![Brooks logo]

Guidance Dispense System

User Manual

Part Number 608329, Revision A

Brooks Automation

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Table of Contents

1. Safety

Safety Setup

Brooks uses caution, warning, and danger labels to convey critical information required for the safe and proper operation of the hardware and software. Read and comply with all labels to prevent personal injury and damage to the equipment.

⚠ **DANGER**	
Read the Safety Chapter	
Failure to review the *Safety* chapter and follow the safety warnings can result in serious injury or death. • All personnel involved with the operation or maintenance of this product must read and understand the information in this safety chapter. • Follow all applicable safety codes of the facility as well as national and international safety codes. • Know the facility safety procedures, safety equipment, and contact information. • Read and understand each procedure before performing it.	

Authorized Personnel Only

This product is intended for use by trained and experienced personnel. Operators must comply with applicable organizational operating procedures, industry standards, and all local, regional, national, and international laws and regulations.

Explanation of Hazards and Alerts

This manual and this product use industry standard hazard alerts to notify the user of personal or equipment safety hazards. Hazard alerts contain safety text, icons, signal words, and colors.

Safety Text

Hazard alert text follows a standard, fixed-order, three-part format.

- Identify the hazard
- State the consequences if the hazard is not avoided
- State how to avoid the hazard.

Safety Icons

- Hazard alerts contain safety icons that graphically identify the hazard.
- The safety icons in this manual conform to ISO 3864 and ANSI Z535 standards.

Signal Words and Color

Signal words inform of the level of hazard.

⚠ **DANGER**	Danger indicates a hazardous situation which, if not avoided, **will result in serious injury or death**. The Danger signal word is white on a red background with an exclamation point inside a yellow triangle with black border.
⚠ **WARNING**	Warning indicates a hazardous situation which, if not avoided, **could result in serious injury or death**. The Warning signal word is black on an orange background with an exclamation point inside a yellow triangle with black border.
⚠ **CAUTION**	Caution indicates a hazardous situation or unsafe practice which, if not avoided, **may result in minor or moderate personal injury**. The Caution signal word is black on a yellow background with an exclamation point inside a yellow triangle with black border.
NOTICE	Notice indicates a situation or unsafe practice which, if not avoided, **may result in equipment damage**. The Notice signal word is white on blue background with no icon.

Alert Example

The following is an example of a Warning hazard alert.
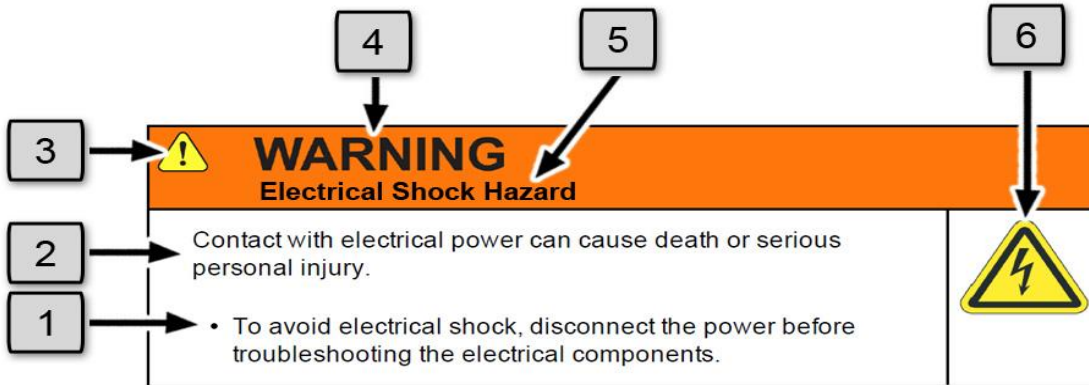
Number	Description
1.	How to Avoid the Hazard
2.	Source of Hazard and Severity
3.	General Alert Icon
4.	Signal Word
5.	Type of Hazard
6.	Hazard Symbol(s)

General Safety Considerations

⚠ WARNING	
Software	
Software is not safety rated. Unplanned motion can occur as long as power is supplied to the motors. Maximum torque could be momentarily applied that may cause equipment damage or personal injury. • Only operate the robot with its covers installed. • Guarantee that safety controller features are in place (for example, an emergency stop button and protective stop). • Regularly test safety components to prove that they function correctly.	

⚠ WARNING	
Robot Mounting	
Before applying power, the robot must be mounted on a rigid test stand, secure surface, or system application. Improperly mounted robots can cause excessive vibration and uncontrolled movement that may cause equipment damage or personal injury. • Always mount the robot on a secure test stand, surface, or system before applying power.	

⚠ WARNING	
Do Not Use Unauthorized Parts	
Using parts with different inertial properties with the same robot application can cause the robot's performance to decrease and potentially cause unplanned robot motion that could result in serious personal injury. • Do not use unauthorized parts. • Confirm that the correct robot application is being used.	

⚠ **WARNING**	
Magnetic Field Hazard	
This product contains magnetic motors that can be hazardous to implanted medical devices, such as pacemakers, and cause personal harm, severe injury, or death. • Maintain a safe working distance of 30 cm from the motor when with an energized robot if you use a cardiac rhythm management device.	

⚠ **CAUTION**	
Unauthorized Service	
Personal injury or damage to equipment may result if this product is operated or serviced by untrained or unauthorized personnel. • Only qualified personnel who have received certified training and have the proper job qualifications are allowed to transport, assemble, operate, or maintain the product.	
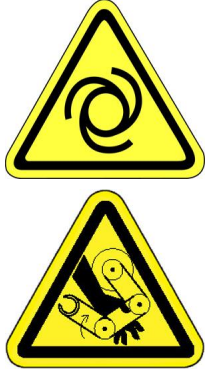
⚠ **CAUTION**	
Damaged Components	
The use of this product when components or cables appear to be damaged may cause equipment malfunction or personal injury. • Do not use this product if components or cables appear to be damaged. • Place the product in a location where it will not get damaged. • Route cables and tubing so that they do not become damaged and do not present a personal safety hazard.	

⚠ **CAUTION**	
Inappropriate Use	
Use of this product in a manner or for purposes other than for what it is intended may cause equipment damage or personal injury. • Only use the product for its intended application. • Do not modify this product beyond its original design. • Always operate this product with the covers in place.	

⚠ CAUTION	
Seismic Restraint	
The use of this product in an earthquake-prone environment may cause equipment damage or personal injury. • The user is responsible for determining whether the product is used in an earthquake prone environment and installing the appropriate seismic restraints in accordance with local regulations.	⚠

Mechanical Hazards

⚠ CAUTION	
Pinch Point	
Moving parts of the product may cause squeezing or compression of fingers or hands resulting in personal injury. • Do not operate the product without the protective covers in place.	⚠

⚠ WARNING	
Automatic Movement	
Whenever power is applied to the product, there is the potential for automatic or unplanned movement of the product or its components, which could result in personal injury. • Follow safe practices for working with energized products per the facility requirements. • Do not rely on the system software or process technology to prevent unexpected product motion. • Do not operate the product without its protective covers in place. • While the collaborative robotics system is designed to be safe around personnel, gravity and other factors may present hazards and should be considered.	⚠ ⚠

⚠ **CAUTION**

Vibration Hazard

As with any servo-based device, the robot can enter a vibratory state resulting in mechanical and audible hazards. Vibration indicates a serious problem. Immediately remove power.

- Before energizing, ensure the robot is bolted to a rigid metal chamber or stand.

Electrical Hazards

Refer to the specifications of the *Guidance Controller Quick Start Guide* for the electrical power.

⚠ **DANGER**

Electrical Shock Hazard

Contact with electrical power can cause personal harm and serious injury.

- To avoid electrical shock, disconnect the power before troubleshooting the electrical components.

- Check the unit's specifications for the actual system power requirements and use appropriate precautions.

- Never operate this product without its protection covers on.

⚠ **WARNING**

Electrical Burn

Improper electrical connection or connection to an improper electrical supply can result in electrical burns resulting in equipment damage, serious injury, or death.

- Always provide the robot with the proper power supply connectors and ground that are compliant with appropriate electrical codes.

⚠️ **WARNING**

Electrical Fire Hazard

All energized electrical equipment poses the risk of fire, which may result in severe injury or death. Fires in wiring, fuse boxes, energized electrical equipment, computers, and other electrical sources require a Class C extinguisher. • Use a fire extinguisher designed for electrical fires (Class C in the US and Class E in Asia). • It is the facility's responsibility to determine if any other fire extinguishers are needed for the system that the robot is in.	⚡

NOTICE

Improper handling of the power source or connecting devices may cause component damage or equipment fire.

• Connect the system to an appropriate electrical supply.

• Turn off the power before servicing the unit.

• Turn off the power before disconnecting the cables.

Ergonomic Hazards

⚠️ **CAUTION**

Heavy Lift Hazard

Failure to take the proper precautions before moving the robot could result in back injury and muscle strain. • Use a lifting device and cart rated for the weight of the drive or arm. • Only persons certified in operating the lifting device should be moving the product.	🏋️

⚠️ **CAUTION**

Tipover Hazard

This product has a high center of gravity which may cause the product to tip over and cause serious injury. • Always properly restrain the product when moving it. • Never operate the robot unless it is rigidly mounted.	⚠️

⚠️ **CAUTION**

Trip Hazard

Cables for power and communication and facilities create trip hazards which may cause serious injury.

- Always route the cables where they are not in the way of traffic.

Emergency Stop Circuit (E-Stop)

The integrator of the robot must provide an emergency stop switch.

