Development of FA Integrated Engineering Software for PLM

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Mitsubishi Electric Corporation has developed "MELSOFT iQ Works," factory automation (FA) integrated engineering software for programmable logic controllers (PLCs), motion controllers, human-machine interfaces, robots, and inverters. MELSOFT iQ Works, with "MELSOFT Navigator" system management software as its core, is an integrated suite of engineering software programs. The product is already on the market and has helped improve the efficiency of equipment design in product lifecycle management (PLM) through data linkage between our engineering software programs.

Recent years have seen the increasing use of mechanical and electrical CAD software in equipment design, accompanied by rising demand for linking CAD software with engineering software. In addition, to shorten the period for on-site equipment adjustments after completion of the control design, customers are calling for more efficient program debugging without using actual equipment.

To meet these needs, Mitsubishi Electric Corporation has developed MELSOFT iQ Works functions for enhanced interconnection in the PLM engineering chain to provide design and debugging environments in addition to the control design phase: We have achieved (1) linkage simulation of a PLC, motion controller, network, human-machine interface, and 3D CAD and (2) data linkage between electrical CAD and MELSOFT iQ Works.

1. Introduction

The FA sector mainly in Japan, Europe, and the U.S. is faced with increasing labor costs for engineering work, such as system design, programming, operation, and maintenance, due to the introduction of larger FA systems with more functions. In emerging countries such as China and Southeast Asia, the labor cost for engineers has also been increasing, which is becoming a worldwide issue. Accordingly, there is a demand mainly in the manufacturing industry to reduce the total cost of ownership (TCO) by making engineering work more efficient.

In response, we developed "MELSOFT iQ Works" FA integrated engineering software and released it in 2009. MELSOFT iQ Works can be used for implementing system design and programming, creating human-machine interface screens, and starting, operating, and maintaining equipment through an integrated approach.

This paper describes two new functions that MELSOFT iQ Works offers along with its mechanisms and characteristics.

2. Configuration of MELSOFT iQ Works and its New Functions

MELSOFT iQ Works consists of the following six software programs.

(1) System management software "MELSOFT Navigator"

Provides a system management function that serves as a core for linking the individual engineering software programs (2) to (6).

(2) PLC engineering software "GX Works3"

Supports the programming, configuration, and maintenance of PLCs that control FA equipment.

(3) Interface engineering software "GT Works3"

Supports the preparation of human-machine interface screens.

(4) Motion controller engineering software "MT Works2"

Supports the programming, configuration, and maintenance of motion controllers that drive servo motors and other equipment.

(5) Robot engineering software "RT ToolBox2"

Supports the programming, configuration, and maintenance of robots.

(6) Inverter setup software "FR Configurator2"

Supports the configuration, adjustment, and maintenance of inverters.

In line with the increasing use of mechanical and electrical CAD software in equipment design there is increasing demand for linking CAD software with engineering software. In addition, to shorten the period for on-site equipment adjustments after completion of the control design, customers are calling for more efficient program debugging without using actual equipment. To meet these demands, Mitsubishi Electric Corporation has developed MELSOFT iQ Works functions for enhanced interconnection in the PLM engineering chain to provide design and debugging environments in addition to the control design phase.

Figure 1 illustrates the functions that contribute to enhanced interconnection in the PLM engineering chain with MELSOFT iQ Works as the core. MELSOFT iQ Works offers the following two new functions.

(1) Linkage simulation function for PLCs, motion

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controllers, networks, human-machine interfaces, and 3D CAD

(2) Function for data linkage between electrical CAD and MELSOFT iQ Works

3. Linkage Simulation

The simulation function of MELSOFT iQ Works offers a PLC simulator, motion simulator, and human-machine interface simulator. Each simulator makes it possible for system designers to check the program functions before the equipment and machines are assembled, thus reducing man-hours for programming.

Customers also want to shorten the period for on-site equipment adjustments. To meet this need, Mitsubishi Electric Corporation provides a linkage simulation function for PLCs, motion controllers, networks, human-machine interfaces, and 3D CAD, making it possible to check the operation of all equipment by simulation alone (Fig. 2). This function significantly reduces system designers' man-hours for programming and improves the quality level before on-site adjustments, thus reducing TCO.

