Smart Manufacturing: Practical Experience in Production Digitalization

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The article presents the practical experience of Tarkett Vinisin LLC (Kalush), where systems for monitoring the microclimate, power consumption and performance of production equipment have been implemented step by step. The collected data is used to monitor downtime, productivity and product quality, and to calculate OEE, AGrade, specific energy consumption and production losses. The solutions are built on Microl LLC equipment, Weintek HMI/IIoT devices and the CODESYS software environment. Design, programming, equipment integration, installation and commissioning were carried out by Microl Engineering LLC.

A modern industrial enterprise needs more than automatic control of its process equipment. To improve efficiency, one must understand how the equipment actually works, how much energy it consumes, where downtime occurs, what losses it causes, how much product is made and of what quality. That is why energy monitoring, production data acquisition and analysis, and Smart Manufacturing systems are becoming a key area of industrial automation (Fig. 1). A practical example of this approach is a set of projects implemented at Tarkett Vinisin LLC using equipment and software solutions from:

- Microl LLC — a Ukrainian manufacturer of industrial automation equipment, Ivano-Frankivsk;
- Microl Engineering LLC — a Ukrainian engineering company, Ivano-Frankivsk, which carried out the design, programming, equipment integration, installation and commissioning of the systems;
- Weintek Labs., Inc. — a Taiwanese manufacturer of HMIs, IIoT devices and software solutions for industrial automation.



Fig. 1. Equipment performance dashboard of the Smart Manufacturing system

Microl LLC manufactures a wide range of industrial automation equipment: regulators and controllers for process control, instruments for measuring electrical parameters, temperature and humidity, I/O modules, communication equipment and other means of collecting, processing and transmitting process data.

Weintek equipment provides the operator and software level of automation systems: process visualization, data acquisition, processing and archiving, remote access and IIoT functions. CODESYS-enabled panels also make it possible to run PLC logic and calculation algorithms directly on the HMI device.

Weintek equipment is represented and supplied in Ukraine by *Microl TD LLC*, Ivano-Frankivsk.

TARKETT VINISIN LLC: A STEP-BY-STEP AUTOMATION STRATEGY

Tarkett Vinisin LLC is an industrial enterprise in Kalush, Ivano-Frankivsk region, and part of the French international Tarkett Group. The company's core business is the production of floor coverings for residential and commercial use.

The company has chosen a path of gradual automation and digitalization — from simple local systems to comprehensive monitoring and production analytics. Instead of a complete modernization all at once, separate systems are introduced one after another, each solving a specific task and laying the foundation for the next stage. This makes it possible to spread investment over time and make the most of the infrastructure already in place.

Three main projects have been implemented:

- temperature and humidity monitoring at 9 control points;
- power consumption monitoring of 25 production units;
- comprehensive monitoring of production equipment performance.

Project 1. Temperature and Humidity Monitoring System

The first project was a system for continuous monitoring of temperature and relative humidity in production and storage areas.

Nine temperature and relative humidity control points were set up (Fig. 2). The system collects and archives data in real time and responds automatically when parameters go beyond the set limits.

The implementation uses:

- *BPVT-423* humidity and temperature converter units;
- *MAS-100* data acquisition and archiving modules;
- *Weintek cMT3102X* with *CODESYS Runtime*.

Besides displaying current values, the data is processed in software, including calculation of equilibrium moisture content and weighted average parameters (Fig. 3).

This is particularly important for woodworking production, since wood is a hygroscopic material. The weighted average temperature describes the conditions the material has been exposed to over a long period better than a single instantaneous measurement. Together with relative humidity, it makes it possible to assess the conditions that affect the moisture content of wood, its shrinkage, swelling and dimensional stability.



Fig. 2. Humidity and temperature control point



Fig. 3. Humidity and temperature graphs on the cMT3102X

The cMT3102X with CODESYS processes the measured values, performs calculations, checks permissible limits and generates alarm states. The panel thus serves as both an HMI and a programmable controller (Fig. 3).

When temperature or humidity goes beyond the set limits, the system generates an alarm message. Responsible staff can receive push notifications and e-mail notifications. Remote viewing of the parameters is also provided.

