# NLMK GROUP

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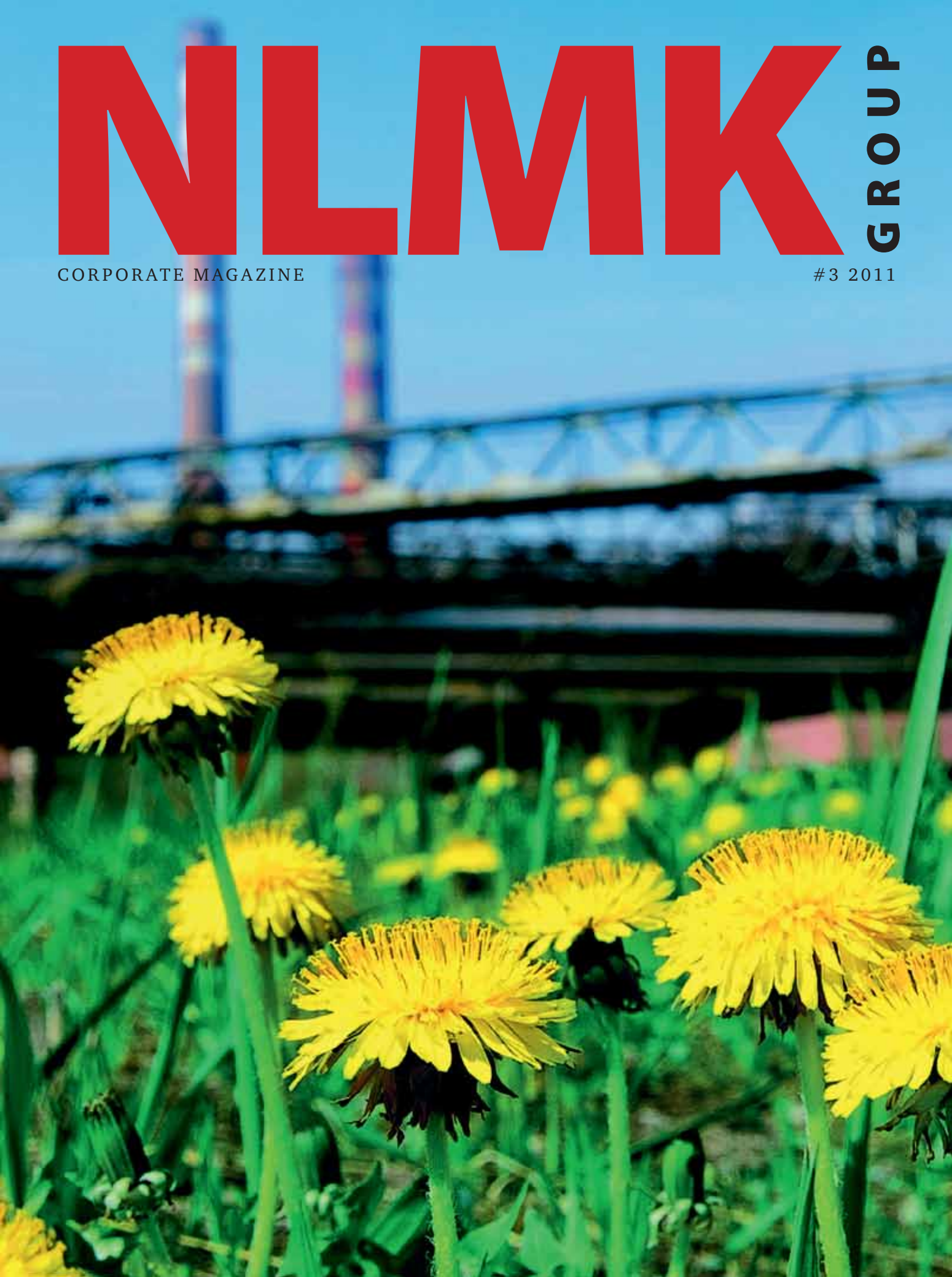

# Annual General Meeting of Shareholders

The Annual General Meeting of Shareholders of NLMK was held publicly on June 3, 2011. Shareholders approved the Company's 2010 annual report, annual financial statements and allocation of profit, including the dividend payment for the financial year 2010.

NLMK's shareholders approved the total dividend for the financial year 2010 of RUR1.82 per ordinary share. Taking into account the previously paid interim dividends for the first half of 2010 of RUR0.62 per ordinary share, additional payment will amount to RUR1.20 per ordinary share.

NLMK shareholders elected members to the Board of Directors, the Internal Audit Commission and the President of NLMK (Chairman of the Management Board), as well as the Company's Auditor.

NLMK shareholders elected nine members to the Board of Directors: Vladimir Lisin, Oleg Bagrin, Bruno Bolfo, Nikolai Gagarin, Karl Doering, Helmut Wieser, Karen Sarkisov, Vladimir Skorokhodov and Franz Struzl.

Alexey Lapshin was elected President of the Company (Chairman of the Management Board).


## Biographies of new directors

**Helmut Wieser** is an executive vice president of Alcoa and Group President responsible for Alcoa's global mill products and rigid packaging businesses. He also oversees Alcoa's businesses in the Asia Pacific region, with a focus on China, the Australian rolled products businesses and Alcoa's operations in Russia. In addition, Helmut Wieser is a member of the Alcoa Executive Council, the senior leadership group that provides strategic direction for the company. He also serves on the board of governors of the International Graduate University in Washington, D.C. on Capitol Hill.

In 1967 **Franz Struzl** joined Alpine Steelgroup, later renamed Voestalpine AG, based in Linz, Austria, serving the Company for over four decades. During his career at Voestalpine Franz Struzl held various positions in a number of fields including strategic planning, commercial and technical areas. In 2001 Franz Struzl was appointed as Voestalpine Group Chief Executive Officer and Chairman. He held the position until 2004, when he moved to become Chief Executive Officer of Voestalpine, Brazil - Villares Metals, remaining there until his retirement in 2010.

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The new NLMK Board of Directors held its first meeting. Vladimir Lisin was elected Chairman of the Board of Directors, and Vladimir Skorokhodov was elected Deputy Chairman of the Board of Directors.

The Board of Directors established the Strategic Planning, Audit, Personnel, Remuneration and Social Policy committees.






## CARING FOR THEIR NATIVE LAND

**European Bank for Reconstruction and Development (EBRD) has awarded Novolipetsk a prize for Excellence in Sustainable Energy and Climate Change.**

This is one of several awards received by Novolipetsk for its environmental protection efforts. Together with VIZ-Stal it was ranked among 2010 Russia's Top 100 – Ecology and Environmental Management.

In 2010 Novolipetsk reduced its atmospheric emissions by 1,400 tonnes even though its steel output grew by 781,000 tonnes (up to almost 9,300,000 tonnes). River water consumption was decreased by 11.1 mln cubic meters, and there was no waste water discharge into the Voronezh River. The amount of previously stockpiled waste was reduced by more than 500,000 tonnes. In 2010 the Company's environmental investments amounted to RUR4,137 mln (~$136.2 mln; ~€102.9 mln).

VIZ-Stal has implemented over 60 environmental protection measures. Sergey Makurov, CEO of VIZ-Stal, was awarded the honorary title of Environmentalist of the Year 2011, and Tatyana Koscheyeva, Head of the Water and Air Protection and Industrial Ventilation Laboratory, received the honorary decoration of Best Manager in Environmental and Industrial Safety.

VIZ-Stal's authorized laboratory conducts regular monitoring of the state of soils, atmospheric air and storm water. In 2010 the site's environment footprint was significantly below allowed statutory levels on all accounts, including discharges of sewage (reduced by 50%), emissions of pollutants into the atmosphere (reduced by 20%), and a 40% reduction in accumulation of new waste. A phased re-vegetation of the Lesnoy industrial waste landfill is under way, with 200 pine, birch and willow trees planted in addition to trees which had been planted earlier and have already taken root. Treatment facilities are also being revamped, and the sanitary protection zone is undergoing development.

Last year VIZ-Stal spent a total of RUR170 mln (~$5.6 mln; ~€4.2 mln ) on environmental protection projects. ■

**FOR REFERENCE**

The European Bank for Reconstruction & Development is an international financial organization that finances projects in 29 countries, from Central Europe to Central Asia.

The EBRD awards a prize to two of its projects across all of the countries in which it operates for their achievements in the area of environment and social improvement. In 2010 NLMK signed a loan agreement with the EBRD worth EUR125 mln to finance its Energy Efficiency Program. The EBRD funding was earmarked mainly for the construction of a 150 megawatt combined heat and power plant fired by waste gases from the steel plant's blast furnaces at its Novolipetsk works, as well as for financing NLMK's plans to integrate Pulverized Coal Injection (PCI) technology into its blast furnace operations.

## INVESTMENT GRADE

**The international rating agency Fitch has upgraded the company's long-term credit rating from BB+ to the investment grade level at BBB- with a stable outlook.**


Fitch highlights NLMK's progress in balancing its 40% crude steel growth and re-rolling production capacities through acquisition of the rolling assets of Steel Invest and Finance (for details see Asset Synergies section). Fitch states that the acquisition decreases excessive exposure to the volatile semi-finished steel products market and ensures additional value to be delivered from its efficient upstream operations. Additionally, better sector exposure and geographic diversification contributes to the stability of a company's operational performance in the future. Fitch positively views NLMK's commitment to continuing with its conservative financial strategy and following good corporate governance practices compared with other Russian peers. ■

**Ms Galina Aglyamova, NLMK's CFO, commented:**

"We are very pleased by the decision of Fitch to grant NLMK a BBB- rating. This decision represents a favorable outside assessment of the Company and the strategic, operational and organizational progress that we have made in recent years. We believe that this also confirms the sustainability of our business model and our ability to maintain a resilient performance through the cycle."

# New Outlines of Global Development

**The acquisition by NLMK of the 50 percent stake in the Steel Invest and Finance (SIF) joint venture registered in Luxemburg from the Swiss-Italian Duferco Group (Duferco) generated wide coverage in the steel industry.**

The transaction has resulted in SIF becoming a 100% owned subsidiary of NLMK. The 50% stake in the company was priced at around $600 mln, payable in four equal annual installments. The transaction has significantly enhanced NLMK's international downstream portfolio through the complete integration of 7 rolling assets in Europe and the US with total rolling capacity of over 5.5 mtpy and 2010 combined output of 3.2 mtpy, as well as several distribution facilities. In its turn Duferco obtained the joint venture's steelmaking assets in Belgium, including the Carsid blast furnace and the electric arc furnace at the La Louvière, and the long products operations of 0.3 mtpy capacity. The partners to the joint venture agree that these assets are better suited for restructuring within Duferco, which has accumulated a wealth of experience in similar restructuring exercises, while NLMK has no synergies with these assets.

