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THE DEVELOPMENT OF GRAPHICAL USER INTERFACE OF AUTOMATED DISPATCH CONTROL SYSTEM

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Process control and equipment management requires operator to have a high reaction speed, rapid response capacity and ability to analyze a lot of information in a short time to make the appropriate decision. Automatic dispatch control system (ADCS) allows to simplify management process and make operator's work more efficient. ADCS provides an interface to the operator, which allows the operator to interact with process *plant in more intuitive way. In most cases the interface is a graphical user interface. In this paper, an example of graphical user interface design of ADCS of electric power distribution system is presented as well as the underlying principles of graphical user interface design.*

Automatic dispatch control system – is a control system that uses computers, networked data communications for high-level process supervisory management and other peripheral devices such as programmable logic controllers and discrete PID controllers to interface to the process plant or machinery. ADCS allows to interact with process plant through high-level interface, which is usually graphical user interface (GUI).

The reason why software giants have spent a lot of resources developing the best user interface (UI) and user experience (UX) is because they've done the research and recognize the real benefits of implementing good design [1]. Success and speed of operator's work largely depends on UX. Ill-conceived UX could lead to frequent delays and mistakes of operator. Because GUI in most cases is the main user interface of ADCS, it largely determines UX. In most cases the reason of UX ineffectiveness is the ill-considered GUI. Ultimately, providing reasonable GUI with ADCS software that makes the operators' job easier, allowing them to catch errors and resolve them immediately, minimize timewasting traps, save millions in machine damage and lost productivity cascading down the manufacturing process.

There are primarily six principles which can be used as the guidelines for user interface design [2]

1. User familiarity: the purpose of screen elements should be clear and understandable without prior training; permissible manipulations with these elements should also be intuitively understood. The user interface should not contain too much detail;
2. Consistency: A user with experience with some software can quickly adapt to any similar software. It also refers to different operations in the context of one program: the skills learned from one operation can be easily applied to other operations;
3. Minimal surprise: means that the comparable operations should incur the comparable results. If this does not happen, the users will become confused and frustrated, and even raise the doubt on the software design quality;
4. Recoverability: The system should not be sensitive to operator errors. The operator must be able to cancel any of his actions. For this purpose multiple confirmations, cancellations, backtracking, setting of control points, etc. are used;
5. User guidance: A well-designed help system is highly necessary. It should be incorporated and become a built-in component of the overall system. Also, comprehensive search and index tools should be provided to make the user query more convenient.
6. User diversity: A novice user should have a simpler interface with more tips. For an experienced user, the number of prompts should be reduced, as they interfere with work.

To implement the principles, the following components are used [3]:

• Color and contrast: Color and contrast often communicate before all other visual factors like text are taken into account. Color is used to convey instant meaning to objects, to draw attention to specific places that may need focus, and to distinguish items from each other. To create an interface that corresponds to the principles indicated above, you must select a color palette and assign each individual color with your own meaning. For example, red color means that an alarm has been triggered, or a power line is emergency shutdown. Operators must memorize the designations for each color, and therefore having a standardized set of colors will decrease confusion and speed up data interpretation.

Color contrast between lighter and darker tones can be used to make one object stand out compared to its surroundings. The greater the contrast between two colors is the more noticeable and legible it becomes.

• **Layout:** Layout gives operator a frame of reference for how they should interact with an environment. Layout refers to how buttons, diagrams, and other elements are laid out on screen in an organized fashion.

• **Navigation:** every ADCS software needs well-designed navigation to give users access to critical information quickly and intuitively. Basic rules include:

- A hierarchy should be consistent
- The navigation bar should be in the same place on all screens
- A process overview should provide quick access to any part of the system

Ideally, with a well thought-out, consistent navigation system, someone without training but familiar with the plant should be able to navigate to any part of the ADCS without heading down dead ends.

• **Typography:** Typography refers to the use of fonts, font sizes, and font styling to convey meaning. Use of typography can be used to emphasize and de-emphasize content – such as by increasing contrast and boldness for important alerts, displaying hints with plain text, and using certain heights and colors for headings and subheadings.

• **Iconography and imagery:** Right image or icon could convey more information than a thousand words. However, large images are not recommended in industrial systems because screen real estate is precious and loading times can reduce speed. Instead, intuitive icons and shapes are preferred. A good icon should be simple, easy to read at different sizes, and clear in meaning.

• **Feedback:** To reach effective communication between operator and ADCS interface, it's important that the operator knows if the program understood him. Operator usually cannot see the plant and therefore needs to receive feedback that what he did had an effect.

On Fig 1. below graphical user interface of the system being developed is shown.