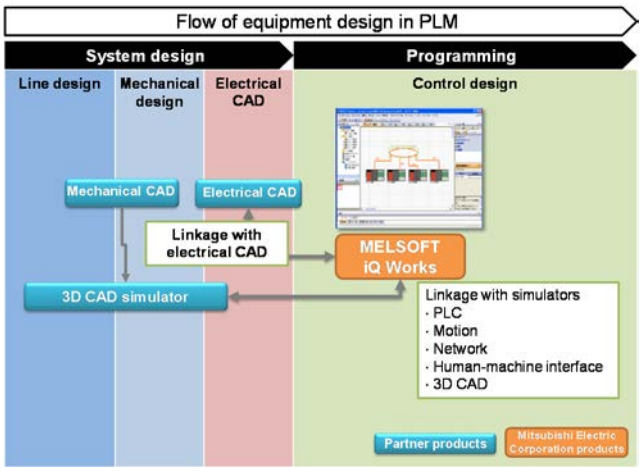

Fig. 1 Outline of the functions contributing to enhanced PLM engineering chain linkage with MELSOFT iQ Works as its core

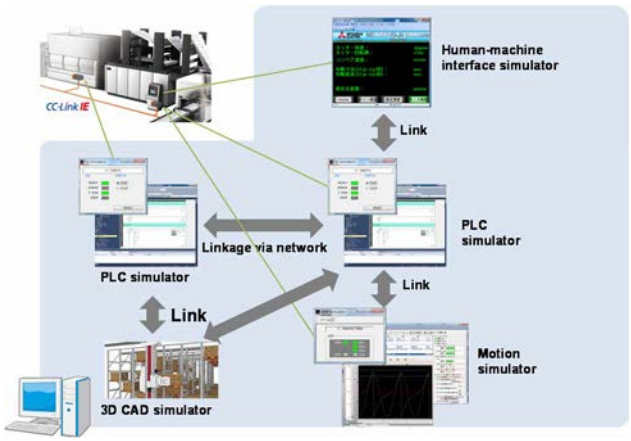

Fig. 2 Outline of linkage of a PLC simulator, motion simulator, human-machine interface simulator, and 3D CAD simulator

This section describes PLC-motion linkage simulation, network linkage simulation, and 3D CAD simulation linkage.

3.1 PLC-motion linkage simulation

3.1.1 Motion systems

For equipment requiring motion control, a multi-CPU system having a PLC CPU and motion CPU is often used. The motion CPU handles complex motion control tasks and the PLC CPU handles other sequence control tasks. As a result, the processing load can be distributed, which makes it possible to increase the number of equipment units and achieve high-speed processing.

The GX Works3 simulation function imitating a PLC CPU makes it possible to verify the sequence control without using the actual equipment, while the MT Works2 simulation function imitating a motion CPU makes it possible to verify the motion control without using the actual equipment. However, these simulation functions can only debug each CPU; therefore, each program must be downloaded to the actual equipment to verify the commands, response timing, and data exchange between the CPUs.

3.1.2 Realization of a PLC-motion linkage simulation function

To eliminate the inconvenience of downloading each program described in section 3.1.1, Mitsubishi Electric Corporation has developed a new PLC-motion linkage simulation (hereafter, "system simulation") function that allows the PLC CPU to work with the motion CPU. This function enables the debugging tasks listed below without using actual equipment.

(1) Operation check of an interrupt program through inter-module synchronization of the PLC CPU with the motion CPU

(2) Operation check of startup linkage of motion-specific sequence commands

(3) Operation check of buffer memory data exchange between CPU modules by multi-CPU setting

In addition, the system simulation function saves the run status of the GX Works3 and MT Works2 system simulation. This means that if the processing is interrupted in the middle of a simulation, debugging can be restarted from the stopped point.

3.1.3 System simulation function

For the PLC CPU to work with the motion CPU through the system simulation function, a new system bus imitation function was developed, which has realized the following functions (Fig. 3).