Our readers may remember that NLMK and Duferco established the joint venture on a 50-50 basis in 2006. Back then NLMK paid $805 mln for its 50% stake, while Duferco contributed production assets to the joint venture's capital, including a steel factory in Belgium and five rolling operations in France,

**Alexey Lapshin, NLMK President (Chairman of the Management Board):**

"NLMK is actively growing its business and this acquisition is in line with our strategy to deliver sustainable long term growth.

"This move makes us a truly global steel player with a footprint in 3 continents, positioned to exploit geographic advantages. Our mining and steelmaking operations are located in one of the best places to produce crude steel efficiently while the rolling assets are now located in close proximity to our key clients. Such a combination can allow cost advantages to be leveraged across the value chain.

"Since the formation of the JV we have been growing our sales to the acquired rolling assets and this was one of the factors that allowed us to achieve 100% utilization rates of our Russian operations in the midst of the crisis in 2009. Now those assets provide us with an opportunity for an increase of value added product sales after the launch of the new Blast Furnace in Lipetsk later this year."

Belgium, Italy and the United States. The joint venture also owned Transformation Europe (DTE), a subsidiary of Duferco, which operated nine service centers in France, Belgium and the Czech Republic.

In 2006 the joint venture embarked on a program of technology upgrades. Notwithstanding the crisis the partners continued to invest in assets in Belgium, with capital expenditures for their development reaching €440 mln over a period of four years from 2007 to 2010. Investments into the development of the Flat Products Business Unit, including the La Louvière, Manage, Jemappes, Beautor, and Sorral sites, amounted to €110 mln, including €92 mln for the construction of a new heating furnace, a new pickling line, a vacuum vessel in the Electric Melt Shop, a new fully automated slab storage facility, and a new sheet treatment line at La Louvière. This allowed for an increase in output of finished products from the current 1.8 mln t to 2.5 mln t, expansion of the value-added processing capacity,

**FOR REFERENCE**

European facilities of Steel Invest and Finance SA (SIF) with a capacity of around 2.4 mtpy produce a variety of flat products, including cold-rolled, galvanized and pre-painted steel. European assets also include facilities for the manufacture of thick plates, with a capacity of around 1.35 mtpy. SIF's US-based flat steel production facilities have a total capacity of 1.8 mtpy, including 0.8 mtpy of galvanized steel. Around 75% of SIF's products are sold to the machine-building sector.


including galvanization and treatment of rolling stock, and improvements in the logistics and distribution systems.

The Thick Plate Business Unit (the Clabecq facility) received €150 million in investments, including €100 mln to install the Quenching & Tempering Line, and €50 mln for the construction of heating furnaces and the installation of a new melting machine, allowing it to produce new varieties of heavy-duty steel required by international and Russian markets.

**Oleg Bagrin, Chairman of the Strategic Planning Committee of NLMK Board of Directors:**

"The story of NLMK-Duferco JV over the last four years was built on confidence and trust between the joint venture partners against the backdrop of tough business conditions. On behalf of NLMK Board, I would like to thank Duferco, and personally Bruno Bolfo, for their commitment and hard work. Their contribution helped us to create value in the JV, resulting in a mutually beneficial strategic outcome.

We welcome the employees of SIF and many former Duferco managers to NLMK family and expect to benefit from their experience and contribution to our growth and success."

In 2010 NLMK obtained an indefinite option to buy Duferco's stake, and has now chosen to exercise this option. This led to what may be called a qualitative leap in the implementation of NLMK's strategy of becoming a highly efficient global company and reinforcing its competitive advantages in international markets. Full control over seven rolling assets shall strengthen NLMK's position as supplier to key markets in Western Europe and the United States, and shall also significantly expand its product mix.

This acquisition will enable NLMK to:

■ Secure further processing and distribution of crude steel (slabs) to be produced with the commissioning of the new 3.4 mtpy BF in Lipetsk, Russia in 2011;

■ Significantly increase global finished steel capacity from 70% to more than 90% as compared to our overall slab producing capacity with an emphasis on premium clients in automotive, energy and machinery building industries in the European and North American markets;

■ Increase the speed and quality of supply of finished products to the European and American customers;

■ Mitigate risks associated with concentration on one single product (slabs) and single market (S.E.Asia);

■ Use the acquired distribution operations as a basis for building a modern distribution network on the established and premium European markets;

■ Continue further efficiency improvements through the adoption of management best practices and technology transfer across the Group.

NLMK will continue to invest in SIF rolling operations. Over the next three years these investments may reach €80 mln, which will be used to support production operations and will be distributed across all businesses.

A statement by the European Commission says that it has approved the acquisition of Steel Invest and Finance by NLMK.

**Anton Bazulev, Director for External Relations, NLMK:**

"The European market has always been one of our priority export destinations. Now our position in this important and capacious market will strengthen as we will have the capability to increase our sales to important consumers, i.e. the automotive and machine-building sectors. Traditionally, European producers have always been strong in these markets, and now we can compete with them directly via the Duferco assets."

# Cooperation Continues

**Horacio Malfatto, CEO of NLMK Europe and Member of the Board of Directors of NLMK International BV, answers questions from Alexander Alekseyev, the NLMK Corporate Magazine.**

**Q: NLMK and the Duferco Group have been cooperating since 2006. What is your assessment of the outcome of this cooperation? Are you satisfied with it?**
**A:** We are very pleased with the outcome of our collaboration. In late 2006 the NLMK Group and Duferco created the Steel Invest & Finance joint venture. Let me recall that the objective of this partnership was to implement an operations strategy which was based on the development of production capacity and increased share of products with high value-added. In order to achieve these objectives the shareholders designed a large-scale program for strategic investments. Between January 2007 and December 2010, and notwithstanding the 2008 crisis, NLMK and Duferco have invested more than €1 billion into the business, of which €440 million were spent on strategic investments in support of the production system, and €560 million were targeted for normalizing the financial liquidity of the system. By continuing to make investments despite the crisis, the shareholders have shown that they believe in the future of the joint venture's production assets and are keen on implementing a long-term development strategy. These investments have allowed us to substantially increase the share of products with high value-added, in particular, steel used for manufacturing of automotive sheet. Within the Thick Plate Business Unit we have also launched production of special grades of steel at the Clabecq and Verona Steel factories. In addition, the Clabecq facility will begin operating the new Quenching and Tempering Line, allowing for the production of new grades of heavy-duty steel with high elasticity limits.

**Q: What do employees of the Duferco Group businesses think about the intensified cooperation between the two companies?**
**A:** Company personnel appreciate that the Duferco Group businesses would have had a very difficult time addressing the crisis if it were not for the support from NLMK. By relying on the delivery of slabs from NLMK we were able to continue mastering the production of new grades of steel. Also, company personnel are confident that NLMK will continue to pursue a responsible social policy.

**Q: Did you meet with any challenges affecting your cooperation between NLMK and the Duferco Group? How did you handle them?**
**A:** I think that the major challenges that we faced were related to the differences in corporate cultures. Before the crisis, in a favorable market environment, this did not cause any concern. When the crisis broke out, it made things more difficult. We were able to overcome these difficulties because both NLMK and Duferco are dedicated to their business of making steel. It was exactly this dedication that helped us understand each other and find a solution through joint efforts.

**Q: What are the most memorable events in your cooperation with NLMK?**
**A:** I would highlight three events over the four years of the joint venture's existence. First, I would mention the decision by the shareholders to invest in the construction of the new Quenching and Tempering Line at Clabecq. It became an important strategic decision for the future of the business.
Secondly, the key role played by the €500 plus million which the shareholders had allocated for the stabilization of financial liquidity of the joint venture.
And finally, we have established a unique logistical cooperation between Russia and Belgium in terms of slab supplies. We have arranged for weekly deliveries of slabs, which will allow us to respond to the needs of our clients much more quickly and with greater flexibility. This became possible through the joint efforts of SIF and NLMK employees.

**Q: How do you see the prospects for further strengthening the partnership between companies? What are these prospects?**
**A:** The shareholders have decided to withdraw from the joint venture, but this does not imply that the companies will stop cooperating. The Duferco Group, a most experienced market player, will continue to provide us with trading services. In addition, NLMK and Duferco will continue to collaborate on the restructuring of the La Louvière operations.

# Almost There...

**The Blast Furnace No. 7 project at the Company's main production site in Lipetsk has entered its final stage.**

Work at the facility continues around the clock and involves more than 4,000 contractor employees. Their efforts to install process equipment and to adjust and fine-tune the information systems are assisted by Novolipetsk employees. This is only natural, since the latter will be operating the facility and want everything to be done in the best possible manner. For example, one can hardly underestimate the contribution of experienced NLMK blast furnace operators to the process of assembling the furnace equipment. They have studied it to the last bolt and know how to mount one or another unit or component quickly and properly. Our photographer visited the construction site on the first day of summer. We make a point of noting the time, because things at the project site can change dramatically overnight: where equipment had been delivered the day before, it may already be

## Blast Furnace No. 7 Project in Numbers

**BF-7 has:**

- More than 270,000 cubic meters of reinforced concrete;
- More than 61,000 tonnes of fabricated metal parts;
- 25,600 tonnes of refractories;
- 66.4 kilometers of pipes;
- 72,000 tonnes of process equipment;
- About 30 kilometers of railroad connections.

installed the next day. Apart from man's immense and impressive creations we wanted the pictures to show the attitude of the people engaged in building Russia's first post-Soviet blast furnace, which complies with all modern environmental standards. They are almost there and it's just a matter of short time before this beauty of a furnace comes alive and begins to breathe at full strength. And its powerful breath can only be treated as a harbinger of Russia's future technological transformation.

# Achieving Self-Sufficiency in Raw Materials

**NLMK is known to have adequate supplies of iron ore and other raw materials required to make steel, with the only exception of coking coal.** Alexander Sutormin discusses the integration of coal mining assets within the Group with Alexander Saprykin, VP and Head of Coal Division.

