Robotics packaging line solution

Startup Guide

Vision & Robot Integrated Simulation

SYSMAC-SE2□□□

SYSMAC-RA401L

NJ501-4□□□

R88D-KN□-ECT

FH-1□□□

FH-3□□□

Y128-E1-01

NOTE

Introduction

The *Startup Guide for Vision & Robot Integrated Simulation* (hereinafter, may be referred to as "this Guide") describes the procedures for 3D simulation of the pick-and-place operation, where an NJ-series CPU Unit is used in combination with FH-series Vision Systems and G5-series AC Servomotors/Servo Drives, by using the Sysmac Studio. A simple machine model example is used for the discussion. You can perform the procedures that are presented in this Guide to quickly gain a basic understanding of a Vision & Robot integrated simulation.

This Guide does not contain safety information and other details that are required for actual use. Thoroughly read and understand the manuals for all of the devices that are used in this Guide to ensure that the system is used safely. Review the entire contents of these materials, including all safety precautions, precautions for safe use, and precautions for correct use.

Intended Audience

This Guide is intended for the following personnel.

- Personnel in charge of introducing FA systems
- Personnel in charge of designing FA systems

The personnel must also have the following knowledge.

- Knowledge of electrical systems (an electrical engineer or the equivalent)
- Knowledge of NJ-series CPU Units
- Knowledge of G5-series Servomotors/Drives
- Knowledge of FH-series Vision Systems
- Knowledge of operation procedure of Sysmac Studio
- Knowledge of NA-series Programmable Terminals

Applicable Products

This Guide covers the following products.

- CPU Units of NJ-series Machine Automation Controllers
- Automation Software Sysmac Studio
- G5-series Servomotors/Servo Drives
- FH-series Vision Systems
- NA-series Programmable Terminals

Special Information

The icons that are used in this Guide are described below.

Precautions for Correct Use

Precautions on what to do and what not to do to ensure proper operation and performance.

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Additional information to read as required.

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- When building a system, check the specifications for all devices and equipment that will make up the system and make sure that the OMRON products are used well within their rated specifications and performances. Safety measures, such as safety circuits, must be implemented in order to minimize the risks in the event of a malfunction.
- Thoroughly read and understand the manuals for all devices and equipment that will make up the system to ensure that the system is used safely. Review the entire contents of these manuals, including all safety precautions, precautions for safe use, and precautions for correct use.
- Confirm all regulations, standards, and restrictions that the system must adhere to.
- Check the user program for proper execution before you use it for actual operation.

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Software Licenses and Copyrights

The NJ-series CPU Units and Sysmac Studio incorporate certain third party software. The license and copyright information associated with this software is available at http://www.fa.omron.co.jp/nj_info_e/.

Related Manuals

The following manuals are related. Use these manuals for reference.

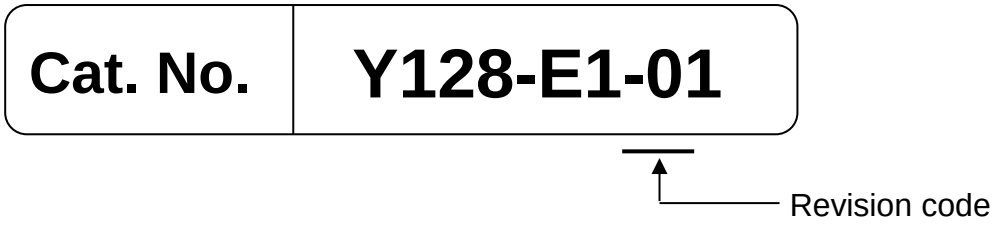
Manual name	Cat. No.	Model	Application	Description
Startup Guide for Vision & Robot Integrated Simulation (This Guide)	Y128	SYSMAC-SE20□□ SYSMAC-RA401L NJ501-4□□□ R88D-KN□-ECT FH-1□□□ FH-3□□□	Learning about the operating procedures of Vision & Robot integrated simulation.	Describes the operating procedures of Vision & Robot integrated simulation.
Sysmac Studio Version 1 Operation Manual	W504	SYSMAC-SE2□□□	Learning about the operating procedures and functions of the Sysmac Studio.	Describes the operating procedures of the Sysmac Studio.
NJ-series NJ Robotics CPU Unit User's Manual	W539	NJ501-4□□□	Using the robot control with NJ-series Controllers.	Describes the robot control. Use this manual together with the *NJ/NX-series CPU Unit Motion Control User's Manual* (Cat. No. W507) and the *NJ/NX-series Motion Control Instructions Reference Manual* (Cat. No. W508).
NJ-series CPU Unit Hardware User´s Manual	W500	NJ501-□□□□ NJ301-□□□□	Learning the basic specifications of the NJ-series CPU Units, including introductory information, designing, installation, and maintenance. Mainly hardware information is provided.	Provides an introduction to the entire NJ-series system along with the following information on the CPU Unit. • Features and system configuration • Overview • Part names and functions • General specifications • Installation and wiring • Maintenance and inspection Use this manual together with the *NJ/NX-series CPU Unit Software User's Manual* (Cat. No. W501).
NJ/NX-series CPU Unit Software User's Manual	W501	NJ501-□□□□ NJ301-□□□□	Learning how to program and set up an NJ/NX-series CPU Unit. Mainly software information is provided.	Provides the following information on a Controller built with an NJ/NX-series CPU Unit. • CPU Unit operation • CPU Unit features • Initial settings • Language specifications and programming based on IEC 61131-3 Use this manual together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500).

Manual name	Cat. No.	Model	Application	Description
NJ/NX-series CPU Unit Motion Control User's Manual	W507	NJ501-□□□□ NJ301-□□□□	Learning about motion control settings and programming concepts.	Describes the settings and operation of the CPU Unit and programming concepts for motion control. When programming, use this manual together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500) and *NJ/NX-series CPU Unit Software User's Manual* (Cat. No. W501).
NJ/NX-series Instructions Reference Manual	W502	NJ501-□□□□ NJ301-□□□□	Learning detailed specifications on the basic instructions of an NJ/NX-series CPU Unit.	Describes the instructions in the instruction set (IEC 61131-3 specifications). When programming, use this manual together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500) and *NJ/NX-series CPU Unit Software User's Manual* (Cat. No. W501).
NJ/NX-series Motion Control Instructions Reference Manual	W508	NJ501-□□□□ NJ301-□□□□	Learning about the specifications of the motion control instructions that are provided by OMRON.	Describes the motion control instructions. When programming, use this manual together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500), *NJ/NX-series CPU Unit Software User's Manual* (Cat. No. W501), and *NJ/NX-series CPU Unit Motion Control User's Manual* (Cat. No. W507).
NJ/NX-series Troubleshooting Manual	W503	NJ501-□□□□ NJ301-□□□□	Learning about the errors that may be detected in an NJ/NX-series Controller.	Describes concepts on managing errors that may be detected in an NJ/NX-series Controller and information on individual errors. Use this manual together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500) and *NJ/NX-series CPU Unit Software User's Manual* (Cat. No. W501).
G5-series AC Servomotors/Servo Drives with Built-in EtherCAT Communications User's Manual	I576	R88D-KN□-ECT/ R88M-K	Learning detailed specifications of a G5-series Servo Drive.	Describes how to install and wire the Servo Drive, set parameters needed to operate the Servo Drive, and remedies to be taken and inspection methods to be used in case that problems occur.
G5-series AC Servomotors/Servo Drives with Built-in EtherCAT Communications Linear Motor Type User's Manual	I577	R88D-KN□-ECT-L/ R88L-EC	Learning detailed specifications of a G5-series Servo Drive.	Describes how to install and wire the Servo Drive, set parameters needed to operate the Servo Drive, and remedies to be taken and inspection methods to be used in case that problems occur.
EtherCAT Remote I/O Terminal GX-series EtherCAT Slave Units User's Manual	W488	GX-□□□□□□□	Learning detailed specifications of a GX-series EtherCAT Slave Unit.	Provides information on a GX-series EtherCAT Slave Unit.
NA-series Programmable Terminal Hardware User's Manual	V117	NA5-□W□□□□ NA5-□□W□□□□	Learning the specifications and settings required to install an NA-series Programmable Terminal and connect peripheral devices.	Provides information on NA-series Programmable Terminal specifications, part names, installation procedures, and procedures to connect an NA Unit to peripheral devices. Also provides information on maintenance after operation and troubleshooting.

Manual name	Cat. No.	Model	Application	Description
NA-series Programmable Terminal Software User's Manual	V118	NA5-□W□□□□ NA5-□□W□□□□	Learning about NA-series Programmable Terminal pages and object functions.	Describes NA-series Programmable Terminal pages and object functions
NA-series Programmable Terminal Device Connection User's Manual	V119	NA5-□W□□□□ NA5-□□W□□□□	Learning the specifications required to connect devices to an NA-series Programmable Terminal.	Provides information on connection procedures and setting procedures to connect an NA-series Programmable Terminal to a Controller or other device.
NA-series Programmable Terminal Startup Guide	V120	NA5-□W□□□□ NA5-□□W□□□□	Learning in concrete terms information required to install and start the operation of an NA-series Programmable Terminal.	Describes the part names and installation procedures followed by page creation and transfer procedures with the Sysmac Studio. Also describes operation, maintenance, and inspection procedures after the project is transferred. Sample screen captures are provided as examples.
Vision System FH Series Operation Manual for Sysmac Studio	Z343	FH-1□□□ FH-3□□□	Learning about how to configure settings for and operate the sensor controller for the FH Series from the Sysmac Studio FH Tools.	Describes how to configure settings for and operate the sensor controller for the FH Series from the Sysmac Studio FH Tools.
Vision Sensor FH Series Conveyor Tracking Application Programming Guide	Z368	SYSMAC-SE20□□ SYSMAC-RA401L NJ501-4□□□ R88D-KN□-ECT FH-1□□□ FH-3□□□	Learning the setting procedure of sample macros for conveyor tracking.	Describes the setting procedure of sample scenes or sample macros used for applications of conveyor tracking on FH Sensor Controllers.
Vision Sensor FH Series Operation Manual Sysmac Studio Calibration Plate Print Tool	Z369	SYSMAC-SE20□□ SYSMAC-RA401L NJ501-4□□□ R88D-KN□-ECT FH-1□□□ FH-3□□□	Learning the setup procedure for printing the Pattern on a Calibration Plate used for calibration for cameras and robots on the Sysmac Studio.	Describes how to configure and operate the Calibration Plate Print Tool on the Sysmac Studio on FH Sensor Controllers.
Vision Sensor FH Series Operation Manual Sysmac Studio Conveyor Tracking Calibration Wizard Tool	Z370	SYSMAC-SE20□□ SYSMAC-RA401L NJ501-4□□□ R88D-KN□-ECT FH-1□□□ FH-3□□□	Learning the setup procedure of the wizard style calibration for cameras, robots, or conveyors.	Describes how to configure and operate the Conveyor Tracking Calibration Wizard Tool on the Sysmac Studio on FH Sensor Controllers.
Vision Sensor FH Series Operation Manual Sysmac Studio Conveyor Panorama Display Tool	Z371	SYSMAC-SE20□□ SYSMAC-RA401L NJ501-4□□□ R88D-KN□-ECT FH-1□□□ FH-3□□□	Learning the setup procedure of panorama display for image capture of targets on conveyors.	Describes how to configure and operate the Conveyor Panorama Display Tool on the Sysmac Studio on FH Sensor Controllers.
Vision & Robot Integrated Simulation Calibration Parameter Technology Introduction Guide	Y213	SYSMAC-SE20□□ SYSMAC-RA401L NJ501-4□□□ R88D-KN□-ECT FH-1□□□ FH-3□□□	Learning calibration parameters created using the 3D Equipment Model Creation Wizard for the Vision & Robot integrated simulation.	Describes calibration parameters created using the 3D Equipment Model Creation Wizard for the Vision & Robot integrated simulation.

Revision History

A manual revision code appears as a suffix to the catalog number on the front and back covers of the manual.



Revision code	Date	Revised content
01	December 2015	Original production

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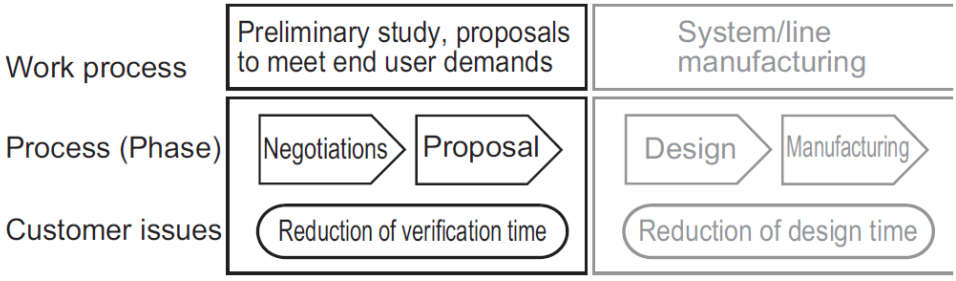
1. Overview of Simulation

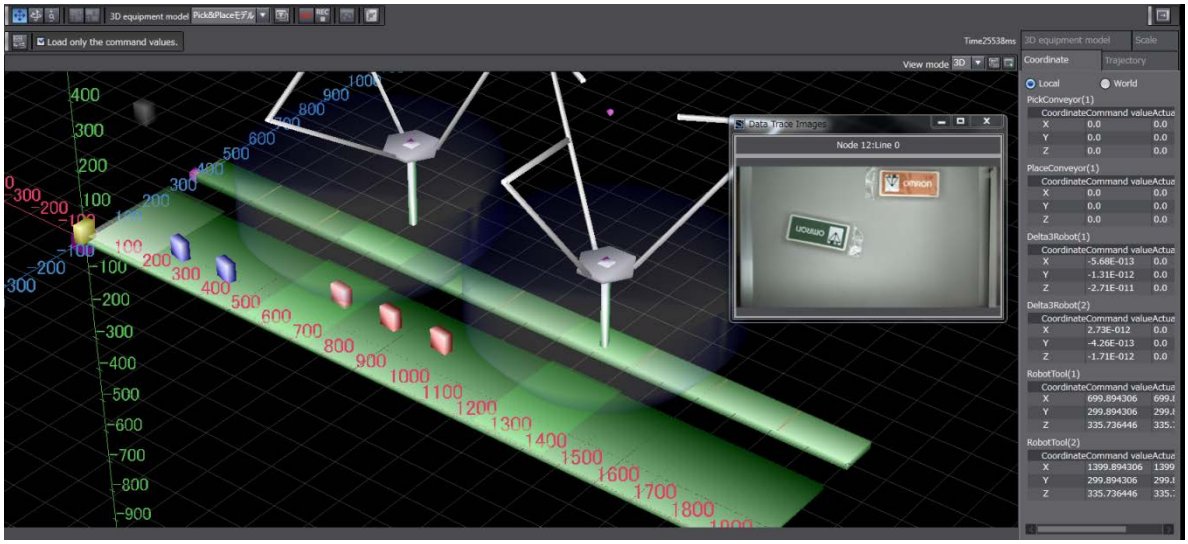
1.1. Simulation function

This section describes the simulation executed in this Guide.

When you consider newly introducing a pick-and-place application device, you need to perform verification based on the actual device environment.



You can use the Sysmac Studio's simulation function to perform this verification. This simulation is called “Vision & Robot integrated simulation.”
In the Vision & Robot integrated simulation, you can simulate the operation of the pick-and-place application in 3D. This leads to the reduction of time for the verification.



The following table shows the software that must be installed on a PC (OS: Windows 7 64-bit edition, Memory: 8 GB).

Manufacturer	Name	Version
OMRON	Sysmac Studio	Version 1.14
OMRON	Robot Additional Option	

Sample program used in this Guide

Item	Description
Project name	NJ-Robotics_ConveyorTrackingApplication_SampleProgram
Version	Rev A

Additional Information

For how to create control programs for robots and conveyors, refer to the *NJ-series NJ Robotics CPU Unit User's Manual* (Cat. No. W539), *NJ/NX-series CPU Unit Motion Control User's Manual* (Cat. No. W507), and *NJ/NX-series Motion Control Instructions Reference Manual* (Cat. No. W507).