As a result, the company obtained a continuous automated microclimate monitoring system with archiving, calculation functions and deviation notifications.

Project 2. Power Consumption Monitoring of 25 Equipment Units

The next stage was a system for individual monitoring of power consumption and electrical network parameters of production equipment.

25 monitoring points are connected to the system.

The implementation uses:

- *IPM-103* three-phase network parameter indicators;
- *MAS-100* data acquisition and archiving modules;
- *Weintek cMT-FHDX820* screenless HMI/IIoT device.



Fig. 4. Electrical energy parameter measurement point



Fig. 5. Power consumption visualization in Weintek cMT Viewer

The IPM-103 units measure voltage, current, frequency, active, reactive and apparent power, as well as the power factor (Fig. 4).

Data is transmitted to the cMT-FHDX820 via RS-485/Modbus RTU, the MAS-100 modules and the local network.

For each connected consumer, one can analyze:

- start-up time;
- current and peak loads;
- consumption during productive operation and downtime;
- consumption per shift and per day;
- history of changes in electrical parameters.

Monitoring power consumption during downtime is especially important: equipment may produce nothing yet still consume electricity. Individual monitoring reveals such unproductive consumption (Fig. 5).

The Weintek cMT-FHDX820 (Fig. 6) is the central HMI/IIoT device of the system. It provides data acquisition, archiving and visualization, viewing of current and historical values, and creation of mimic diagrams and dashboards.

The HMI project is created in Weintek EasyBuilder Pro, and *cMT Viewer* is used for remote access.

EasyBuilder Pro is Weintek's free software environment for creating HMI projects, mimic diagrams, trends, alarms, archives and operator interaction tools. Creating and expanding HMI projects requires no separate development environment license.



Fig. 6. Weintek cMT-FHDX820

Thus, the cMT-FHDX820 forms a local supervisory level for analyzing equipment operating modes and detecting unproductive power consumption.

Project 3. Comprehensive Monitoring of Production Equipment Performance

The most comprehensive stage of automation was a system for monitoring the actual operation of production machines. The main goal was to obtain reliable information on how long the equipment actually runs and stands idle, why stoppages occur, how much product is made and of what quality, and how efficiently the equipment is used during the shift.