**Q: Mr. Saprykin, among large steelmakers in Russia NLMK is probably the only one fully dependent on third-party suppliers of coking coal. Some experts see this as a shortcoming for the Company. What do you think?**

**A:** I wouldn't call the absence of operating coal assets a shortcoming for our Company. I think that you would agree that all assets are different. And we want our coal businesses to be competitive in all respects, i.e. provide us with merchantable coal at the least possible cost and irrespective of market developments.

The market situation is in a constant state of flux, and this makes a definite impact on prices, and we always procure coal at market prices. When there is uncontrolled growth in demand, it is primarily caused by demand from steelmakers, who are also benefiting from their own strong sales and product prices. In this case by buying coal on the market we share some of the value-added with our suppliers, but we also make a profit. But when demand slumps and prices collapse, we are not required to guarantee profitability of sales to someone else, and we procure the goods we need at the lowest available price and also use this to our advantage in an economic downturn.

Allow me to remind you that with the onset of the crisis steelmakers that own coal assets had to subsidize their coal businesses in order to help them stay afloat. While at the same time they themselves were facing certain challenges, with demand for steel contracting several fold, prices collapsing, and most importantly, and it continues to this day, no one can be certain that this will not repeat itself.

**Q: How much coal do Group businesses consume? Who do we buy it from?**

**A:** Our businesses require about 9 mln tonnes of coking coal, of which around 5.5 mln tonnes are consumed by Altai-Koks, and the balance is consumed by Novolipetsk. Our businesses use this coal to produce more than 6 mtpy of coke, with two thirds being consumed by NLMK blast furnace operations and one third being sold to third parties. With the commissioning of BF-7 the latter will also be consumed by NLMK.

We procure coking coal from suppliers in the market. Most of it comes from independent producers, who are not part of vertically integrated steel companies. And only 20% of the coal charge is procured from coal manufacturers associated with steelmaking companies.

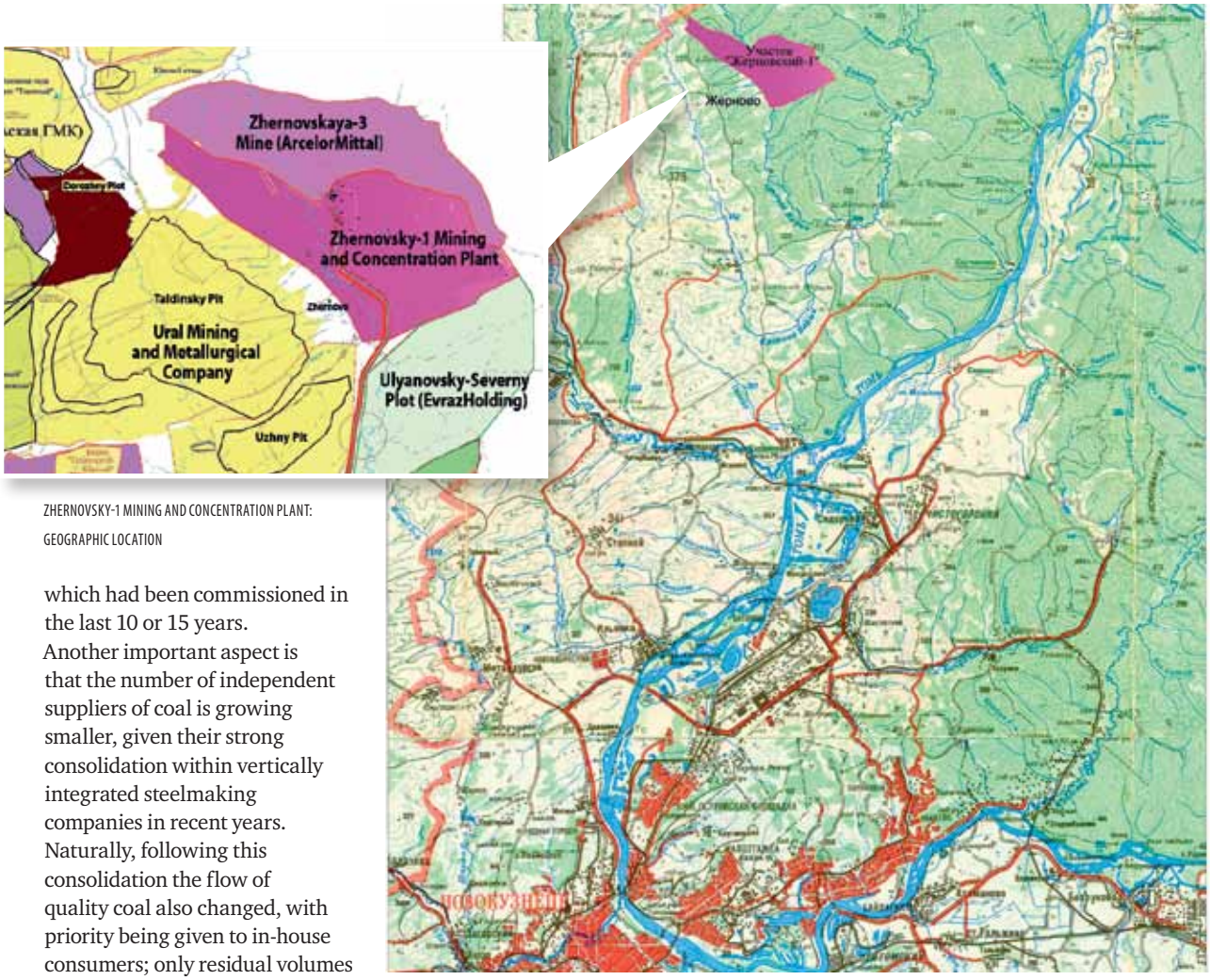
Our supplier relations are based on long-term contracts, ensuring an uninterrupted supply of coal to the Group businesses.

**Q: The Company has managed to operate without its own coal assets, and now comes the decision to acquire deposits of coal. What is the reason for that?**

**A:** We have already shown interest in coal assets and deposits in the past, but they failed to meet all our requirements.

A shortage of quality grades of coking coal has emerged in the Russian market over the last few years. Because any deposit is likely to be exhausted sooner or later. You start by extracting the reserves with more favorable geology and which are easier to mine. It was mainly due to the depletion of reserves that many mines in Russia had to be abandoned in the 1990s; and a special government program had to be introduced to provide funding for that.

Existing underground and open-pit coal mines are also gradually depleting their reserves, while the development of new, previously untapped deposits of coking coal remains problematic for a number of both objective and subjective reasons. There are only a handful of new coal mining operations




ZHERNOVSKY-1 MINING AND CONCENTRATION PLANT: GEOGRAPHIC LOCATION

which had been commissioned in the last 10 or 15 years.
Another important aspect is that the number of independent suppliers of coal is growing smaller, given their strong consolidation within vertically integrated steelmaking companies in recent years. Naturally, following this consolidation the flow of quality coal also changed, with priority being given to in-house consumers; only residual volumes are being supplied to the market and other buyers.
It has become very difficult to produce good quality coke using domestic coal concentrate available in the market. This has been a challenge for a number of years for all Russian steelmakers, including those with their own coal assets.
All of these factors prompted us to consider looking for new promising deposits of good quality coking coal.

**Q: You mentioned the issue of coke quality. How do you address it?**
**A:** This issue of coke quality has been on our agenda for a long time and we are tackling it successfully by procuring imported coal of proper quality, and also by improving the processes which utilize domestic coal charge by applying various additives.
Our first contract to import coal from the United States was signed in 2007. We were the first Russian steelmakers to do this, but our peers have since followed suit.
We collaborate with one of the leaders of the US coal industry under a long-term contract with a fixed annual price. The share of imported coal in our total coal purchases does not exceed 10%, but it has led to substantial improvements in the quality of coke produced by our in-house coke-chemistry operations. For example, today CSR is at least 58%, and until recently the coke-chemical operations could barely make it reach 52% to meet the requirements of applicable NLMK standards.
We continue our efforts to improve the processes for producing good quality coke, and we are also designing and implementing a number of other technical proposals.

**Q: How do you offset the cost of US coal: it may itself be cheap, but the cost of transporting it must be rather high?**
**A:** This is achieved through better quality of coke which improves blast furnace performance. The cost of transportation is mitigated by lower coke consumption rate and increased blast furnace efficiency. This is one battle definitely worth fighting.

**Q: We have digressed somewhat from our main topic. Let's return to the coal deposit acquisitions...**

**A:** Our objective is to make the Company self-sufficient in good quality coal. No alternative supplier will be able to resolve that challenge in our favor or in our stead. We need to build our own modern and competitive coal businesses, this is the strategy for vertical integration and it will be implemented sooner or later. The acquisition of appropriate deposits is only the first step in this direction, but a very important step, because the Russian Federation does not have too many unallocated deposits with marketable coal and favorable geology, allowing for the coal to be extracted in an efficient, technologically advanced and safe manner.

In 2005 the Company obtained a license for the development of the Zhernovskoye-1 deposit, with an adjusted on-balance reserve of grade Zh, GZh, GZhO coals (Russian categories of reserves) of 163 mln tonnes. Just recently we obtained a license to explore and develop the Zhernovski Gluboki plot of the Zhernovskoye coal deposit located just below the Zhernovskoe-1 deposit. The Zhernovski Gluboki plot holds about 73 mln tonnes of on-balance reserves of high-quality hard coking coal in the Zh, GZh, and GZhO grades. Development of the two plots (Zhernovski Gluboki and Zhernovski-1) in a single scheme (the Zhernovski Mining and Concentration Plant) will allow sharing costs for the construction of a common infrastructure using best available technologies compliant with all modern security requirements. Moreover, integrating the newly acquired reserves will substantially improve the mine life of the deposit. In terms of developing the Zhernovskoye deposit, design work is already under way, and we are at the same time also addressing issues with land utilization and gaining access to local infrastructure facilities, and dealing with other matters. This year we shall spend more than RUR1 billion (~$33.6 mln; ~€24.9 mln) on groundwork for the development of the mining works. The Zhernovsky Mining and Concentration Plant is expected to reach design capacity in 2016 and to produce 4.5 mtpy of ordinary coal, which will be used to produce between 3.5 and 3.7 mln tonnes of coal concentrate.