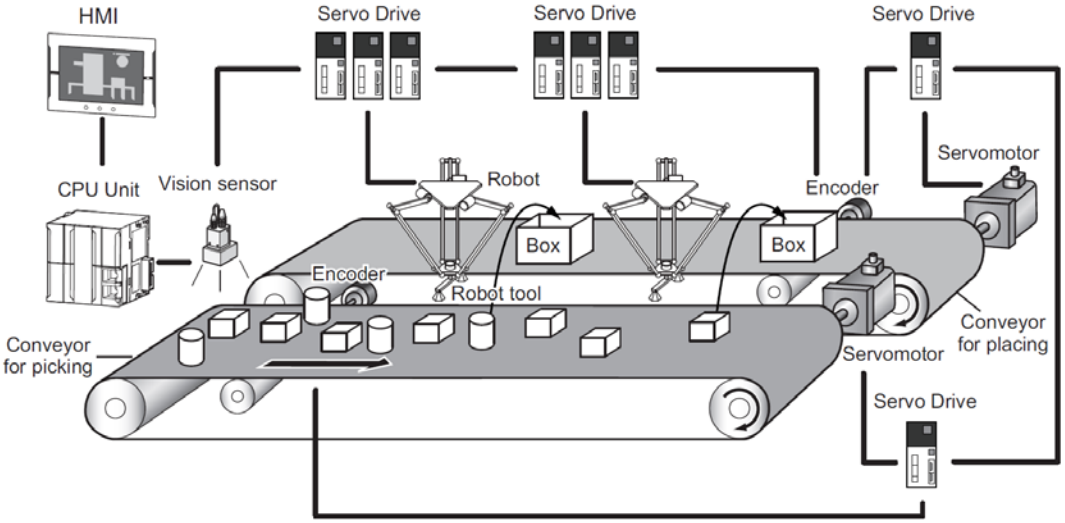
For how to set sample scenes and sample macros used for the Vision Sensor FH series, refer to the *Vision Sensor FH Series Conveyor Tracking Application Programming Guide* (Cat. No. Z368).

For how to set sample scenes and sample macros of the Vision Sensor FH series in the Sysmac Studio, refer to the *Vision System FH Series Operation Manual for Sysmac Studio* (Cat. No. Z343).

For screen design and functions of the NA-series Programmable Terminal, refer to the *NA-series Programmable Terminal Startup Guide* (Cat. No. V120) and *NA-series Programmable Terminal Software User's Manual* (Cat. No. V118).

1.2. Models that Support Simulation

This section provides an example of system configuration that enables you to perform a simulation in the pick-and-place application, where this Controller is used in combination with one or more vision sensors and robots.



• CPU Units

The compatible models are listed in the following table.

Series	Product	Model	Version
NJ5	Robotics	NJ501-4300/-4400/-4500	CPU Units: Version 1.10 or later Robots: Version 1.02 or later
		NJ501-4310	
	Robotics/DB Connection	NJ501-4320	

• Vision Sensors

The compatible models and the number of supported units are listed in the following table.

Series	Model	Qty
FH	FH-1□□□ FH-3□□□	1 sensor for each conveyor for picking

• Servo for Driving Robots

The compatible models are listed in the following table.

Series	Product	Model
G5	AC Servo Drive	R88D-KN□-ECT
	AC Servomotor	R88M-K□

• Servo for Driving Conveyors

A conveyor drive system consists of a combination of two elements, the conveyor drive source and the device to detect the travel distance of the conveyor. The following table shows the possible combinations of the conveyor drive source and the device to detect the travel distance of the conveyor.

	Conveyor drive source	Device to detect the conveyor travel distance
(1)	G5-series Servo Drive and Servomotor	G5-series Servomotor encoder
(2)	Any	Encoder connected to an encoder input slave (GX-EC□□□□)
(3)	Any	Encoder connected to an NX-series Position Interface Unit (NX-EC□□□□)

• Conveyor for Picking and Conveyor for Placing

You can specify up to the following number of conveyors for picking and conveyors for placing.

- At least one conveyor for picking
- Up to six conveyors for picking and conveyors for placing in total

• Robot

You can specify one to eight Delta3/Delta3R robots.

• Robot Tool

You can specify the vacuum-type robot tool only. The number of the robot tools that you can specify depends on the number of robots.

• HMI

You can perform a simulation of HMI projects along with a Vision & Robot integrated simulation. The compatible models are listed in the following table.

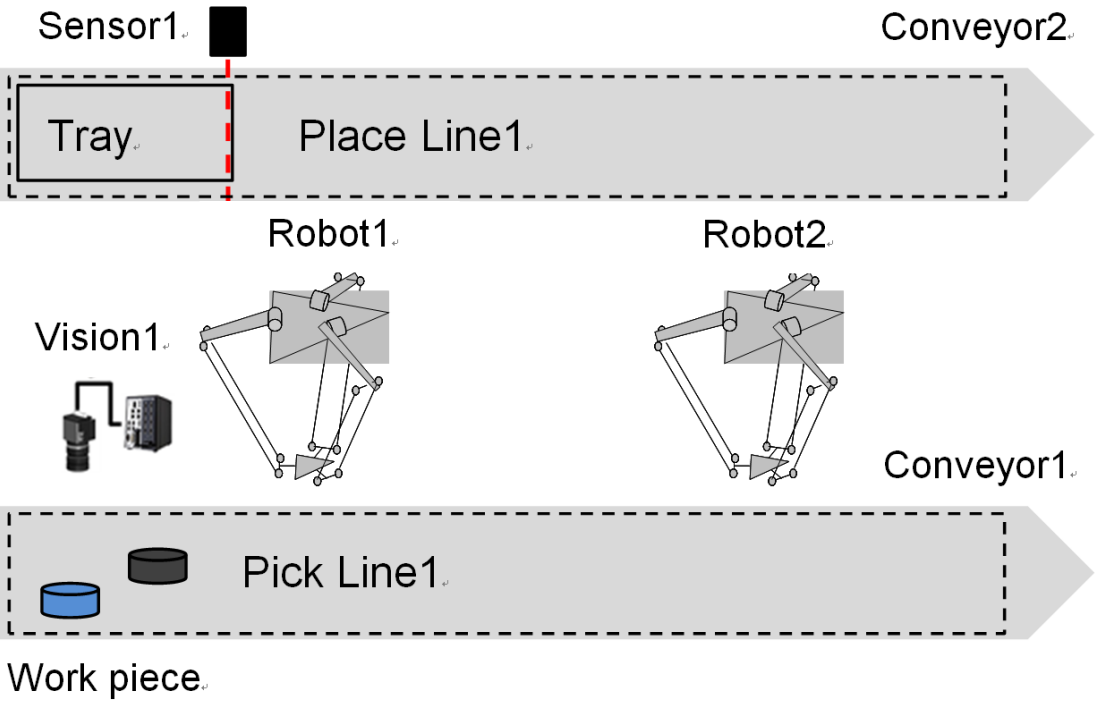
Series	Model
NA	NA5-15W101□
	NA5-12W101□
	NA5-9W001□
	NA5-7W001□

⚠ Caution

Although the Sysmac Studio's simulation function simulates the operations of the Controller and vision sensors, there are differences from the Controller and vision sensors in operation and timing.
After you use the simulation function to debug the user program, always check operation and perform adjustments on the physical Controller and vision sensors before you use the user program to operate the controlled system. Accidents may occur if the controlled system performs unexpected operation.

1.3. Equipment Model to Simulate

Create an equipment model that consists of one conveyor for picking, one conveyor for placing, two robots, and one vision sensor.



2. Before You Begin

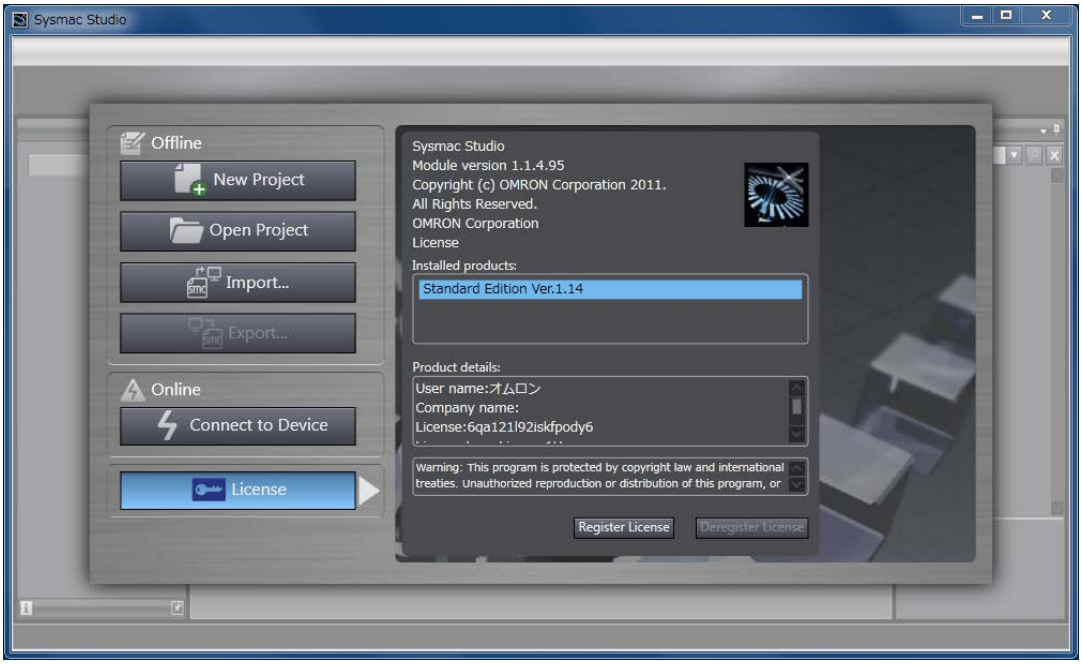
2.1. Enabling Robot Additional Option

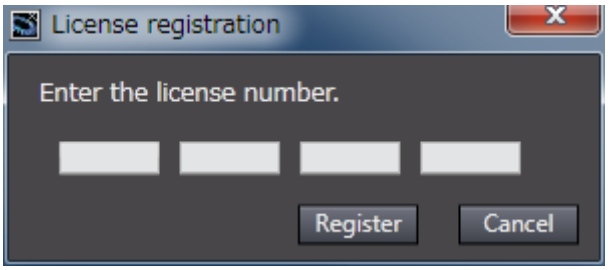
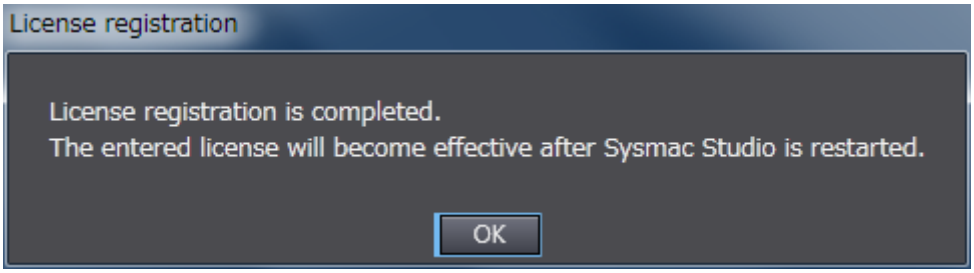
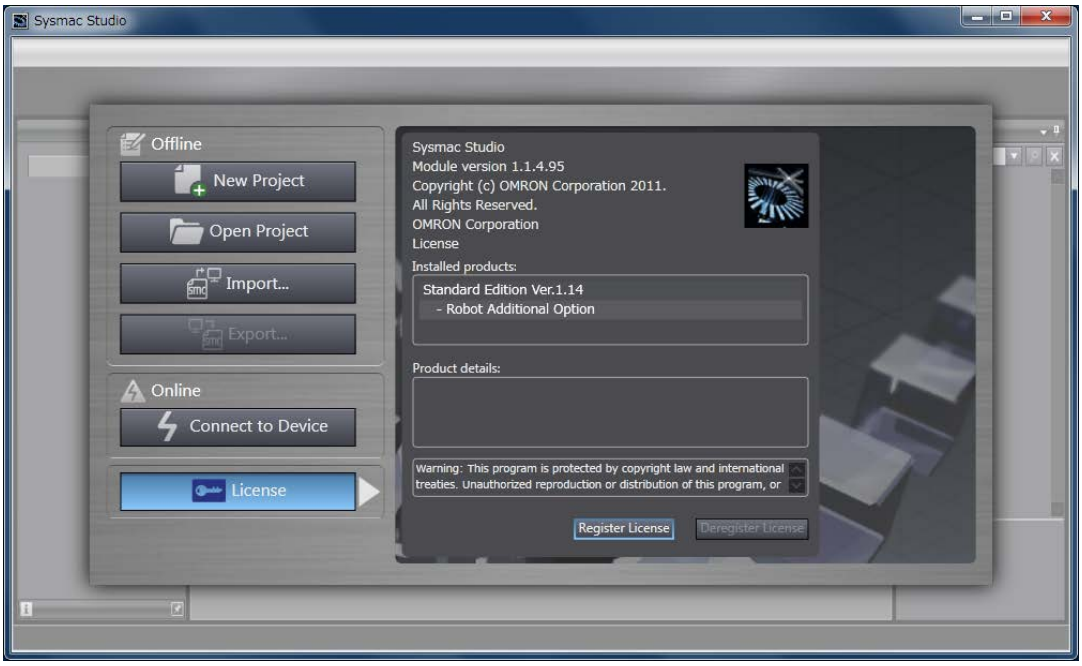
You can use the following functions necessary to perform a Vision & Robot integrated simulation after registering your Robot Additional Option license on the Sysmac Studio.

- Addition and editing of 3D equipment models for the pick-and-place application, including the conveyors for picking
- Creation and configuration of 3D equipment models for the pick-and-place application using the wizard
- Calculation of calibration parameters
- Display of captured images in 3D Motion Monitor

■ Enabling the Robot Additional Option

Take the following procedure on the Sysmac Studio.

1	Install the Sysmac Studio Standard Edition. Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for how to install.
2	Start the Sysmac Studio and click the **License** Button on the left side of the startup window. 
3	Click the **Register License** Button.

4	Enter the Robot Additional Option license number, and click the **Register** Button. 
5	If the license is registered successfully, the following message appears. Click the **OK** Button to close the window. 
6	Confirm that **Robot Additional Option** is displayed under **Installed products** as shown below. Restart the Sysmac Studio. 

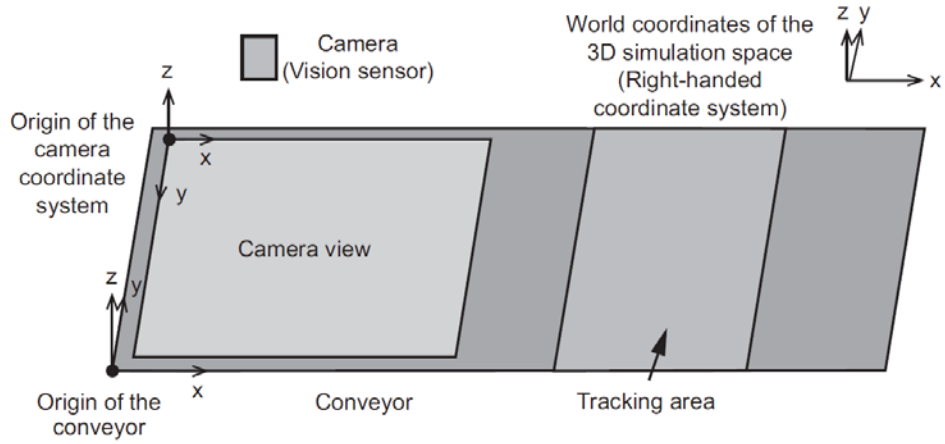
2.2. Details of Equipment Model

With the Vision & Robot integrated simulator, you can configure the position and size parameters of each machine model. Prepare the details of the equipment model before simulation.

The following equipment model is used for simulation in this Guide.