⚠️ **WARNING**	
Emergency Stop Circuit	
Using this product without an emergency stop circuit may cause personal injury. • Customer is responsible for integrating an emergency stop circuit into their system. • Do not override or bypass the emergency stop circuit.	⚠️

Recycling and Hazardous Materials

Brooks Automation complies with the EU Directive 2002/96/EU Waste Electrical and Electronic Equipment (WEEE).

The end user must responsibly dispose of the product and its components when disposal is required. The initial cost of the equipment does not include cost for disposal. For further information and assistance in disposal, please email Brooks Automation Technical Support at support_preciseflex@brooksautomation.com.

2. Introduction

System Introduction

Guidance Dispense (GD) is a set of hardware and software components that can be utilized to implement a complete automated dispensing system. When these components are integrated with a robot and combined with syringes and needles, they can automatically dispense adhesives, sealants and other fluids along both simple and arbitrarily complex paths. Path programming is performed using simple teach-and-repeat methods that can be augmented by machine vision to automatically correct for deviations in part position and orientation.

Since dispensing encompasses an extremely wide range of requirements, Guidance Dispense has been designed as a very open system that permits hardware and software components to be tailored for the application. While GD has been designed for use with the PrecisePlace Cartesian robots, GD can be employed with any robot that is controlled by a PreciseFlex Guidance Controller. As appropriate, the GD software can be coupled with 3rd party hardware or the GD hardware could be employed without the GD software. For simple dispensing applications, a user can purchase just the PrecisePlace robot with the simple GD fixed syringe holder and the GD software and supply their own air dispenser, syringes, needles, and air plumbing.

In this manual, it is assumed that the full set of Guidance Dispense hardware and software components are being utilized, but this is only done to simplify the manual. Skip those sections of the manual that do not apply to the specific system configuration at hand.

The Guidance Dispense hardware consists of the following:

- A dual control air dispenser that can drive two syringes
- A simple fixed position syringe clamp
- A second syringe clamp that moves on a vertical slide under pneumatic control and includes a contact sensor
- An arm mounted camera that includes a variable intensity ring light

The dual air dispenser includes two regulators for controlling the air pressure that forces out the fluid in the syringes as well as two additional regulators for controlling vacuum for quickly releasing the pressure on the syringes. The air dispenser housing includes buttons with lights as a teaching aid and to indicate system status. The air dispenser solenoids, buttons and lights, pneumatic clamp piston, and contact sensor are all interfaced to the robot's controller to permit automatic operation.

The Guidance Dispense software is an open source package that executes on any Guidance Controller. In the case of the PrecisePlace robot, this software executes in a controller that is integrated into the back of the robot's X-axis. The operator interface is implemented as a series of web pages that can be viewed locally or remotely via a web browser. This software permits dispensing paths and processes to be taught and executed without the need for programming. The graphical user interface provides all of the tools for teaching straight and curved three-dimensional paths and controlling the operation of the two syringes. The system includes an operator control panel and run-time that permits paths to be played back while maintaining excellent speed control to enable consistent results.

GD also supports PreciseVision for performing vision-guided path dispensing. This permits a camera mounted above the work area or on the end of robot to locate objects or fiducial marks and to utilize the detected positions and orientations to automatically update dispensing paths. This reduces the need for complex fixtures and allows for a more flexible approach to dispensing.

3. Setup, Installation, and Execution

Interfacing a Robot to a PC
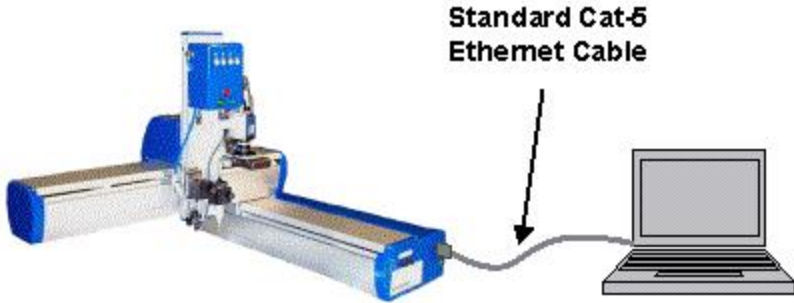
All of the software and data necessary to teach and execute a dispensing process (with the exception of machine vision) resides on the robot's controller. However, a PC is utilized as the graphical user interface (GUI) for the Guidance Dispense software. Except for one-time system setup procedures, the only application software required on the PC is a standard web browser. For the best results, it is suggested that the user use the following PC equipment for a non-vision system:

- A 500 MHz or faster PC running a Windows XP or later system
- Microsoft Edge version 6.x or later
- A 10/100 Ethernet card
- A standard Cat-5 Ethernet cable

If the user's system includes PreciseVision, the vision software will be executed on the PC. In this case, the recommended equipment is the following (see the PreciseVision manual for additional information on cameras and installation of the PreciseVision software):

- A 2.3Ghz or faster Pentium 4 PC running a Windows XP or later system
- Microsoft Edge version 6.x or later
- Gigabit Ethernet (recommended and required for certain cameras), otherwise 100Mb Ethernet interface
- A standard Cat-5 Ethernet cable
- 512 MB of RAM
- At least 1 GB of space on the PC's disk
- A 2x CD-ROM drive interfaced to the PC or access to the Brooks Support website

To connect the robot's controller to a PC, perform the following steps:
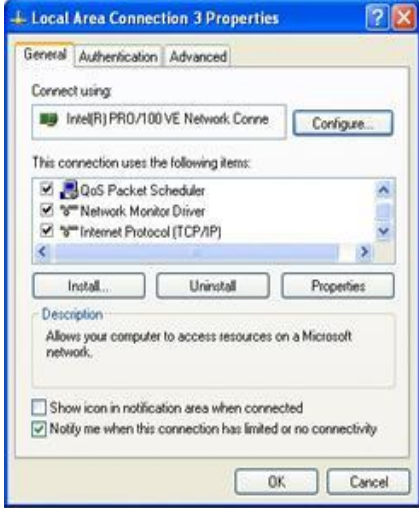
Step	Action
1.	Connect the robot's controller to the PC directly or via a hub or switch using the appropriate cable as described above. ⚠️ **DANGER** Before operating your robot, ensure that the following steps have been performed: (1) the robot has been properly mounted; (2) all required safety interlocks have been installed and tested; and (3) power has been connected. For the PrecisePlace robots, this information is provided in the *PrecisePlace 2300/2400 Robot, Hardware Introduction and Reference Manual*.
2.	If utilizing a PrecisePlace robot, the Ethernet cable is plugged into either of the sockets on the right end-cap of the robot, as shown. Standard Cat-5 Ethernet Cable Set the IP address and subnet mask on the PC to be compatible with the controller. By default, the controller's IP address is 192.168.0.1 and the subnet mask is 255.255.255.0. If not familiar with the procedure for changing the IP address and subnet mask on the PC, see the next section. Alternately, the user can utilize the Guidance Discovery application to set the controller's IP information to be compatible with the PC.

For instructions on the use of the free Guidance Discovery utility, see the "Guidance Discovery" chapter of the "Guidance Development Suite" section of the *PreciseFlex Library*.

Setting the IP Address in Windows

This section provides detailed instructions if the user requires assistance in configuring their PC's IP address and subnet mask to be compatible with the robot's controller. If the IP address has already been changed and subnet mask on their PC is compatible, skip this section.

By default, the Guidance Controller is factory configured with the IP address/subnet mask of 192.168.0.1 and 255.255.255.0. The PC must be compatible with this IP specification. For Windows users, complete the following steps:

Step	Action
1.	Open the PC control panel by clicking **Start > Settings > Network Connections**.
2.	Right-click on the icon for the Ethernet card that is connected to the controller and select **Properties**.

Step	Action
3.	Highlight **Internet Protocol (TCP/IP)** and click **Properties**.
4.	If the PC is using DHCP and is not compatible with the controller, the user must specify a compatible IP address and subnet mask. Click the **Use the following IP address** radio button and enter IP information that is compatible. Once connected to the controller, change the IP address and subnet mask of the controller to be compatible with the network.
5.	If the PC is using a static IP address the user does NOT need to change the IP address and subnet mask. Instead, click **Advanced**.
6.	Click **Add** and enter in a compatible IP address and subnet mask. For example, 192.168.0.200 and 255.255.255.0.
7.	Click **OK** to activate the changes.