*This year we shall spend more than RUR1 billion (~$33.6 mln; ~€24.9 mln ) on groundwork for the development of the Zhernovski Mining and Concentration Plant*

Mining works of almost the same capacity will also appear at the Usinsky deposit in the north-eastern part of the Pechora Coal Basin, in the Komi Republic. NLMK acquired a license to develop this deposit earlier this year in January. The Usinsky-3 deposit has over 227 mln tonnes of on-balance reserves of high-quality hard coking coal (grades Zh and KZh, Russian categories of reserves). Coal of the KZh grade is essentially ready-made coking charge, and it can be used to obtain high quality coke without mixing it with other varieties of coal. Within the next seven years, NLMK plans to complete geological exploration activities, draw up a technical design for the commercial development of the deposit and launch the construction of a mining facility. Mine commissioning is planned for 2016, reaching the design capacity of approximately 4.5 mln tonnes in 2018.

**Q: Will the proposed operations cover all of the NLMK Group's requirements in coal concentrate? In other words, will this make NLMK fully self-sufficient in terms of fat and coking grades of coal?**

**A:** It will cover 100% of our demand for fat coals, i.e. the Zh and GZh grades; in fact, I believe that we may have an excess supply of these and will be able to market it to third parties.

Overall, given the properties of the KZh grade, this will cover up to 60% of the Group's demand for coking coal. As regards the remaining 40%, i.e. the K grade coal and its substitutes, for the time being we intend to continue procuring them from the market.

**Q: If I understand you correctly, we don't know yet the exact answer to whether any additional coal asset acquisitions should be expected?**

**A:** On the contrary, if we see an asset that meets our requirements appear for sale, we will look into the option of acquiring it. We are open for cooperation with all market players and are willing to entertain all available opportunities for the development of our Company's coal operations.

**Q: The future development of the coal business, in my view, is predicated on more than only acquisitions of coal assets, but also on rational and efficient utilization of raw materials in the production of coke.**

**A:** You are absolutely right. As I have said earlier, we have certain ideas and proposals that would allow us to use less valuable grades of coal for coke-making purposes, without impairing the quality of coke. A lot depends on the design of the coke batteries, the opportunities for upgrading them in the best possible manner, and the suitability of processes and economics. This, as well as other topics discussed above, is now the focus of our research, and I suggest that we revisit this item once we have accumulated more applied knowledge and material regarding the conditions applicable to our businesses.

# The Possibility of the Impossible

**The AISTech 2011 Iron and Steel Technology Conference and Exposition, arranged by the American Association of Iron and Steel, was held in May.**

Traditionally this event gathers representatives from steel companies, universities and research institutions from all over the world. This year it was attended by about five thousand guests from Australia, Austria, Brazil, Canada, China, Germany, India, Italy, Japan, Korea, Russia, Spain, the United States and other countries. More than 250 presentations were made during the conference, including "A Specific Production Rate of Blast Furnaces: How to Calculate it Correctly" made by Ivan F. Kurunov, Doctor of Science, Professor, Chief Blast Furnace Expert, NLMK, and Alexander M. Tseitline, Ph.D., Vice President, NLMK Indiana. Through theoretical computation and computer simulations based on the Kurunov-Yaschenko model of the blast furnace process, and the review of performance of several Russian and overseas blast furnaces of various capacity, the presentation persuasively proves that the most objective indicator of a blast furnace's productivity is its specific productivity per hearth section area unit.

The presentation was met with keen interest and caused a lively discussion at the Ironmaking – Blast Furnace Operations technical session.

The story of how the two authors of the presentation met is also worth telling. In the early 1980s Ivan Kurunov, who was then a professor at the Department of Thermal Processes for Treatment of Ore with the

Moscow Institute of Steel and Alloys, speaking at a research workshop for department faculty and post-graduate students raised the question of how one could evaluate the effects of fuel-enriched blast, charge quality and other process factors on the productivity of blast furnaces. Alexander Tseitline, a post-graduate student at the department, was one of the participants at that workshop. Professor Kurunov continued his research in the field and some years later published an article in the University News: Steelmaking magazine and also wrote the chapter on blast furnace specific productivity indicators in a textbook on ironmaking. A little over three years ago the authors of the aforementioned presentation met again. Fate's will was to have them both employed by NLMK Group businesses. They were prompted to revisit the issue of proper assessment of the productivity of blast furnaces by the construction of BF-7, the newest and most powerful blast furnace, at the NLMK Group's production site at Novolipetsk. It is the only blast furnace to be built in Russia in the post-Soviet era, and it is the second most powerful blast furnace in the country after the famous Severyanka BF-5 in Cherepovets.

The design of Blast Furnace No. 7, construction of which is nearing completion, incorporates cutting edge engineering ideas. Running on sintered ore and pellets and using pulverized coal injection, it will have specific productivity of at least 70 tonnes per square meter per day, which is in line with the indicators for some of the most productive and fuel efficient blast furnaces in China, Europe, Japan, and Korea.

# Stoilensky Gets Second Wind

**Stoilensky's integration within NLMK has pre-defined the mining business's development strategy for years to come.** As Novolipetsk increases output of steel, Stoilensky's job will be to fully meet the demand for iron ore raw materials.

By now Stoilensky is already operating at 150% above its design capacity in terms of output and has reached a stage where further increases in output would be impossible unless new capacity is installed. Hence, the Stoilensky capital expenditure program calls for the construction of a whole range of modern facilities. The most important of these is the Pelletizing Plant which will produce something Stoilensky had never produced before, namely, iron ore pellets, at a rate of 6 mtpy. Pellets are currently procured by Novolipetsk from third-party suppliers. The plant is expected to go online in 2014, and will fully meet NLMK's demand for this raw material, even after the commissioning of the 3.4 mtpy Blast Furnace No. 7.

This will also require increased output of high quality iron ore concentrate which will be used by the new plant to produce pellets. Construction of Section IV of the Concentration Plant began in 2005. A competitive tender identified the general contractor – Metallurgstroy from Stary Oskol, and Tsentrogiproruda and Mekhanobrchermet as the two contractors responsible for project design.

"Stoilensky itself handled all of the preparatory work, i.e. developed the plot for the construction camp, installed the utility connections, installed the framework, spans and girders," comments Valery Arzhanov, Stoilensky's Chief of Capital Construction and Maintenance Department.

In January 2006 the re-preparation section was commissioned, with a capacity of 980,000 tonnes of iron ore concentrate per year. It comprises one fine grinding mill, two stages of wet magnetic separation and washing, and classification using hydrocyclones. The name of the section accurately describes its purpose, which is to provide additional preparation of concentrate for the three operating Concentration Plant sections if the process properties of ore deteriorate, in order to maintain output at existing levels.

During the crisis construction work had been temporarily suspended, but it has resumed since then. January 2010 saw the completion of Phase 1 of the Process Section IV,

which includes 2 mills, and classification and concentration equipment. A transfer ceremony was held, with red ribbon cutting and handing over of symbolic keys. After their commissioning last year the new facilities helped produce an additional 1.7 mln tonnes of concentrate. Altogether the phased-in introduction of Section IV facilities by the Plant generated about 5 mln tonnes of additional output of concentrate.

Section IV of the Concentration Plant became fully operational in April this year.

"In the future, Process Section IV is expected to provide 4 mln tonnes of concentrate with 66.3% ore content to be used by the Pelletizing Plant. Its design is based on the most recent advances in non-ferrous ore concentration. Among other things, it involves a process of both wet and dry pre-concentration of incoming ore. This will provide for separation of tailings prior to crushing and prevent excess load on the mills. By the way, secondary crushing will be handled by two mills, unlike single-mill crushing done at the three 'legacy' sections. Also, Derrick screens are used for fine screening prior to tertiary crushing, so as to separate finished concentrate and prevent it from excessive crushing. Kostomuksha is the only other mining and ore concentration operation in Russia which uses similar technology," Vyacheslav Chakov, Director of the Concentration Plant, explains the technological innovations. "The pre-concentration section is


expected to become operational in summer 2011."

One needs to understand that all the sections at the Concentration Plant are not stand-alone operations and also require raw materials. And this again involves a whole range of operations, beginning with the open-pit mine where ferrous quartzites and sintered ore are mined.

"We have installed new capacity at the pit, and are now producing 32 mtpy of ferrous quartzites. We are altering the mining transport arrangements, and are conducting stripping operations at a very quick pace," says Nikolay Churilov, Development Director for Stoilensky. "At the Pre-concentration Plant's secondary and fine crushing shop we have completed the replacement of 12 (a total of three lines) UZTM-manufactured crushers with high-performance SANDVIK crushers, and are now installing process equipment at the concentrate loading circuit. Pre-commissioning works are under way to complete expansion of the pumping station for the second lift at the tailings handling shop. In order to supply electric power to Section IV facilities a 110/6 kilowatt mains step-down transformer substation has been installed. Currently, construction operations are carried out around the clock at five project sites. The total cost of construction for Section IV facilities is more than RUR11 billion (~$362.1 mln; ~€273.7 mln). This implies that for the first time in the last two decades the raw materials base for Russia's mining sector is


now being developed again. And I am happy that our company pioneered this process.

The Stoilensky Technical Upgrade Program calls for increasing the production capacity of the ferrous quartzite open-pit mine to 42 mtpy; it also proposes to commission one additional primary crushing shop, to expand the secondary and fine crushing shop together with the commissioning of the second ore transport circuit which will supply ore, and to build Section V of the Concentration Plant. And, of course, as we have already mentioned earlier, it includes the commissioning of the Pelletizing Plant, which will produce 6 mtpy of iron ore pellets.

These projects will help achieve the key objectives under Stoilensky's second Technical Upgrade and Development Program, i.e. to ensure that it fully meets the demand for iron ore from Novolipetsk, considering the proposed increase in steel output to 12.4 mtpy; as well as to reach optimum capacity utilization levels for Stoilensky itself.

Georgy Poltavchenko, Presidential Envoy to the Central Federal District, toured the Stoilensky operations during his working visit to the Belgorod Province, and made the following comment: "The proposed project is very attractive. The Company intends to build and to introduce additional production capacity using modern technology. This is modernization in action, exactly what is required today."

