards ...". The letter indicated that the mill should be built "in the German model" and at those plants to keep near German masters Russian people with, who will be given them for science, or wishers themselves who come for the studying and skill don't hide from those students nothing ... so that beams and planks sawing business and mill's plants in the German model henceforth in our Imperial Majesty Russian kingdom in cities and counties by Russian people to start and multiply. [32]. It is quite possible that there was also a mill of the Dutch type (smock) in Voronezh, which is depicted in the book de Bruin (Fig. 4) [37].

Fig. 4. Possible the first image of a Dutch type mill (smock-) in Voronezh from the book de Bruin [38]

The saw mill had been working in St. Petersburg or in the vicinity already in 1703. One Dutch windmill was shown at the plan 1706. Saw Mills "from the first years of construction were on Vasilevsky Island," at the place of the Sciences Academy and belonged to Prince Menshikov. After some time they were moved to Ohta "to clean the space under the Sciences Academy and mills were about fifteen." P.N. Stolpyanski described mills in his book "Petersburg" published in 1918. He also wrote that on the stone shaft of the Petropavlovskaya fortress more windmills were began to build, but soon they were removed with the mismatch of windmills and the fortress [32]. (Fig. 5).

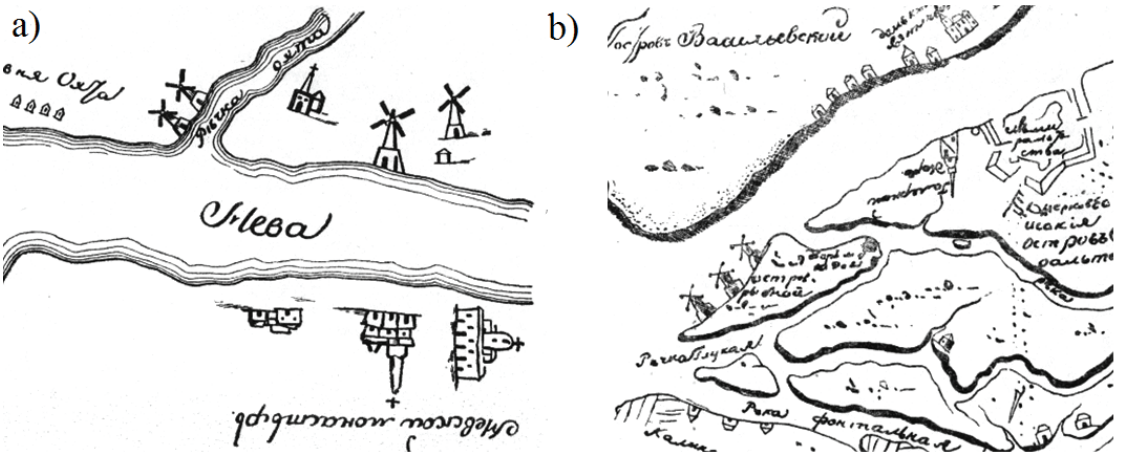

Fig. 5, a) Petersburg plan's fragments by midshipman Ignatius Plemyannikov 1725, showing seven Dutch windmills – three were on the Fish Island, b) Two on the opposite banks of the river Okhta at its confluence into the Neva.

Peter I perfectly realized the important role of the windmill is mainly more powerful Dutch which could be used anywhere and not only for grinding grain in contrast to the widespread water mill at those time. According to the testimony of the surviving manuscript "fairy tales" Russian mills census conducted in 1704 by decree of Peter I, in the beginning of the XVIII century there were thousands of mills. Construction of Dutch windmills quickly spread throughout Russia and the end of the XIX century there were more than 200 thousand. Ruban listed "sawing, powder, hummer, where every iron is forged, anchors and rifle case", polishing, paper and "water pouring from the canal." "If all the mills are calculated, then there are up to 50, so that more than 15 mills are at one Okhta, and in other places where two, three and impossible to know a number of them" [38].

