

# PRODUCTION AUTOMATION

## TECHNOLOGY BREAKTHROUGH PROGRAMME

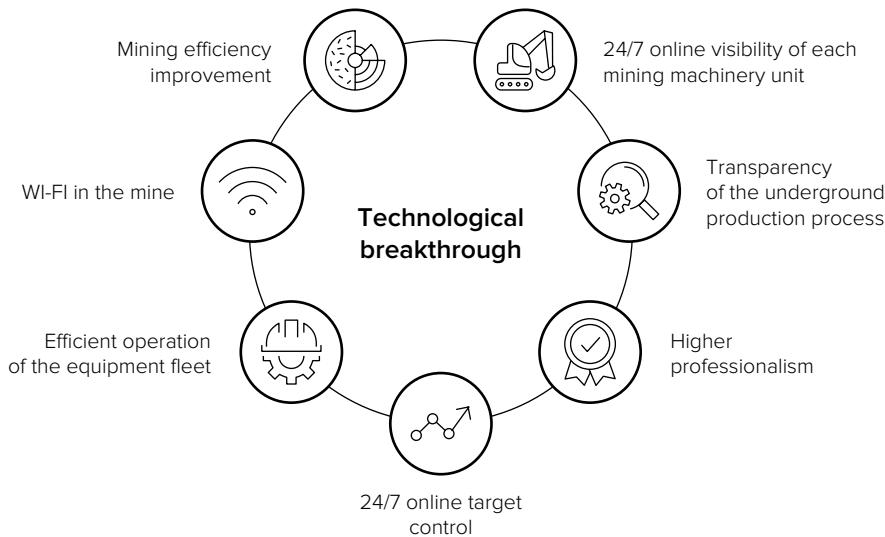
In 2015, as part of basic production automation, Nornickel launched the Technology Breakthrough programme running from December 2015 to April 2021.

The programme's key objective is to embed all operating processes in a new effective system of multiple option planning and automated day-to-day monitoring, aligning performance with KPIs.

By December 2020, 26 IT projects were implemented under the Technology Breakthrough programme, 31 IT systems were developed and put into operation at all relevant sites, and 2,418 users were connected.

## UNDERGROUND INFRASTRUCTURE AND DISPATCH PROGRAMME

### UNDERGROUND INFRASTRUCTURE AND MINING CONTROL



**>70 km**  
of cable laid

**365**  
contact points established

**386**  
self-propelled diesel equipment items equipped

**>500**  
employees trained

#### EXECUTION CONTROL

- Mining plan implementation
- In-mine ore movement control
- Hourly performance profile

#### PRODUCTION CULTURE

- Execution discipline
- Employee qualifications data

#### STATISTICS

- Mining operations performed
- Equipment use statistics

In 2018, a separate programme was spun off from the Technology Breakthrough programme – Underground Infrastructure and Mining Operations Dispatch that comprises six IT projects to be implemented between July 2018 and December 2020.

All systems were put into operation at all relevant sites in 2020, and in December 2020, the Underground Infrastructure and Mining Operations Dispatch programme was completed with the following measures implemented:

- Dispatch control over rock delivery from the mine face to the ore pass and further from the ore pass to the intermediate stockpile (autonomous haul trucks, rail transport)
- Dispatch control over drilling operations

More than 70 km of fibre was laid in mines, 365 access points were installed to provide Wi-Fi coverage, 386 pieces of mining equipment were connected, and more than 500 specialists were trained.

At the same time, the progress on the mining and ore transportation plan is monitored online 24/7. These measures helped enhance the production culture and execution discipline.

## EFFECTIVE SOLUTIONS FOR PRODUCTION MANAGEMENT

By end-2020, upon completion of the Technology Breakthrough and Underground Infrastructure and Mining Operations Dispatch programmes, the Company implemented unique solutions that significantly improved production management efficiency. The solutions were deployed across all production operations, from ore mining to metals production.

### INDUSTRIAL SAFETY MANAGEMENT

The Control, Management, Safety system was designed to collect, process, record and analyse health and safety data. The system's main objectives are to automate labour-intensive and routine functions associated with health and safety processes and to create a single information environment for its users. This will reduce time and information constraints when making management decisions, and improve the quality and efficiency of industrial safety processes.

### PRODUCTION DISPATCH

All key processes in the Company are controlled from control centres at the Norilsk and Kola Division, covering a total of 18 operating units. Dispatch control allowed the Company to completely abandon collecting information by phone and recording it on paper. By automating the collection of data from production chains, Nornickel is able to effectively calculate and monitor process and production parameters, including development of production plans and schedules and progress monitoring in real time.

## METALS BALANCE

Based on real-time data, all production units simultaneously prepare metals inventory plans, enabling detailed, granular views into metal-bearing products at each production stage, and accurate real-time control over commodity flows within the Company and the actual volume of products manufactured.

## GEOLOGICAL MODELLING AND MINE PLANNING SOLUTIONS

By deploying geological modelling and mine planning solutions, the Company was able to develop a single mining database, design underground workings and obtain survey data. 3D models of underground ore bodies or workings can be displayed at any time to assess the current situation in a mine. The system enables the preparation and feeding to automated drill rigs of electronic data sheets, with significant gains to be achieved in drilling and blasting performance.

## SIMULATION MODELLING SYSTEM

The simulation modelling system enables the development and prompt analysis of mining plan options to select the best ones. To make it possible, more than 500 pieces of equipment were modelled, including LHDs, autonomous haul trucks and self-propelled drilling rigs, electric locomotives and skip shafts. Simulation models comprise data on 5,000 underground workings and their characteristics. Nornickel plans to create a single simulation model covering all production operations – a full digital twin that will feature optimal operation modes to manage all processes in the Company, based on modelling and big data.