Guidance Dispense Software Installation

To use the Guidance Dispense software package and it has not been pre-installed on the robot's controller, or to upgrade GD software to a new version, this section describes the software installation and upgrade process.
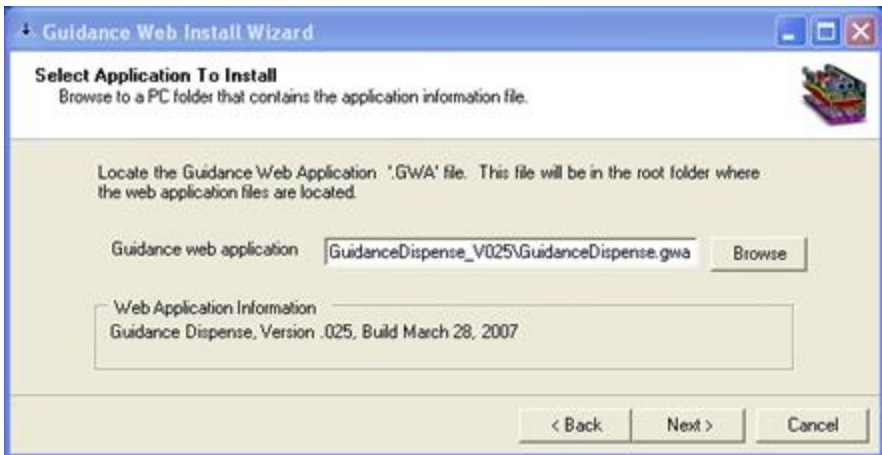
The GD software is an open source application that consists of a GPL "project" and a set of custom web pages. This information is contained in a collection of disk files that must be loaded into the robot controller's flash disk in the "/flash" directory. For simplicity, all of the required files are distributed in a single compressed .zip file.
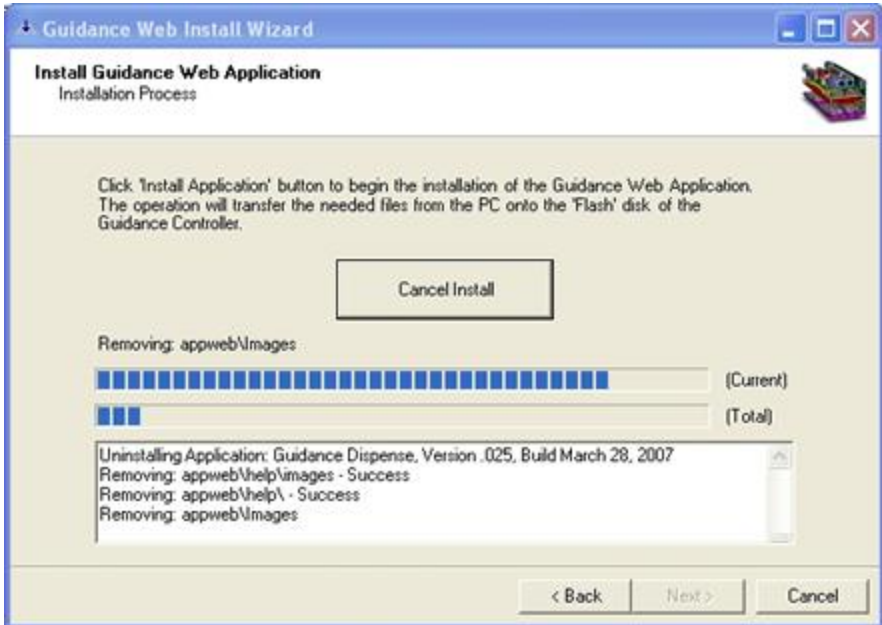
To successfully install a new version of GD, the following is required:
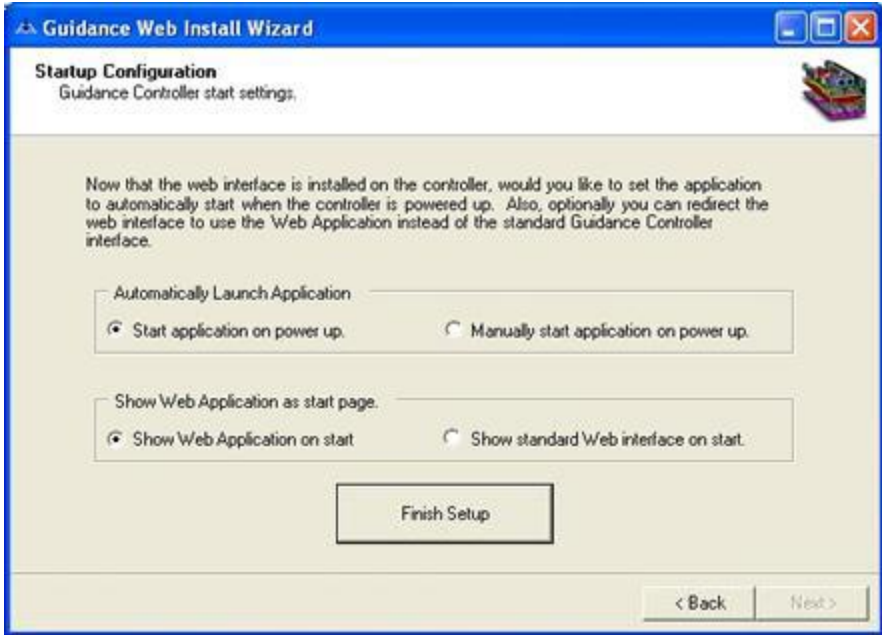
- A distribution copy of the GD software. This file is typically named "GD_Version_xxx.zip."

- A copy of the Guidance Develop Suite (GDS) version 1.4 or later installed on your PC. For this procedure, it is not necessary to purchase a licensed copy of GDS since the installation utility will operate without a license.

- A PC with a suitable browser interfaced to the robot's controller via Ethernet.

- At least 1.5MB of free space available on the robot controller's flash disk.

- A copy of GPL version 1.3 or later executing on the robot's controller. GPL is the motion control system software that is provided with each PreciseFlex Guidance Controller.

To install the new Guidance Dispense software, complete the following steps:

Step	Action
1.	Copy the Guidance Dispense distribution file to the PC's hard drive and uncompress the zip file. Recent versions of the Windows operating system provide built-in utilities for uncompressing zip disk files. Typically, if the user right-clicks on a zip file, they will see an "Extract all" option. If the version of Windows does not include this feature, they can obtain a free version of an UnZip utility from multiple sites on the Internet. Once the GD distribution is uncompressed, the user can execute the "Guidance Web Install Wizard" to copy all of the files to the robot controller. This utility is part of the Guidance Development Suite. During the installation of the application, if an existing installation of a web-based application is detected, the wizard will prompt the user to replace this with the new application.

Step	Action
2.	To launch the installation application, click **Start→Programs→PreciseFlex Automation→GDS x.x→Guidance Web Install Wizard**.
3.	Follow the instructions of this wizard to install the Guidance Dispense application.
4.	Provide the directory path and name of the file that contains the load instructions for the installer. For GD, this file is named "GuidanceDispense.gwa" and will be located in the top-level directory of the unZipped files.
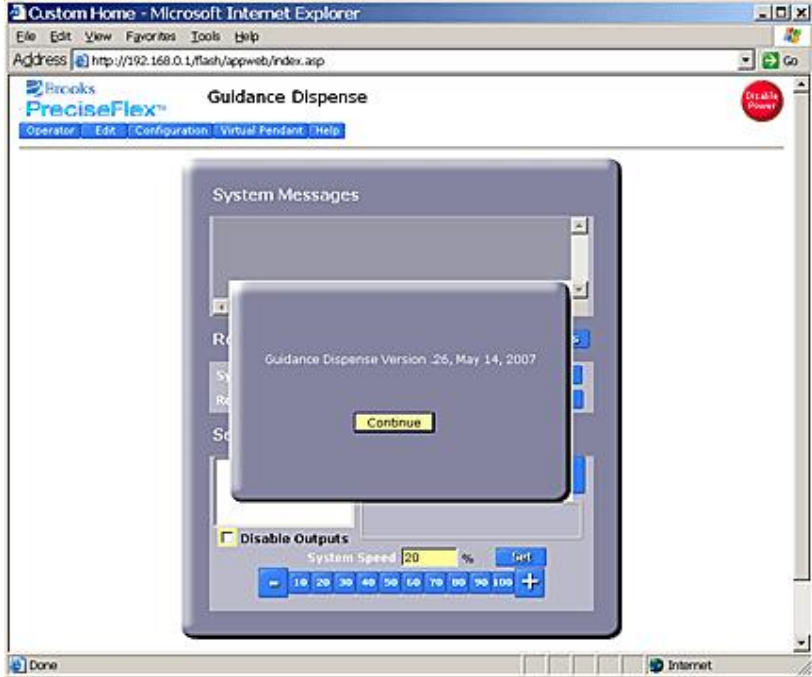
Step	Action
5.	Ensure that the IP address is correct and click **Next**. ![Guidance Web Install Wizard — Enter IP address of controller. Enter the Guidance Controller IP address. Enter the IP address of the controller that you wish to install the Guidance Web Application. Controller IP: 192.168.0.1 (i.e. 192.168.0.1). Back / Next> / Cancel]
6.	The wizard may take a few minutes to complete the process. ![Guidance Web Install Wizard — Install Guidance Web Application. Installation Process. Click 'Install Application' button to begin the installation of the Guidance Web Application. The operation will transfer the needed files from the PC onto the 'Flash' disk of the Guidance Controller. Cancel Install. Removing: appweb\Images (Current) (Total). Uninstalling Application: Guidance Dispense, Version .025, Build March 28, 2007. Removing: appweb\help\images - Success. Removing: appweb\help\ - Success. Removing: appweb\Images. Back / Next> / Cancel]

Step	Action
7.	Click **Finish Setup**. ![Guidance Web Install Wizard - Startup Configuration screen showing Automatically Launch Application options with "Start application on power up" selected, Show Web Application as start page options with "Show Web Application on start" selected, and a Finish Setup button]
8.	Once the wizard is completed, restart the robot's controller to begin execution of the Guidance Dispense application.

Starting the Guidance Dispense Application

As a configuration option for the robot's controller, each time the controller is restarted, the Guidance Dispense Application can be automatically executed and the web pages redirected to the GD application pages.

Step	Action
1.	To access the Guidance Dispense Application user interface, start the robot's controller by turning on the robot's AC power.

Step	Action
2.	On the PC interfaced to the controller via Ethernet, launch a browser and enter the IP address of the robot's controller. By default, the controller's IP address is set to 192.168.0.1. If Guidance Dispense and its web pages have been automatically started, the following web page will be displayed within the browser. The background image is the GD Operator Control Panel. In the foreground is a pop-up window that identifies the version of the GD software.
3.	If this web page does not appear, refer to the *Guidance Controller Setup and Operation, Quick Start Guide* for instructions for loading and executing a GPL project. The project to be loaded and executed should be on the controller's flash disk and be named "Gdispense." If the software cannot be located, or to automatically start the GD, execute the software installation process described in "Guidance Dispense Software Installation" on page 17 and select the auto start options on the final screen. Once able to view the start-up pages for GD, continue with the remainder of this section.
4.	Click the **Continue** button to dismiss the Guidance Dispense version identification pop-up window.

