



DATA-CENTER AUTOMATION

# EFFECTIVE DIGITALIZATION

OBJECT RELATIONS TECHNIQUE  
FOR MANUFACTURING DATA MIND (ORT MDM)



DATA-TRACK



EXPERT BASE



DATA-PLAN

I N D U S T R Y 4.0

D I G I T A L I Z A T I O N

C O M P U T E R V I S I O N

C O N T I N U O U S  
I N T E L L I G E N C E ( C I )

**DATA CENTER AUTOMATION HAS BEEN A PROVIDER OF INNOVATIVE SOLUTIONS AND DEVELOPMENTS IN THE FIELD OF DIGITALIZATION AND AUTOMATION OF PRODUCTION USING ARTIFICIAL INTELLIGENCE, TECHNICAL VISION AND PRODUCTION ANALYTICS SINCE 1993.**



- 1993 – The STARC (Statistics, Analysis, Recognition, Clustering) system was developed and delivered by DATA-CENTER Automation for the German company "Parsytec" GmbH.
- 2004 – The project for the reconstruction of the automated control system of continuous casting machines was implemented at the Magnitogorsk Iron and Steel Works. The "Digital twin" technology was applied. This project got the Award of the Government of Russia in the field of science and technology in 2004.
- 2008-2010 – The Automated Process Control System "Technology" at Severstal PJSC, Cherepovets Steel Mill. More than 7000 data source systems, real-time data analytics and research, control of production processes across the enterprise were implemented.
- 2012-2019 – Participation in the project to deploy an end-to-end MES at the Cherepovets Steel Mill (in cooperation with Danieli Automation and Quintiq).
- 2015-2018 – Implementation of the MES in the continuous smelting department, hot rolling production and long product rolling of ArcelorMittal Temirtau branch (together with Ausferr).
- 2020-2022 – Implementation of the MES for the hardware production of NLMK-Metiz LLC.
- 2020-2021 – Installation of a system for optimizing dispatching and logistics in the converter shop No. 2 of the Novolipetsk Steel Plant, the city of Lipetsk.
- 2020-2022 – Implementation of a project for end-to-end digitalization at the Abinsk Electro-Metallurgical Plant as part of the national program "Digital Economy 2024".

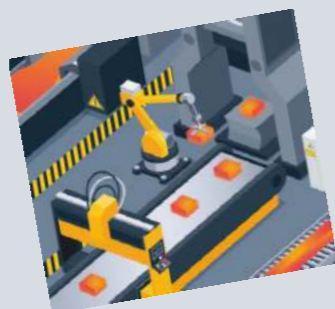
# CHALLENGES OF GLOBAL DATA-DRIVEN ENTERPRISE MANAGEMENT.

The data of an enterprise is closed inside a large number of automation and digitalization systems. Models and data formats are determined by the business process of the production site and are therefore specific to each system.

If there is a need to analyze production when the data is contained in several systems, then the analytics process becomes costly:

- Data from different systems are uploaded to EXCEL tables.
- The data is brought together in a single table.
- Data is processed in MATLAB or STATISTICA packages.
- A research report is made up in the WORD package.
- The report is sent by mail.
- A decision is made to change the rules of production or clarifying questions are asked, as a result of which the whole process is repeated.

Data-driven management is constantly interrupted to move between systems. It's like transporting blanks between different enterprises instead of processing them on a single conveyor.



# SOLVING THE PROBLEM OF GLOBAL ENTERPRISE MANAGEMENT BASED ON DATA.



EXCERPT FROM FORBES MAGAZINE 2017:

"Analytics that are disconnected by separate modules, separate tasks and separate teams with specialized skills steal time away from what matters most today – which is timely nonstop information from all your data."



DATA-TRACK



EXPERT BASE



DATA-PLAN

TO SOLVE THE PROBLEM OF GLOBAL DATA-DRIVEN MANAGEMENT, THE ORT AND THE PLATFORMS CREATED TO IMPLEMENT THIS APPROACH ARE USED:

The DATA-TRACK platform transforms the flow of production data to a universal ORT model of their representation, common for any production module and any production task, regardless of the subject specifics and business process. Data processing is no longer separated by modules and specific data formats.

The EXPERT BASE platform is used to extract information from a single production data without IT specialists, which will ensure continuous data processing from statistical calculations to layout and publication of research results or alienation of intelligent assistants.