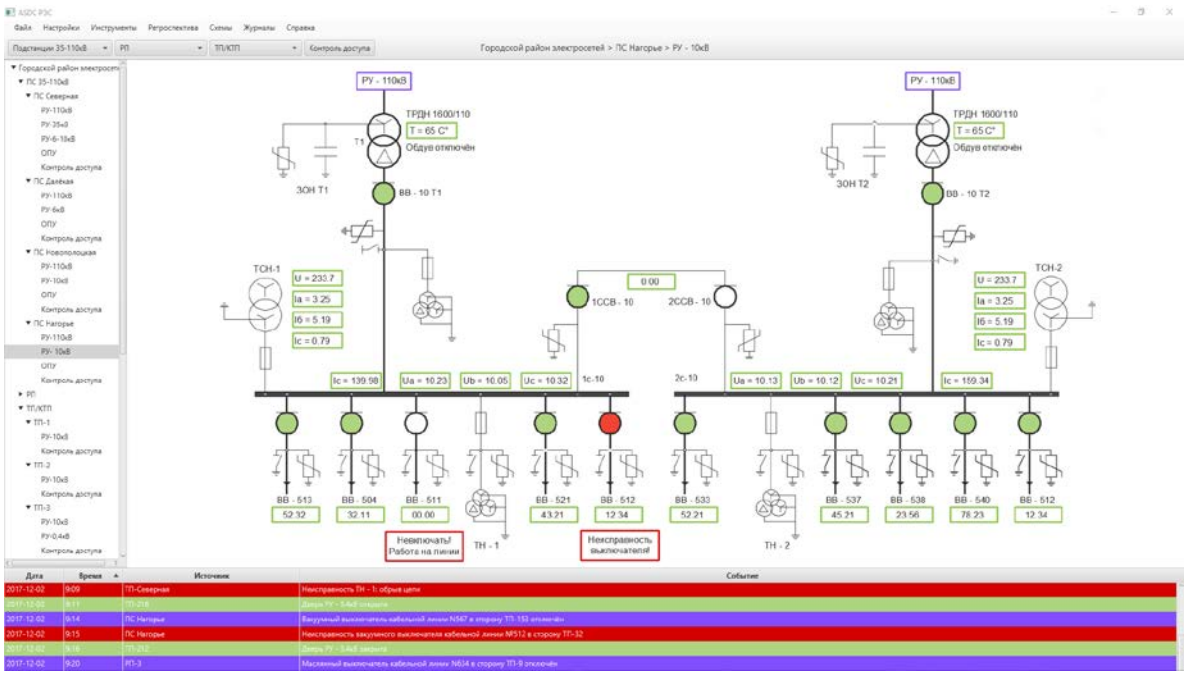

Fig. 1. Graphical user interface of the system being developed

GUI of ADCS consist of several parts: mnemonic diagram, units list, events box. Mnemonic diagram in the center of the screen is the main part of any ADCS or SCADA software. It displays information about the monitored process in real time and allows the operator to maintain normal system state. It was created in such a way to be much similar to power engineering drawing so that every engineer could understand it without prior training. Mnemonic diagram's color palette consist of four main colors. Light green color indicates that circuit breaker is on. Also it indicates an acceptable value of the controlled parameter. Boxes with light green border indicate that value of the controlled parameter inside the box in the normal range. If actual value deviates from the specified critical value, box borders become red. Red color indicates failures. Blue color is used to highlight jump points to other parts of mnemonic diagram. All power lines, busbars and other equipment are shown in black.

Primary equipment lines have a greater contrast than lines of secondary equipment. That allows operator to focused on most important parts of power system.

On the left of the screen there is a unit tree list. It is used for navigation purposes. Every power station, substation and switchgears are presented here hierarchically to allow operator to be aware of which point of the power supply system is shown in the center of the screen now so that he could jump to any other as quickly as possible.

At the bottom of the screen, the events box is displayed. It displays messages about controlled object state. There are three types of messages: notification message, normal state change messages and alert messages. Notification message notify operator about normal usual events in the power system, such as closing substation door or receiving acceptable value of the controlled parameter. Normal state change messages indicate normal changes in power system and provide feedback to operator when he changes power system state. Alert messages signal an accident for example equipment failure. Each massage type has its own color: light green for notification message, blue for normal state change messages and red for alert messages. This color palette allows operator to distinguish messages by priority instantly and focus on the most important.

Adherence to the principles stated above allow us to create GUI for industrial software that is easy and even fun to use. Easiness and fun are important because they tangibly affect the operator's ability to control the process and respond quickly when things go awry. And over time, the engagement and performance of well-designed systems provide positive returns in decision-making speed and accuracy, plant productivity, and reduced training time.

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