Step	Action
5.	If this is the first time that the GD application is being executed, you will see the following error pop-up message that indicates that the "Safe Point" has not been taught. You will also see a number of errors listed in the "Systems Messages" area that indicate that other data has not yet been defined.
6.	Click **OK** to ignore this error for now and select **No** when you are asked to teach this position. The "Safe Point" will be discussed in later sections of this manual. You should now see the following Operator Control Panel screen that indicates that the Guidance Dispense application has been successfully started and is now operational.

⚠ **DANGER**	
Before operating a robot, ensure that the following steps have been performed: (1) the robot has been properly mounted; (2) all required safety interlocks have been installed and tested; and (3) power has been connected. For the PrecisePlace robots, this information is provided in the *PrecisePlace 2300/2400 Robot, Hardware Introduction and Reference Manual*.	⚠

4. Hardware Introduction

Guidance Dispense Hardware Overview

This chapter describes how to operate and adjust the Guidance Dispense hardware components after they have been mounted and interfaced to a robot and the Guidance Dispense software has been installed on the robot's controller. For individuals who require an in-depth understanding of the this hardware and for those who want to configure a robot system with these components, detailed descriptions of the GD hardware are provided in Chapter 4: Reference Information.

Figure 4-1 illustrates a full-featured PrecisePlace 1300 (3-axis XYZ) robot that includes all of the Guidance Dispense hardware components. With the addition of loaded syringes with needles and a PC interfaced via Ethernet, this equipment would be ready to apply to a vision-guided dispensing application.
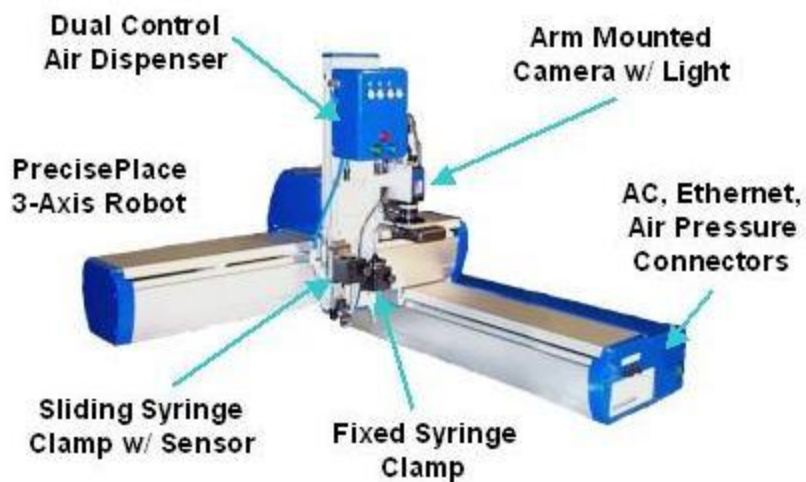
Figure 4-1: PrecisePlace 1300 (3-Axis XYZ) Robot

⚠️ **DANGER**	
Electrical Shock Hazard	
The robot's controller and power supplies are located beneath the X-axis cover. These units are open frame electrical devices that have exposed unshielded high voltage pins, components and surfaces. In addition, the motor power supply provides 320VDC volts to the motors and takes about two minutes to bleed down after power is disconnected. AC power to the robot must be disconnected prior to removal of the X-axis cover for any reason.	⚡

Mounted on the Z-axis of the robot are the following:

- The dual control air dispenser

- A sliding syringe clamp with a Z-Contact sensor

- A fixed position syringe clamp

- An arm-mounted downward looking camera with a variable intensity ring light

This system dispenses fluids by applying air pressure to a plunger within a syringe. This air pressure must be provided by an external source that is connected to an air intake fitting mounted on the robot's right end-cap. The air line is routed through the interior of the robot and the Z-axis E-chain and terminates at a fitting in the right side of the air dispenser. The dual control air dispenser regulates and manages the airflow and provides two output air lines, one for each of two possible syringes held by the two syringe clamps.

If the system is equipped with the machine vision option, the camera can either be attached to a stationary mount above the robot or can be mounted to the Z-axis of the robot as pictured in Figure 4-1. The benefit of a stationary mount is that a picture can be taken while the robot has moved away. The benefit of an arm-mounted camera is that a higher resolution, smaller field of view lens can be selected and the camera can be repositioned in the workspace as required.

If an arm-mounted camera is utilized, the DC power for the camera and the light are provided at the Z-axis. The Ethernet cable that is connected to the camera is routed through the interior of the robot and its signals are available on the robot's right end-cap.

The next sections of this chapter provide instructions on operating and adjusting the hardware components.

Dual Control Air Dispenser

The Dual Control Air Dispenser drives the air lines for the two syringes and the pneumatic actuator for the sliding syringe clamp. In addition, this device has back-lit buttons that greatly simplify teaching path "nodes" and that display the system execution state when a path is being executed. Figure 4-2 illustrates the key elements of this device.
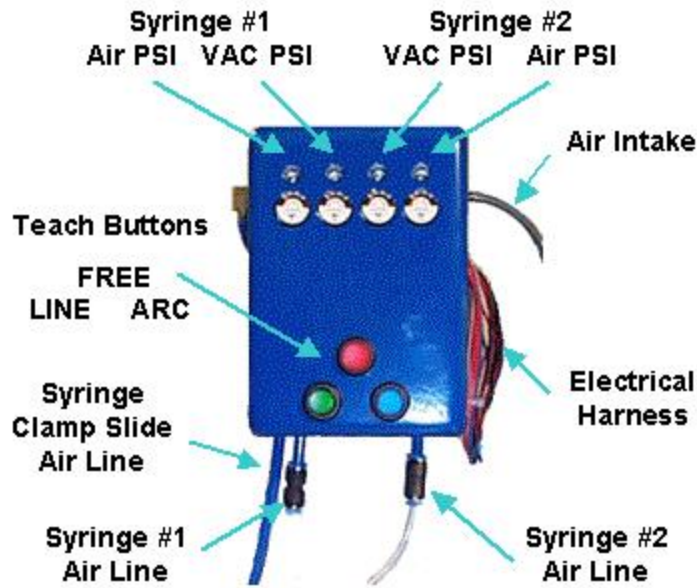
Figure 4-2: Dual Control Air Dispense

For each syringe, this device provides two pressure regulators: one to control the positive pressure that forces the syringe plunger to dispense fluid, and a second regulator that supplies air to a venturi device that creates a vacuum in the syringe air line when the positive pressure is turned off. The vacuum assists in backing off the syringe plunger to minimize dribbling of the dispensed fluid.

Each of these regulators can be adjusted from 7 PSI up to 100 PSI. An adjustment screw is available through a hole that is above each of the miniature pressure regulator meters.

> **NOTE:** To avoid accidental changes in the pressure settings, the air pressure screw adjustments normally have a locking nut engaged. To release the lock nut, remove the cover of the air dispenser and loosen the nut.

> **NOTE:** The positive pressure for each syringe should be adjusted to provide the desired flow rate of dispensed material. If the pressure is too high, the fluid will be too thick. If the pressure is too low, a continuous bead will have unexpected breaks in the bead.

The three-backlit buttons on this unit provide a very convenient means for teaching a path. When the top button is clicked, the robot is "freed" to permit it to be manually moved to any desired position. For robots like the PrecisePlace that have direct drive motors on the X & Y axes and very little friction, it is quick and easy to manually push the robot and accurately position the syringe tip in free mode. When the robot has been properly positioned, clicking one of the two lower buttons records either a node on a straight line or arc path. These three buttons provide a very intuitive and rapid means for training even complex paths.

Table 4-1 describes the use of the buttons and the interpretation of the button lights during both path teaching and normal execution.

Table 4-1: Button Lights

Backlit Button		During Teaching	During Process Execution
Red (Free)		Click to "Free" or "UnFree" all axes of the robot. Backlight is on when in Free mode.	In dispense simulation mode, backlight is on when fluid should be dispensing.
Green (Line)		Click to create and teach a Line node. Backlight blinks momentarily to indicate node created.	Backlight is on when a Line node being executed.
Blue (Arc)		Click to create and teach an Arc node. Backlight blinks momentarily to indicate node created.	Backlight is on when an Arc node being executed.
Blue & Green		N/A	Both backlights are on when executing a Dot or Pause node.