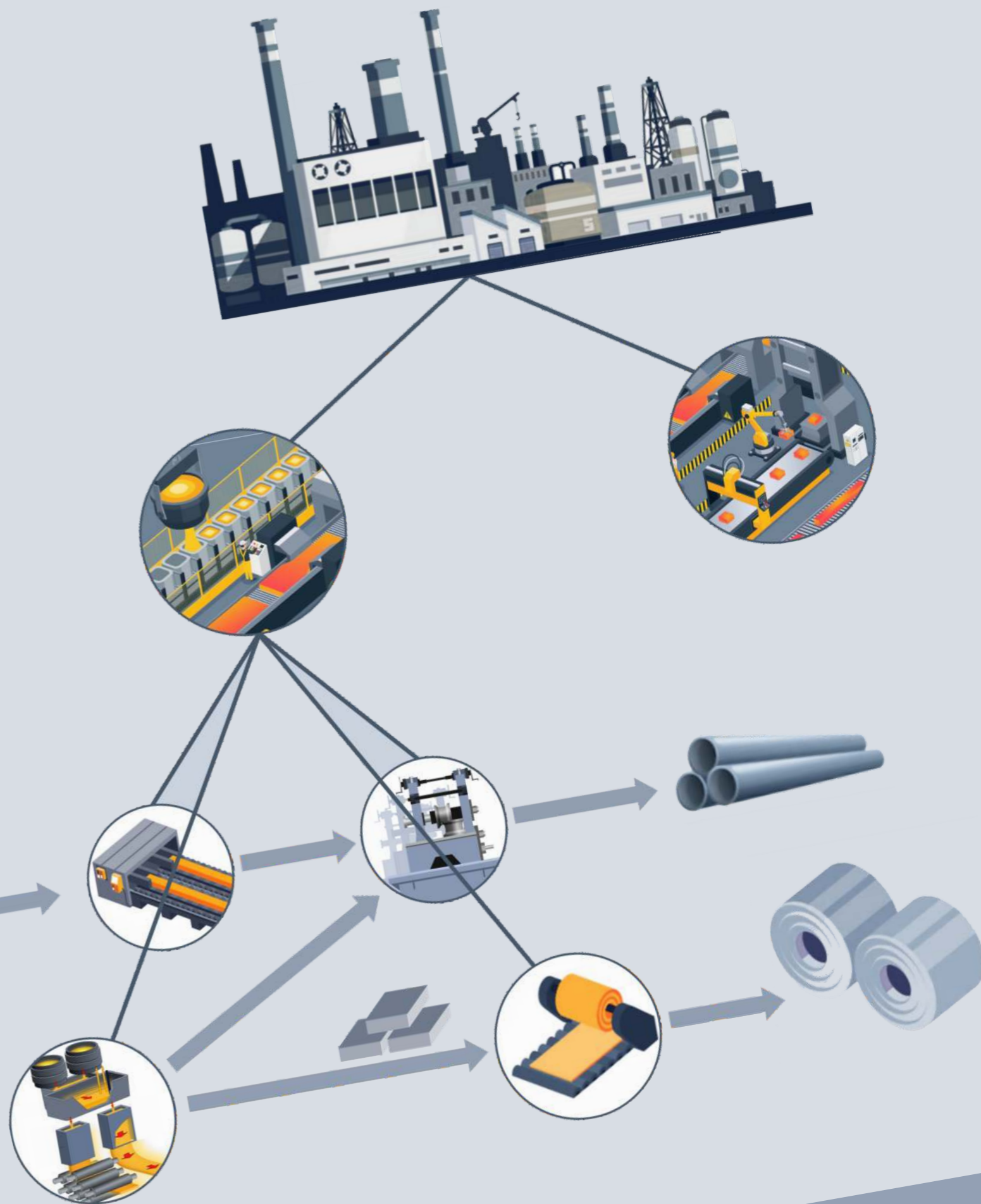
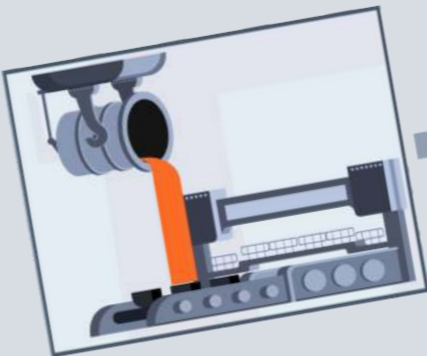
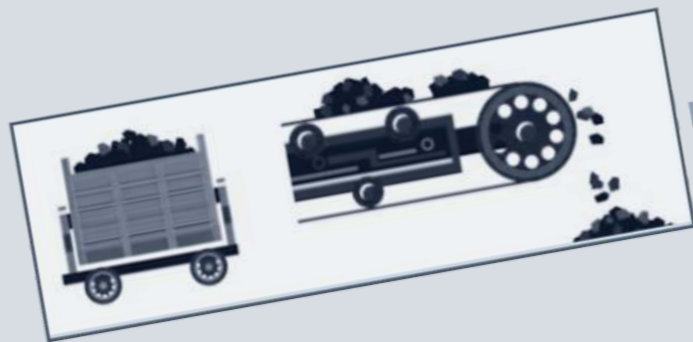
DATA - PLAN platform for optimization and management, working on single global ORT data.