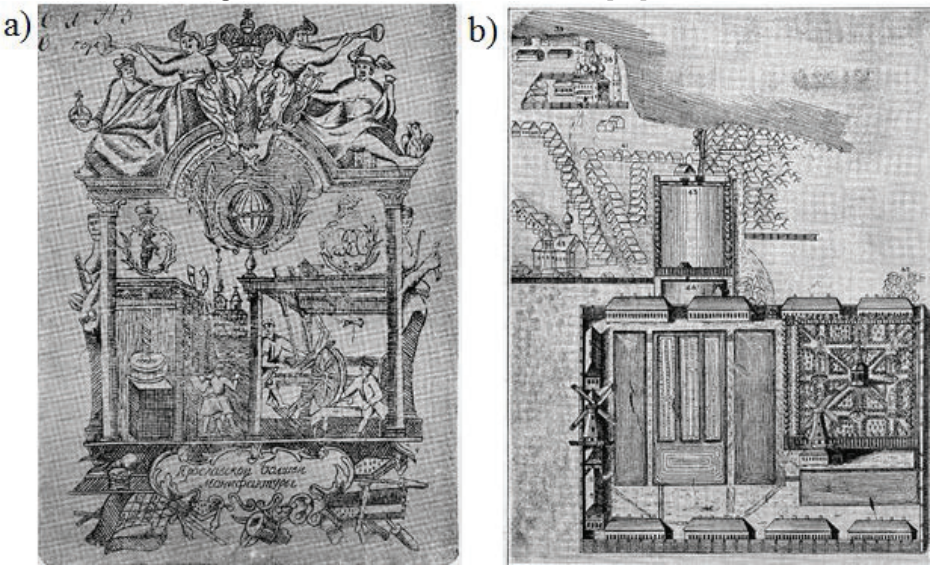

Fig. 6, a) Water and windmills at theYaroslavl manufactory plan XVIII c., b) A water wheel on the trade label of the Yaroslavl manufactory, XVIII c.

Nevertheless hand mills were the simplest device for grinding grain into flour in Russian for ever. They are known within the territory of the Eastern Slavs settlement according to archaeological data from the VIII century.

Being found in the excavations hand mills stones were round (diameter 60-80 cm), drilled in the center. Lower millstone had convex conical work surface, and the top – a concave respectively. In XVIII – XIX centuries hand mill hocks were almost in every peasant's house. It was placed in a corner of the hut (which is called “millstoun angle”) or in passage, sometimes on underground. Grinding grain manually produced in very small scale – for the needs of the family, when you do not have time to go to the mill and had no money to pay for grinding. The bulk of the grain farmers drove to grind at the nearest water or windmills [39].

"Throughout in goverments among the peasants it give assent to thresh grain at the mill. And because the number of flourmills so limited, and only a small urban deliver benefits to their owners; located in the same counties, usually constitute the belonging of landlords, and are mostly only for their own use and delivered to them own small benefits.

Saw mills are all small size and their performance is negligible. Manual sawing is in the greater use here" [40].

Despite the widespread use of hand millstones and manual sawing, according to questionnaires mills were in all counties, from one to three in each parish. Wind and watermills could meet. By the XIX century water mills had been building mainly. Widespread wind as in Europe had received only in the XIX century.

In Acts and censuses we can find descriptions of mills that existed already in the XVI century: "The inspection saved of the mill at the Petrovsky churchyard on the river Redie from 1672: 7x 4 sazhene... and there are 2 dry dilapidated wheels in a barn, vernal water had knocked the wheels from shafts, two shafts, one of them is old, another new, two bad fine-tune millstones, those millstones can’t continue to grind, and new millstone is one , not fine-tune 2 gears with spindle and poroplitsa and iron step-bearing shabby, 4 hoop iron shabby on the shafts, one hoop at each end, and 4 iron step-bearigs at the ends, 2 iron tooths with a setup than forge millstones. There are the hut of four sazhenes for visitors millers at the same mill ..." In 1659 in Kolomenskoye graveyard Onesimus Borisov’s weels mill had washed by water "and there were millstones and crush in it, and near to it house was with small yard" [41].

In the XIX century mills existed in different forms of ownership: worldly, ie belonging to the community, state-owned or state, monastic, aristocratic and finally private. In references also possible to determine that the mills mainly at that time owned the churches and monasteries. Some peasants without their own mills took monastic on the rent. There were also descriptions of the mill yard or farm in some documents.