(1) Inter-module synchronization function

A motion CPU processes motion control at fixed-

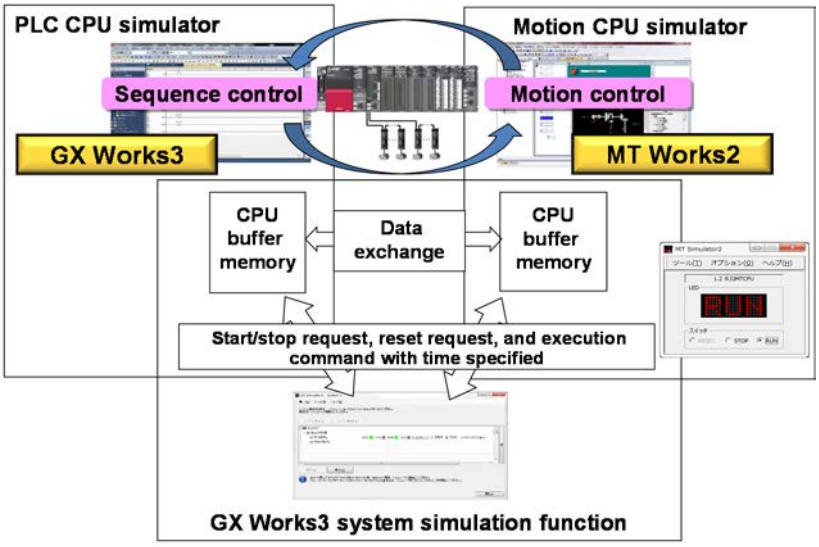

Fig. 3 Schematic diagram of the system simulation function

cycle intervals (222 μs in the shortest case) as the module specification. Inter-module synchronization of the GX Works3 PLC CPU simulator with the MT Works2 motion CPU simulator has been realized by allowing the system simulation function to imitate the fixed-cycle inter-module synchronization at intervals of 222 μs.

(2) Inter-module communication function

Imitation of the inter-module communication function enables automatic incorporation by reading and writing to each CPU memory for communications and notification of interruption between the CPUs.

3.2 Network linkage simulation

3.2.1 Network systems

Systems with multiple PLCs connected via networks are used in the semiconductor, liquid crystal, and automobile sectors where large-scale manufacturing equipment is required.

The conventional GX Works3 simulation function could only debug a single PLC CPU. Consequently, each program needed to be downloaded to the actual equipment to verify the data exchange via a network.

To solve this problem, the system simulation function described in section 3.1.2 was expanded to the network level, which enables verification of entire systems including PLCs, motion controllers, and networks. This function allows debugging of cyclic data exchange between network modules without using the actual equipment.

3.2.2 Realization of a network linkage simulation function

To realize a network linkage simulation function, two new functions were added to the system simulation function.

(1) Inter-network synchronization function

Data is periodically exchanged between network modules by link scanning. A simulator carries out inter-process communications at link scan intervals to synchronize the processing timing by queuing (time synchronization).

(2) Network module imitation function

By imitating a network module included in a network, it is possible to handle network parameters set to the control station (CC-Link IE Control) or master station (CC-Link IE Field). This function enables verification of data exchange set to the network parameters without using the actual equipment.

3.3 3D CAD simulation linkage

The 3D CAD simulator software is used for checking the operation of a mechanism in mechanical design. Previously, a 3D CAD simulator was used to check the mechanical design and a PLC simulator was used to check the control design. However, even after a thorough check, problems occurred when the equipment and control were combined, and it was necessary to return to the design phase.

To solve this issue, Mitsubishi Electric Corporation has realized a function for linking the 3D CAD simulator, the system simulation function described in section 3.1, and the “GT simulator,” which is a human-machine interface simulator. This enables verification of the operations listed below without using actual equipment.

(1) Mechanism operation when the equipment and control are combined
(2) Sequence control operation when the equipment and control are combined
(3) Combined operation of the human-machine interface and sequence control

To realize these linkage functions, an “EZSocket” interface has been implemented in PLC CPU simulators.