# UNIFIED PRODUCTION DATA MODEL. OBJECT RELATIONS TECHNIQUE (ORT).

ORT, INSTEAD OF DESCRIBING BUSINESS PROCESSES, INTRODUCES THE DESIGNATION OF OBJECTS TO WHICH THESE PROCESSES ARE DIRECTED. IN THIS CASE, PRODUCTION IS REPRESENTED BY A FLOW OF OBJECTS THAT, UNDER THE INFLUENCE OF PROCESSES, CHANGE PROPERTIES AND ENTER INTO RELATIONS WITH EACH OTHER (OBJECT RELATIONS TECHNIQUE), WHICH MAKES IT POSSIBLE TO INTRODUCE A UNIFIED DATA DESCRIPTION MODEL.

- An object is any production entity to which the efforts, attention, desire and will of the business are directed.
- Objects enter into relationships with each other through the formation of links. For example, the object "shop" is associated with the objects "processing centers" or "aggregates".
- Transformation of the object during production forms a connection, for example, a hot-rolled coil is connected to the slab from which it is rolled, and the slab is connected to the smelting.
- The processing of an object on the unit forms a connection, for example, a slab is connected to a furnace in which it was heated. Connections can occur at certain time intervals, these events are logged.
- Processing an object on the unit changes the properties of the object, the properties of the object are logged as object parameters, for example, "heating temperature in the furnace zone" for a slab.





# HISTORY OF SUCCESS. EFFECT DUE TO UNIFIED DATA OF THE ENTERPRISE IN TERMS OF TIME.

Tracking of products and material flows  
of the enterprise.



Severstal



Global analytical system based  
on big data.



Optimal operational planning.



Quality analysis and optimization of technological  
processes.

Severstal



АЭМЗ

Our 30 years of experience in building data-driven production  
management systems has shown that the described approach  
does not depend on the subject specifics for solving any  
digitalization tasks, for example:

Creation of a single source of data for all links  
of digitalization (single source of truth).

Severstal



АЭМЗ

Building smart assistants and prompters.



Creation of global BI systems.



АЭМЗ

Creation of MES.



АЭМЗ



# PLANNING, OPTIMIZATION AND DISPATCHING OF CONVERTER PRODUCTION.

## PRODUCT TRACKING AND OPTIMAL PLANNING.



### WORK RESULTS

Converter production produces 10 million tons of steel per year, which is 14% of all steel produced in Russia. The project received the RB Digital Awards 2021 and awards for the best cases in the field of digital transformation in the Production category. Siemens star 4.0 digital industrial innovation competition award in the Reduced lifecycle cost nomination.

### ECONOMIC EFFECT

- Saving resources and materials up to 100 million rubles per year.
- Optimal long-term and operational planning.
- Production tracking.
- Online monitoring planned and actual data.
- Online rescheduling.



# CONVERTER PRODUCTION. DIGITAL ADVISER. FILLING RECOMMENDATION.

**Поступающие ковши**

| №  | 12.40 | № выпуска | 2978 | Дп 7 | 37   | 36   | 35   | 34   | 33   |
|----|-------|-----------|------|------|------|------|------|------|------|
| №  | 40    | 39        | 38   | 37   | 36   | 35   | 34   | 33   |      |
| т  | 100   | 100       | 100  | 100  | 100  | 100  | 100  | 100  |      |
| Мn | 0,32  | 0,32      | 0,32 | 0,32 | 0,32 | 0,32 | 0,32 | 0,32 | 0,32 |
| Si | 0,55  | 0,55      | 0,55 | 0,55 | 0,55 | 0,55 | 0,55 | 0,55 | 0,55 |
| S  | 0,15  | 0,15      | 0,15 | 0,15 | 0,15 | 0,15 | 0,15 | 0,15 | 0,15 |

12.40 № выпуска 2978 Дп 7 37 36 35 34 33  
т 100 100 100 100 100 100 100 100 100  
Мn 0,32 0,32 0,32 0,32 0,32 0,32 0,32 0,32 0,32  
Si 0,55 0,55 0,55 0,55 0,55 0,55 0,55 0,55 0,55  
S 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15

