Complex solution for enterprise production equipment and operative personal monitoring

AIS «Dispatcher»
Information system for Manufacturing Data Collection (MDC)

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Objectives and problems

**Main objectives** – increased operating efficiency and minimized power consumption of production industrial machinery and equipment
Objectives and problems

Dispatcher to solve many enterprise problems:

• automated online monitoring of productive machinery, equipment and operating personnel;

• preparation of work shift schedules and online production control at workshop level;

• centralized storage of control programs (CP) for various numerically controlled machine tools and distribution of these CPs on demand by means of LAN and auxiliary devices;

• online monitoring of machine tools parameters: power consumption and electrical characteristics in different working modes;

• management of service, repair and maintenance tasks and teams of MRO specialist;

• collecting and analyzing work time and states for equipment and machinery used in production processes and preparation of maintenance schedules and procedures based on gathered data.
Objectives and problems

Gathered data help in making optimal control decisions at different levels of production enterprise, in monitoring the results of these decisions and calculating economical effect of their implementation.

1. Control of equipment and personnel work.
2. Analysis of collected data.
3. Planning management actions (control decisions) aimed to raise equipment load and optimize personnel work.
4. Implementation of planned measures.
5. Repetitive control and estimating of management measures efficiency.

Phases of continuous production management cycle:

- **Planning**
- **Implementation**
- **Control**
- **Analysis**
Production management systems

**MES - Manufacturing Execution System**
- Синхронизация, координация, оптимизация выпуска продукции;
- оперативное календарное планирование.

**DTM – Downtime management**
- TPM – Total productive maintenance;
- DTM – Downtime management.

**MDC – “AIS Dispatcher”**
- Data of objective monitoring of equipment and operating personnel;
- Data of power consumption of equipment, etc.

**Adaptable control systems**

**MDCs of various equipment vendors**

Reports, Graphics

Variety of equipment

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Architecture of AIS «Dispatcher»

**AIS «Dispatcher»** – patented complex of hardware and software for continuous real-time monitoring of industrial equipment connected to LAN, collecting received data and processing data to get analytical reports.

Dispatcher has interfacing features to connect practically any industrial production machinery of different make and year of issue.
Arrangement of controlled equipment

Automated mode – gathering data from Numerically controlled machine tools and/or special plant terminals. Manual mode - data on machinery states changing and quantitative results of plant work are input by operative personnel.

Dispatcher users communicate with this system by means of client software or through web-based access. Getting needed information as well as data input with mobile devices or collective monitoring workstation are possible alternative ways of working with Dispatcher.
Hardware: basic set of devices

**Terminal TVV-10 for connecting machine tools helps to:**
- Gather data from machine magnetics of equipment working in automated mode (up to 5 digital inputs);
- Get in manual mode information on results of machine tools productive work from operation personnel (causes of equipment downtime, identification of technological operation, quantities of good and defected (faulty) parts processed on machine tools, classification of faulty production etc.);
- Send numerical control programs to NC machine tools.

**Recorder «R-02»** (enhanced capabilities to control equipment work data) **adds features:**
- Automated recording of extra signals from machine magnetics (up to 8 digital inputs);
- Recording of analog signals (up to 2 signals);
- Monitoring of power consumption by machine tools and additional parameters – active power, total power, current, input voltage of each phase, voltage spikes and depressions.

**Auxiliary equipment**
Bar-code scanner; video recorder; eddy-current transducers; alarm signaling device; wireless communication device.

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Hardware: minimal set of devices

Terminal registrar «TR-05»
- Automated collecting and processing data from machine tools magnetics;
- Up to 6 digital and 2 analog signals;
- Monitoring of power consumption by machine tools and additional parameters – active power, total power, currents and input voltages of each phase, voltage spikes and depressions.

Monitoring control devices

PM-03 – indication of main states of machine tools, selection, input, indication and reset types of machine tools downtime.
PM-02M - indication of machine tool state, machine tool downtime type input (code or name) and indication, personnel registration; selection, indication and reset of current manufacturing operation for machine tool.
MPM/CPM - indication of machine tool states duration and causes (types) of downtime, personnel registration; selection and reset of downtime type, selection, indication and reset of current manufacturing operation, entering quantities of good and defected parts processed.

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Examples of device mounting
NC plants connection without input-output terminals: Heidenhain, Fanuc, NC, Mayak

Connection requirements:
• Ethernet interface at NC control block
• Open data exchange protocol for gathering monitoring information

Information from NC control block, received automatically:
• Current mode of work and machine tool state; position of axes movement; execution state; overall state of NC and machine tool; NC block readiness, main signals of machine tools magnetics;
• emergency conditions; IDs of current main CP and subprogram; current NC sentence; counter of parts processed; current G-function; ID of active tool;
• ID of active tool; cause of downtime, etc.