## PRODUCT QUALITY MANAGEMENT

LIMS (Laboratory Information Management System) automates operations at control and analysis centres and supports the entire cycle of quality control processes, from sample registration to reporting on test

results. With LIMS, Nornickel has centralised the collection and storage of all information about laboratories' activities and ensured its reliability and confidentiality.

## ENERGY ACCOUNTING

The automated system for commercial energy accounting monitors the consumption of electricity, heat, gas, cold water, as well as industrial oxygen and compressed air in real time. Thanks to the energy accounting system, enterprise managers will be able to see the actual consumption of all resources at once, track any deviations from the planned parameters, and decide on necessary measures to ensure efficient use of resources.

# TECHNOLOGY BREAKTHROUGH 2.0 PROGRAMME

In 2020, the Company launched the Technology Breakthrough 2.0 programme, which, in turn, includes 10 sub-programmes. Business milestones have already been set for each sub-programme, with a roadmap consisting of 42 IT initiatives and IT projects to achieve these milestones.

The Technology Breakthrough 2.0 Programme is planned to be implemented within five years with a total budget of RUB 6.5 billion.

Our experience in implementing projects across existing operations over the last five years gives us confidence that we will also successfully complete Technology Breakthrough 2.0.

To sum up, between 2015 and 2020:

- all projects approved for implementation were completed
- the targeted outcomes and outputs were achieved under the Technology Breakthrough and Underground Infrastructure and Dispatch programmes

- a 2020–2024 further development plan was prepared.

## TRANSITION FROM BASIC AUTOMATION TO DIGITAL OPERATIONS

In 2020, the Company completed the basic automation of its production processes, with 31 information systems (including systems developed under the Technology Breakthrough and Underground Infrastructure and Dispatch programmes) deployed and put into operation with more than 3,000 active users.

As a result of basic production automation, all underground mines were equipped with positioning and communication systems. A powerful system was created to feed data from the surface underground and back. All in all, we have created the basic infrastructure to manage mining operations.

We collected and digitised all equipment data sheets and process sheets for the most critical equipment, which allows effective production asset management via a unified system. The deployment of geological and mining information systems has enabled us to develop a single mining database and 3-D models of underground ore bodies, design mine workings and

## OPERATIONAL EXCELLENCE

### Improved production asset performance

- Reliability management
- EBITDA@RISK modelling
- Workload management

### Improved energy efficiency

- Energy management
- Energy balance

### Lights-out/autonomous operation

- Automatic management of self-propelled drilling rigs during extraction and shaft sinking operations
- Autonomous remote management of electric locomotive haulage
- Autonomous remote management of self-propelled diesel vehicles

### Improved efficiency of mining and exploration operations

- Processing and analysis of mining and geological data
- Licence risk management

### Production planning and management

- Precious metal balance
- Inventory and semi-product movement accounting
- Management of ore dressing, charge blending and concentration processes with forecasting

- Day-to-day planning of mining and metallurgical operations
- Modelling the content of valuable components in the ore released and optimising the release strategy

### Process data analysis

### Occupational safety

- Occupational health
- Smart PPE and intelligent analytics
- Contractor management
- Mobile solutions

### IP asset management

### Digital model to manage capex projects

- Digital construction control
- Netgroup management
- Interactive and analytical reports
- Database of resource and process models

### Investment activities

manage mine survey information. 100% of ore bodies and measured reserves of the Company have been digitised, with mining plans designed based on this data. Local mining projects have also been fully digitised in 3D.

The mining plans generated by the geological and mining information systems are promptly checked for feasibility in a simulation modelling system. The mine simulation model can simulate the implementation of the annual programme in less than 10 minutes, factoring in:

- the actual geometry of the transport network
- the position of mine workings
- the operation of the core and some of the auxiliary equipment
- the actual performance parameters of the equipment
- the mine's operating mode
- emergency and scheduled repairs
- restrictions during blasting and venting operations.

Moreover, the system's deployment delivered significant economic benefits, sparing the need to purchase 40 units

of mining equipment. Currently, over 80% of operations (all key processes) are monitored in real time from control centres at the Company's Polar Division and Kola MMC.

Based on real-time data, all production units simultaneously prepare metals inventory plans, enabling detailed, granular views into metal-bearing products at each production stage, and accurate real-time control over commodity flows within the Company and the actual volume of products manufactured.

All energy consumption is also metered in real time now. Data from the core process equipment is fed into the process data storage, which captures over 100 thousand parameters collected from the Company's enterprises.

We also made further progress towards the Company's digital future, with plans for remote equipment control, big data analytics, AI-based decision making and unmanned mines where human involvement in the production process will be minimised. We are currently working on unmanned solutions

and have already obtained the first results. For example, in February 2020, Russia's first unmanned autonomous haul truck was successfully tested at a Nor Nickel mine. Through this entire transformation journey, we will build highly effective and agile digital operations with advanced business processes.

## AWARDS OF THE TECHNOLOGY BREAKTHROUGH PROGRAMME

Industry experts have been long interested in and recognised the contribution of the industrial automation projects integrated into the Company's ambitious Technology Breakthrough programme to improve operational efficiency of operations. In October 2020, the Company was given the Russian Mining Award for its Underground Infrastructure and Dispatch programme implemented at seven mines. The Technology Breakthrough programme has a total of eight awards.