12.40 № выпуска 2977 Дп 7 37 36 35 34 33  
т 100 100 100 100 100 100 100 100 100  
Мn 0,32 0,32 0,32 0,32 0,32 0,32 0,32 0,32 0,32  
Si 0,55 0,55 0,55 0,55 0,55 0,55 0,55 0,55 0,55  
S 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15

**Отработанные ковши**

| №  | 12.40 | № выпуска | 2974 | Дп 7 | 37   | 36   | 35   | 34   | 33   |
|----|-------|-----------|------|------|------|------|------|------|------|
| №  | 40    | 39        | 38   | 37   | 36   | 35   | 34   | 33   |      |
| т  | 100   | 100       | 100  | 100  | 100  | 100  | 100  | 100  |      |
| Мn | 0,32  | 0,32      | 0,32 | 0,32 | 0,32 | 0,32 | 0,32 | 0,32 | 0,32 |
| Si | 0,55  | 0,55      | 0,55 | 0,55 | 0,55 | 0,55 | 0,55 | 0,55 | 0,55 |
| S  | 0,15  | 0,15      | 0,15 | 0,15 | 0,15 | 0,15 | 0,15 | 0,15 | 0,15 |

12.40 № выпуска 2974 Дп 7 37 36 35 34 33  
т 100 100 100 100 100 100 100 100 100  
Мn 0,32 0,32 0,32 0,32 0,32 0,32 0,32 0,32 0,32  
Si 0,55 0,55 0,55 0,55 0,55 0,55 0,55 0,55 0,55  
S 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15

12.40 № выпуска 2973 Дп 7 37 36 35 34 33  
т 100 100 100 100 100 100 100 100 100  
Мn 0,32 0,32 0,32 0,32 0,32 0,32 0,32 0,32 0,32  
Si 0,55 0,55 0,55 0,55 0,55 0,55 0,55 0,55 0,55  
S 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15

12.40 № выпуска 2972 Дп 7 37 36 35 34 33  
т 100 100 100 100 100 100 100 100 100  
Мn 0,32 0,32 0,32 0,32 0,32 0,32 0,32 0,32 0,32  
Si 0,55 0,55 0,55 0,55 0,55 0,55 0,55 0,55 0,55  
S 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15

12.40 № выпуска 2971 Дп 7 37 36 35 34 33  
т 100 100 100 100 100 100 100 100 100  
Мn 0,32 0,32 0,32 0,32 0,32 0,32 0,32 0,32 0,32  
Si 0,55 0,55 0,55 0,55 0,55 0,55 0,55 0,55 0,55  
S 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15 0,15

**ЧВК в обработке**

11 рельсовый путь 2975 30,15 30,55 Мn 0,32

| № к | 78   | 16   | 25   | 35   |
|-----|------|------|------|------|
| т   | 100  | 100  | 100  | 100  |
| Si  | 0,55 | 0,55 | 0,55 | 0,55 |
| S   | 0,15 | 0,15 | 0,15 | 0,15 |

12 рельсовый путь 2976 30,15 30,55 Мn 0,32

| № к | 86   | 18   | 45   | 96   |
|-----|------|------|------|------|
| т   | 100  | 90   | 100  | 100  |
| Si  | 0,55 | 0,55 | 0,55 | 0,55 |
| S   | 0,15 | 0,15 | 0,15 | 0,15 |

**Рекомендации наливов**

| ЧЗК № | Si   | S    | Факт раск. т/т | План т/т | Факт весы т/т |
|-------|------|------|----------------|----------|---------------|
| 1     | 0,55 | 0,15 | 302            | 290      | 301           |
| 3     | 0,55 | 0,15 | 302            | 300      | 305           |
| 96    | 0,55 | 0,15 | 302            | 300      | 300           |

| ЧЗК № | Среднее значение    | Факт раск. | План | Факт в. |
|-------|---------------------|------------|------|---------|
| 4     | 30,15 30,55 Мn 0,32 | 298        | 300  | 299     |
| 4     | 30,15 30,55 Мn 0,32 | 296        | 300  | 299     |
| 4     | 30,15 30,55 Мn 0,32 | 298        | 300  | 299     |
| 4     | 30,15 30,55 Мn 0,32 | 298        | 300  | 299     |
| 4     | 30,15 30,55 Мn 0,32 | 298        | 300  | 299     |