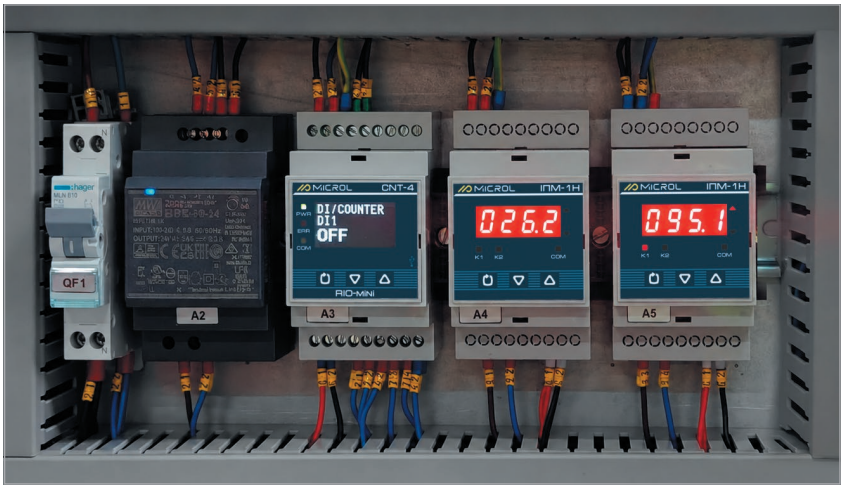


Fig. 7. Production data acquisition and processing loop

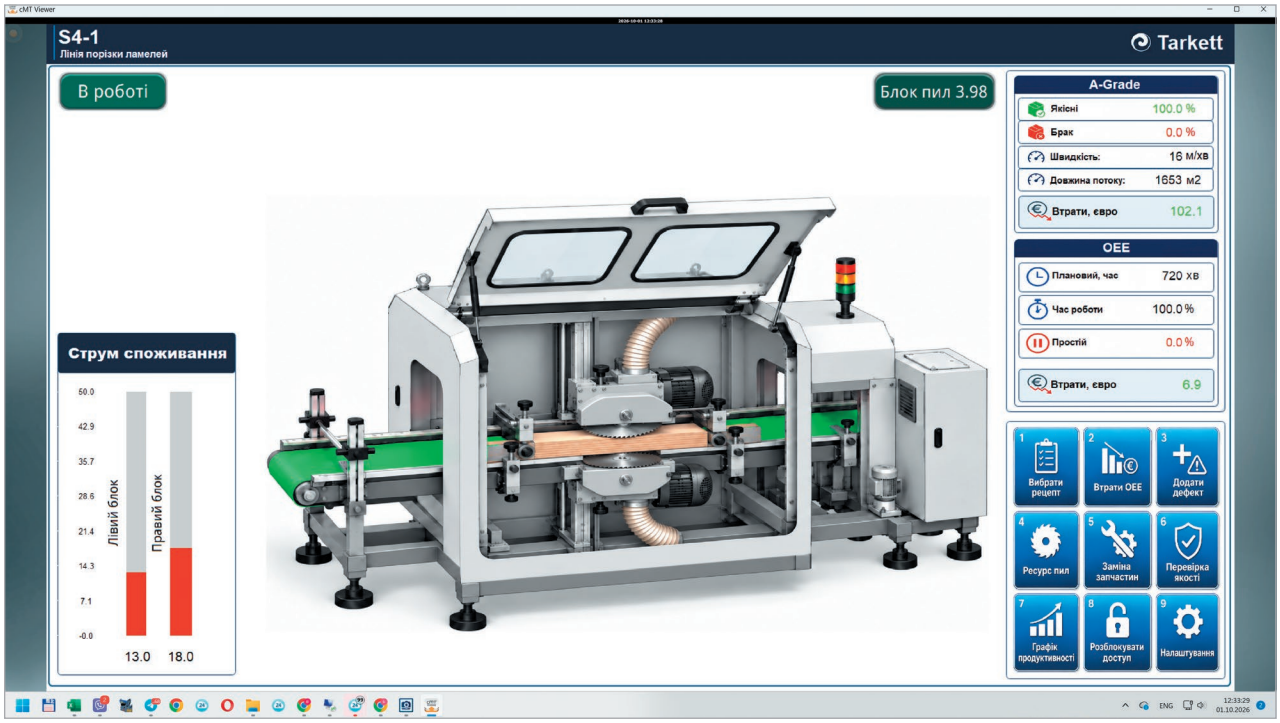


Fig. 8. Machine operator screen

An important requirement was that the new system must not interfere with normal machine control. It was therefore implemented as a parallel loop for collecting and processing production data that receives the necessary signals from the equipment without changing its basic operating algorithms.

Primary data is collected by CNT-1, IPM-1N, THM-1 and RIO-mini DI8 devices (Fig. 7) manufactured by Microl LLC:

- *CNT-1* is used to count products, pulses from sensors and other process events.
- *IPM-1N* is used to measure analog DC current and voltage signals.
- *THM-1* monitors the rotational speed or travel speed of mechanisms and counts operating hours.
- *RIO-mini DI8* receives discrete signals on the state of equipment, sensors, limit switches and other process signals.

All acquired information is sent to the *Weintek cMT3162X* HMI with *CODESYS Runtime*. In this project, the cMT3162X is used not only as an operator panel but also as a platform for running program logic and calculation algorithms.

CODESYS is used to determine operating time and downtime, accumulate shift statistics, classify downtime causes, count products, account for good and defective products, and calculate productivity, OEE, AGrade, specific energy consumption, operating hours, motor life and economic indicators.

Thus, Microl devices form the primary production data acquisition level, while the cMT3162X with CODESYS handles data processing, calculation of indicators and operator visualization (Fig. 8).

