

## Analysis of strategical aspects of technology transfer in metallurgy



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#### Abstract

The article deals with the theoretical aspects of the analysis of technology transfer in metallurgy. The classification of levels of technology transfer analysis and agent-based classification of the participants in this process are proposed. It is also proposed to evaluate the effectiveness of industry development based on technology transfer in the form of a neuron.

Keywords: TECHNOLOGY PACKAGE; METALLURGY; TECHNOLOGY TRANSFER; DEVELOPMENT STRATEGY

#### Problem statement

Increasing the strategic needs of business and society significantly influences on the realization of the most important areas of scientific and technological development in the area of new materials of metallur-

gy (alloys and steels of different purposes), technologies of their production and processing.

However in the beginning of 2015, experts of World Bank in review «Global Economic Prospects» [5] noted that «drop of oil could mean the end of the»

super cycle» of increasing in raw material prices». Moreover, «raw materials» is understood as all types of raw materials which are traded on world markets, including the production of metallurgical complex.

The analysis shows that the current progress in development of metallurgy of CIS countries is caused by several losing the advantage of position. In this case the most important indicator of development is the maintaining and expansion of export industry opportunities at the same time can be specified as the high level of competitiveness of metallurgical industry in foreign markets, but also on the cost advantages due to the low share of so-called “strategic costs” [1].

Substantial savings for energy carriers, understated the cost of labor, savings on ecology and understated depreciation. In terms of cost reduction the domestic product meet the demand on international market, but the prospects of development of each position lead to their rise in price, which ultimately will lead to costs increase.

At the same time global trends such as the continuing consolidation, “migration” of production to countries with lower costs, increasing of operational efficiency and processes standardization lead to global metal prices decrease, which affects for the enterprises efficiency. Therefore metallurgical companies bring to the forefront the problem of optimizing costs and improving the efficiency of production. According to this we believe that the technological aspect is a key factor and as the tool of technology system development we offer to consider the technology transfer [1; 3; 4; 7].

The aim of the article is to analyze the strategic aspects of technology development of metallurgical industry based on technology transfer and to develop of theoretical and methodological foundations of its analysis. To solve this task in the article system approach for the analysis of the relationship between technologies and the theory of neural networks for characterization factors for the development of industry technologies at the micro level are used.

### **Main material**

Considering that metallurgical enterprises in average are in operation 40 years or more, the development of technological systems of metallurgical industry we propose to consider in the context of evolutionary strategy as the main objectives of innovative developments implementation in industry can be considered as the improvement and modernization of already functioning enterprises and equipment used on them. The analysis of existing research and strategic documents has shown that this aspect insufficient attention is paid.

According to experts [1] from the end of the 1990s in global metallurgical industry successful restructuring occurs that includes four elements:

- accelerated consolidation of assets (intra-regional and international);
- privatization of loss-making state-owned assets;
- reorientation of most steel companies for high-tech products production;
- modernization of steel capacity in China, India and the CIS countries.

Potential international mergers and acquisitions contributes the desire of manufacturers from developed countries use facilities in low-cost countries for the production of high value added products, which requires the implementation of technology transfer. At the same time we also can expect the increase of demand for high-quality metal from such important customers as the automotive industry and production of household appliances, which also rapidly transferred to low-cost countries.

The leading factor of these trends is technological one that provides impact on the cost changes in each unit of technological chain to obtain a commercial product. Modern metallurgical production is characterized by complex circuits of processing the source material. Therefore we must also consider results of foresight studies which have identified list of future priorities of ferrous (technology change in the physical structure of ferrous metals, removal and recycling of solid waste) and non-ferrous (release technology start-up of nanostructured hard alloys, technology of computer prediction properties, simulation and implementation of modern high-performance production processes) metallurgy.

In the analysis of technological development in the context of the above mentioned industry trends it should be noted that there is “no-return point” and “inappropriate point” when there is no sense of innovative processes implementation. Therefore in the context of the analysis of technology transfer in metallurgical industry we propose to consider system and fragmented innovation.

System innovations involve a radical re-engineering of existing technology package, which leads to the actual creation of new production (construction of new plant). For example, metal smelting technology without using of blast furnaces is actively developed. In turn the specialized innovations provide a specific technology changes or changes of management process (or groups of process) within the technology package. For example, a dry gas purification system for oxygen converters LD provides a reduction of power consumption to 50% compared with the tech-

nology of wet gas purification, reducing operating costs by reducing losses at low pressure, there is no need of processing waste water and sludge.

When the main objective is the transition to more sophisticated product mix production there are technical difficulties that can't be solved simply by changing one of the technological system parameters. In this case you have to change the entire production chain from raw materials to production quality. For example, the quality of steel and solidification process in the continuous casting ingot must strictly conform to specify the parameters for possible influence for the mechanical properties in the rolling process. So the competences of the company should covers both the technology and the equipment for the entire value chain from the needs raw materials to liquid phase and ultimately to the finished product. This applies not only for metallurgy and technologies, but also for the engineering of appropriate mechanical equipment as well as experience in the electrical and automation field.