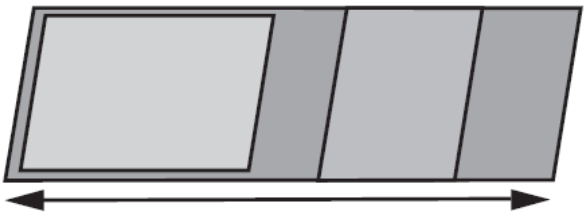
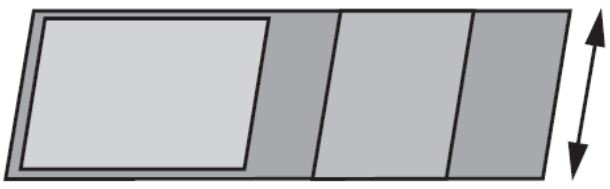
• Conveyor for Picking

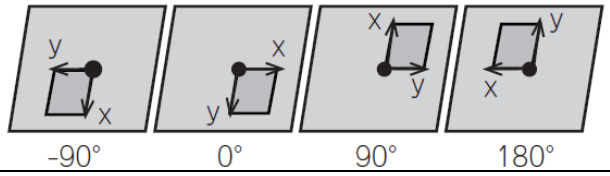
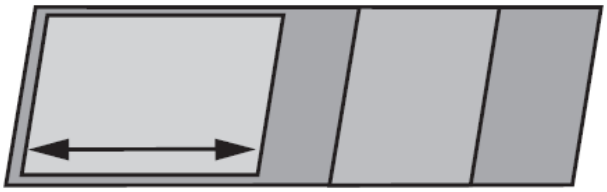
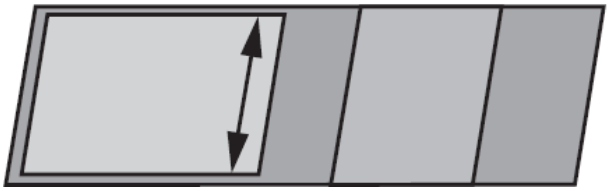
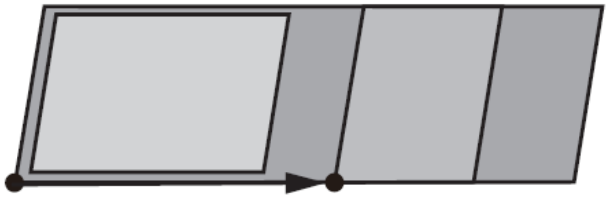
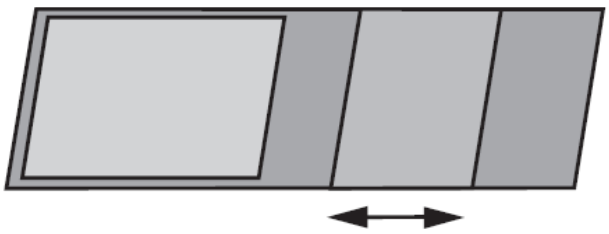
The machine model for a conveyor for picking has the components shown in the figure below.



Component name	Description
Camera view	The area in which the vision sensor captures images. The workpieces detected by the vision sensor's simulator are displayed in this area.
Conveyor	The conveyor for picking. It moves the workpieces displayed in the camera view.
Tracking area	Robots can pick the workpieces located in this area.This area has the same width as the width of the conveyor.
Camera	The model of the camera used for the simulation of the pick-and-place application.

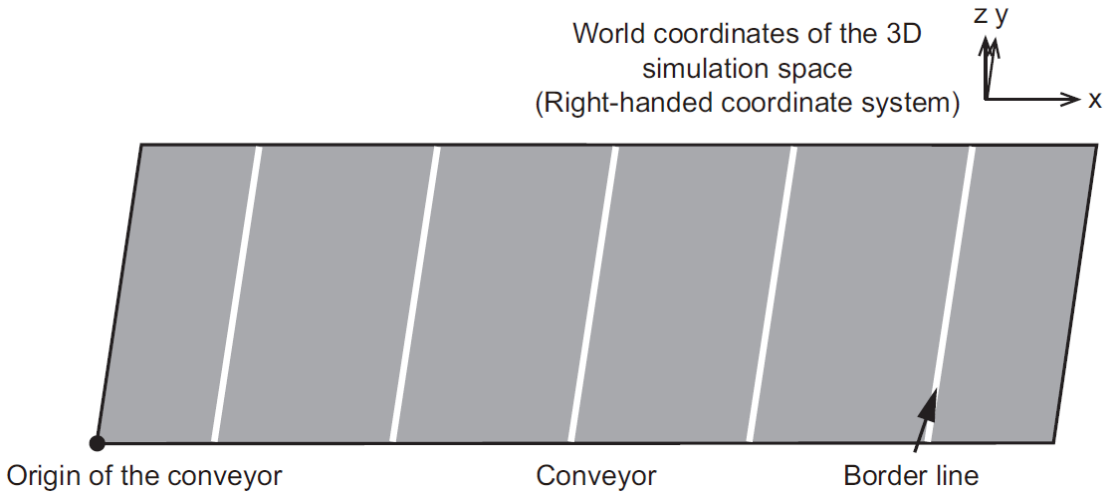
Setting values of conveyor for picking

Name	Setting value	Description
Conveyor: Length	2000 mm	The length of the conveyor's belt 
Conveyor: Width	300 mm	The width of the conveyor's belt 

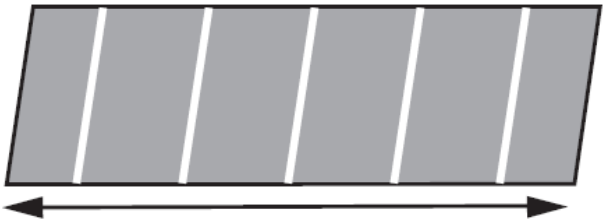
Camera: Orientation	90°	The orientation of the camera coordinate system relative to the conveyor coordinate system 
Camera view: Origin (X)	0 mm	The relative position of the origin of the camera coordinate system relative to the origin of the conveyor
Camera view: Origin (Y)	0 mm	
Camera view: X view	300 mm	The length of the camera view 
Camera view: Y view	200 mm	The width of the camera view 
Workpiece: Height	50 mm	The shape of the workpiece that is displayed on the 3D Motion Monitor View
Workpiece: Length	25 mm	
Workpiece: Width	50 mm	
Tracking area 1: Position (X)	550 mm	The position of the conveyor area where Robot 1 can pick workpieces 
Tracking area 1: Length	200 mm	The length of the conveyor area where Robot 1 can pick workpieces 
Tracking area 2: Position (X)	1250 mm	The position of the conveyor area where Robot 2 can pick workpieces
Tracking area 2: Length	200 mm	The length of the conveyor area where Robot 2 can pick workpieces

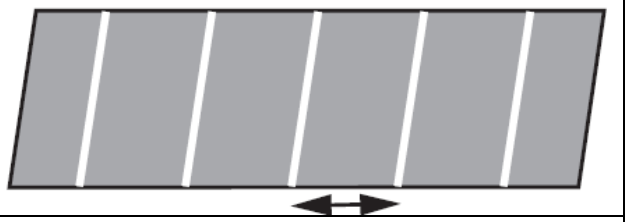
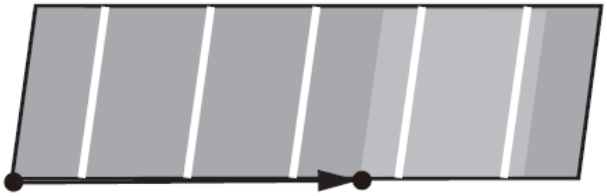
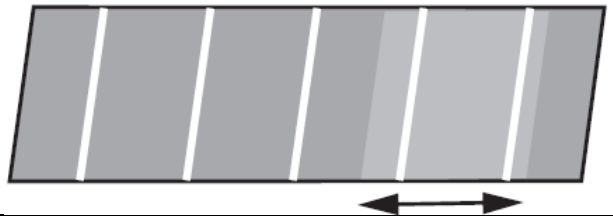
• Conveyor for Placing

The machine model for a conveyor for placing has the components shown in the figure below.



Setting values of conveyor for placing

Name	Setting value	Description
Conveyor: Length	2000 mm	The length of the conveyor's belt 
Conveyor: Width	100 mm	The width of the conveyor's belt 
Conveyor: Workpiece acceptance height	0 mm	The height at which workpieces are considered to come in contact with the conveyor. Any workpiece placed at this height or lower is considered to be in contact with the conveyor and moved in conjunction with the conveyor. 

Border line: Interval	200 mm	The display interval between two adjacent border lines 
Tracking area 1: Position (X)	500 mm	The position of the conveyor area where Robot 1 can place workpieces 
Tracking area 1: Length	200 mm	The length of the conveyor area where Robot 1 can place workpieces 
Tracking area 2: Position (X)	1200 mm	The position of the conveyor area where Robot 2 can place workpieces
Tracking area 2: Length	200 mm	The length of the conveyor area where Robot 2 can place workpieces

Additional Information

Refer to the *NJ-series NJ Robotics CPU Unit User's Manual* (Cat. No. W539) for the details of setting values of 3D machine models.

2.3. Preparing Image Data

The Vision & Robot integrated simulator uses image data captured by the Vision Sensor FH series. Prepare the image data used for simulation in advance.

• Image file format

File extension	Description	Resolution
.ifz	Bayer images that can be used for OMRON vision sensors	Depending on the resolution of the vision sensor
.bfz		
.bmp	Bitmap images that are widely used	640 x 480 min. 4084 x 3072 max.

• Saving image data

Image data can be saved to the following destinations.

(1) RAMDisk folder created on the C: drive

C:\Users*User name*\Documents\OMRON FZ\RAMDisk

(2) External hard drive or flash memory

Choose one of the above destinations to save an image file.

Additional Information

Refer to the *Vision System FH Series Operation Manual for Sysmac Studio* (Cat. No. Z343) for details of image data.

3. Performing Simulation

3.1. Simulation procedures

Use the following flow chart to perform a Vision & Robot integrated simulation.
The following sections describe each step of the flow chart.

3.2 Creating an Equipment Model

▼

3.3 Loading Sample Images

▼

3.4 Performing NA Integrated Simulation

▼

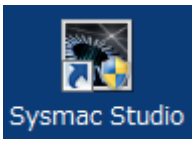
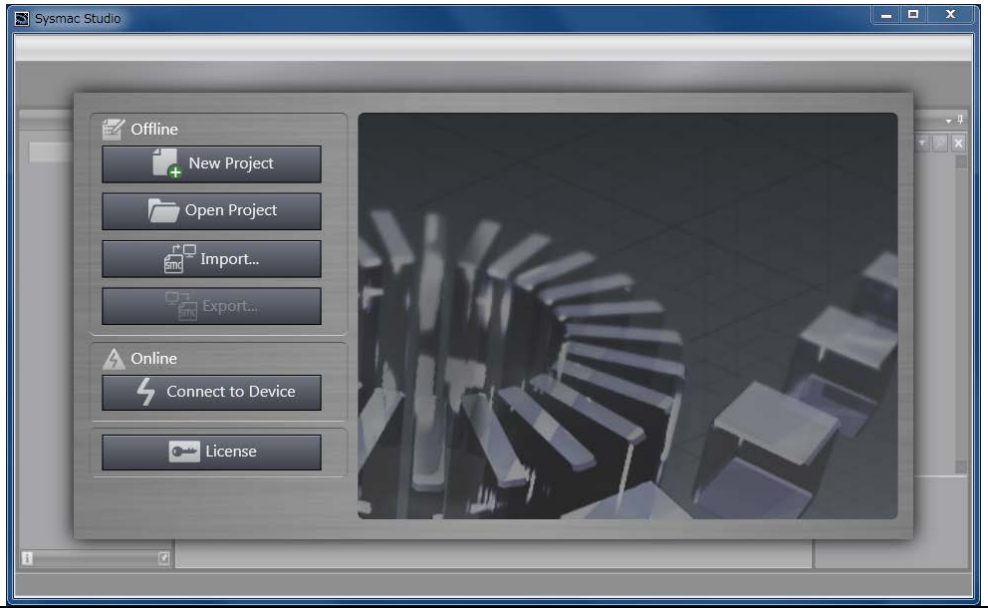
3.5 Displaying 3D Motion Monitor

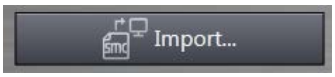
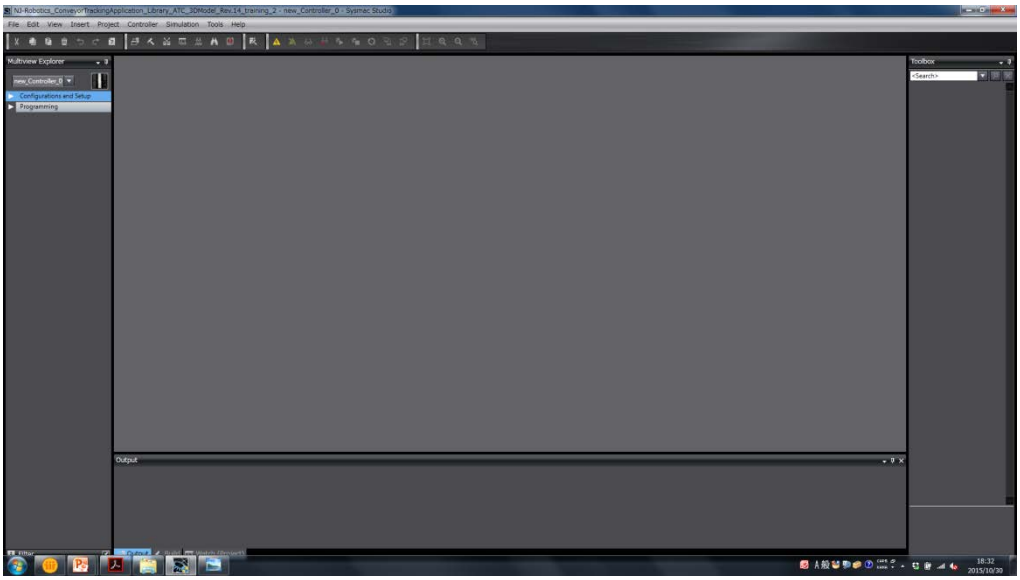
3.2. Creating an Equipment Model

Equipment models can be created using the 3D Equipment Model Creation Wizard.
This section describes how to configure 3D machine models according to *2.2. Details of Equipment Model* using the 3D Equipment Model Creation Wizard.

In order to perform the Vision & Robot integrated simulation, the program to operate the equipment model is required. The sample program is used for simulation in this Guide.