**График производства 18.06**

| Заказ     | УПС | Б  | Маршрут | План т/т |
|-----------|-----|----|---------|----------|
| 243542070 | 6   | 15 | АПК     | 300      |
| 243542070 | 7   | 15 | АПК     | 300      |
| 243542070 | 6   | 15 | АПК     | 300      |
| 243542070 | 9   | 25 | АПК     | 300      |
| 243542070 | 9   | 25 | АПК     | 300      |
| 243542070 | 9   | 25 | АПК     | 300      |

| Заказ     | УПС | Б  | Маршрут | План т/т |
|-----------|-----|----|---------|----------|
| 243542068 | 6   | 15 | АПК     | 290      |
| 243542068 | 6   | 15 | АПК     | 290      |
| 243542068 | 6   | 15 | АПК     | 290      |

| Заказ      | УПС | Маршрут |
|------------|-----|---------|
| 2435542066 | 6   | АПК     |
| 2435542066 | 6   | АПК     |
| 2435542066 | 6   | АПК     |
| 2435542066 | 6   | АПК     |
| 2435542066 | 6   | АПК     |







# END-TO-END CONTROL AND PRODUCTION MANAGEMENT.

GLOBALTRACKING, MES, GLOBALBI.

## WORK RESULTS

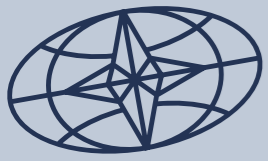
End-to-end management and real time control of the entire production from the loading of materials to the release of finished products make it impossible to hide problems.  
Digital twin of production and end-to-end product passport.  
Optimization of the technological process based on the analysis of the collected information.

## ECONOMIC EFFICIENCY

Economic indicators of the project:  
The NPV of the project for 5 years will be 560.0 million rubles.  
Payback period < 5 years.  
Project IRR – 41%.

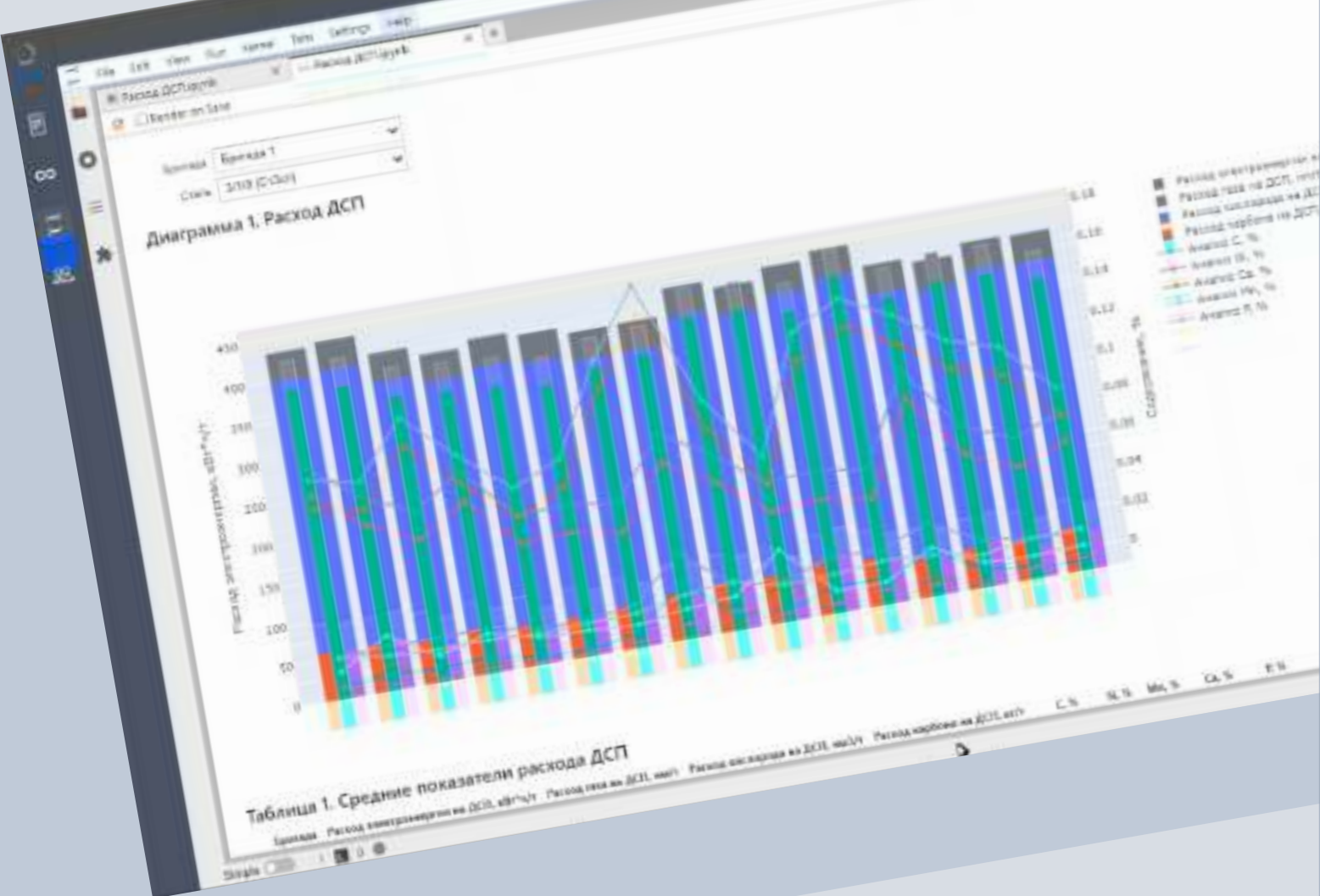
Achieved through:  
Growth in labor productivity by 10%.  
Growth in energy efficiency by 20%.  
Reduce downtime by 15%.