**By Irina Tkacheva**

# Turning Waste into Earnings

**Forced to substitute steel scrap with iron-and-steel waste in steelmaking operations NSMMZ is now turning this into a very gainful project.**

Iron-and-steel wastes are waste products of iron and steelmaking and foundry operations, which are contaminated with slag. Waste generation was the inevitable side-effect of open-hearth furnace operations. During a heat steel may have escaped through charging doors or it may have been rejected because there was not enough of it to fill a mold, so it would have to be discarded into slag pots and then sent to a landfill. These landfills where later one would find conglomerates of slag and steel from slag pots weighing 20 or 30 tonnes became the legacy of open-hearth furnaces. During their lifetime open-hearth furnaces produced millions of tonnes of steel waste (pit scrap).

NSMMZ was no exception and it had also accumulated an immense volume of waste in its slag landfills. The landfills themselves were a period phenomenon because it was not considered necessary to recycle pit scrap. There was no advantage to it, nor was any such interest in recycling pit scrap fostered by the technological challenges involved and the pricing policy.

Driven by the call to produce as much steel for the country as possible, few would care about the environment and the fact that raw materials for metallurgy could at some point simply run out. Besides, regular scrap metal was cheap, and there was never any shortage of it. By the way, collecting scrap metal was one of the favorite pursuits of the Young Pioneers, the Soviet counterpart to the Scout Movement; back then they knew how to engage kids in productive activities. In view of all of the above there was no sense in considering the pit scrap, and no one did. Why bother, when there is a handy supply of scrap metal? “Scrap it, and we’ll collect it,” was the slogan for the Young Pioneers, and it seemed that these easy times would last forever. While in the meantime the landfills continued to grow, hurting the environment and making the land they occupied unusable for other purposes.

As foretold by some, the market economy has put a lot of things, if not everything, where it belongs. In 2007 NSMMZ ran into a major problem with supplies of scrap. This, in fact, became a challenge for almost all steelmakers during the crisis. At that point it was decided to rely on iron-and-steel waste, and this helped NSMMZ to continue its operations, while at the same time maintain its profit margin.

Iron-and-steel waste is a cheap resource at almost half the price of regular metal scrap. The costs involved include the recovery of large-sized pit scrap pieces, partial removal of slag, and transportation. Basically, the mill was getting its raw materials almost for free. The business was killing two birds with one stone by recycling the pit scrap and reducing the cost of production. NSMMZ became the first company to venture into utilizing iron-and-steel waste, and by now it is clear that it was the right thing to do.

It wasn’t all smooth sailing, of course. In order to process iron-and-steel waste in electric arc furnaces the process had to undergo major alterations. Given the special nature of the material personnel at the mill had to resolve several new challenges. Another difficulty stemmed from the fact that no one had tried this before, and it was impossible to build on someone else’s experience.

Because iron-and-steel waste contains slag elements, the first stumbling block was to prevent damage to the electrodes. Working together with process engineers, Automation Shop specialists defined the optimal electric melting conditions, and fine-tuned the ArCOS electrode control system to process iron-and-steel waste with high slag content. No less serious was the problem of burnout of copper inserts in the oxygen refining burners. The design of the

inserts had to be changed and now the plant is using combined iron and copper inserts which have increased durability.

Notwithstanding the required alterations in the process the iron-and-steel waste did not have any impact on the quality of steel. After testing, the mechanical and chemical properties of finished rolled products, which were manufactured using the new process, were found to be in full compliance with statutory requirements and export contract specifications.

Let me reiterate that the use of iron-and-steel waste helped reduce the cost of production and avoid interruptions with supplies of raw materials at the peak of the crisis. By relying on iron-and-steel waste NSMMZ managed to continue its operations at a profit even in times of reduced demand.

Special mention should be made of the most positive environmental effect of this innovation. NSMMZ was able to clear the landfills on its site. For example, in Nizhnie Sergi production waste was completely removed from the bed of the Serga River.

Novolipetsk has accumulated more than 300,000 tonnes of iron-and-steel waste, and it took NSMMZ two years to recycle it, averaging 20,000 tonnes per month.

By now NSMMZ has completely recycled all of its own pit scrap. Any new iron-and-steel waste generated today is also fully recycled.

It's quite fascinating that this raw material, which had not been considered as such by anyone until recently, seems to have started a new field in metallurgy. Businesses have emerged which develop landfills and supply iron-and-steel waste. The quality of pit scrap has also improved, and now NSMMZ obtains iron-and-steel waste with lowered slag content. Pit scrap is supplied to the mill from Zlatoust, Nizhny Tagil, Kushva, Alapaevsk and other industrial centers across the country.

In terms of volume NSMMZ is the largest consumer of iron-and-steel waste in the country and no other mill stands close. For every heat NSMMZ currently utilizes 50 tonnes of iron-and-steel waste, making a significant gain. The numbers are as follows: between 2008 and 2010 the plant has processed 803,000 tonnes of iron-and-steel waste, and the economic effect from recycling pit scrap in the two years has exceeded RUR1 billion (~$33.6 mln; ~€24.9 mln ).

**By Marina Saifieva**

## INSTALLING AN OVERHEAD CRANE

**VIZ-Stal is installing a new 22-tonne overhead crane to support the operations of four assemblies of Decarbonizing Annealing Lines.**

The new equipment will replace the old overhead crane which has been servicing No. 3 and No. 4 Decarbonizing Annealing Lines for many years and has outlived its usefulness. The 'rookie' will have a slightly larger lifting capacity compared to the 'old-timer'. Once installed, it will help improve industrial safety and ensure stable operations of the core production facility.

The cost of the project exceeds RUR23 mln (~$0.8 mln; ~€0.6 mln). ■

## MAKING NEW PRODUCTS

**Metalware Shop at the Urals Precision Alloys Plant (UZPS) is expanding its product mix.** The nail screw will be added to the three regular construction fastener products already manufactured by the plant. Production of furniture fasteners is also expected to be launched later.

In view of demand from the market the shop also intends to improve the production process in order to reduce the weight of its metalware products. Funding has already been allocated for other improvements which will involve upgrading of the Galvanizing Unit in order to provide for simultaneous zinc coating of nails and self-threading screws. ■

## TESTING THE LASER INSTALLATION

**VIZ-Stal has completed the pre-commissioning work and has started performance testing on phase two of the finished products laser treatment facility.** Once commissioned, this additional process facility will boost output of transformer (grain-oriented) steel with reduced specific magnetic losses from 30,000 to 75,000 tonnes per year.

The project is worth more than RUR247 mln (~$8.1 mln; ~€6.1 mln) and is undertaken in collaboration with the Gengroup S.R.L from Italy within the context of VIZ-Stal's comprehensive Technical Upgrade Program, which aims to increase production efficiency and to manufacture new types of products. ■

## MODERNIZATION OF ANNEALING LINES

**VIZ-Stal (Yekaterinburg) has launched the reconstruction of its two Decarburizing Annealing Lines in order to set up a process flow for mastering the production of premium transformer flats from high permeability steel (HPS). The planned capacity for this product will be around 70,000 tonnes.**

The project is being implemented jointly with LOI Thermprocess (Germany) as part of the Company's Technical Upgrade Program. Its goal is to consolidate furnaces for an integrated heat-treatment of transformer steel at the final thickness. The plan for 2011 comprises the engineering of the new line and the dismantling of the existing equipment. The overall cost of the project is expected to be approximately RUR2.4 billion (~$84.2 mln; ~€59.8 mln) and startup of the furnace is scheduled for 2013.

VIZ-Stal representatives travelled to Germany to discuss the technical details of the new project with specialists from LOI; later their foreign counterparts visited VIZ-Stal to see the proposed site for the new installation with their own eyes. ■

# Citius, Altius, Fortius!

**Translated from Latin it means "faster, higher, and stronger".** And this is exactly what any steel worker and resident of Lipetsk can achieve by going to the SportPark sports and health facility which Novolipetsk built in the woodland park area in the Levoberezhny district of the city.

SportPark will be turning two years old in July. The facility's well-planned territory and convenient infrastructure make it a comfortable place to spend the time. Its spacious and modern locker rooms are equipped with showers and infrared tanning stalls.

Another advantage of SportPark is the opportunity to engage in several types of activities, e.g. after visiting the work-out room one can go jogging in the open air, or use cardio-vascular training machines and then join a group for an aerobics session; children can attend tennis classes while their parents enjoy a game of pool, and then the whole family can go bowling.

Every month some three hundred athletes attend tennis lessons, learn how to play squash, which is quickly gaining popularity, bowling or billiards, train at the work-out or aerobics rooms, and go to the tanning parlor.

The facility has already hosted nine corporate bowling and billiards tournaments for teams from various Novolipetsk units.

SportPark devotes special attention to children. For the youngest kids, age one to seven, there is a games room and a variety of development activities. There is a dedicated group for kids who want to learn how to bowl. Schools use the facility for their Fitness Day activities. Nevertheless, traditional athletic activities are most popular with the younger generation of Lipetsk residents, and 135 of them attend tennis lessons in 15 training groups. Who knows, one of these boys or girls may in the future become the athletic pride of Russia.


PRECOR
PRECOR

# An Engineer by Training and a Photographer at Heart

**An outstanding engineer, the designer of hyperboloid towers and steel gridshells, one of the founding fathers of the modern oil industry, Vladimir Shukhov was also a passionate photographer.** Photography was more than just a hobby to him. In some strange way it is inextricably linked to every creative work of the great engineer. He would describe himself as "an engineer by training and a photographer at heart."