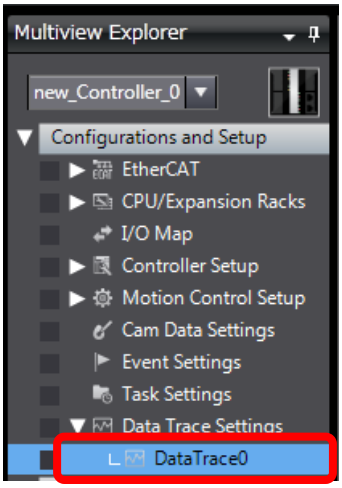
■ Loading the sample program

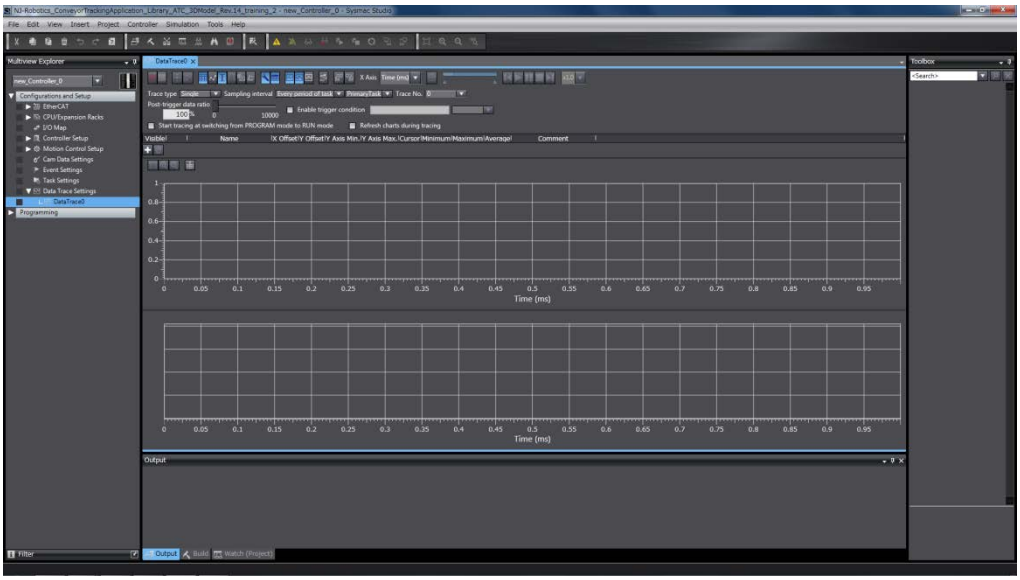
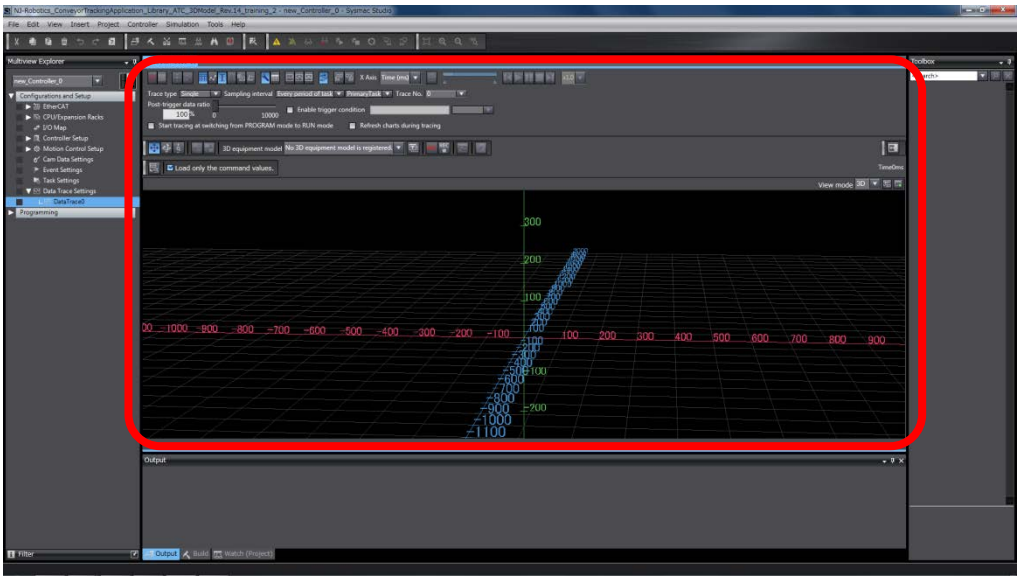
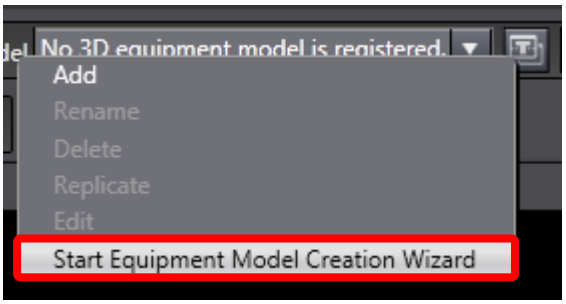
1	**Starting the Sysmac Studio** Use one of the following methods to start the Sysmac Studio. (1) Double-click the Sysmac Studio shortcut icon on your desktop.  (2) Select **All Programs - OMRON - Sysmac Studio - Sysmac Studio** from the Windows Start Menu. The Sysmac Studio starts and the following window is displayed. 

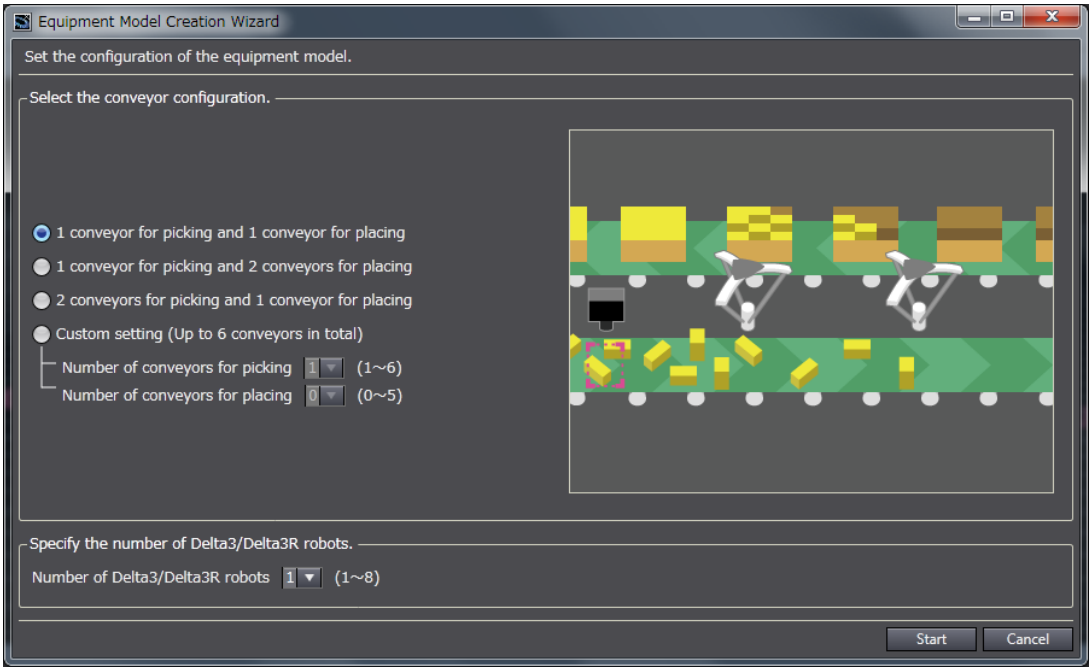
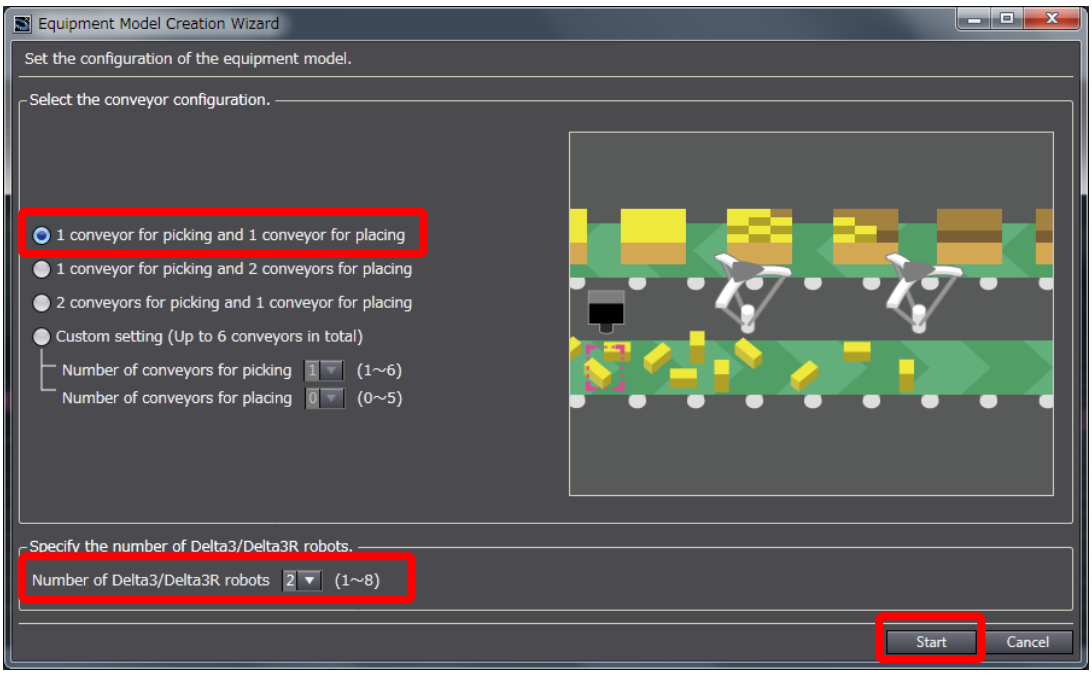
2	**Importing the sample program** Click the **Import** Button in the Project Window.  The following window is displayed. 

Next, create and configure machine models using the 3D Equipment Model Creation Wizard.

■ **Starting the 3D Equipment Model Creation Wizard**

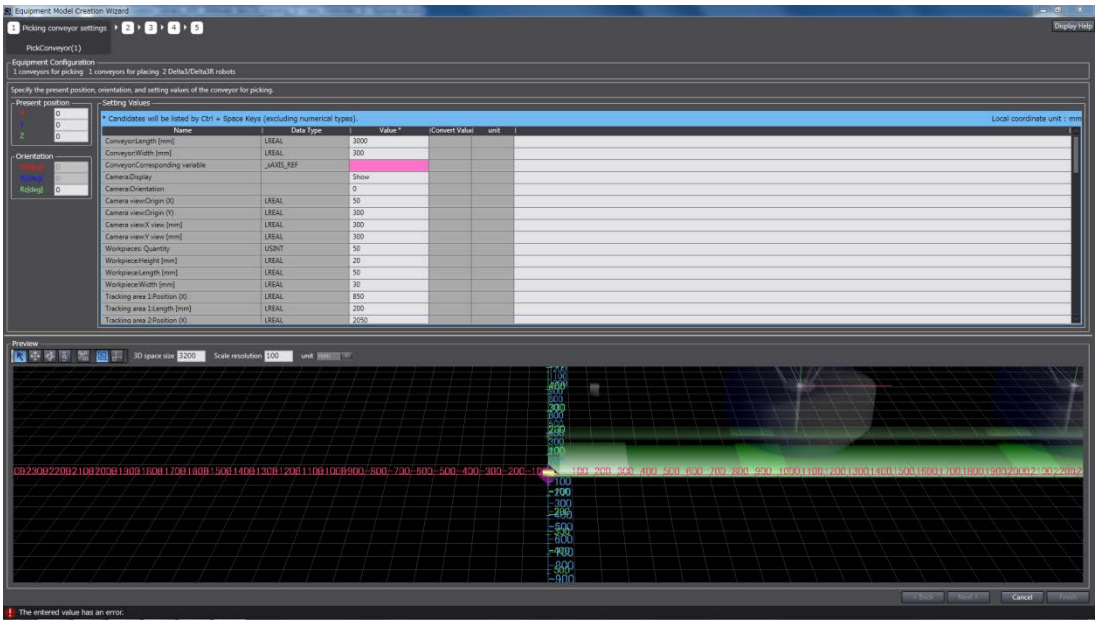
1	Right-click **Data Trace Settings** under **Configurations and Setup** in the Multiview Explorer and select **Add − Data Trace** from the menu. **DataTrace0** is added. 

2	Double-click **DataTrace0** to show the following window. 
3	Click the **Display 3D Motion Monitor** Button in the DataTrace0 Tab Page. 
4	3D Motion Monitor is displayed on the DataTrace0 Tab Page. 
5	Click the *3D equipment model* Box in the 3D Motion Monitor View and select **Start Equipment Model Creation Wizard**. 

6	The following window appears. 
7	Select the conveyor configuration and specify the number of Delta3/Delta3R robots in this wizard. Set the conveyor configuration to **1 conveyor for picking and 1 conveyor for placing** and the number of Delta3/Delta3R robots to **2**.  * You can simulate up to six conveyors for picking and placing in total. After you complete the settings of the equipment model, click the **Start** Button at the lower right corner of the window.

■ Setting machine models

When you click the **start** Button in the 3D Equipment Model Creation Wizard, the window to set the machine models appears.



Three categories of setting values are used to set machine models.

A: Setting values related to the sizes and positions of machine models

B: Setting values related to program variables

C: Setting values related to 3D motion monitor display

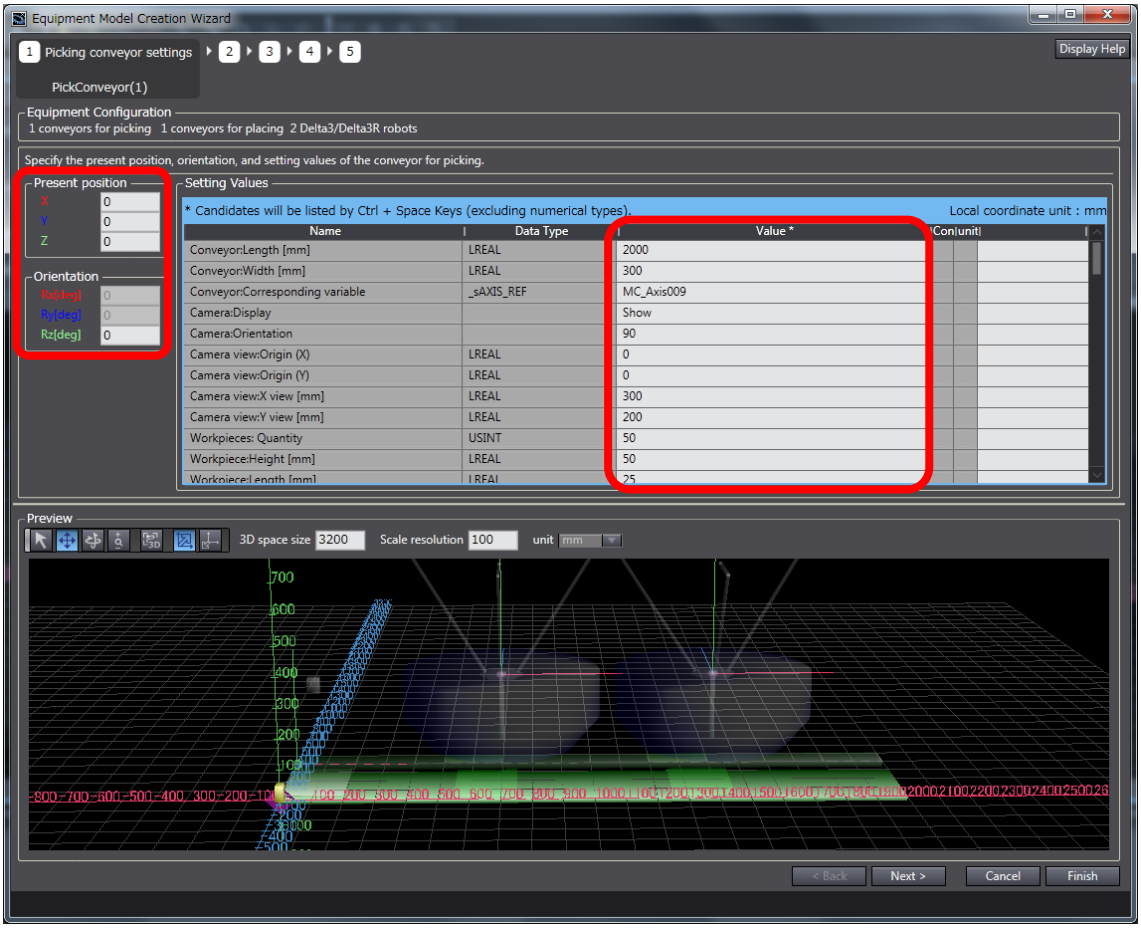
Set A according to the setting values of equipment model in *2.2. Details of Equipment Model*.

Set B according to the used program.

C is the drawing method in 3D motion monitoring. Set arbitrary values.

(1) Creating the machine model for a conveyor for picking

Enter values in the *Value* Column in the 3D Equipment Model Creation Wizard.



The following setting values for the conveyor for picking are used in this Guide.

Name	Data Type	Value	Category
Conveyor:Length	LREAL	2000	A
Conveyor:Width	LREAL	300	A
Conveyor:Corresponding variable	_sAXIS_REF	MC_Axis009	B
Camera:Display		show	C
Camera:Orientation		90	A
Camera view:Origin (X)	LREAL	0	A
Camera view:Origin (Y)	LREAL	0	A
Camera view:X view	LREAL	300	A
Camera view:Y view	LREAL	200	A
Workpieces:Quantity	USINT	50	C
Workpieces:Height	LREAL	50	C
Workpieces:Length	LREAL	25	C
Workpieces:Width	LREAL	50	C
Tracking area 1:Position (X)	LREAL	550	A
Tracking area 1:Length	LREAL	200	A
Tracking area 2:Position (X)	LREAL	1250	A
Tracking area 2:Length	LREAL	200	A
Active robot1		Delta3Robot(1)	B
Active robot2		Delta3Robot(2)	B
Vision sensor:Node address	UINT	12	B
Vision sensor:Line No.	USINT	0	B
Vision sensor:Variables of detected workpiece information	sSimWorkInitalData	SimInitialization.SimWorkInitData[0]	B

* Category is not displayed in the 3D Equipment Model Creation Wizard.