Technological development strategy of metallurgy we offer interconnected consider at following levels:

1. Micro level – intracorporate technology transfer. In conditions of market relations the innovative development of metallurgical industry enterprises should mainly rely on own investment resources (depreciation and part of net income that companies can direct to investment providing of innovations) which is caused by current economic situation.

2. Industry level: establishing relations between metallurgists, when, for example, the space metallurgy technologies can even in case of incomplete using of their potential give significant effect for relatively traditional metallurgy areas. The lack of such interaction is harmful for industry because one group of technologies could give benefits for others.

3. Macro level. The strategy provides the formation of unified industrial-technological platform for development, production and use of materials and technology of metallurgy, including designing products for various industries. In this context the widespread involvement of the results of fundamental and fundamentally-oriented research institutes of the national academies of sciences, public research centers and institutions of higher school for solving strategic scientific, technological and industrial problems is actual.

We underline that the long-term cooperation between the manufacturers and developers of technologies helps both parties to keep production processes up to date and implement new standards.

In the analysis of technology transfer at sectoral

and micro levels we propose to consider it as a multi-agent process and so it can be analyzed as a set of different flows between agents. Formalization of technology adoption task under existing restrictions can be considered on the basis of such main agents and flows:

– TD – technology developers. DT – developed technological solutions.

– PT – manufacturers of equipment. T – technological equipment, transmitted over technology transfer.

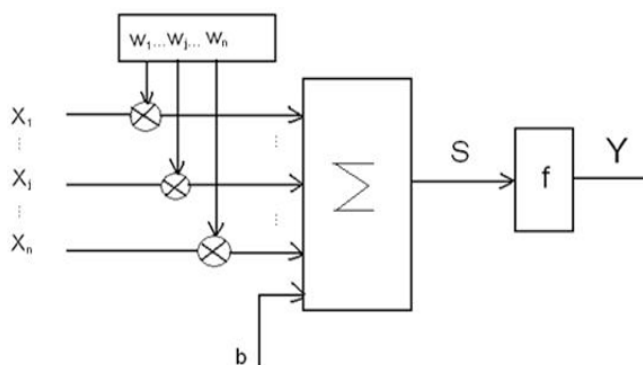
– D – equipment distributors. E – samples of the equipment passed through the channels of technology transfer.

– PrM – producers of raw materials. M – raw materials for the equipment which is transferred through the channels of technology transfer.

– CG – goods and services. C – final consumers of goods and services.

This list can be significantly expanded according to the degree of technology complexity. The integration of these groups of agents within the innovation network [6] will implement the principle of technological platform in developing of strategic plans for research and development in the field of alloys and steels of different function, technologies of their production, processing and implementation with the help of all stakeholders; attracting additional public, corporate and private financial and other material resources to carry out the necessary researches and developments.

The mathematical model for evaluating the effectiveness of technology transfer can be represented as a neuron circuit structure (Fig. 1), in which we can evaluate the influence of input vector of technology transfer on existing technology package.



**Figure 1.** The technological system as a neuron

where  $X_i$  ( $i = 1, \dots, n$ ) – component of the input vector (input) – incoming technological and supported financial and information flows;  $n$  – number of neuron inputs (number of technologies and channels

of technology transfer);  $W_i$  ( $i = 1, \dots, n$ ) – weights of neuron adjusted during development (criticality level of inputs);  $b$  – neuronal bias which is entered to initialize the network (changes in the technological scheme); it is connected to the immutable entry  $b = +1$  (initial state of the neuron);  $S$  – adder (determines the result of the summation);  $f$  – non-linear transducer (activation function), i.e. perception of the degree of innovation adaptation in technology package;  $f$  – non-linear transducer (activation function), i.e. degree of innovation perception, which shows that potential of innovation (innovations) could be increased or reduced;  $Y$  – output signal the neuron is defined as competitiveness at different levels (company, products).

So the model of the formal neuron of technology system can be shown as:

$Y = f(S)$ , where  $S = \sum W_i * X_i + b$ , then  $Y = f(\sum W_i * X_i + b)$ .

Thus the technological system as neuron is described by the weights of importance  $W_i$  and transfer function  $f(S)$ . After receiving a set of indicators of factors (vector)  $X_i$  as inputs the result is an integrated indicator of technological system ( $Y$ ).

In assessing the technology transfer effectiveness we must also consider that the most significant effect is given as a result of complex using (synthesis) of technologies, which combines the development in the field of intelligent modules micromechanics, materials science, nano- and bioengineering and others that will broaden the range of products and production of new metals with special properties.

### Conclusions

The character and pace of changes of international metallurgical markets point for producers to the need of rethinking their business and technology strategies. The acceleration of scientific and technological development of industry is possible on the basis of new information technology capabilities, as well as the best available technology. For ensuring the effectiveness of technology transfer for metallurgical companies necessary to carry out large-scale reforms aimed to improve the sustainability of business models, implementation of project and investment management, optimization of processes and systems for continuous improvement.

Modern metallurgy development is result of a number of innovations interaction and is based on complex inter-sectoral transfer of technologies, which continues rapidly develop nowadays. The main tasks

of technology transfer management must be realized as part of business strategy and implementation of different types of innovations (specialized (sectoral) or (and) e.g., technologies of lean production) and continuous improvement with a proven economic and social benefits.

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