Dual Syringe Clamps

The Air Dispenser can control the air pressure for two syringes. Two syringes permit quick change over when dispensing two types of fluids or when using two needle sizes. To accommodate two syringes, two syringe clamps are provided. To avoid physical interference, one syringe clamp is mounted in a fixed position on the robot's Z-axis, and the second clamp is mounted on a pneumatically operated vertical slide so its tip can be positioned below the fixed syringe when in use and moved up when not needed. Another feature of the Sliding Syringe Clamp is that it is equipped with a sensor that can detect when the syringe needle touches the work surface.
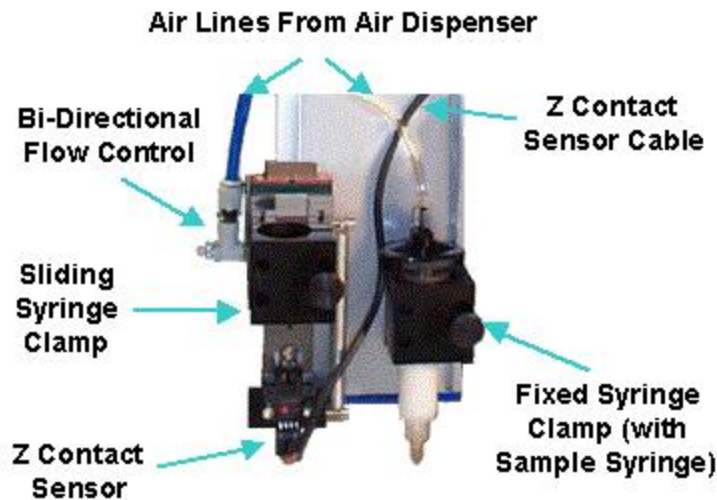
Figure 4-3: Clamps

As pictured in Figure 4-3, the vertical positions of both the Fixed and Sliding Syringe Clamps can be adjusted by sliding them up or down within the Z-axis T-slots before being tightened down. Both clamps have thumbscrews for retaining a syringe and can accommodate syringes up to 25 mm in diameter. For smaller diameter syringes, a standard plastic insert can be obtained.

The Sliding Syringe Clamp has a total travel of 30 mm. When there is no air pressure, the clamp is pulled into the down position by a spring. If the tip of the syringe mounted in this clamp touches a surface, the clamp will rise up in the slide with a resistance generated by the spring. The Z-Contact Sensor will detect this relative motion and this event will be captured by the robot's controller. Typically, the Z-Contact Sensor is utilized for accurately setting the Z height at which to dispense a fluid. This can compensate for manufacturing variations from part to part and can aid in ensuring that the dispense process yields high quality results.

To ensure that the Sliding Syringe Clamp moves up and down quickly but without excessive impact, a Bi-Directional Flow Control is mounted between the air supply line and the pneumatic actuator. Two knobs are provided that control the air flow rate when the air pressure is applied or eliminated.

Arm-Mounted Camera and Light

If the system in use includes an arm-mounted camera and variable intensity light, Figure 4-4 illustrates how these units can be attached to the Z-axis of the PrecisePlace 2300 robot.
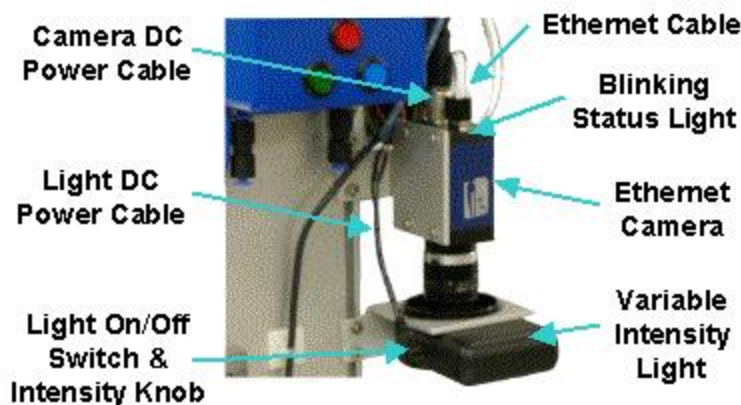
Figure 4-4: Camera on Z-axis of the PrecisePlace 2300

> **NOTE:** Both the camera and the light mounting brackets can slide up and down in the T-Slot of the Z-axis to permit these units to be positioned at the correct heights for an optimal camera field-of-view.

In order to operate, the camera requires that an Ethernet and DC Power Cable be plugged into the side opposite from the lens. The DC Power Cable furnishes 12VDC. The Ethernet cable is used to receive commands from the PreciseVision software and to transmit back digitized camera images. Typically a manually operated lens that provides an f-stop and focus ring is mounted to the camera.

To avoid having these settings change during operation, the lens often has setscrews for fixing the positions of the rings. These setscrews must be loosened in order to adjust either the f-stop or focus. The Ethernet camera includes a Status LED on the same surface as the Ethernet connector.

Table 4-2: LED Status

LED State	Camera Status
Off	Camera is not receiving power.
Steady Red	Camera is not initialized.
Slow Flashing Red	Camera initialization problem. Most likely indicates a camera hardware failure.
Fast Flashing Red	Camera is too hot.
Slow Flashing Blue	Waiting for an IP address.
Fast Flashing Blue	Ethernet cable is disconnected (no link).
Steady Blue	IP address assigned, PreciseVision is not connected to camera.
Steady Green	**PreciseVision connected to camera, standard operational state**
Slow Flashing Green	Camera waiting for hardware trigger to take picture.
Fast Flashing Green	**Continuous acquisitions in progress, standard live video state**

Since the light normally remains on at all times, it is not operated by the robot's controller. There is a switch (labeled in Figure 4-4) that can be used to turn off the light, even when the controller is powered on. In addition, there is a small knob by the on/off switch that controls the intensity of the light. Normally, the light intensity should be set bright enough to overcome variations in the ambient light but not so bright as to create a reflected glare back into the camera lens. For detailed information on programming the machine vision system, see the *PreciseVision Machine Vision System, Introduction and Reference Manual.*

PrecisePlace Robot Facilities End Cap

If the Guidance Dispense hardware components are mounted on a PrecisePlace Cartesian robot, the robot's Facilities End Cap on the right side of the X-axis contains the plugs and connectors for AC power, pneumatic air lines, Ethernet, and Digital IO signals.
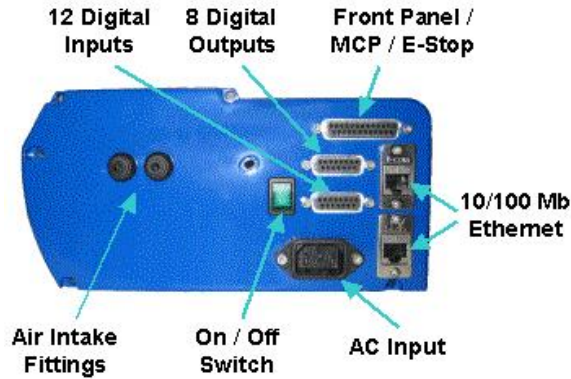
Figure 4-5: Robot End Cap

To provide air pressure to the Dual Control Air Dispenser, clean, dry external air should be connected to the LEFT air fitting. This air line is routed through the interior of the robot and exits at the Z-axis E-Chain where it plugs into the Air Dispenser.

⚠️ **CAUTION**	
Air pressure	
The maximum air pressure that can be conveyed by the air lines through the robot is **75 PSI**. Applying a pressure exceeding this level may disconnect interior connections or damage fittings or hoses. If a higher pressure is required, an external air line should be utilized.	⚠️

If the system in use is equipped with an arm-mounted camera, the camera communicates with PreciseVision via Ethernet. The Ethernet cable that plugs into the camera is routed through the interior of the robot and is connected to the robot controller's integrated Ethernet switch. The two 10/100 Mb Ethernet ports on the End-Cap are also connected to the same switch. Therefore, either Ethernet plug can be used to interface to the camera and the robot's controller. The second Ethernet port is provided as a wiring convenience.

If the system in use is equipped with a PreciseFlex Manual Control Pendant or an E-Stop box, these units can be directly plugged into the "Front Panel / MCP / E-Stop" connector. The E-Stop button on these units will be directly tied to the controller's hardware E-Stop inputs to ensure that the robot's motor power can be quickly and reliably disabled.

The electric power required by the robot, its control electronics, the arm-mounted camera and its light, and the Guidance Dispense hardware is all derived from the AC input line. The robot is equipped with power supplies that can be utilized worldwide since they can accept voltages from 90

to 132 VAC and 180 to 264 VAC, 50-60 Hz. Turning off the green backlit On/Off switch on the end-cap will turn off power to the robot and all of the mounted hardware.

⚠ **DANGER**	
Electrical Shock Hazard	
The robot's controller and high voltage power supplies are located beneath the X-axis cover. These units are all open frame electrical devices that have exposed unshielded high voltage pins, components and surfaces. In addition, the motor power supply provides 320VDC volts to the motors and takes about two minutes to bleed down after power is disconnected. AC power to the robot must be disconnected prior to removal of the X-axis cover for any reason.	⚡

To obtain detailed pin-out information for the Digital Input, Digital Output or Front Panel connectors, see the *PrecisePlace 2300/2400 Robot, Hardware Introduction and Reference Manual.*

5. Software Introduction

Guidance Dispense Software Overview

The Guidance Dispense product includes an open source application program with a web-based graphical user interface. The purpose of this software package is to permit the user to teach and execute a sequence of operations that will move a syringe tip along a taught path while simultaneously sending commands to the dual control air dispenser to force out fluid as required. This chapter introduces the software's principal concepts, terminology, and features. In additional, each of the web pages and the function of their buttons and fields are described.

In Chapter 5: Step-By-Step Tutorials, this information is put to use in a series of step-by-step tutorials that illustrate all of the basic operations of the system.

Within the Guidance Dispense software package, a complete dispensing operation is organized into a dispensing **Process** that consists of one or more dispensing **Paths** that in turn consist of one or more dispensing **Nodes**.
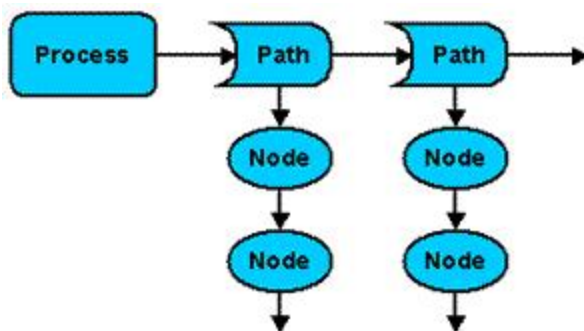
Figure 5-1: Dispensing Process

Using a simple web-based control panel, an operator can select and execute a taught dispensing Process. A Process consists of a list of Paths that are performed in the sequence in which they are defined within the Process. A Path defines a series of motions that control the position of a syringe tip. The Path includes the specification for how fast the tool tip is to move when dispensing fluid and how high above the start and end of the path the tool tip should be moved to start and end the motion sequence.