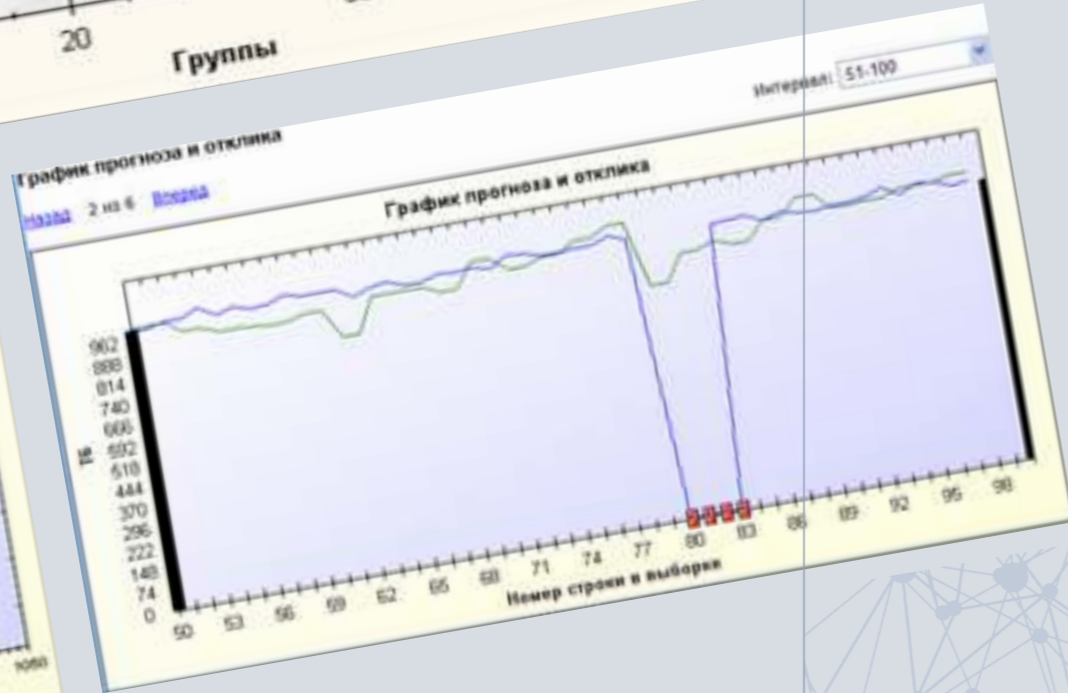
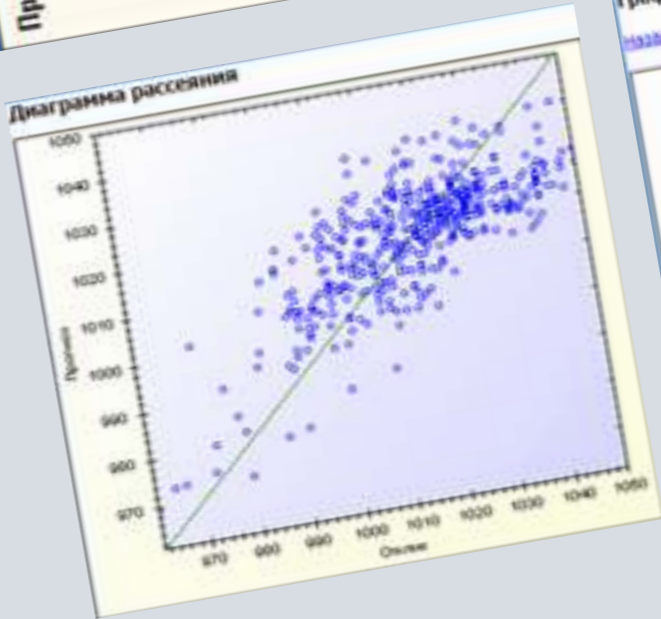