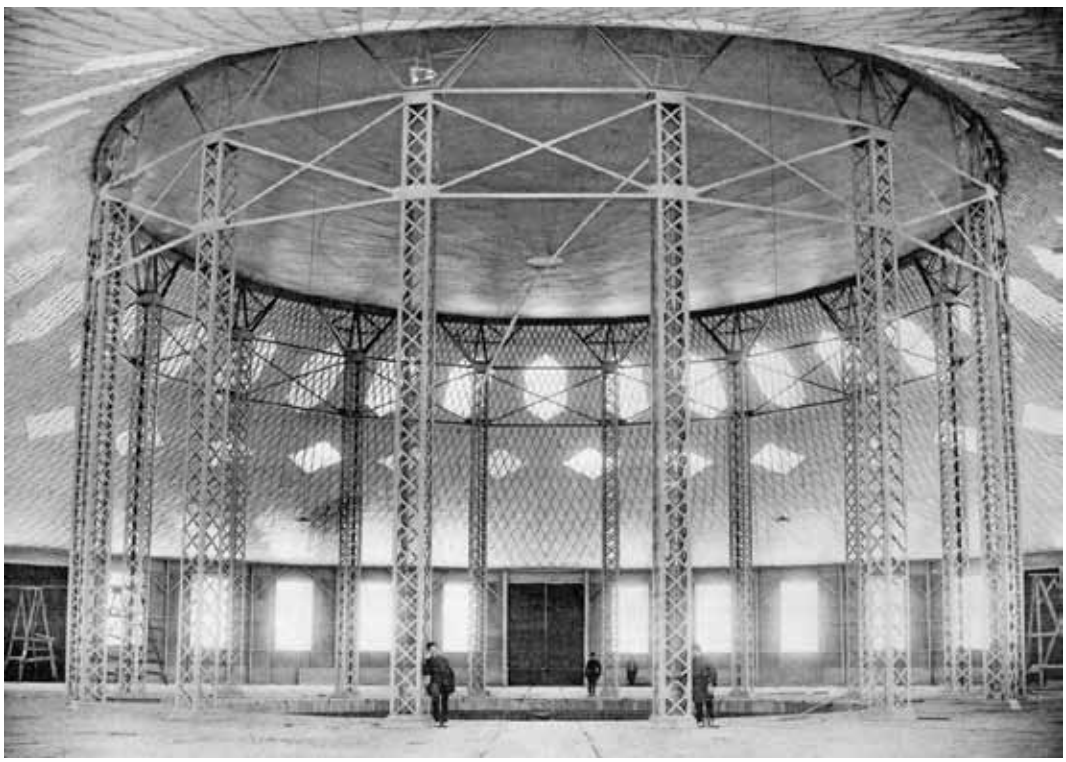
THE SHUKHOV TOWER AT SHABOLOVKA STREET IN MOSCOW

There are photographs made by Shukhov at the age of twelve, which at the time, in 1865, was a very young age for an amateur photographer. The photo cameras were cumbersome and difficult to handle. And great patience was required from a photographer; the exposition times were long and any careless movement would spoil everything.

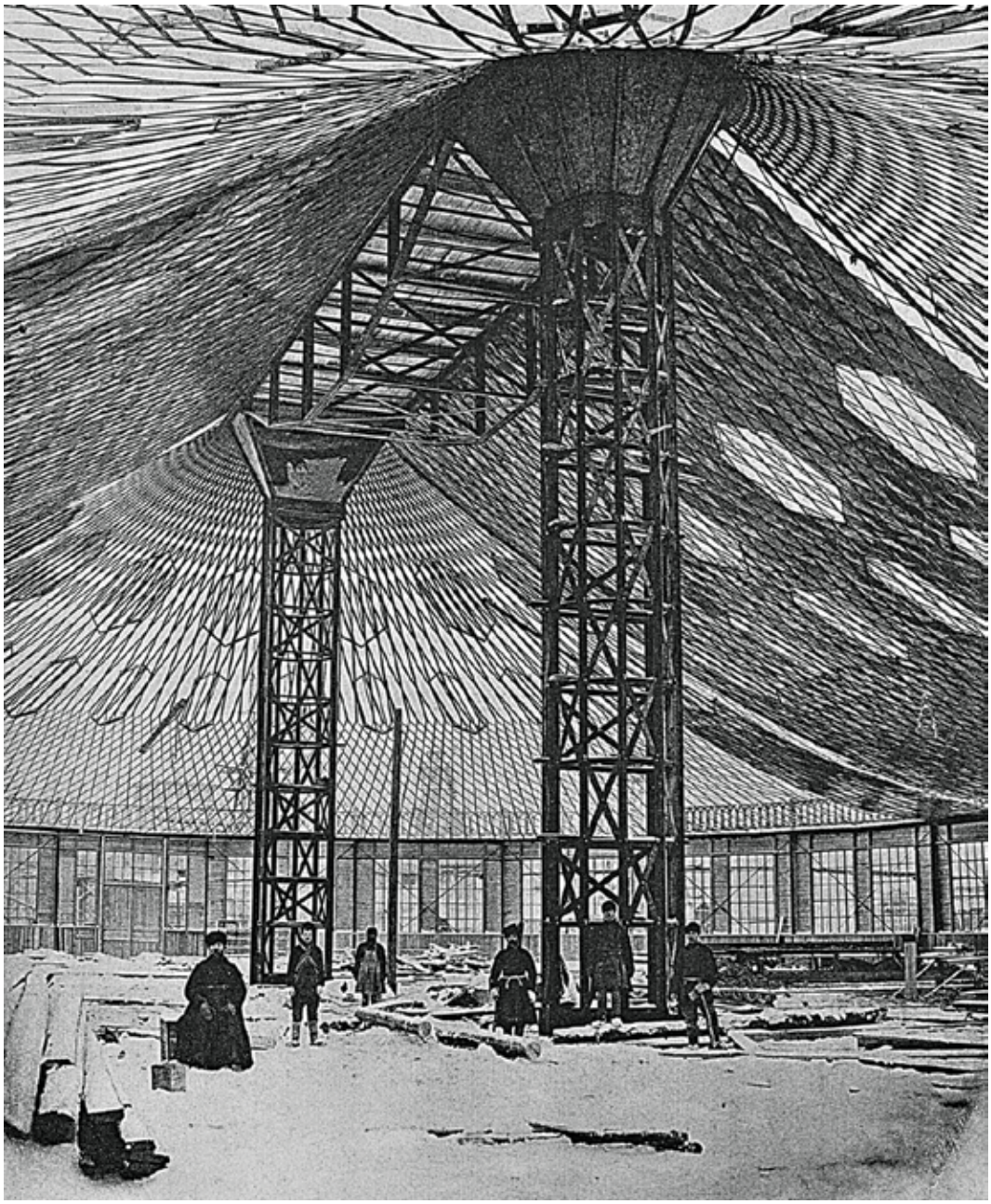
In 1871, upon advice from his father, Vladimir Shukhov entered the Imperial Moscow Technical School, now known as the Bauman Moscow Public University of Technology. The training process involved a strong combination of practical and theoretical studies. Shukhov proved to have an exceptional talent: while still a freshman he came up with an original design for a liquid fuel atomizer and built a model of it in the school's workshop. The design proved to be so good that it was later used by the industry, and Dmitry Mendeleev, the great chemist, placed its drawing on the cover of his book "The Basics of Factory Production".

Shukhov graduated from the Technical School in 1876 with a Gold Medal, several awards, the title of Mechanical Engineer, and waiver of final research paper defense because it was obvious to his tutors that he had already excelled at it.

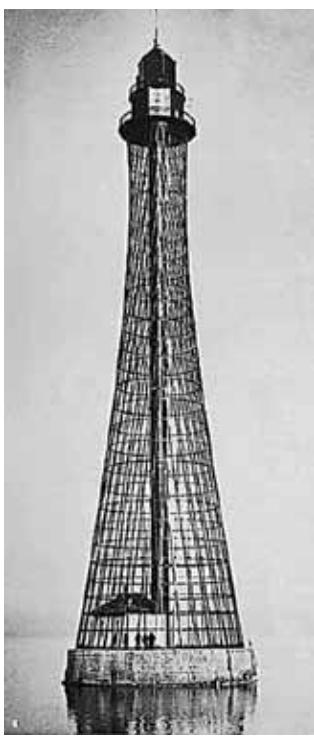
After graduation Shukhov was hired to work as a draftsman for the Warsaw-Vienna railroad. This simple and routine work was not challenging enough for



THE WORLD'S FIRST MEMBRANE ROOF MADE OF STEEL; THE SHUKHOV ROTUNDA, NIZHNY NOVGOROD, 1896



CONSTRUCTION OF THE OVAL-SHAPED PAVILION WITH A LATTICE SHELL STEEL HANGING ROOF FOR THE PANRUSSIAN EXHIBITION, 1896



THE ADZIOGOL LIGHTHOUSE, A LATTICE SHELL STRUCTURE AT THE MOUTH OF THE DNIEPER RIVER CLOSE TO KHERSON, BUILT BY VLADIMIR SHUKHOV IN 1910

the creatively gifted Shukhov, who wanted to learn as much as possible. So in 1877 he was happy to use the references provided by well-known surgeon Nikolay Pirogov, a friend of the family, and joined the Military Medical Academy as an informal attendance student. After two years of attending lectures he became strongly convinced that the most perfect structure is a living organism. Several years later Shukhov will still be guided by this conviction while designing his lattice shell buildings.

One of the rewards received by Shukhov after graduation from the Technical School was internship in the United States. During his internship he learned a wealth of new things about engineering design, and became convinced of the immense potential of modern-day technology, but that was not the most important part. In the United States he got acquainted with Alexander Bari, a Russian emigrant and young engineer and entrepreneur. This event changed Shukhov's life completely. Together the two of them would revolutionize the oil industry and architecture; in fact, many other significant developments in the history of technology would be linked to the creative collaboration of Bari and Shukhov.

Their first joint project, which helped to draw Shukhov away from the dull routine of the railroad office, involved the development of oil fields in Baku. The young engineer was involved in resolving the most challenging problems of oil production, storage and transportation for companies owned by the Nobels, and Russian entrepreneurs Lianozov and Shibaev. Among other things Shukhov designed and built the first Russian pipeline between Balkhany and Cherny Gorod.

Work in the oil industry became a true breakthrough

KIEV RAILWAY STATION TRAIN SHED, MOSCOW

HYPERBOLOID LATTICE-SHELL TOWER IN SEA-PORT OF KOBE, JAPAN

TELEVISION TOWER IN SYDNEY

SHUKHOV HYPERBOLOID 610-METER TALL TELEVISION TOWER IN GUANGZHOU, CHINA

for Shukhov and his business partner Alexander Bari. Between 1880 and the early 1900s they implemented so many projects and designed and introduced such a multitude of inventions that it would be difficult to find any area in the oil industry where their ideas had not been put to use. According to one of Shukhov's disciples "oil, lifted from the ground using Shukhov-designed pumps, was efficiently processed using Shukhov-designed oil cracking plants, then safely stored in Shukhov-designed tanks and transported without loss by Shukhov-designed tank barges, and was in a most heat-efficient manner burned by Shukhov-designed spray burners in boilers designed by Shukhov." In a decade Shukhov's star shone so brightly that it dimmed those of his many famous colleagues, and it helped turn Alexander Bari into a major businessman and millionaire.