In the Novgorod chronicles first mention of the water-mill construction on the Volkhov found at 1528. In 1600 "for all men surprisingly" mill was built in Veliky Novgorod by Boris Godunov’s order, in where the Treasury is going to be great, and fishing, and the bridge across the Volkhov ...". According to the monastery inventories the rare Monastery of the Novgorod land was without own mills where the grain was ground "about monastic everyday life" and for the surrounding population for a fee [42]. Trinity Mills were owned by local clergy too. From the archives documents of 30 – 40 years XVIII century it is known that around village Trinity on the lake and other high places there were four windmills. It was a post-mills which was known in Novgorod in the late XVII century and is widely spread in the XVIII – XIX centuries [43].

In Lakeland, according to the documents of the XVIII century post-mills mentioned in the villages Three Youths, Zdrinoga and others. At the Klopski monastery two buildings more were indicated "on wood frame and one post" that stood beside the river Veryazha and milled "only about monastic everyday life". More productive smock-mills had begun to spread later, as elsewhere on the north-west of Russia. "Wind is a so-called Dutch type of smock-mills, which first appeared in Russia in the early XVIII century. At the same time they became known in Novgorod province. Unlike post-mills in tent mills instead of turning the whole body around the pole only the upper part resembling a tent rotates... Due to lack of the forest in these area..., windmills with its carcass structure and cladding planks were widespread in the Novgorod province in the late XIX – early XX centuries. Stationary octagonal building tapers upward. Often these mills were with "two grinders"[43]. In the middle of the XIX century there was 2700 water and wind mills only in 5 counties of the Novgorod province.

At the same time more water mills recorded on documents in some counties of the Pskov province, "... where is the river, there is watermill." "Even if there's a windmill, more millers even it is further, go to the water" [44].

Generally, preference was given to water engine as stronger and more constant, more uniform, does not require careful maintenance and supervision during operation. The report of Agronomy travel to Pskov province in 1855 by Professor Krause noted: "Water for movement of the overshot wheels is enough at all times", and that the water

mills are used widely for other productions: "The mill, with the saw, gives an annual income of 60 to 80 rubles sil" [45].

Researchers in different regions of Russia noted more widespread water mills [46]. "German Wheel" was mentiond very often. It was mills with vertical wheels.

Mill buildings were built in the "modeled" or "on the Project." Small village mill probably were built by the type of neighbor which adapts with the general scheme to a particular place. Large mills with many grinders and a variety of additional production were built on standard or individual projects. For the mills construction masters were invited which were acquainted with the specifics of these structures. Under their leadership carpentry local teams had been working too. For example in May 1802 the monastery has concluded two contracts for the construction of a new mill with Pskovian Everts and peasants Filipov from the village Podgorie and Terenty Vasiliev from the village Bugrovo. Name Everts found in references to other mills, for example, in Izborsk, which is 30 km from Pskov. Apparently, he was known to the Pskov province as the master of mills building. The contract for construction bugrovskoy mill was one example of the design early XIX century. According the Contract masters had to "at the monastery mill' designated place which was in the village Bukrovoy to build a new flour Mill with two grinders and create one dam on the place where the first mill had been ..." [47]. We also know that German or French engineers and craftsmen wereoften invited for the construction of mills [48]. The photos of German millers, who built a mill on the river Blue in Krasnogorodsk County Pskov province in 1898 are stored in the Russian Etnographical Museum archive [49].

This is confirmed by comparison other data the continuity and the relationship of the principles and building techniques of the mills.

4. Summary

Hand millstone were known in the ancient world, used in many countries including Russia and throughout the history of their construction had remained almost unchanged. In the north-west of Russia mills also were widespread and were belonging almost every sector.

The invention of the turbine windmill in Greece, the Roman mill with vertical wheel, and later the windmill was tremendous achievements of people in the use of new and renewable sources of energy for the basic necessities of life process.

The use of wind and water engine was a real engineering breakthrough and by the end of the XIX century had been determining the nature of many types of industries: flour, fulling, woodworking, glass, manufacturing of paints, etc.

Principles of the mills construction determined common European technological advances and development. The choice of the mill type depended only on the conditions of the building. Mills were built around by a project or likeness.

Mill buildings were utilitarian and functional. Their change is related to the process and its improvement. The peculiar features of the mill buildings appeared only in connection with the characteristic of particular region general construction technologies, traditional building materials and the level of construction equipment.

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