Set values related to the vision sensor for *Vision sensor: Variables of detected workpiece information*.

The sample program has the sSimWorkInitalData data type. When this data type is used, member variables included in this data type are automatically set.
The sSimWorkInitalData data type includes the member variables listed below.

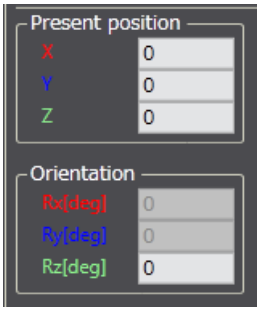
• Simulation\sSimWorkInitialData

Member variable	Data type	Description
TotalJudgement	BOOL	Total Judgment output when FH captured image (unused in sample program)
ResultNotification	BOOL	Data output completion when FH captured image
ResultTotalNumber	LREAL	Number of workpieces detected when FH captured image (Positive number, 0)
EncPosition	LREAL	Encoder position when FH captured image [mm] (Positive number, 0)
ResultData	ARRAY[0..6] OF Simulation\sSimWorkData	Workpiece data when FH captured image (Positive number, negative number, 0)

• Simulation\sSimWorkData

Member variable	Data type	Function
WorkType	LREAL	Index of detected workpiece (Positive number, negative number, 0)
Position	ARRAY[0..2] OF LREAL	Position of detected workpiece Position[0]: X (Positive number, negative number, 0) Position[1]: Y (Positive number, negative number, 0) Position[2]: Rz (-180 to 180)

Set the origin position of the conveyor for picking as shown below.



Once you complete setting the conveyor for picking, click the **Next >** Button at the lower right corner of the window.

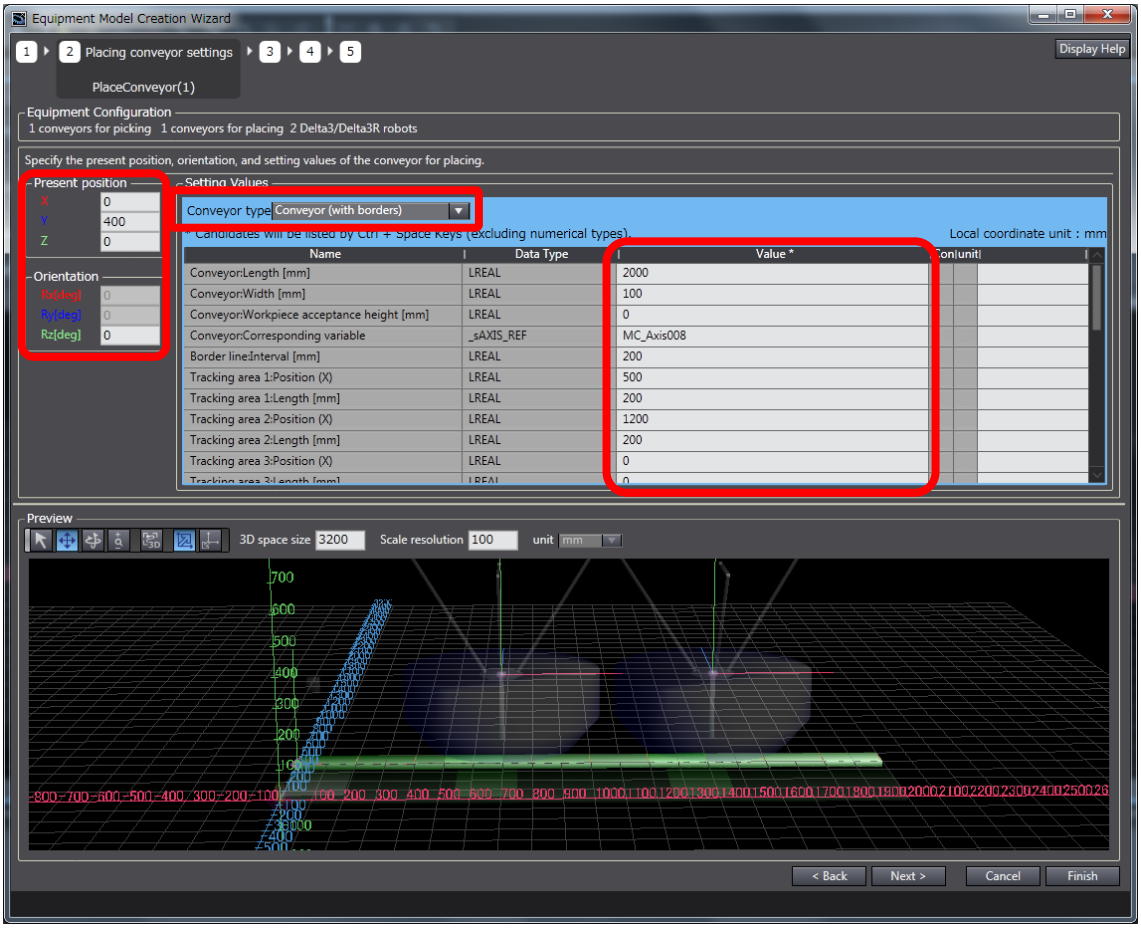
Additional Information

Refer to the *NJ-series NJ Robotics CPU Unit User's Manual* (Cat. No. W539) for the details of machine models.

(2) Creating the machine model for a conveyor for placing

Enter values in the *Value* Column in the 3D Equipment Model Creation Wizard.

Select **Conveyor (with borders)** in the *Conveyor type* Box.

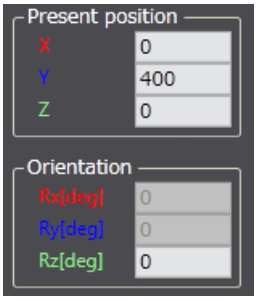


The following setting values for the conveyor for placing are used in this Guide.

Name	Data Type	Value	Category
Conveyor:Length	LREAL	2000	A
Conveyor:Width	LREAL	100	A
Conveyor:Workprece acceptance height	LREAL	0	A
Conveyor:Corresponding variable	_sAXIS_REF	MC_Axis008	B
Border line:Interval	LREAL	200	A
Tracking area 1:Position (X)	LREAL	500	A
Tracking area 1:Length	LREAL	200	A
Tracking area 2:Position (X)	LREAL	1200	A
Tracking area 2:Length	LREAL	200	A
Active robot1		Delta3Robot(1)	B
Active robot2		Delta3Robot(2)	B
Trigger cariable:Corresponding variable	BOOL	PlaceLine1.SensorInput[1]	B

* Category is not displayed in the 3D Equipment Model Creation Wizard.

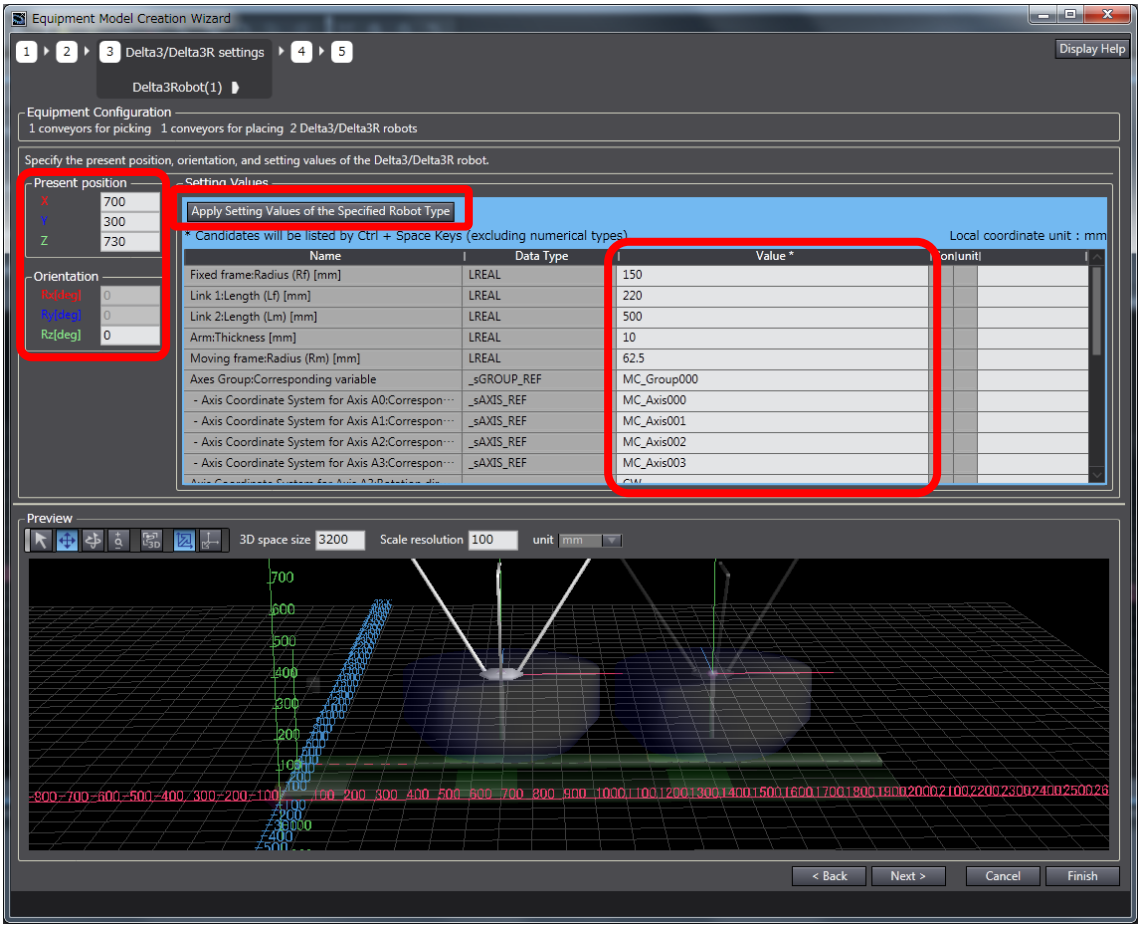
Set the origin position of the conveyor for placing as shown below.



Once you complete setting the conveyor for placing, click the **Next >** Button at the lower right corner of the window.

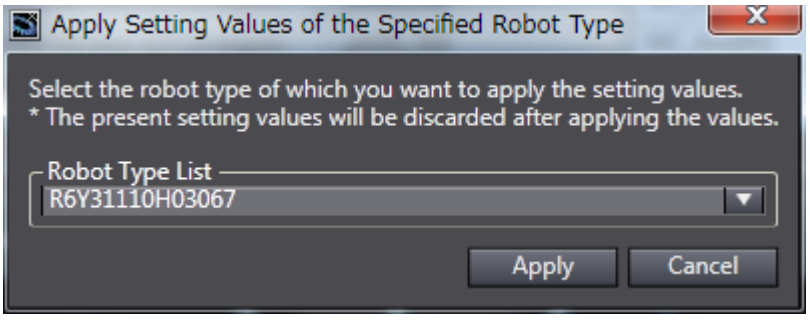
(3) Creating the machine models for Delta3/Delta3R robots

Enter values in the *Value* Column in the 3D Equipment Model Creation Wizard.



Click the **Apply Setting Values of the Specified Robot Type** Button.

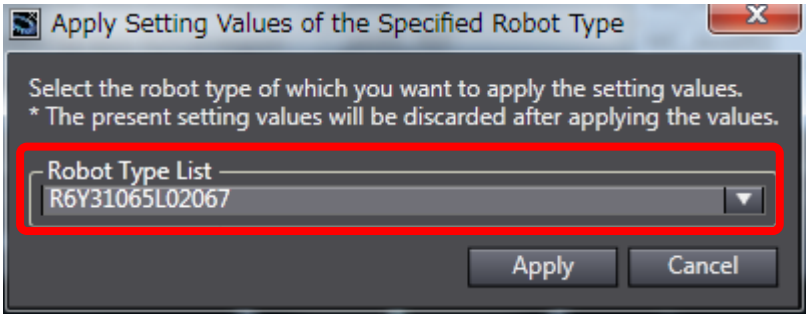
The following dialog box appears.



Additional Information

Refer to *4.1. Robot Type List* for robot types.

Select the robot type to use in the *Robot Type List* Box.
Select **R6Y31065L02067** in this Guide.

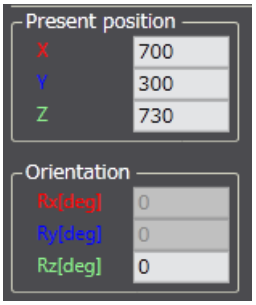


Click the **Apply** Button to apply the kinematics and workspace setting values of the selected robot type to the *Value* Column in the 3D Equipment Model Creation Wizard.

Next, set *Axes Group: Corresponding variable* of the robot.
The setting values for Robot 1 used in this Guide are listed in the following table.

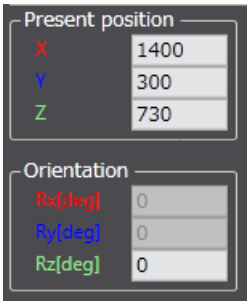
Name	Data Type	Value	Category
Fixed frame:Radius (Rf)	LREAL	150	A
Link 1:Length (Lf)	LREAL	220	A
Link 2:Length (Lm)	LREAL	500	A
Arm:Thickness	LREAL	10	A
Moving frame:Radius (Rm)	LREAL	62.5	A
Axes Group:Corresponding variable	_sGROUP_REF	MC_Group000	B
-Axis Coordinate System for Axis A0:Corresponding variable	_sAXIS_REF	MC_Axis000	B
-Axis Coordinate System for Axis A1:Corresponding variable	_sAXIS_REF	MC_Axis001	B
-Axis Coordinate System for Axis A2:Corresponding variable	_sAXIS_REF	MC_Axis002	B
-Axis Coordinate System for Axis A3:Corresponding variable	_sAXIS_REF	MC_Axis003	B
Axis Coordinate System for Axis A3:Rotation direction		CW	B
Axis Coordinate System for Axis A1:Initial angle	LREAL	0	B
Axis Coordinate System for Axis A2:Initial angle	LREAL	0	B
Axis Coordinate System for Axis A3:Initial angle	LREAL	0	B
Origin position for rotation around Z axis of machine coordinate system:Theta[deg]	LREAL	0	B
Workspace:Show		show	C
Workspace:Transparency [%]	UINT	80	A
Workspace:Front position of the cylinder (Zu)	LREAL	-379	A
Workspace:Radius of the cylinder (Rcy)	LREAL	325	A
Workspace:Hight of the cylinder (Hcy)	LREAL	150	A
Workspace:Hight of the cone (Hco)	LREAL	100	A
Workspace:Redius of the cone bottom (Rco)	LREAL	240	A

Set the origin position of Robot 1 as shown below.