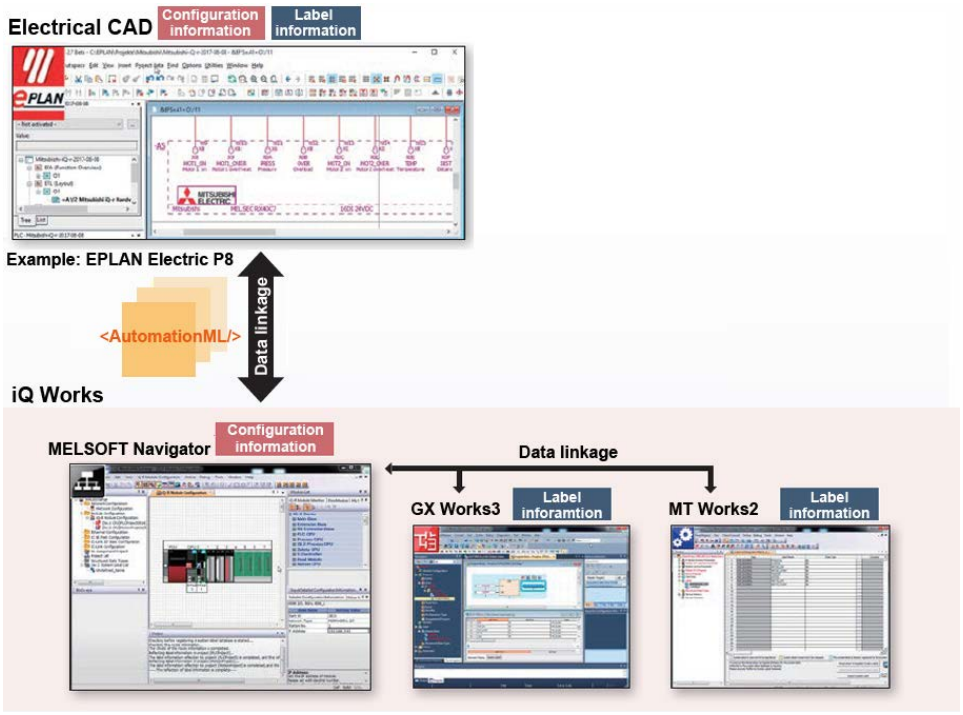

Fig. 4 Example of data linkage between electrical CAD and MELSOFT iQ Works

EZSocket refers to the interfaces used on actual CPUs. This implementation allows access to actual CPUs and CPU simulators in the same procedure.

The GT simulator and 3D CAD simulator having a function for accessing the EZSocket can work together.

4. Electrical CAD Data Linkage in MELSOFT iQ Works

Regarding the electrical design and control design, although the information set to the PLC module configuration is the same as that set to the labels, the software used for electrical CAD is different from that for MELSOFT iQ Works, which poses the following issues.

(1) The number of man-hours required for setting is doubled.

(2) An operation mistake results in deviation of the settings between the two software programs.

These issues have been solved by means of data linkage between the electrical CAD and MELSOFT iQ Works. Users set the module configuration information and label information on either the electrical CAD or MELSOFT iQ Works: The data linkage function allows the information to be incorporated in other software. The data linkage function can eliminate repeated work by users, improving the efficiency of operations. In addition, since human work is not required, the results are free from human errors, setting errors, and omissions.

MELSOFT iQ Works enables data linkage of module configuration information and label information with electrical CAD thanks to MELSOFT Navigator. MELSOFT Navigator can link label information with GX Works3 and MT Works2, making it easier to incorporate label information in the programming software. Figure 4 shows an example of data linkage.

Open standard AutomationML is used for data linkage. AutomationML is a data format in Extensible Markup Language (XML) developed to seamlessly connect engineering tools. Existing XML data format standards, such as Computer Aided Engineering Exchange (CAEX), PLCOpenXML, and Collaborative Design Activity (COLLADA), have been combined to achieve the specifications. The use of the open standard eliminates work for individual electrical CAD tools and enables cooperation with all electrical CAD vendors that use AutomationML. Currently, electrical CAD tools that support data linkage with AutomationML are EPLAN Electric P8 (EPLAN Software & Service) and the E3.series (Zuken Inc.). The number of such tools may increase further in the future, resulting in an increase in the number of linkable electrical CAD tools as well.

5. Conclusion

This paper described two new functions added to MELSOFT iQ Works FA integrated engineering software for enhanced interconnection in the PLM engineering chain. In addition to these functions, we will continue to improve MELSOFT iQ Works as engineering software that con tributes to reducing customers' TCO.