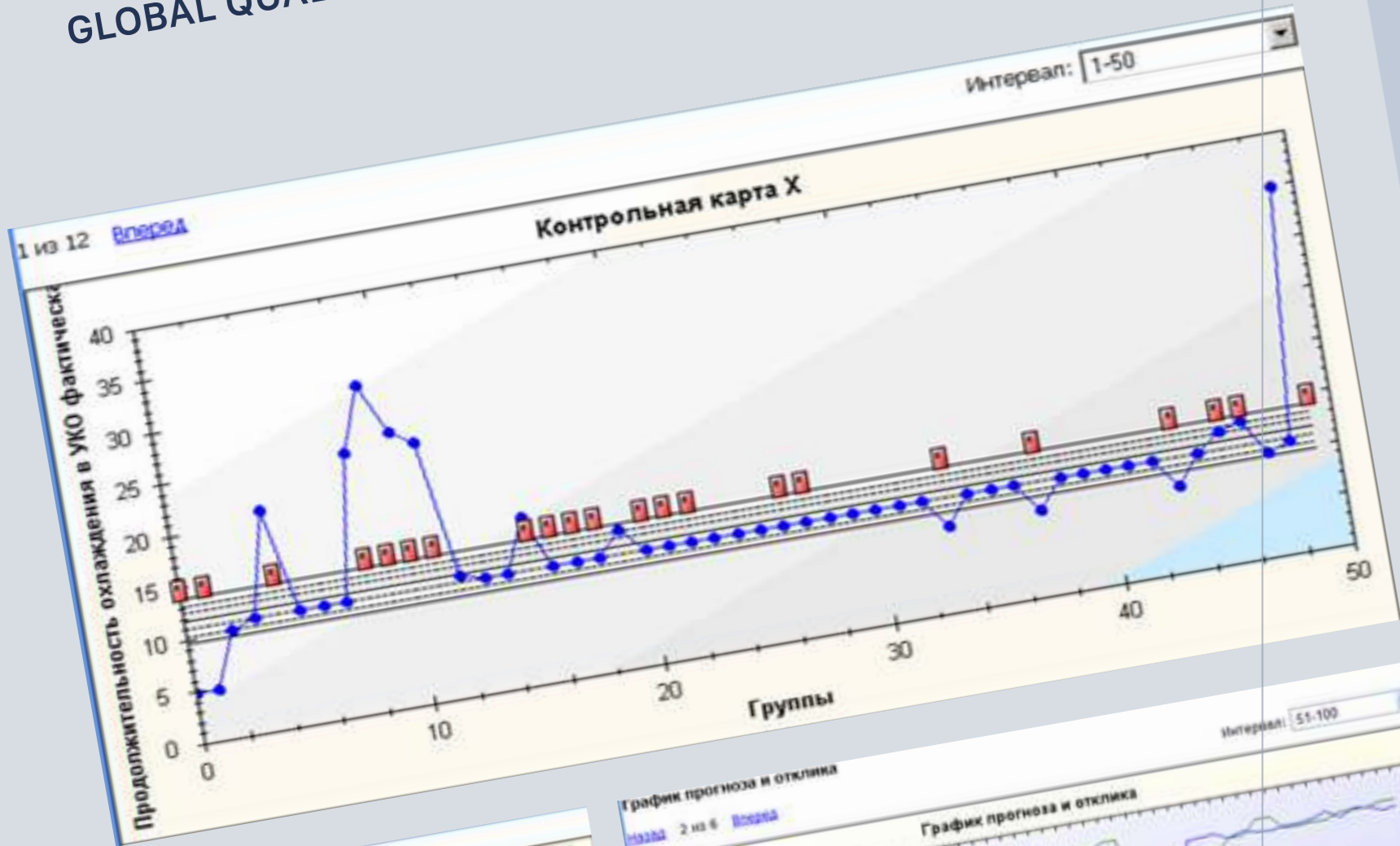
# AEM3