Manual data are input by means of monitoring control devices MPM or CPM
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AIS Dispatcher Software

Dispatcher software uses MS SQL Server 2008 R2 Express Edition and is divided to Client and Server applications.

Client
- Displays monitoring information;
- Creates analytical reports;
- Shows reference tables and manufacture record books.

Server
- Gathers data from terminals and NC control blocks;
- Offers functions for system setting.

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Dispatcher software can be adapted and extended for special customer requirements and/or integrated to custom enterprise information system currently used
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PACKAGE «BASIC»

Variants of information display

- line diagram and plant arrangement plot;
- table view with machine tools list and events;
- cross-tabulation table;
- measured parameters graph.
Notification system

Monitoring of events at equipment, creation and sending notifications to responsible personnel (servicemen, technologists etc.) in order to start necessary measures as soon as possible.

Sending control programs to NC machine tools via LAN

Centralized storage of CPs and their sending to NC machinery via enterprise LAN:

- Authorized access of personnel to Archive of Control programs;
- Integration with PDM-systems - WindChill, Search and others;
- Loading CP to NC control block through RS232, USB, Ethernet, IRPR interfaces;
- «Endless tape» work mode.
Auto creation of .xlsx files and sending to subscription users:
Reports on enterprise equipment and personnel work at given period.
Work schedules can be prepared for the entire enterprise, different shops and machine tools.

OEE overall equipment efficiency

OEE = Availability x Productivity x Quality x 100

Actual worktime of machine tools
Availability = -------------------------------

Planned worktime of machine tools
Current production
Productivity = --------------------------

Planned production
Amount of good products
Quality = ----------------------------------

Total products
Option «Power consumption monitoring»

- registering of power consumption by machine tools – active power, total power,
- calculating power consumption and power factor \((\cos \phi)\) for every piece of equipment and per products produced;
- detecting overload states;
- creating analytical reports on energy characteristics.

Option «Efficiency Panel»

- calculating efficiency parameters of enterprise shops (production areas) and visual display on large monitors or TV screens;
- Increased motivation of productive personnel.

Option «Report Generator»

- Preparation of custom reports based on machine tools data for registered states duration accumulated by monitoring system
- Wide choice of chart and diagram types, source data and time periods;
- Automated sending ordered types of reports to subscription users.
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Option «Video monitoring»

- Video recording at chosen points of production area (e.g. near machine tools) on IP-cameras;
- Online video stream display;
- Playback of history video records at point of interest by place, time and duration (e.g. with respect of emergency events)

Option «Mobile panel for monitoring»

- Real-time remote monitoring of equipment, indication of states durations and causes of downtime
- On mobile devices with Android or iOS operating systems;
- Connection through Wi-Fi, Internet, USB-to-Ethernet cable;
- Simultaneous work with multiple pieces of equipment.

Option «Collective panel for monitoring»

- Real-time remote monitoring of equipment, indication of states durations and causes of downtime;
- Registering machinery personnel
- Controlled execution of scheduled work shift jobs;
- Simultaneous work with multiple pieces of equipment.
«Production control» module

Collecting and processing of various data on productive usage of machine tools, counting of parts made by different operators, counting of defective parts classified by causes of defects.

- Three levels of control: by operator, automatic by the system, by foreman at end of shift;
- Counting of good and defective parts with classification by causes of defects;
- Reference table of causes of defects;
- Preparation of shift job for enterprise shop level;
- Production daybook of parts produced.

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«Downtime management» module

Equipment downtime and recovery monitoring:

- Registering events of out of order states of machine tools – when machinery don’t work, work slowly or with low quality;
- Analyzing causes of downtime, preparing and controlling activities for eliminating machinery problems, getting data for more efficient work of equipment.

Downtime management subsystem

- Supervising work of repairmen of enterprise and/or shops responsible for equipment recovery;
- Preparation and accounting of spare parts and consumables for service shops making repairs.

Total productive maintenance subsystem

- Preparation plans for scheduled maintenance works on machine tools and other equipment and for preventive maintenance;
- Registering details of maintenance works by service shops and personnel responsible for equipment healthy condition.
Tasks of downtime management module (DTM)

- Establishing responsibility of various service teams in doing repair works on classes of equipment allocated to these teams;
- Fixing exact time of downtime events, complete monitoring of all phases of downtime elimination works – from first moment of emergency until full recovery of equipment productive state;
- Registering amounts of spare parts and consumables that were used by repair teams.

Special means of notification can be used to deliver urgent information to supervising staff, co-workers and concerned operators of machine tools.
Tasks of total productive maintenance (TPM) module

- Dispatcher scans TPM schedule and sends to service teams notices to get prepared for doing planned works. When planned time comes, Dispatcher sends another notice to get work started;
- Start and end times of TPM works, their types and details as well as names of repairmen, materials and spare parts used are registered in work logs of service teams. These records are then used to make analytical reports.
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