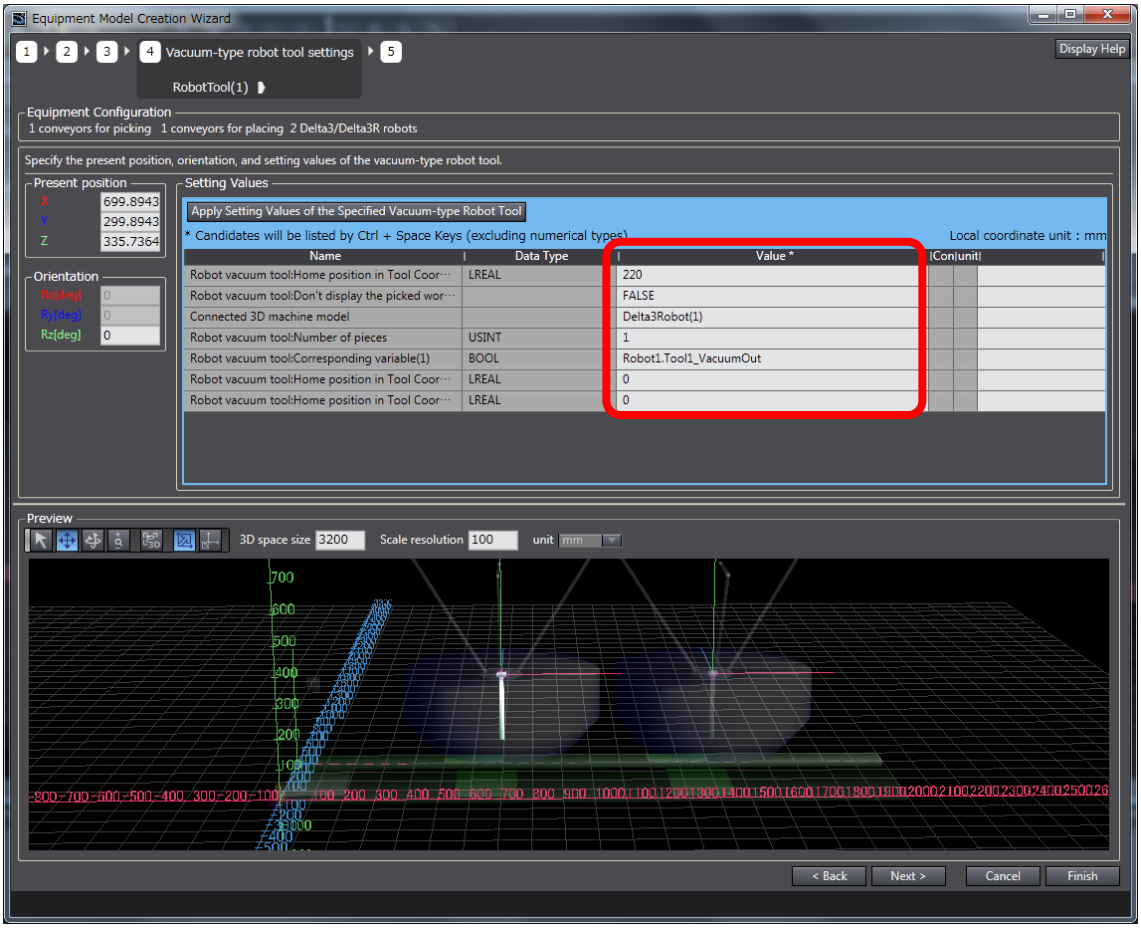
Once you complete setting the Delta3/Delta3R, click the **Next >** Button at the lower right corner of the window.

The settings of the second Delta3/Delta3R are the same as that of Robot 1.
Set the origin position of Robot 2 as shown below.



(4) Creating the machine model for a vacuum-type robot tool

Enter values in the *Value* Column in the 3D Equipment Model Creation Wizard.



The following setting values for the vacuum-type robot tool for Robot 1 are used in this Guide.

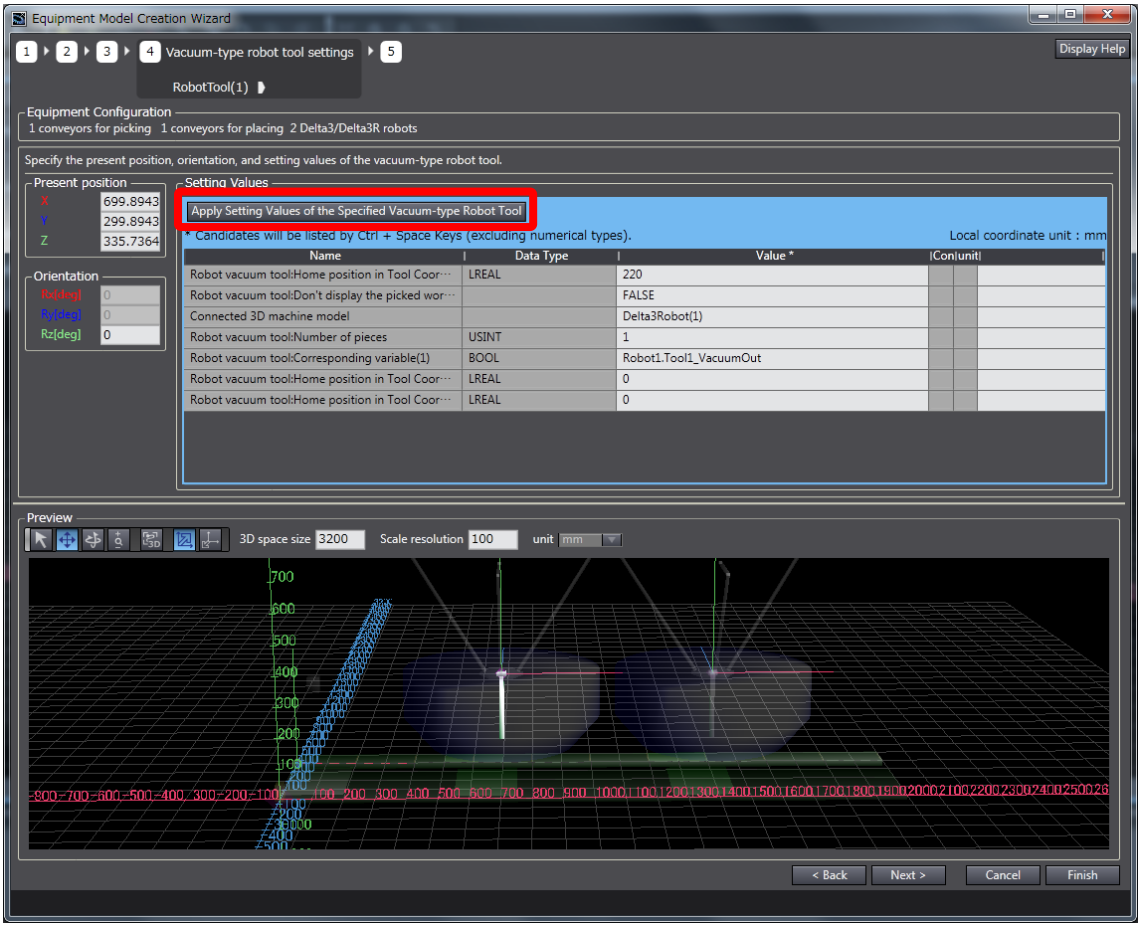
Name	Data Type	Value	Category
Robot vacuum tool:Home position in Tool Coordinate System	LREAL	220	A
Robot vacuum tool:Don't display the picked workpieces		FALSE	C
Connected 3D machine model		Delta3Robot(1)	B
Robot vacuum tool:Number of pieces	USINT	1	A
Robot vacuum tool:Corresponding variable(1)	BOOL	Robot1.Tool1_VacuumOut	B
Robot vacuum tool:Home position in Tool Coordinate System (Tz)(1)	LREAL	0	A
Robot vacuum tool:Home position in Tool Coordinate System (Ty)(1)	LREAL	0	A

Once you complete setting the robot tool, click the **Next >** Button at the lower right corner of the window.

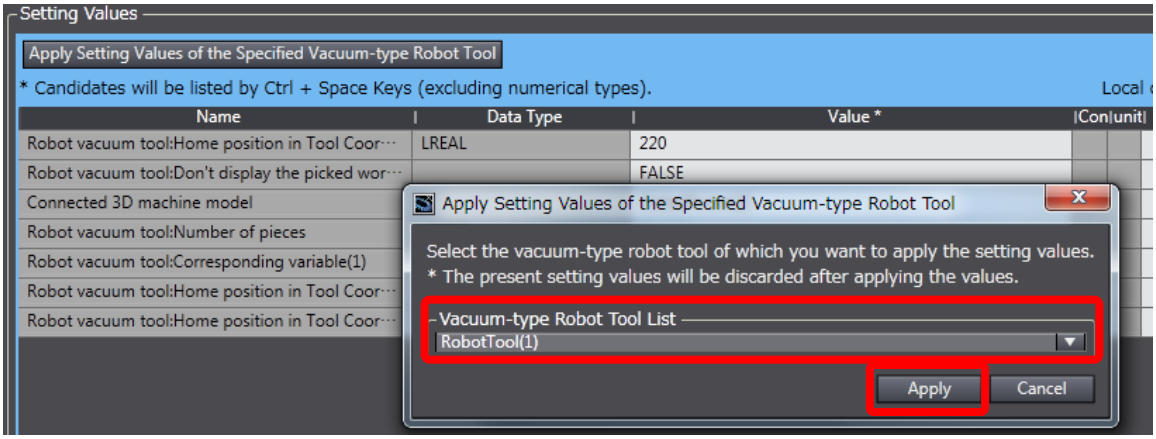
(5) Copying the machine model for a vacuum-type robot tool

As the setting values of the machine model for the robot tool for Robot 1 are the same as those for Robot 2 in this simulation, copy the machine model.

Click the **Apply Setting Values of the Specified Vacuum-type Robot Tool** Button in the *Setting Values* Field in the 3D Equipment Model Creation Wizard.



The following dialog box appears.

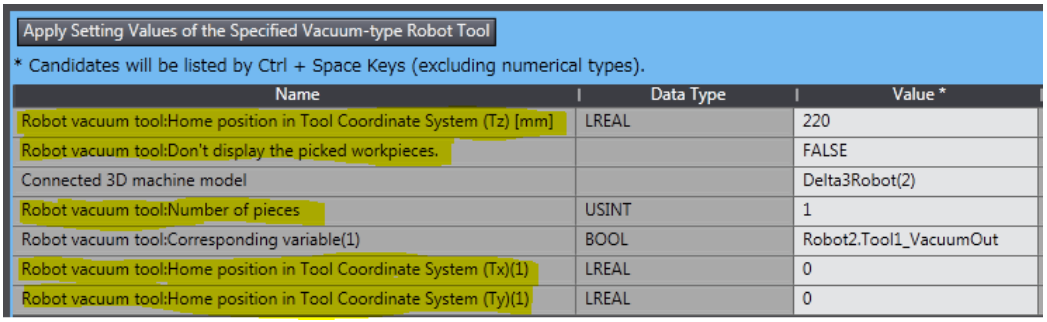


Select **RobotTool (1)** in the *Vacuum-type Robot Tool List* Box.

Click the **Apply** Button.

Check that the setting values of the yellow-highlighted variables shown below are copied from

those of the machine model of the vacuum-type robot tool for Robot 1.



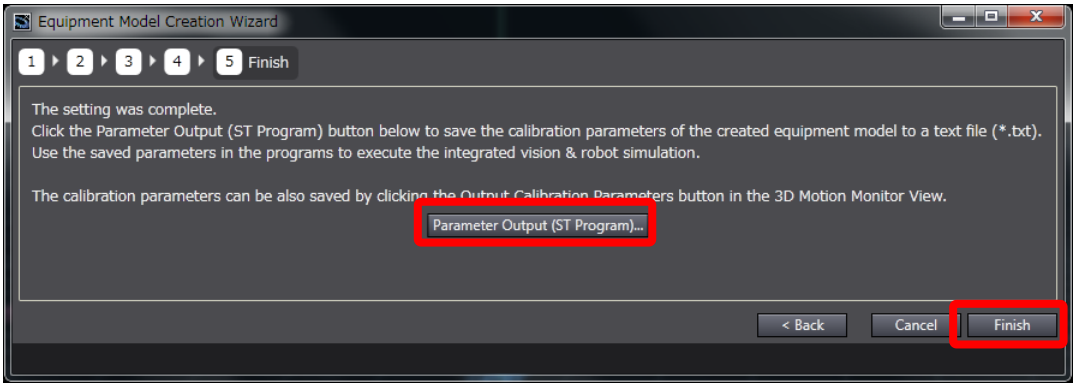
The setting values for the vacuum-type robot tool for Robot 2 used in this Guide are listed in the following table.

Name	Data Type	Value	Category
Robot vacuum tool:Home position in Tool Coordinate System	LREAL	220	A
Robot vacuum tool:Don't display the picked workpieces		FALSE	C
Connected 3D machine model		Delta3Robot(2)	B
Robot vacuum tool:Number of pieces	USINT	1	A
Robot vacuum tool:Corresponding variable(1)	BOOL	Robot2.Tool1_VacuumOut	B
Robot vacuum tool:Home position in Tool Coordinate System (Tz)(1)	LREAL	0	A
Robot vacuum tool:Home position in Tool Coordinate System (Ty)(1)	LREAL	0	A

Once you complete setting the robot tool, click the **Next >** Button at the lower right corner of the window.

(6) Outputting calibration parameters

Once you complete setting all the machine models, you can output the calibration parameters to a file. Click the **Parameter Output (ST Program)** Button.



A dialog box appears. Save the file into the specified folder.

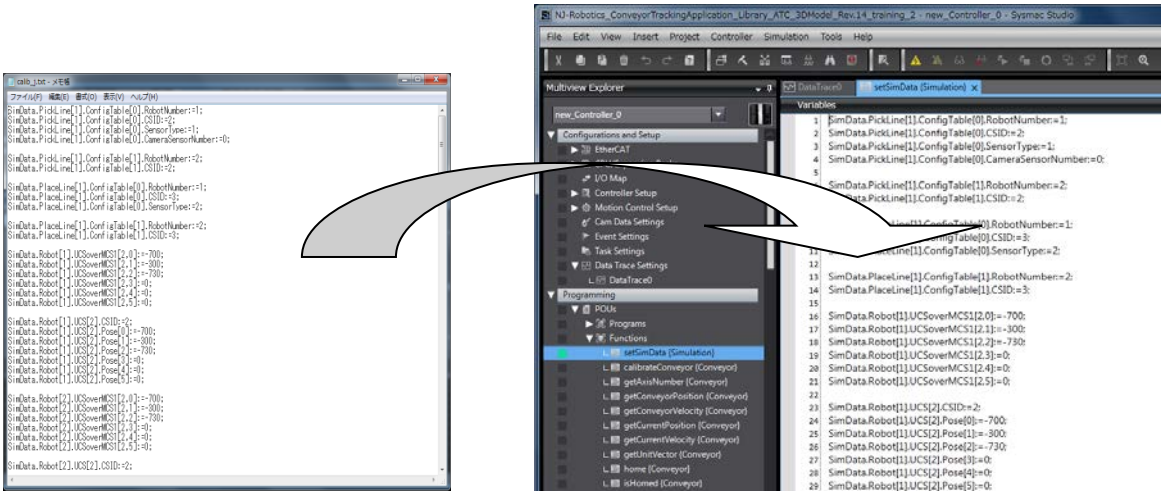
After saving the calibration parameters to a file, click the **Finish** Button at the lower right corner of the window to end setting the equipment model.

■ Loading calibration parameters

Transcribe the saved calibration parameters to the setSimData function to use them in the program to perform the simulation.

Double-click **setSimData** under **Programming - POUs - Functions** in the Multiview Explorer to open the setSimData function.

Delete all the codes on the setSimData function, and then copy and paste the calibration parameters.



```
SimData.PickLine[1].ConfigTable[0].RobotNumber:=1;
SimData.PickLine[1].ConfigTable[0].CSID:=2;
SimData.PickLine[1].ConfigTable[0].SensorType:=1;
SimData.PickLine[1].ConfigTable[0].CameraSensorNumber:=0;

SimData.PickLine[1].ConfigTable[1].RobotNumber:=2;
SimData.PickLine[1].ConfigTable[1].CSID:=2;

SimData.PlaceLine[1].ConfigTable[0].RobotNumber:=1;
SimData.PlaceLine[1].ConfigTable[0].CSID:=3;
SimData.PlaceLine[1].ConfigTable[0].SensorType:=2;

SimData.PlaceLine[1].ConfigTable[1].RobotNumber:=2;
SimData.PlaceLine[1].ConfigTable[1].CSID:=3;

SimData.Robot[1].UCSoverMCS1[2,0]:=-700;
SimData.Robot[1].UCSoverMCS1[2,1]:=-300;
SimData.Robot[1].UCSoverMCS1[2,2]:=-730;
SimData.Robot[1].UCSoverMCS1[2,3]:=0;
SimData.Robot[1].UCSoverMCS1[2,4]:=0;
SimData.Robot[1].UCSoverMCS1[2,5]:=0;

SimData.Robot[1].UCS[2].CSID:=2;
SimData.Robot[1].UCS[2].Pose[0]:=-700;
SimData.Robot[1].UCS[2].Pose[1]:=-300;
SimData.Robot[1].UCS[2].Pose[2]:=-730;
SimData.Robot[1].UCS[2].Pose[3]:=0;
SimData.Robot[1].UCS[2].Pose[4]:=0;
SimData.Robot[1].UCS[2].Pose[5]:=0;

SimData.Robot[2].UCSoverMCS1[2,0]:=-700;
SimData.Robot[2].UCSoverMCS1[2,1]:=-300;
SimData.Robot[2].UCSoverMCS1[2,2]:=-730;
SimData.Robot[2].UCSoverMCS1[2,3]:=0;
SimData.Robot[2].UCSoverMCS1[2,4]:=0;
SimData.Robot[2].UCSoverMCS1[2,5]:=0;

SimData.Robot[2].UCS[2].CSID:=2;
```

Calibration parameters are loaded when the simulation is performed.