A Path can be automatically repeated with its positions offset in X, Y, and Z. For example, a Path can be automatically repeated at every position within an two dimensional array of parts.

Each syringe tip position within a Path is defined by a Node. A Node contains both the syringe tip position as well as data specifying whether fluid should be dispensed while moving to this position. A Path can contain thousands of Nodes if needed.

The names of Processes, Paths and Nodes can consists of 1 to 43 characters. Names must start with an alphabetic character or "_" and cannot be a single "_." The first character can be followed by any combination of alphanumeric characters (a-z,A-Z,0-9) and "_." Names cannot contain space characters (" "). Upper and lower case letters are considered different, so names are case-sensitive.

When a Process is being executed, the data for the Process, its Paths and its Nodes are contained in the robot controller's memory. To permanently retain this information, a copy of this data is stored in files in the flash disk. The Guidance Dispense application automatically loads the required data files into the controller's memory when a Process or Path is accessed for editing or execution.

> **NOTE:** *To create and run a complete dispensing operation, the user must first teach a series of Nodes to generate a Path. Then define the sequence in which the Paths are to be performed by specifying their order within a Process. Finally, execute the Process.*

Dispensing Nodes, Node Types, and Reference Frames

A dispensing Node is the most fundamental data element within the Guidance Dispense software. It defines a single syringe tip position and includes information about whether dispensing is turned on or off relative to this position. In order to specify the robot motion or action associated with a position, Nodes are organized into Node Types. For instance, there is a Node Type that indicates that the syringe tip is to move along a straight line to the position and a different Type to specify that a circular arc path is to be followed.

The following example illustrates a Path that contains four Nodes:

- **Step 1:** Moves the syringe tip to a starting location. When this location is reached, dispensing is turned on.

- **Step 2:** Moves the tip along a straight-line path to a location that serves as the end of the line and the start of an arc.

- **Step 3:** Moves the syringe along an arc path.

- **Step 4:** Turns off dispensing.

```
1. LineStrt  -ON
2. LineEnd
```

```
3. ArcMid
4. ArcEnd    -OFF
```

While GD could have been designed to define Node positions with respect to the base of the robot, instead, Node positions are always defined relative to a "reference frame." A reference frame specifies an important XYZ position and orientation that is significant to the dispensing application. For example, to dispense fluid on to a plate, the position and orientation of a corner of the plate could be defined by a reference frame. Then, instead of teaching positions relative to the base of the robot, each Node point would automatically be taught with respect to the corner of the plate. If the plate were later re-positioned or re-oriented, the positions of all of the taught points could be compensated by simply updating the position and orientation of the reference frame. This is illustrated in Figure 5-2.
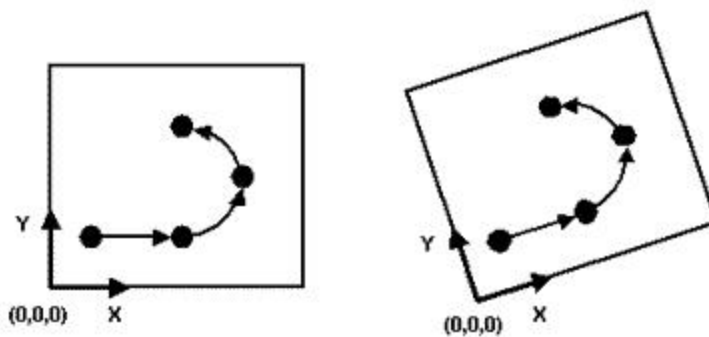
Figure 5-2: Node Paths
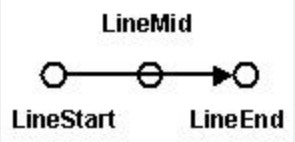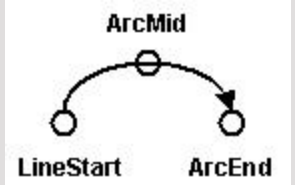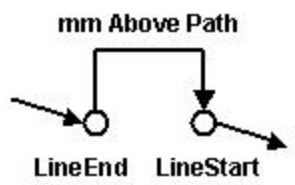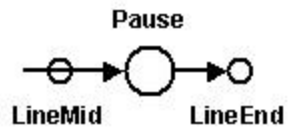
To simplify the use of a reference frame, by default, all Node positions are relative to the Global Frame. A utility for quickly defining the position and orientation of this reference frame is included in the GD software. If the value of the Global Frame is not taught, it will have a NULL value and all Node positions will be with respect to the base of the robot.
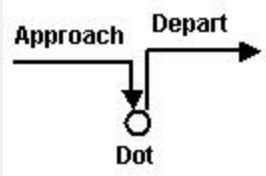
If your system is equipped with PreciseVision, vision can dynamically compute and return a reference frame that replaces all of the coordinates of the Global Frame except for its Z height. In the example above, a camera could be used to locate the position and orientation of the corner of the plate. Then all of the taught Node positions would be automatically adjusted to reflect the plate position and orientation as determined by PreciseVision.

Since application requirements or fluid properties may require that dispensing be turned on at the start of a motion or at the end of a motion or somewhere in between, GD supports a number of means for specifying when dispensing signals should be turned on or off. Each Node can specify that a signal must be changed a fixed distance or time from either end of its motion or as a percentage of travel. By default, signals are changed at the end of each motion.

In Table 5-1, each of the Node Types are described. For some types, like the Line Node, simply specify the need for a Line Node. However, when the Node is subsequently displayed, the software automatically distinguishes whether a Line Node starts a sequence of straight-line motions, ends a sequence, or is in the middle of a sequence. This extra qualification is provided as a visual aid in understanding what motions are to be performed.

Table 5-1: Node Types

Node Type	Description	Graphic
Line	Line Nodes define points between which the syringe tip will be moved along a straight-line path. A minimum of two Line Nodes are required to defined a line path, the "LineStart" and the "LineEnd." In addition, an arbitrary number of Line Nodes can be placed between these points and will be labeled "LineMid." A Line Node can be the first Node in a Path and can be used to start an arc motion.	
Arc	Arc Nodes define a circular arc motion. An arc motion must start with a Line or Pause Node followed by an arbitrary number of pairs of Arc Nodes. The minimum arc motion consists of a Line Node followed by two Arc Nodes. Arc Nodes cannot be placed after a Path Break or Dot. The last Arc Node in a sequence is labeled the "ArcEnd" and all of the intermediate points are labeled "ArcMid." The following rules apply: • Arc Nodes must be defined in pairs. • The first Arc Node must be proceeded by a Line or Pause Node. • Arc Nodes cannot be placed after a Path Break or Dot Node. • Arc Nodes cannot be the first Node of a Path.	
Path Break	If you want to stop dispensing fluid and start another dispensing sequence within a single Path, as a programming convenience, you can insert a Path Break Node. This Node will turn off dispensing, automatically move above the previous Node position by an amount "mm Above Path," and then move to a position "mm Above Path" above the next Node position. The following rules apply: • There must be a Node before and after a Path Break. • Cannot be the first or last Node in a Path. • Cannot be two of these Nodes in a row. • Cannot be moved to since it has no robot position.	
Pause	A Pause will stop the robot's motion at a Node for a specified period of time. This is useful to form a fill area that is along the Path. This Node can start or end a Path in order to delay before fluid is dispensed or to delay until after the dispensing completes.	

Node Type	Description	Graphic
Dot	A Dot Node dispenses a single dab of fluid at the Node position. The dispense tip is moved above the Node position by the Path's "Approach" height, moves down to the Node position and turns on dispensing, delays for a specified time, turns off dispensing, and then retracts to the Path's "Depart" height. This Node can start or end a Path. In fact, a Path could consist of several Dot Nodes and nothing else if required.	

Dispensing Paths and Processes

A Path consists of a series of Nodes and can only operate a single syringe tip. A Path can contain as few as one Node or can have thousands of Nodes to represent an extremely complex dispensing pattern.

In addition to the list of Nodes, each Path includes specifications for the following functions and parameters that can be uniquely defined for each Path:

- Z Height Search: At the first Node, GD can utilize the "Z-Contact" sensor or any similar device to detect the actual height of the work surface. The difference between the expected and actual height will then be automatically applied to correct the Z values of all Nodes in the Path.

- X, Y, Z Offset: The positions of all Nodes in the Path can be shifted by a fixed offset in all three directions. This is useful for raising up the entire Path during debugging and for adjusting the Path height following a Z-Search.

- 1D, 2D, 3D Pallets: A Path can be automatically repeated and indexed in 1, 2, or 3 dimensions. This is convenient for repeating a pattern or for executing the pattern at each position in a 2D or 3D grid or pallet.

- Approach and Depart Points: At the start of a Path, the syringe tip can be moved to a position above the first Node before moving to the Node (the "Approach" point). Likewise, after moving to the final Node in a Path, the syringe tip can be moved to a position above the final Node (the "Depart" point). This is a convenient means for avoiding obstacles between dispensing patterns.
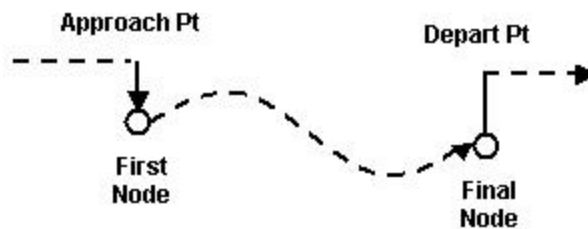
Figure 5-3: Approach and Depart Points

- Vision Process Reference Frame: At the start of the Path, a PreciseVision process can be executed and the resulting position and orientation used in place of all but the Z height of the Global Frame to dynamically compensate all of the Path's Node positions.