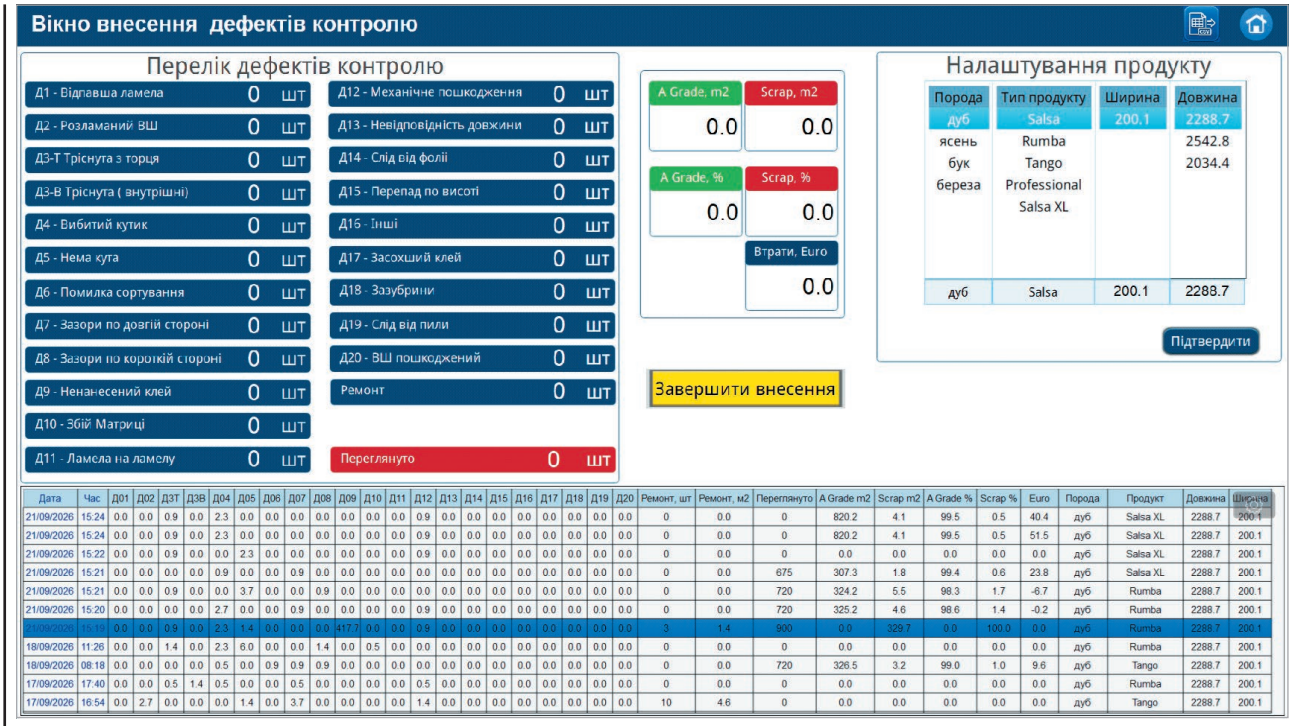
MONITORING OF EQUIPMENT OPERATION, DOWNTIME AND PRODUCTION LOSSES

The company works in 12-hour shifts. Once a shift begins, the system automatically accumulates statistics and identifies periods of productive operation and downtime.