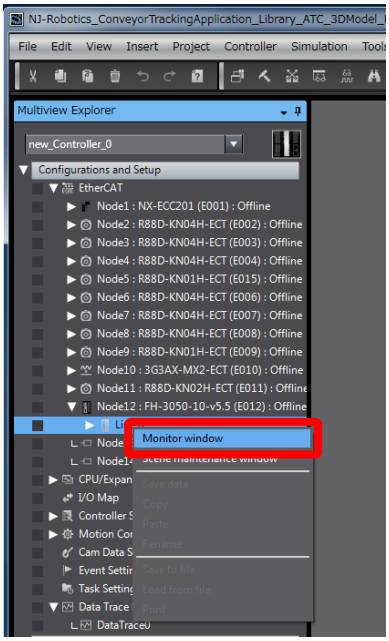
Additional Information

Refer to the *Vision & Robot Integrated Simulation Calibration Parameter Technology Introduction Guide* (Cat. No. ****) for details of calibration parameters.

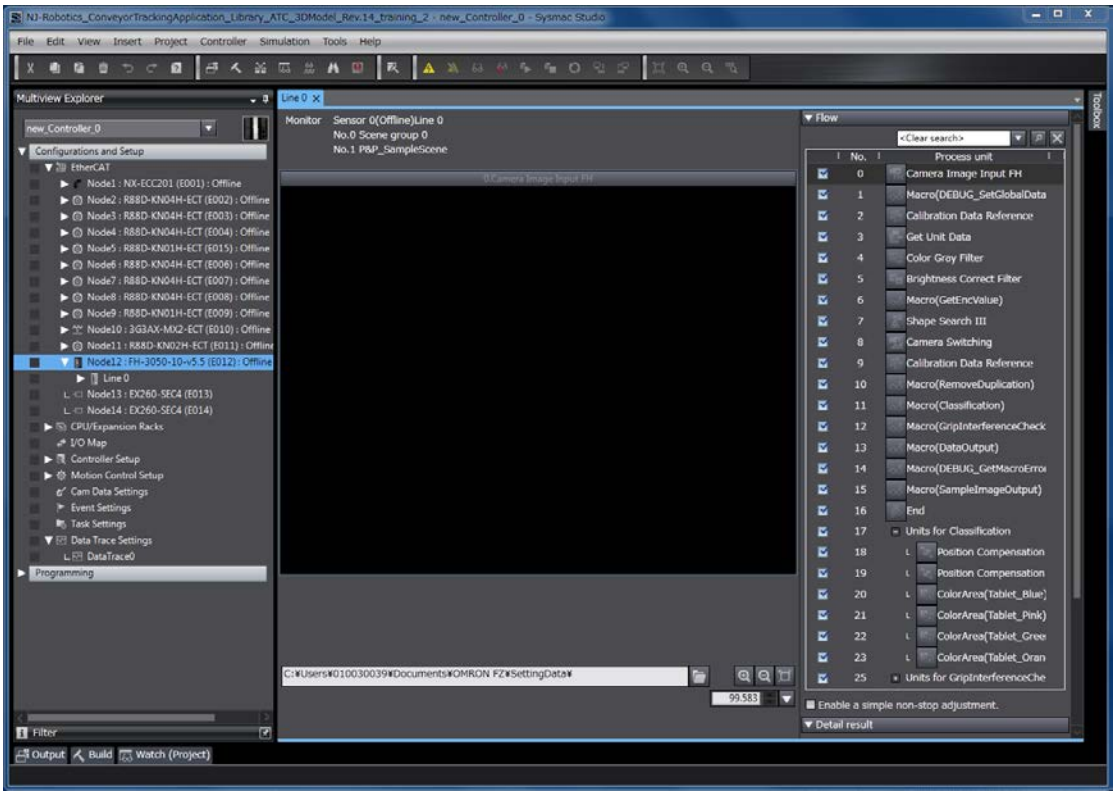
3.3. Loading Sample Images

The Vision & Robot integrated simulator uses image data captured by the Vision Sensor FH series. Load the workpiece sample images prepared in *2-3 Preparing Image Data*.

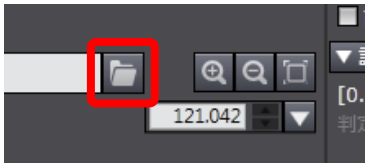
Right-click **Line 0** under **Configurations and Setup - EtherCAT - FH-XXXX** in the Multiview Explorer and select **Monitor window** from the menu to open the Monitor Window.



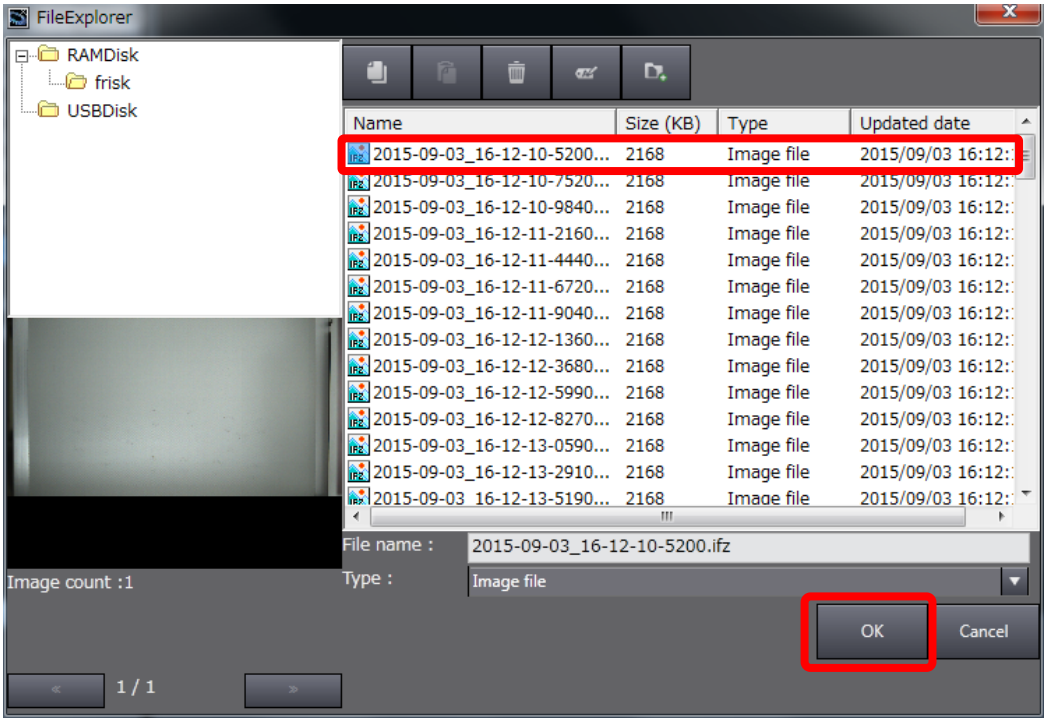
The following window is displayed.



Click the **Select Image File** Button.



Select the first image file and click the **OK** Button.



The workpiece sample images are loaded.

Additional Information

Refer to the *Vision System FH Series Operation Manual for Sysmac Studio* (Cat. No. Z343) for details on setting the Vision Sensor FH series on the Sysmac Studio.

3.4. Performing NA Integrated Simulation

Perform NA integrated simulation to trace the data that is loaded for the 3D Motion Monitor. The following conditions must be met to perform integrated simulation.

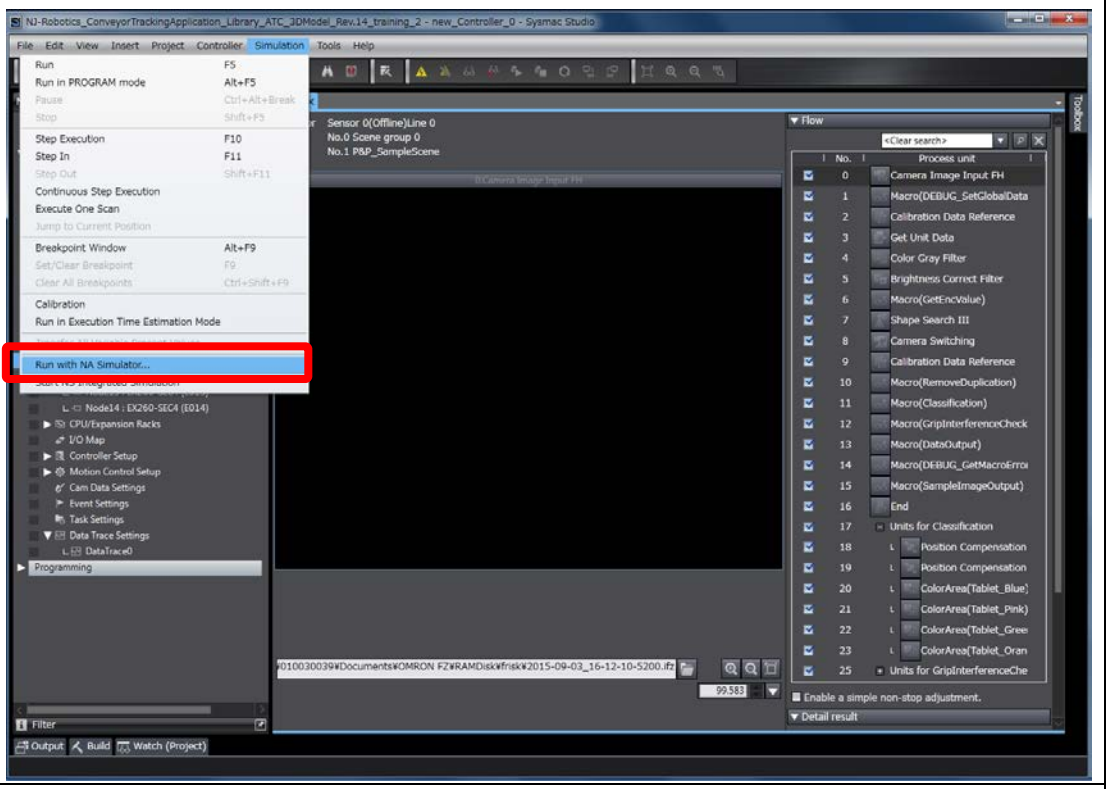
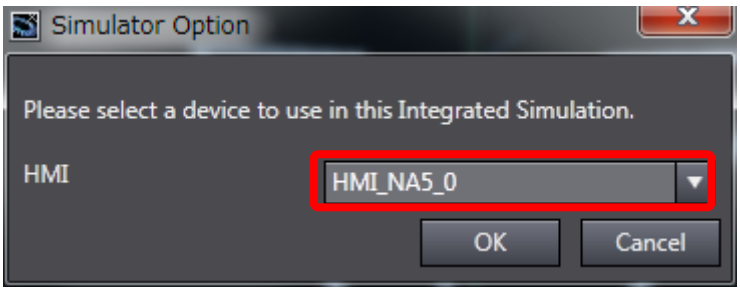
(1) Calibration parameters are transcribed to the setSimData function.
(3.2. Creating an Equipment Model)

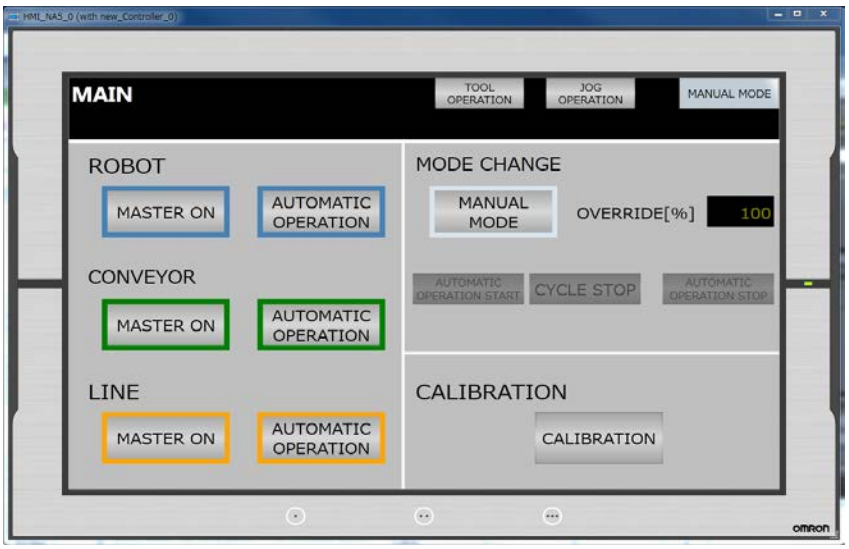
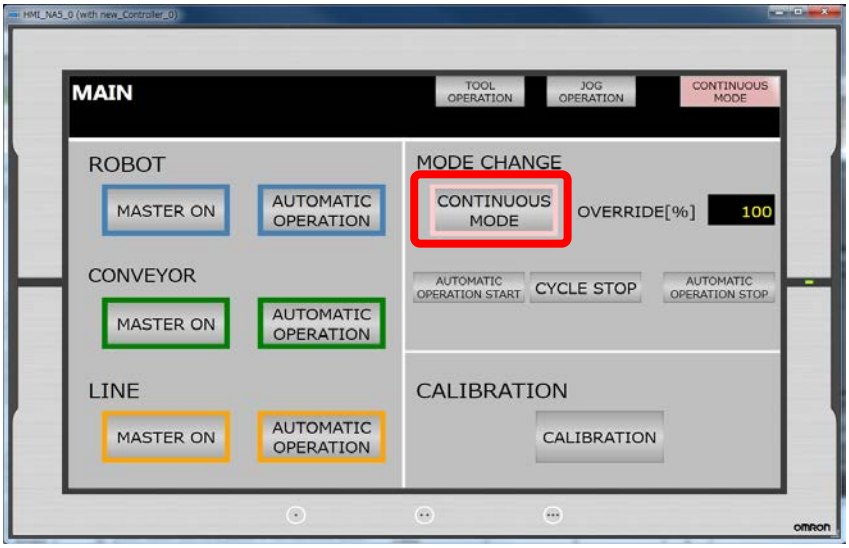
(2) The Monitor Window of the FH is opened.
(3.3. Loading Sample Images)

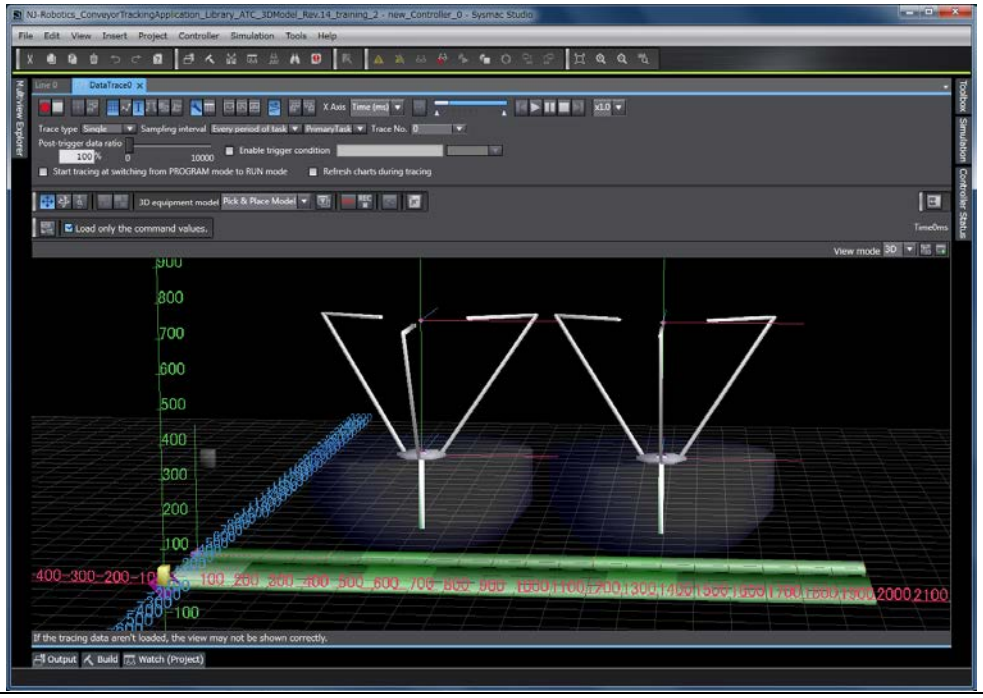
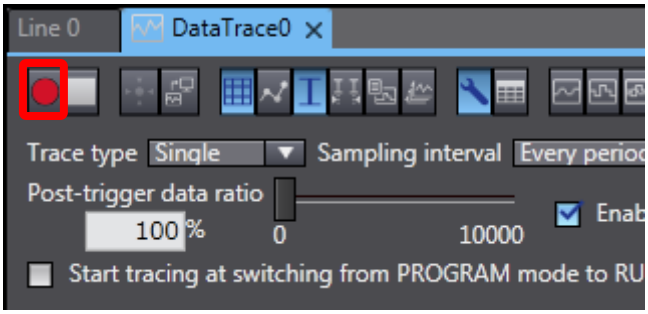
(3) The workpiece sample image file is set.
(3.3. Loading Sample Images)