In 1890, after winning a contest to build the new edifice for the Upper Trading Rows, currently known as GUM, Moscow's Main Department Store, Shukhov and Bari ventured into architecture. It is common knowledge that the special highlight of the design was Shukhov's proposal to install an original transparent vaulted roof which used thin steel spans instead of the traditional heavy beams.

Having successfully completed the construction of the transparent roof for the new building of the Upper Trading Rows, Shukhov continued to develop the idea of a "beamless roof". As a result, for the 1896 exhibition in Nizhny Novgorod he built a series of impressively innovative thin shell structures. These thin shells were comprised of numerous elements joined together into a single structure, and had two to three times the tensile strength of regular spans, a fraction of their weight, and were also very easy to assemble. Among gridshell structures the most prominent was the steel rotunda, currently known as the Shukhov Rotunda with the world's first membrane roof. The membrane was 25 meters in diameter and only 2 millimeters thick, and was designed as a concave sphere-like cupola. A true gem of the exhibition was the hyperboloid gridshell tower, the prototype of all future towers designed by Shukhov.

While designing his pavilions and towers Shukhov had a clear understanding of their innovative nature from a technical perspective. After studying photographs of his structures

STEEL AND GLASS ROOF DESIGNED BY SHUKHOV, GUM, MOSCOW

made by the artist Andrey Karelin, Shukhov, in his own words, learned a very simple truth that "anything that looks beautiful is durable. The human eye is accustomed to natural proportions, and what survives in nature is both durable and reasonable."

This prompted Shukhov to begin making photographs of architectural objects. There exists an immense number of photographs made by Shukhov of early 20th century Moscow, including some unique industrial structures, where Shukhov was one of the first to 'notice' their photographic allure. A photo camera became an indispensable tool for Shukhov's engineering activities. By capturing his own creations and their individual elements Shukhov would gradually elaborate them to superior perfection, which prompted Nikolay Melnikov, famous avant-garde architect, to call him "the artist in structures".

AN OLD RIVETED OIL TANK DESIGNED BY SHUKHOV AT A RAILROAD STATION IN VLADIMIR

Vladimir Shukhov was born on August 16, 1853 in the town of Graivoron to a family of local mayor. His father soon transferred to St. Petersburg to work for a government agency overseeing health institutions, and Vladimir spent a long time in his mother's manor. He attended classical schools first in Kursk and later in St. Petersburg. He then entered the Imperial Moscow Technical School. In the 1880s he was extensively involved in the construction of oil mining, transportation and processing facilities. At around the same time he settled in Moscow. In the mid-1890s he created his first lattice shell structures. During the First World War Shukhov produced new designs for underwater mines and platforms for artillery guns, and also designed floating dams for sea docks. After the Russian Revolution he cooperated with the Soviet government and again worked on projects in the oil industry. Shukhov's hyperboloid gridshell design was used to build the Shabolovka radio tower in Moscow between 1919 and 1922. It later became one of the symbols of the Soviet Union.

Later several hyperboloid towers were built on the Oka River as part of the GOELRO plan (transliteration of the Russian abbreviation for "State Commission for Electrification of Russia") to introduce wider use of electricity in Russia. In collaboration with the architect Nikolay Melnikov, Shukhov designed bridges and pipelines in various parts of the country. In 1928 Shukhov was elected corresponding member of the Academy of Sciences. His last major engineering work was the stabilization of the minaret at the Ulugh Bek madrasah in Samarkand. Vladimir Shukhov died on February 2, 1939 in his apartment in Moscow and was buried at the Novodevichy Cemetery.

# Engravings from Zlatoust and their Bicentennial History

**The coat of arms of Zlatoust displays a golden flying horse, the Pegasus, or the winghorse, as the locals prefer to call it.** This winghorse took to the air through the remarkable artistic work of legendary craftsman Ivan Bushuev. Bushuev's portrayal of two flying Pegasus horses on a sharp blade of a saber was so lifelike that he became famous all over the country and was nicknamed Ivan the Winghorse. His glory brought fame to the Zlatoust school of steel engravings.

It is true that until Bushuev and his contemporaries began to display their work, the Zlatoust engravings were nothing special.

And why expect anything else? Originally, engravings on weapons were an attempt to improve the competitiveness of products of the Zlatoust Cold Weapons Factory, founded in 1815. The factory managers invited weapons artists from Solingen, Germany, which was at the time Europe's leading center for decorating weapons, and for a long time these experienced and skilled craftsmen continued to copy well-known German designs.

The Schaffs, father and sons, were the first foreign experts

to begin developing the art of weaponry engraving in Zlatoust. Gradually, the factory developed a school of engraving art where the German craftsmen would share their trade secrets with the local workers. These included Ivan Bushuev, his brother Efim, and Ivan Boyarshinov, an outstanding artist and engraver, in other words, everyone who would improve the skills and knowledge obtained from foreigners, and make Zlatoust engravings immensely famous in the 19th century. When in 1823 Wilhelm Nikolay Schaff, the head of the Schaff clan, was handing in his resignation, among other things he wrote the following: "The original Solingen factory is unable to produce weaponry of the kind already made in Zlatoust."

The Bushuev brothers, Ivan and Efim, became true reformers and the genuine creators of the special Zlatoust technique of engraving. The classical method for engraving cold weaponry involves the use of a special needle for drawing the pattern on a surface covered with vermillion. Thereafter the pattern needs to be treated with acid or mordant. Next follows the process of gilding by fire, when the etched pattern is filled with a mixture of gold and mercury. When kilned, the mercury evaporates, while the granules of gold are 'glued together' and fill the pattern. This process was replicated ever since engraving on metal had been discovered, and that was how the Schaffs taught their apprentices to do it. Ivan Bushuev, however, turned it completely around, and the etching was now applied to the whole surface, and a brush, instead of a needle, was used to apply the pattern. This produced a very colorful and raised image. The Bushuevs also introduced another novelty to change the

traditional engraving process by using bluing and blackening to obtain the most extensive palette of colors.

But then it wasn't only technological innovation that turned Ivan Bushuev and his brother into famous engravers and living legends. There was also artistic innovation as well. Before the Bushuevs weapons would be decorated with isolated drawings in the classical style. The armorer brothers created a technique for making a continuous pattern, so that now the blade, the hilt, and even the scabbard would show a single vivid design. Also, the craftsmen from Zlatoust were the first to depict events from national history when decorating weapons. And, naturally, like many other Russian artists who had created something truly outstanding, the Bushuevs relied on the so–called Russian style, when the rich decoration of the blade was complemented with numerous details in gold, while the pattern itself was quite sophisticated and intricate.

These technological and artistic peculiarities of the Zlatoust school were displayed in their full in Ivan Bushuev's work, which may be called the pinnacle of his creative efforts, both in terms of time and in terms of their significance. In 1827 Ivan was sent to the St. Petersburg Academy of Fine Arts

HELMET; DETAIL (KNIGHT'S ARMOR). 1820-1830. STEEL, EMBOSSING, ENGRAVING, ETCHING, GILDING. BY IVAN BUSHUEV ET AL.

THE ZLATOUST FACTORY, 1910

GENERAL VIEW OF EXHIBIT ROOM IN THE ZLATOUST FACTORY ARMORY MUSEUM, 1910

in order to become a real artist. There he was introduced to the leading painters of his time and through them was commissioned by the royal family to fabricate knight's armor for the future Emperor Alexander II. After long and tedious efforts Bushuev and his colleagues created magnificent blackened armor with delicate engraved patterns, notched and embossed elements, and large-sized drawings in gold. Alexander liked this iron suit but the prince could not show it off, because by the time it was ready he had already grown out of it.

The early 19th century was the Golden Era of the Zlatoust engravings, but thereafter the craft had fallen on difficult times. There was a continuous struggle

The German craftsmen Wilhelm Nikolay Schaff and his sons, who had created the first Zlatoust engravings, retired from the Zlatoust factory and moved to St. Petersburg, where they set up their own factory. At first the Schaffs produced decorated metal items and tableware, but later switched to cold weapons for officers. The Schaffs factory remained in operation until 1914.

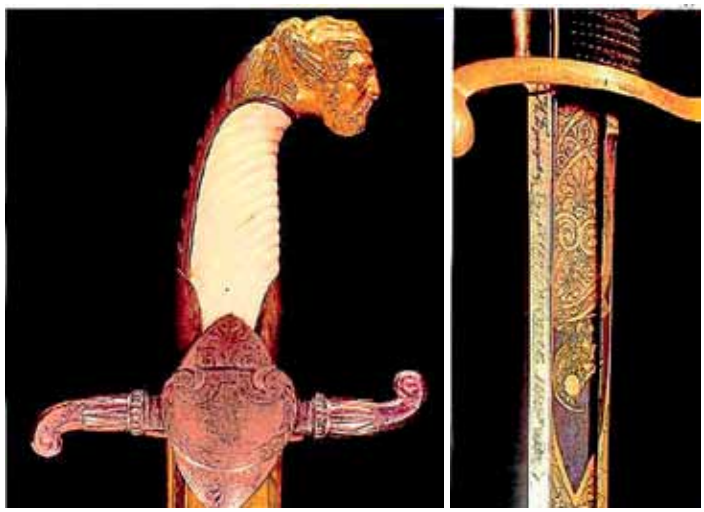
to preserve and develop the artistic legacy of the Bushuevs and other legendary craftsmen who had founded the Urals tradition of engraving. In the 1840s side-arms engraved by artists from Zlatoust fell out of fashion with the Russian military officers, and the demand for weapons produced by the local factory declined.

In the 1860s and 1870s the engraving shop at the Zlatoust factory was joined by many talented craftsmen who improved the steel engraving technique. Among other things, inlaid patterns were now used to decorate weapons and other items. A craftsman would first apply a thin, indiscernible to the eye pattern of incisions in three different directions, making the surface feel like velvet. The incisions would then be inlayed with gold or silver thread. This produced a delicate lace-like Oriental-style pattern, referred to as 'wickerwork'.