## GLOBAL ANALYTICAL SYSTEM OF THE ENTERPRISE LEVEL.



For data analysis, samples are formed in the system, calculation algorithms are selected, research reports are made up, dashboards are formed, reports are laid out in the enterprise network. The data processing pipeline operates continuously. Data across the whole enterprise is taken from a single source. To solve the problems of analysis, there is no need to turn to other systems.

# AUTOMATED PROCESS CONTROL SYSTEM "TECHNOLOGY". GLOBAL QUALITY AND DECISION-MAKING ANALYSIS.



## WORK RESULTS

Collection of current processing parameters from basic automation systems on a plant-wide scale.

Registration and binding of technological parameters to a unit of production at a through processing stage.

Formation of qualitative and quantitative characteristics of manufactured products.

Automation of the collection of information about the operation, shutdowns, modes and technological interruptions in the operation of the equipment, including their duration.

Creation of an object end-to-end data warehouse for global analytics.

## ECONOMIC EFFECT

The economic effect was declared by Severstal PJSC to be more than 180 million rubles per year.

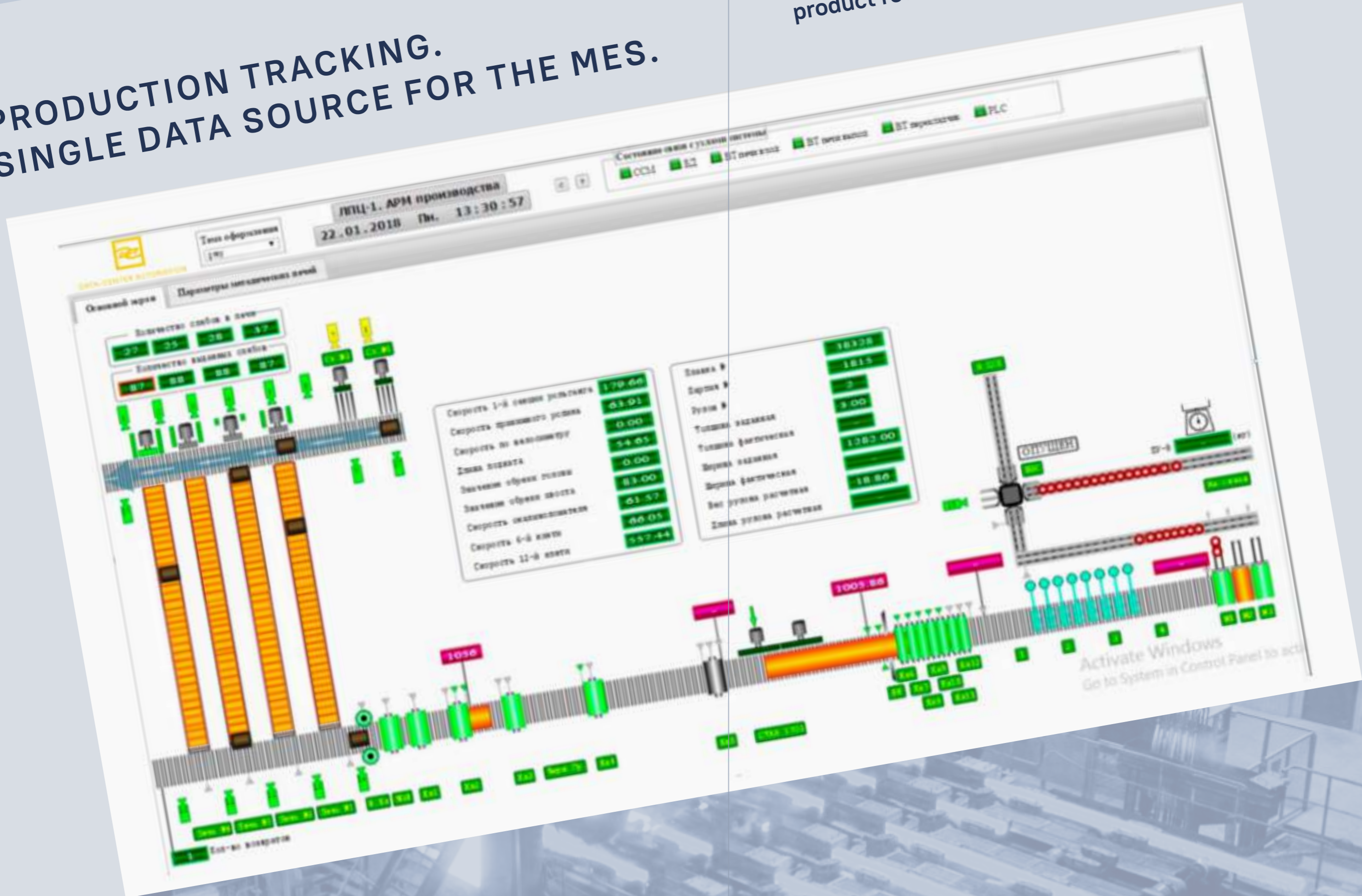
Magazine "STEEL". – M., 2015. – No. 1. – P. 88–92.

Continuous seamless extraction of meaningful business results from the entire set of data, regardless of the boundaries between systems, allows to receive continuous, high-frequency, intuitive information.



# PRODUCTION TRACKING. SINGLE DATA SOURCE FOR THE MES.

Implemented in the continuous casting shop, long product rolling mill and plate rolling shop No. 1.





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