- Dual Syringe Speeds: Different syringe tip speeds can be specified for when fluid is and is not being dispensed to optimize the system cycle time.

Within a Path, there are some restrictions on when the various Node Types can be specified. The following are the rules that apply to all Paths:

- **First Node:** The first Node must be a Line, Point, or Pause Type.
- **Arc Nodes:** Arc Nodes must always be specified in pairs and an arc path must start with a **Line** or Pause Type.
- **Final Node:** The final Node cannot be a Break Path Type.

To permit a complete dispensing operation to be specified, multiple Path's can be combined into a dispensing Process. A Process can be as simple as a single Path or can contain many different Paths and even multiple references to the same Path. Paths are executed in the order in which they are listed in a Process.

If your system includes two syringes and both syringes are utilized in the same operation, each syringe must be controlled by one or more different Paths and these Paths must be specified in a Process in the order in which they are to be executed.

To avoid driving the syringe into an obstacle as it moves to the Approach point for the first Path, a Process always begins execution by retracting the robot to the Z height of a pre-defined Safe Location and then moves horizontally to the Safe Location. Likewise, at the end of each Process, GD retracts the robot to the Safe Location's Z height and then moves horizontally to the Safe Location and terminates execution with the robot at this position.

Standard Web Page Format

The graphical user interface for the Guidance Dispense Application is composed of a series of web pages. These web pages are stored on the robot controller's flash memory along with the application software. They can be viewed either locally or remotely from a PC using Internet Explorer. Since the web pages and the application software are stored in the controller, there is never a problem of inconsistencies between the user interface and the application software.

When GD begins execution in its normal mode of operation, the first web page displayed will appear as follows:
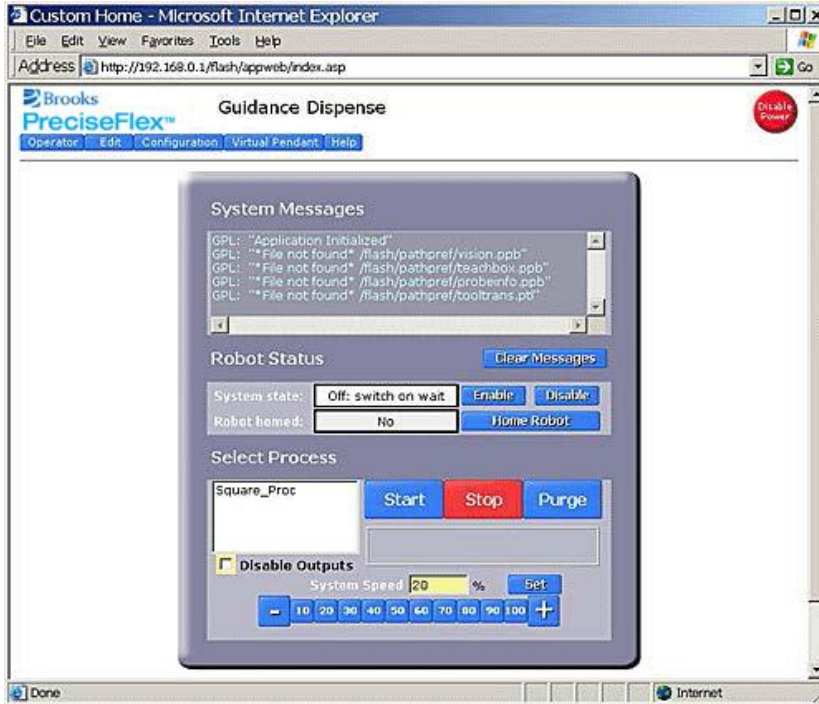
Figure 5-4: Guidance Dispense Web Page Interface

The name of the software application, the top-level navigation bar, and a red **Disable Power** button are displayed at the top of each web page.

> ⚠️ **WARNING**
>
> **Disable Power**
>
> The **Disable Power** button is provided as a convenience for turning off power to the robot's motors. However, this should not be confused with a hardwired E-Stop button. A hardwired E-Stop button directly connects to the controller hardware and guarantees that the motor power will be quickly disabled. The Disable Power button relies upon the proper operation of software to function.

The navigation bar allows the user to quickly switch between main web pages and access their functions. In the case of the "Operator Control Panel" web page pictured in Figure 5-4, all of the operations are available in a single panel. For other pages, a list of sub-pages is displayed in a table on the left. Clicking on listed topics in the left table displays sub-panels that present additional information.

Table 5-2 briefly describes the contents of the pages associated with each of the tabs on the main navigation bar. Each of these web pages and their sub-panels are described in greater detail later in this chapter.

Table 5-2: Main Navigation Bar Tabs

Main Navigation Bar Summary
Operator
Edit
Configuration
Virtual Pendant
Help

As an aid in learning how to use the Guidance Dispense application, a number of web pages and panels contain a help hot spot marked by . Click on this icon to access help information in a new window.

Enabling Motor Power and Homing the Robot

As a convenience, a number of the web pages provide buttons and fields for enabling/disabling power to the robot's motors, displaying the current state of motor power, and for "homing" the robot. For example, the Operator Control Panel has a "Robot Status" section that appears as follows:
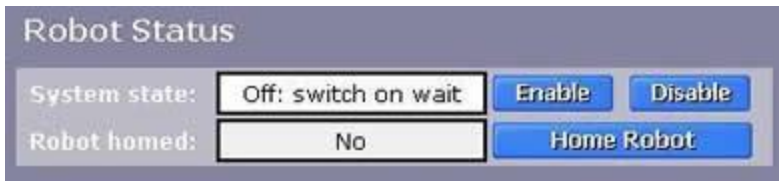
Figure 5-5: Robot Status Section of the Interface

The **Enable** button enables power to the robot's motors and releases any motor brakes. The robot will normally be left in a position control mode and the motors will maintain the current position of the robot until a command to move is generated. The **Disable** button will immediately turn off power to the motors.

⚠ **DANGER**

Electrical Shock Hazard

Before enabling power, ensure that the following steps have been performed: (1) the robot has been properly mounted; (2) all required safety interlocks have been installed and tested; and (3) power has been connected. For the PrecisePlace robots, this information is provided in the *"PrecisePlace 2300/2400 Robot, Hardware Introduction and Reference Manual"*.

When power is enabled, the **System state** transitions from **Off: switch on wait**, which indicates that the system is waiting for a switch to be changed to enable power, to one of the following:

- **GPL Ready** - Indicates that the robot is ready to operate in automatic mode.
- **GPL Executing** - Indicates that a dispensing operation is being run.

Several other informational messages are possible such as those that indicate that the robot is in manual control mode or that a hardware E-Stop button is being asserted.

Some systems are also equipped with a blinking power light. In the case of the PrecisePlace robots, a yellow LED is mounted on the top of the Z-axis motor. When the controller is first powered on, this LED will blink at a rate of about once per second. When motor power is enabled, the LED will blink at a rate of 4 times per second.

Before the robot can execute a dispensing Process or move in certain manual control modes, the robot must be "homed" in addition to having its motor power enabled. Homing is the process in which each axis determines its position relative to an absolute 0 reference position. This permits the robot to accurately repeat a taught motion sequence after AC power has been cycled and the controller is restarted. Homing only needs to be performed once after the controller power is restored, no matter how many times the motor power is enabled or disabled.

When motor power is enabled for the first time after the controller is restarted, click the **Home Robot** button to home the robot. The homing method varies from robot-to-robot and from axis-to-axis. Some axes are equipped with special homing sensors. Others simply rely upon a travel limit signal or hard stop to re-establish the absolute position. In the case of the PrecisePlace robots, the X and Y-axes are equipped with special PreciseFlex Pseudo Absolute Encoders that allow the absolute position to be determined by making a very small 2-4 mm motion. For most robots, the homing process typically takes a minute or so to complete.

At the conclusion of the homing process, the **Robot Homed** field should indicate **Yes** and the robot will be ready to be moved under manual or automatic control.