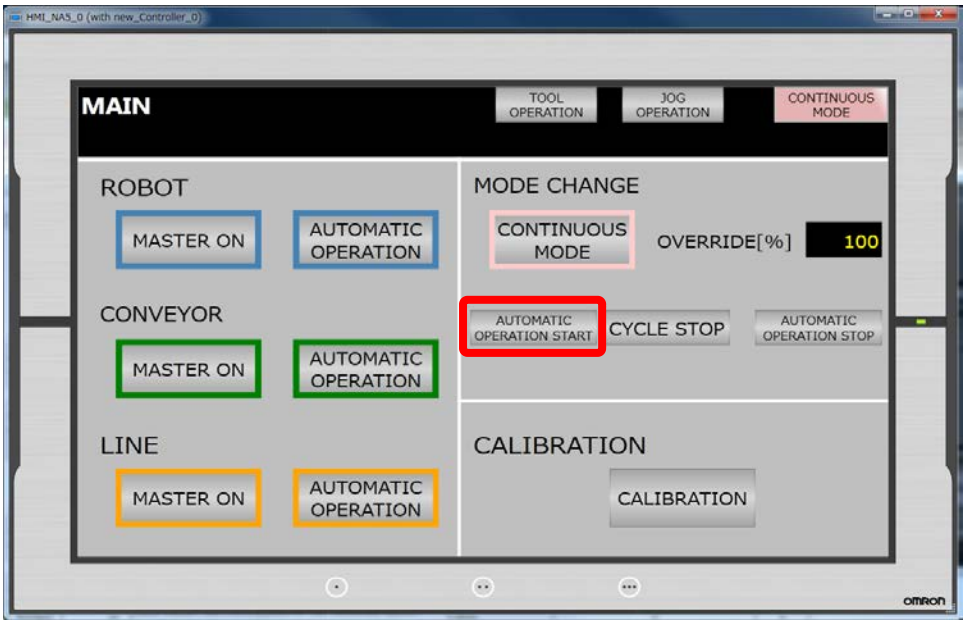
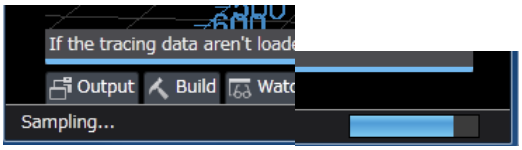
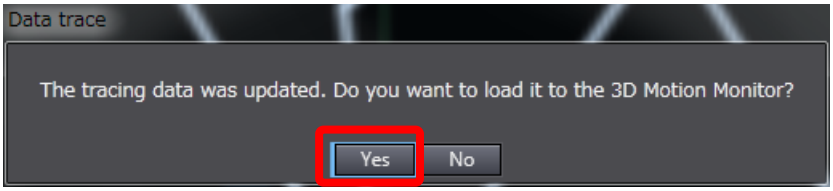
Use the following procedures to perform integrated simulation.

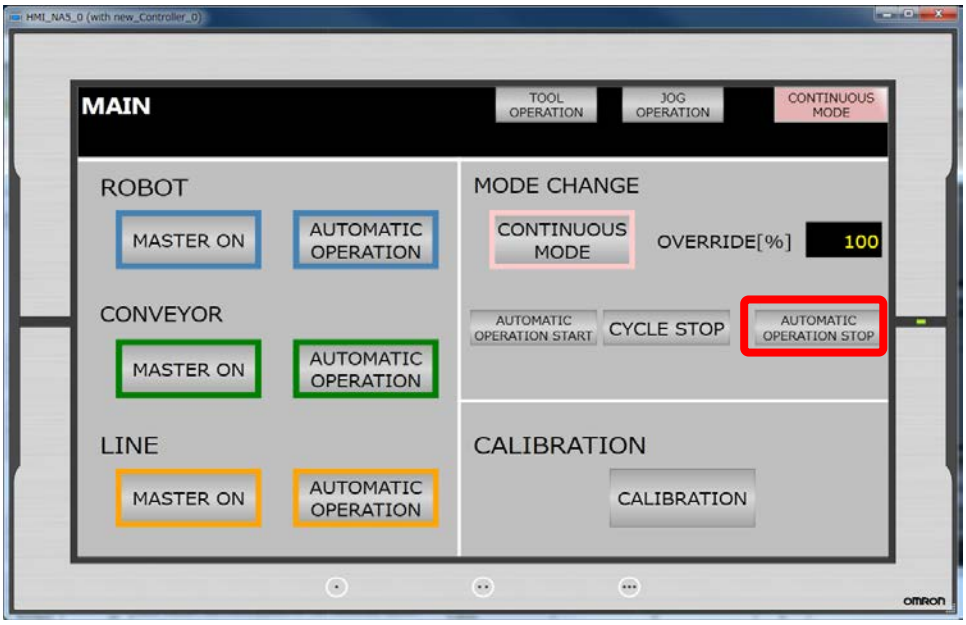
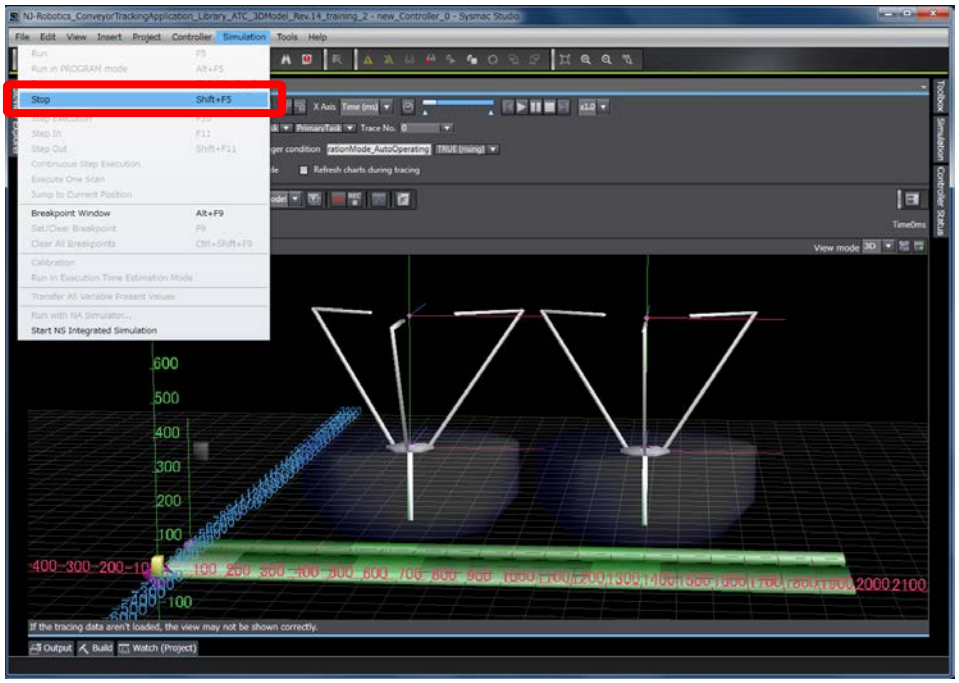
■ Procedures to perform integrated simulation

1	Select **Run with NA Simulator** from the Simulation Menu. 
2	Select **HMI_NA5_0** and click the **OK** Button. 

3	The NA screen included in the sample program is displayed. 
4	Click the **Manual mode** Button in the *Mode change* Field on the Main Screen to change the mode to Continuous mode that enables operation linked with the FH. The label of the button and the text at the upper right corner of the screen are changed from Manual mode to Continuous mode. 

5	Set the trigger condition for data tracing in the Data Trace Tab Page. Double-click **DataTrace0** under **Configurations and Setup - Data Trace Settings** in the Multiview Explorer to display the Data Trace Tab Page created in *3.2. Creating an Equipment Model*. 
6	Select the *Enable trigger condition* Check Box. Enter **CooperationMode_AutoOperating*** in the variable name box to use automatic operation start as a trigger in this Guide. * Enter the variable name to use as a trigger according to the program. 
7	Click the **Execute** Button. Tracing waits for the trigger to begin sampling. 

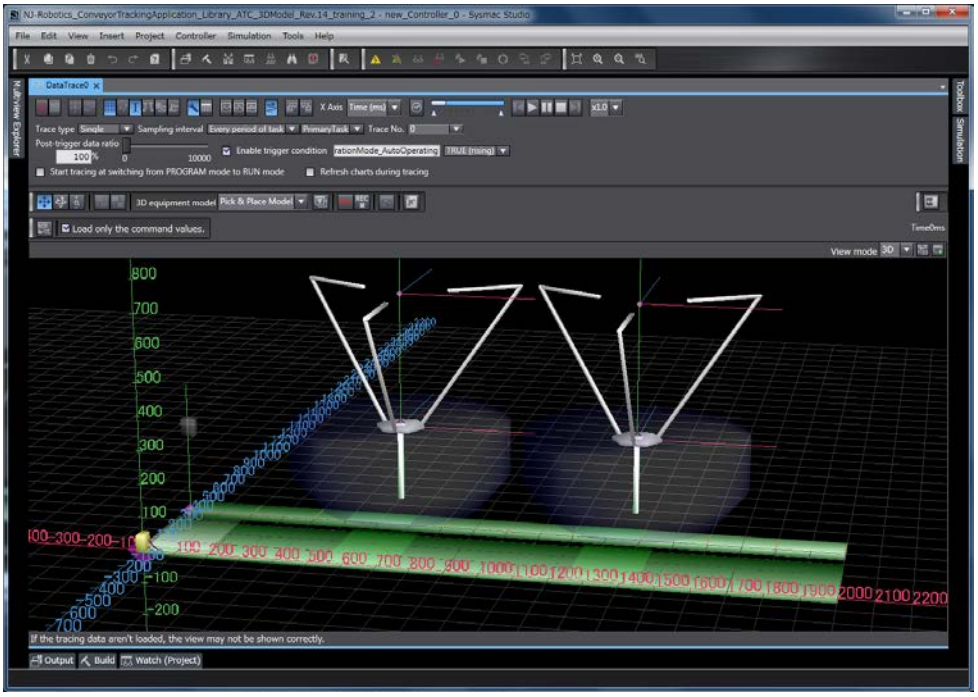
8	Click the **Automatic operation start** Button on the operation panel to start data tracing. 
9	Sampling is started. 
10	When data tracing is completed, the following dialog box appears. Click the **Yes** Button to load the tracing data to the 3D Motion Monitor. 

11	Click the **Automatic operation stop** Button on the operation panel to stop automatic operation. 
12	The simulation is stopped. 

3.5. Displaying 3D Motion Monitor

You can view the loaded trace data in 3D Motion Monitor to check the operation of the equipment model.

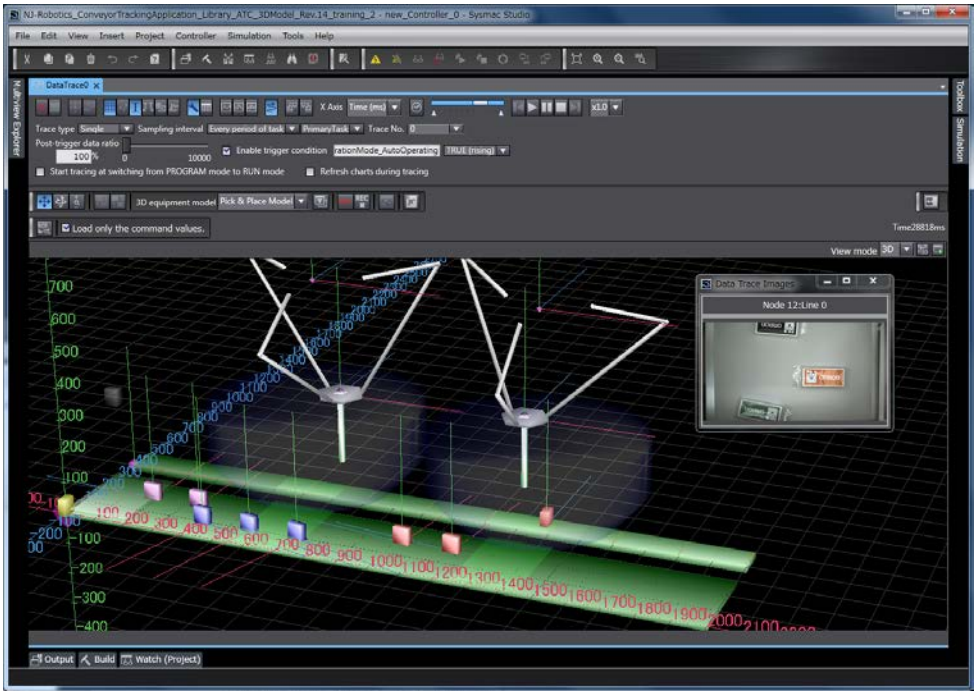
Click the **Trace Data Loading** Button in the 3D Motion Monitor View.
Click the **Play** Button to check the operation of the equipment model with moving graphics.



Click the **Display Images** Button to display workpiece sample images in accordance with the operation.

The following window appears. Workpiece sample images are displayed.

You can view the workpiece sample images in accordance with the operation of the equipment model.



Click the **Record** Button to save the 3D simulation into a video file.

4. Appendix

4.1. Robot Type List

The robots that can be used for machine models are listed in the following table.

Robot type	Description
R6Y31110H03067	Delta robot (Working volume: φ1100 mm, Maximum payload: 3 kg, 1 rotational axis with high inertia)
R6Y31110L03067	Delta robot (Working volume: φ1100 mm, Maximum payload: 3 kg, 1 rotational axis with low inertia)
R6Y30110S03067	Delta robot (Working volume: φ1100 mm, Maximum payload: 3 kg)
R6Y31065H02067	Mini Delta robot (Working volume: φ650 mm, Maximum payload: 2 kg, 1 rotational axis with high inertia)
R6Y31065L02067	Mini Delta robot (Working volume: φ650 mm, Maximum payload: 2 kg, 1 rotational axis with low inertia)
R6Y30065S02067	Mini Delta robot (Working volume: φ650 mm, Maximum payload: 2 kg)

OMRON Corporation **Industrial Automation Company**
Tokyo, JAPAN
Contact: www.ia.omron.com

Regional Headquarters
OMRON EUROPE B.V.
Wegalaan 67-69, 2132 JD Hoofddorp
The Netherlands
Tel: (31)2356-81-300/Fax: (31)2356-81-388

OMRON ELECTRONICS LLC
2895 Greenspoint Parkway, Suite 200
Hoffman Estates, IL 60169 U.S.A
Tel: (1) 847-843-7900/Fax: (1) 847-843-7787

OMRON ASIA PACIFIC PTE. LTD.
No. 438A Alexandra Road # 05-05/08 (Lobby 2),
Alexandra Technopark,
Singapore 119967
Tel: (65) 6835-3011/Fax: (65) 6835-2711

OMRON (CHINA) CO., LTD.
Room 2211, Bank of China Tower,
200 Yin Cheng Zhong Road,
PuDong New Area, Shanghai, 200120, China
Tel: (86) 21-5037-2222/Fax: (86) 21-5037-2200

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