For each shift, the system calculates the duration of productive opera-



Fig. 9. Shop-floor screen showing shift performance in real time



Дата	Час	Д01	Д02	Д3Т	Д3В	Д04	Д05	Д06	Д07	Д08	Д09	Д10	Д11	Д12	Д13	Д14	Д15	Д16	Д17	Д18	Д19	Д20	Ремонт, шт	Ремонт, м2	Переглянуто	A Grade m2	Scrap m2	A Grade %	Scrap %	Euro	Порода	Продукт	Довжина	Ширина
21/09/2026	15:24	0.0	0.0	0.9	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0	820.2	4.1	99.5	0.5	40.4	дуб	Salsa XL	2288.7	200.1
21/09/2026	15:24	0.0	0.0	0.9	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0	820.2	4.1	99.5	0.5	51.5	дуб	Salsa XL	2288.7	200.1
21/09/2026	15:22	0.0	0.0	0.9	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0.0	0.0	0.0	0.0	дуб	Salsa XL	2288.7	200.1
21/09/2026	15:21	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	675	307.3	1.8	99.4	0.6	23.8	дуб	Salsa XL	2288.7	200.1
21/09/2026	15:21	0.0	0.0	0.9	0.0	0.0	3.7	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	720	324.2	5.5	98.3	1.7	-6.7	дуб	Rumba	2288.7	200.1
21/09/2026	15:20	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	720	325.2	4.6	98.6	1.4	-0.2	дуб	Rumba	2288.7	200.1
21/09/2026	15:19	0.0	0.0	0.9	0.0	2.3	1.4	0.0	0.0	0.0	417.7	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3	1.4	900	0.0	329.7	0.0	100.0	0.0	дуб	Rumba	2288.7	200.1
18/09/2026	11:26	0.0	0.0	1.4	0.0	2.3	6.0	0.0	0.0	1.4	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0.0	0.0	0.0	0.0	дуб	Rumba	2288.7	200.1
18/09/2026	08:18	0.0	0.0	0.0	0.0	0.5	0.0	0.9	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	720	326.5	3.2	99.0	1.0	9.6	дуб	Tango	2288.7	200.1
17/09/2026	17:40	0.0	0.0	0.5	1.4	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0	0.0	0.0	0.0	0.0	0.0	дуб	Rumba	2288.7	200.1
17/09/2026	16:54	0.0	2.7	0.0	0.0	0.0	1.4	0.0	3.7	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10	4.6	0	0.0	0.0	0.0	0.0	0.0	дуб	Tango	2288.7	200.1

Fig. 10. Screen for entering inspection defect types

tion and downtime, actual productivity, the number of products made, the number of good and defective products, and power consumption. The indicators are updated throughout the shift, so the operator and management see not only the final result but also the current state of production.

At each stoppage, the system automatically records the start and duration of the downtime, and the operator can select its cause. Up to 15 categories of time losses are provided, including changeovers, waiting for material, process stops, maintenance, repairs, operator absence, waiting for adjacent operations, and other organizational or process-related reasons.

As a result, the system shows not only the total downtime but also the structure of production losses, which makes it possible to identify the main causes of unproductive time.

For operational control, the key indicators of the current shift are also displayed on a large TV screen (Fig. 9) installed directly in the workshop. Staff can see productivity, plan fulfilment, the number of products made, productive time, downtime, OEE and quality indica-