MONUMENT TO IVAN BUSHUEV IN ZLATOUST

At the same time the influence of new artistic styles had an ambiguous effect on the development of Zlatoust engravings. It was with great difficulty that the sophisticated and complicated modernist style was adopted at the turn of the 20th century. This led to the appearance of numerous purely decorative blades with ornate and tangled patterns.

The Soviet period was marked with the introduction of new processes, which simplified and improved the work of engraving artists. Even sad developments were turned for the benefit of the craft. For example, after the Civil War, given the limited availability of material for making richly decorated award blades, the artists focused on making delicate and laconic patterns. And the decline of socialist realism prompted a rethinking of past experience and the appearance of new 'stern' style, with compact, stylized and strict-looking imagery. Patterns were no longer applied to large plates, but rather to medium-sized panels, and more often to small vases, wine glasses, and steel tableware.



HILT OF A SABRE, 1824. BRONZE, IVORY, STEEL, CASTING, CARVING, ENGRAVING, AND GILDING. BY IVAN BUSHUEV

SABRE (DETAIL), 1823. BRONZE, STEEL, PICKLING, BLUING, POLISHING, ENGRAVING AND GILDING. BY IVAN BUSHUEV

ORNAMENTAL PLATE. FLOWERS. 1974. STEEL, ENGRAVING, PICKLING, BLUING, NICKEL-PLATING, AND GILDING. BY O. AVERKIN

Beginning with the 1970s and 1980s the artists at Zlatoust start to experiment extensively with style and form, producing engravings on straight, concave, and convex plates. Tableware and cold weapons are again decorated with engravings and precious metals. The designs also come in a great variety, from Oriental patterns to landscapes and illustrations. The art of Zlatoust engravings continues to develop in our times as well. ✪

Items produced by Zlatoust engravers are kept in museums in Russia and other countries. The largest collection of 200 items is stored at the Hermitage, which after the Russian Revolution assumed the collections from the Tsarskoe Selo Armory. About a hundred unique items, including those made by Bushuev, Boyarshinov, and the Schaffs are in the National History Museum in Moscow. Items produced in the 20th century are kept in the Chelyabinsk Museum of Decorative and Applied Arts of the Urals. Many items produced by contemporary Zlatoust craftsmen are found on display in the engraving shop. And the largest collection of engravings, totaling more than 600 items, is kept at the Zlatoust Museum of Local History.

# Second-Hand Metals

**Recycling of metals is of tremendous importance for the economy, helping to save an immense amount of resources and at the same time achieve a significant improvement in the quality of the environment.** This is all well appreciated in developed countries, where recycling of scrap metals is one of the core trends in the development of modern metallurgy. In Europe, America and Asia every aluminum can is put to use, sometimes in rather unusual fashions.

Recycling of metals is not a new phenomenon. Back in Ancient Rome, when it was very labor-intensive and expensive to produce metals, almost every item made of iron would be re-melted several times. Notwithstanding the fact that some two thousand years later the production of primary metals has increased colossally, the attitude towards scrap continues to remain much the same.

Scrap metal is in high demand all over the world. Global consumption of iron and steel scrap alone is estimated at about 600 mln tonnes, of which 550 mln tonnes, or almost everything, is utilized in the steel industry. In particular, in the United States, which rank second in terms of steel production worldwide, two thirds of the steel is manufactured from scrap. Things stand almost as good in the European Union countries which, taken together, consume most of the scrap in the world. Japan is also recycling itself and supplying to the international markets the lion's share of "second-hand" steel. Other leaders among scrap exporting

DISMANTLING OF SHIPS IN CHITTAGONG, BANGLADESH

countries also include Australia, Kazakhstan, and South Korea. Together with a dozen other nations they supply 5 mln tonnes of scrap metals to just one country, China. Surprising as it may sound, China, which annually produces six to seven times more steel than the United States, imports an immense amount of scrap. But then China is not the leader in this field. The largest importer of scrap is Turkey, with 18.2 mln tonnes of imported scrap last year alone.

Notwithstanding its significance for metallurgy and other industries, recycling of metals in Europe, America and Asia has reached high levels only relatively recently. Back in the 1970s Holland would only export 815,000 tonnes of used iron and steel. And back then the developed industrial Europe was a warehouse of obsolete equipment and waste from the automotive industry. Thirty-five years later this figure increased more than five-fold. It was even worse in the 1970s in Japan, where the waste, and not just from metallurgical businesses, produced a gigantic dump site. By now the Japanese are both making new steel from scrap

EMPLOYEES DISASSEMBLING OLD COMPUTERS AT THE LARGEST RECYCLING FACILITY IN TAOYUAN, NORTHERN PART OF TAIWAN

and recycling almost 99% of all materials which accompany the production of steel.

What prompted the steelmakers to shift to scrap? First was the depletion of mineral resources. Japan has never enjoyed an abundance of iron ore or coal. In Europe the deposits are also far from infinite, and many European mining companies are attempting to move their business to other countries. In Germany, for example, mining of iron ore stopped in 1987, and the last non-ferrous and precious metal mines along the famous Spanish Rio Tinto River, where mining was first started in Ancient Roman times, were abandoned in 1996.

But what is likely to be the main reason for the consistently growing demand for ferrous and non-ferrous scrap is its low cost. Even when you include the cost of collecting, transporting, sorting, and smelting one tonne of ferrous or non-ferrous metal from scrap, processing is still less expensive than the production of one tonne of primary metal. On average, today the market price of one tonne of primary metal is twice as expensive as 'second-hand' metal.

Used automobiles are considered to be the main input for the recycling industry. In the United States, for example, some 14 to 15 million cars are recycled annually, producing about 20 mln tonnes of steel. At the same time almost all new automobiles manufactured in the United States are made from recycled metal. In the European Union countries the number of recycled vehicles is smaller, but it will grow as the environmental standards continue to be upgraded. Some cars, which fail to meet the standards, Europe markets to other countries, but some of them stay within Europe and gradually turn to scrap. Over time they will be replaced with modern environmentally clean automobiles. The fleet of retired vehicles is also increasing in other countries, implying that at least one source of recyclable matter will remain.

Today passenger cars and light commercial vehicles are being successfully recycled in Canada, Japan, the United States, and in EU countries. Usually, overseas cars are recycled using the shredding technology new to Russia. Here is how it works.

First, all 'excess matter' is removed from a vehicle destined for recycling, i.e. liquids are drained, dangerous components are removed, as well as any parts which can still be marketed for spares. Then the vehicle is crushed by presses and forwarded to a shredding facility. The primary purpose of the huge shredding machines installed at these facilities is to turn the automobile into a shapeless mass of small debris. Once this is done the ferrous and non-ferrous metals are separated. Everything else is classified as shredder residue, and usually accounts for 20 to 25% of the original vehicle's weight. Shredder residue is incinerated or otherwise processed, e.g. by waste gasification, and the ferrous

MICROCHIP RECYCLING AT A BUSINESS IN GUIYU, CHINA

and non-ferrous debris are then re-melted.

Certainly, automobile recycling is more than just a showy process of destroying a vehicle. It involves a whole range of operations to collect vehicles which are no longer used.

In Europe, usually, it is the owner who is responsible for recycling and pays an extra charge for post-consumer processing when purchasing a new vehicle. The only exception is Great Britain, where it is believed that the owner owes nothing to thousands of small companies involved in vehicle recycling. And it makes certain sense, because by spending €250 or €350 to recycle one vehicle they may collect various metals worth €500 or more.

Ships which are no longer seaworthy are another traditional source of metal for recycling. However, developed industrial countries do not dismantle ships, with the exception of military vessels, because it requires manual labor which is very expensive in Europe, Japan, and the United States. Most often ships are sent for scrapping to the Indian port of Alang, the Pakistani port of Gadani, or Chittagong in Bangladesh. Here the steel from the ships is not re-melted but is immediately reprocessed into bars.

The 20th century produced a large amount of metal scrap which had never been recycled before. This includes metals which had been in contact with radioactive matter, as well as no longer usable electrical and electronic devices.

A WORKER SORTING BATTERIES AT A RECYCLING FACTORY IN WUHAN

By using special technology, metals from abandoned nuclear industry facilities can be turned into safe raw materials. The Swedish Studsvik RadWaste AB and the German Siempelkamp Nukleartechnik GmbH have made significant progress in recycling metals from nuclear power plants. They begin by sorting metals into those which can be recycled, and those which should be buried. Directional radiation is then applied to decontaminate

SORTING METAL FROM SHREDDED AUTOMOBILES IN SHANGHAI

the materials. Next follows a lengthy melting process, which produces metal ingots ready for new use. In some cases it may even be possible to recycle slag generated while melting metals contaminated by radiation. In Germany, for example, this slag is used to pave roads.

Metallic wastes from the electronics industry are safer than radioactive scrap but their recycling also poses a serious challenge. They often contain elements like lead, mercury, or palladium. At the same time, electronic waste includes millions of tonnes of various metals, predominantly non-ferrous and precious, which can be very lucrative to recycle.

Europe is especially keen on recycling metals from electrical and electronic appliances. Although it was only in the 1990s that Europe began to consistently recycle these wastes, since then the relevant industry has developed so strongly that in some European Union countries certain toxic metals, like lead, are produced exclusively from recycled waste.

Computer hardware recycling is a major issue in the United States. Previously, old hardware would simply get thrown away, contributing to huge computer dumps accumulating in China and Ghana, whereas now there are attempts to recycle it. More than 1200 companies are already involved in this business, and many states are engaged in a variety of activities to collect scrapped computers.

Nowadays, we can find ways to utilize each and every kilogram of scrap metal, sometimes in very unconventional ways. Modern-day artists and sculptors use scrap metal to create works of art, like paintings, mobile sculptures of insects, animals, people, and whole cities. Their work is yet another means of drawing attention to the state of the global environment, and reminds the world that even garbage can be used to make something valuable. And by the way, artwork made of scrap is rather expensive, and sometimes worth much more than a tonne of recycled metal. ✪

### New Trend

As recycling developed there was an increase in thefts of cables, rails, manhole covers and other items made of metals. In October 2010 a 400-kilogram bronze bell was stolen from the chapel at Roseway cemetery in Canada. In Brunei, copper cables, metallic parts and steel doors were illegally removed from 60 power substations. In order to prevent these types of criminal activities, some US states apply special identification markings on metallic items which are municipal property. If stolen, it would be impossible to sell them.