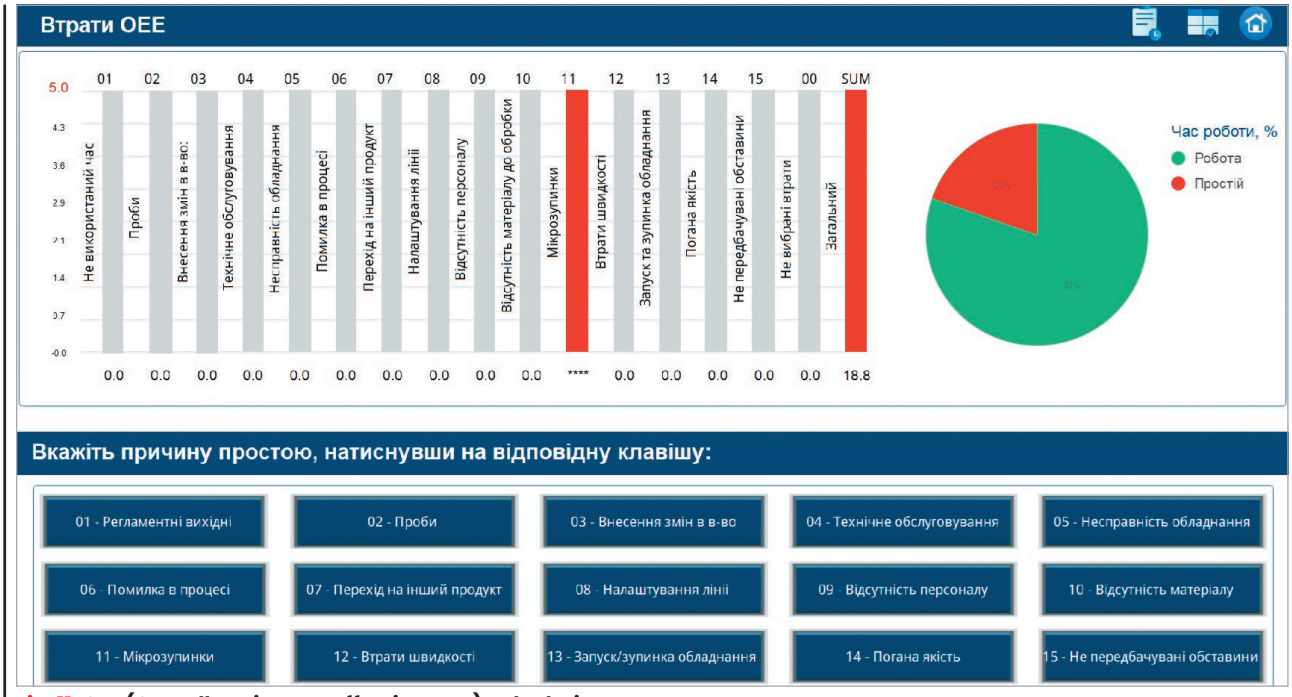


Fig. 11. OEE (Overall Equipment Effectiveness) calculation screen



Fig. 12. Process visualization on a WEINTEK cMT3162X 15

tors in real time. This makes it possible to respond to deviations during the shift.

In parallel, the system tracks product quantity and quality, separately recording total output, good and defective products, defect types, the percentage of good products and the reject rate (Fig. 10). The AGrade indicator provides an additional assessment of good product yield.

Assessment of efficiency, energy consumption and economic performance

Based on the accumulated data, the system automatically calculates OEE (*Overall Equipment Effectiveness*) (Fig. 11), which takes into account three main components:
availability × performance × quality.

Equipment efficiency is thus assessed comprehensively: high operating speed alone does not guarantee a good result if the equipment is often idle or produces many defective products.

OEE is calculated throughout the shift, so the actual efficiency of equipment use can be assessed promptly.

Production indicators can also be converted into a financial equivalent, for example: downtime → reduced productivity → production shortfall → financial loss.

When planned targets are exceeded, the system can likewise show a positive economic result.

Combining power consumption data with the actual output of good products allows calculating kWh per unit of good product. This indicator reflects not just total electricity consumption but the real energy efficiency of the production process.

In addition, the system tracks equipment operating hours and motor life, identifies operators, archives key indicators, exports data to Microsoft Excel and provides remote access to information (Fig. 12).

As a result, the company has a single monitoring system that combines data on equipment operation, downtime, productivity, quality, energy consumption and economic performance.

NEXT STAGE — MICROSOFT SQL SERVER AND POWER BI

The next stage of system development is to centralize production data in Microsoft SQL Server and use Microsoft Power BI for further analysis and visualization.

The single database can receive data on the microclimate, power consumption, equipment operation, downtime and its causes, productivity, product output and quality, OEE, AGrade, motor life and operator performance.

Microsoft SQL Server will serve as the central repository of production information, and Power BI as the tool for building analytical models, reports and interactive dashboards.

Reports and dashboards can be created in the free Power BI Desktop, so production analytics can be introduced with minimal initial software costs.

A significant part of the functions already implemented — monitoring equipment operation, product accounting, downtime and quality analysis, OEE calculation, monitoring of energy consumption and other production indicators — are tasks also handled by MES systems. However, implementing a full-scale MES may require significant investment in software, integration, server infrastructure and ongoing support.

The chosen step-by-step approach based on Microl, Weintek and CODESYS allows the company to implement the functions it needs gradually, using existing infrastructure and expanding the system as production requires. The accumulated data and existing data acquisition channels can later be used for integration with MES or other corporate information systems.

This approach delivers practical results at every stage of digitalization, keeps investment under control and gradually builds a unified information environment for production.

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