Operator Control Panel -- Main Web Page

The *Operator Control* panel is used to select, start, stop, and control the execution of a dispensing Process. It is normally the first web page that is displayed when this software package begins execution. To access the *Operator Control* panel, select the **Operator** tab in the Navigation bar.
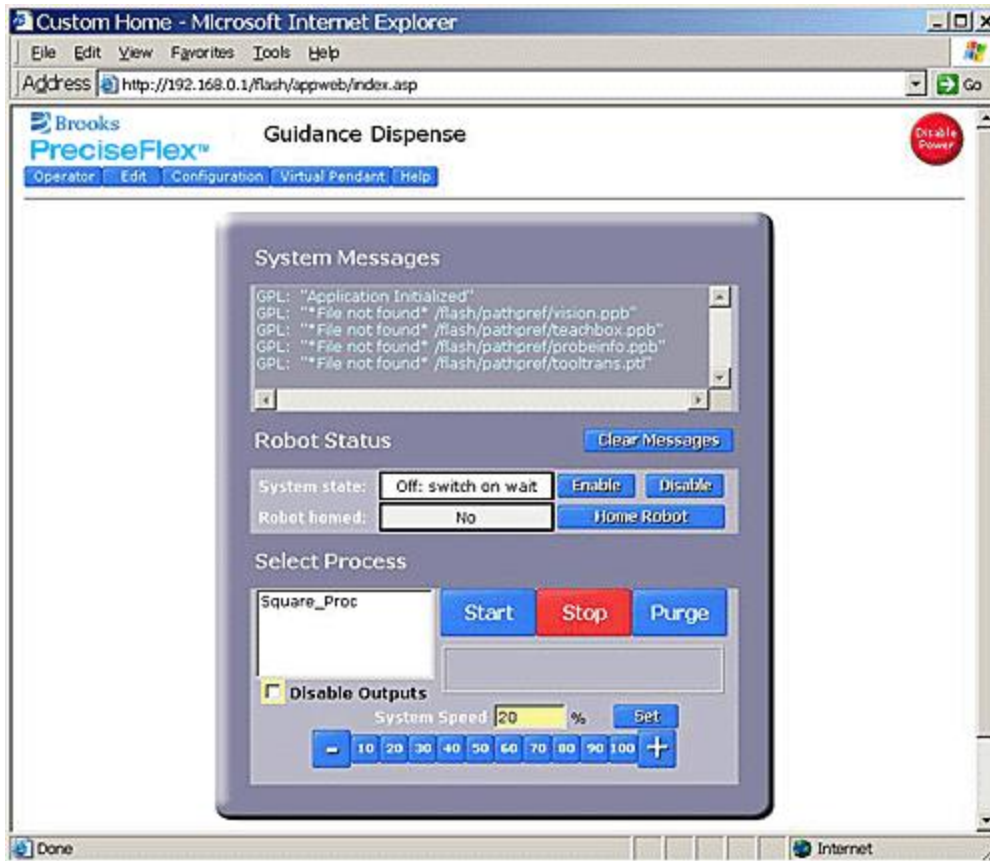
Figure 5-6: Operator Control Panel

This panel is divided into three major sections:

1. System Messages

2. Robot Status

3. Select Process

System Messages

The *System Messages* section at the top of the panel contains a scrolling list of informational and error messages that have been automatically generated. This section contains the following fields and buttons:

Table 5-3: System Messages

System Message	Description
Message box	A read-only text box that displays all system and application messages. The most recent message is displayed on the top line. See Chapter 5: Troubleshooting Guide for a description of common error messages and output generated by Guidance Dispense. See the **PreciseFlex Library→Controller Software→Software Reference→System Error Codes** for a description of the complete list of error messages that can be generated by the robot control system.
Clear message	Clears all messages displayed in the **Message** field This is convenient for deleting old messages that can be confusing if attention is not paid to the message time stamp.

Robot Status

The **Robot Status** field in the middle of the panel contains items for controlling motor power and robot homing.

Table 5-4: Robot Status

Robot Status	Description
System State	See Enabling Motor Power and Homing the Robot for a description of these buttons and fields.
Robot Homed	
Enable	
Disable	
Home Robot	

Select Process

The **Select Process** field at the bottom of the panel permits the operator to select the dispensing Process that they want to execute and to start and stop its execution.This panel also includes aids for debugging and testing a Process.

Table 5-5: Select Process

Select Process	Description
<Process list>	Displays a list of **Processes** that are currently defined. Before the "Start" button is clicked, a **Process** must be selected in this window.
Start	Begins execution of the Process selected in the <Process List>. Before execution can commence, robot motor power must be enabled and the robot must be homed.
Stop	Immediately stops any process currently being executed. The dispense output control signals will be turned off to prevent unintentional dispensing.
Purge	Displays a pop-up window that can move the robot to the designated "Purge" position and turn on the specified dispense head(s). This is used to verify that the heads are working or to clear the needles. See Purge Setup for additional information.
[ ] Disable Outputs	If checked, disables the operation of the dispenser syringes when a Process is executed. The dispenser output signal is re-directed to the **Free** teach button light on the Air Dispenser. This mode is useful for test running an entire dispense Process without dispensing any fluid.
System Speed	Reduces the speed of all robot motions to allow a **Process** to be run slowly for diagnostic and debugging purposes. Normally, this speed should be set to 100% for normal operation.

Editing Web Page

The Edit Page

The *Edit* page provides a series of panels for creating, editing and managing dispensing Processes, Paths, and Nodes. To open the *Edit* page, click the **Edit** tab in the Navigation bar.
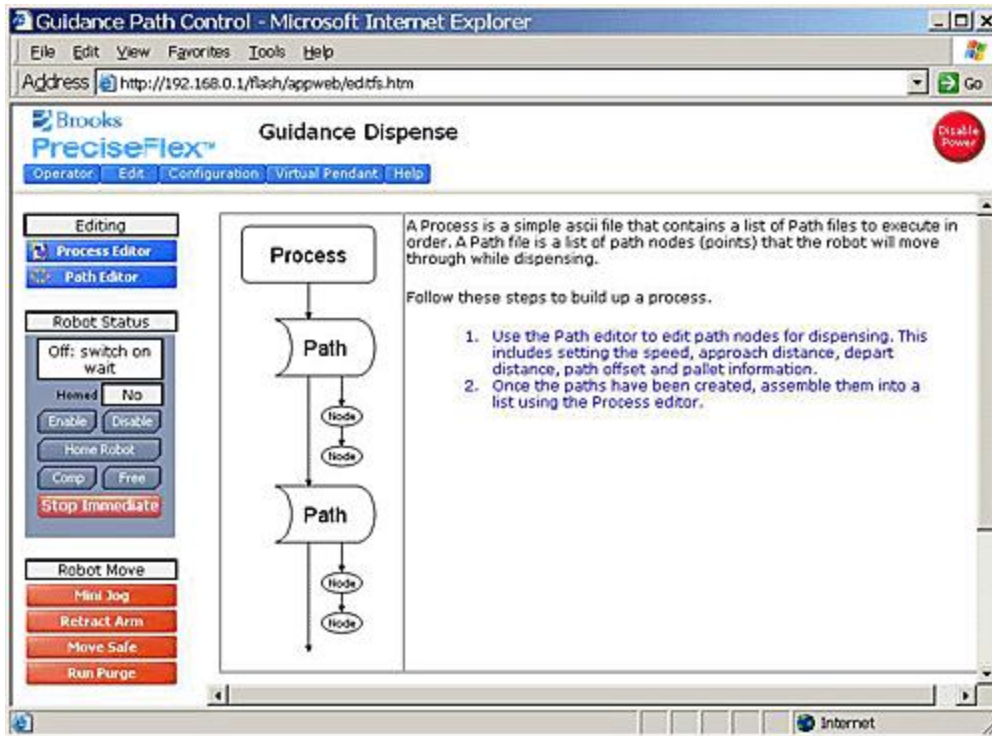
Figure 5-7: The Edit Page

When this page is first displayed, the right panel presents a brief summary of the relationship between the dispensing elements and the steps for creating a complete operation. The three lists on the left select the data to be edited and provide access to buttons for enabling motor power and moving the robot.

The contents of the Editing list is as follows:

Table 5-6: Editing

Editing	Description
Process Editor	Displays in the section to the right, the panel for creating, modifying and deleting dispensing Processes. A detailed description of this panel is provided in the following section.
Path Editor	Displays in the section to the right, the panel for creating, modifying and deleting dispensing Paths and Nodes. A detailed description of this panel is provided in a following section.

The Robot Status list contains a variation of the motor power control and homing items available in the Operator Control Panel. In addition, it provides buttons for assisting in manually positioning the robot. This list and the following list are very useful for defining and touching up **Paths** and **Node** positions.

Table 5-7: Robot Status

Robot Status	Description
\<System State\>	See the section on [Enabling Motor Power and Homing the Robot](#) for a description of these buttons and fields.
Homed	
Enable	
Disable	
Home Robot	
Comp	Places the robot back into computer control mode (to permit automatic execution) if the robot is currently in manual control mode.
Free	Places the robot into manual control mode and "free's" all of the axes. Free'd axes can be positioned by pushing the robot and manually moving it into position.
Stop Immediate	Immediately decelerates and stops the robot if it is in motion and turns off all dispenser output signals. Then, the operator is prompted to determine if the robot should be retracted and moved to the [Safe Location](#).

The Robot Move list provides a number of convenient means for repositioning the robot and purging the syringes.

Table 5-8: Robot Move

Robot Move	Description
Mini Jog	Opens up a miniature version of the [Virtual Manual Control Panel](#) in a separate window. This panel can remain open while jogging and teaching points in the editor.
Retract Arm	If a **Process** is not executing, moves the robot in the world Z direction to the Z height of the [Safe Location](#). This is convenient for clearing an error or debugging an operation.
Move Safe	If a **Process** is not executing, moves the robot in the world Z direction to the Z height of the [Safe Location](#) followed by a horizontal motion to the [Safe Location](#).
Run Purge	Displays a pop-up window that can move the robot to the designated "Purge" position and turn on the specified dispense head(s). This is used to verify that the heads are working or to clear the needles. See [Purge Setup](#) for additional information.

Process Editor Sub-Panel

When the **Edit** tab is clicked and the **Process Editor** button is clicked, the panel pictured below is displayed in the bottom right of the Edit page. This editor allows multiple dispense **Paths** to be

organized into a **Process**. A **Process** can contain any combination of **Paths** and multiples references to the same **Path**. Once a **Process** has been created, it will automatically be displayed in the process list of the Operator Control Panel.

Figure 5-8: Process Editor

The "Process Files" list displays the names of the **Processes** that have already been created. Each **Process** is preserved in its own file on the flash disk. Guidance Dispense automatically loads the data for a **Process** back into the controller's memory when it is required for editing or execution. However, modified **Process** data is only stored to a disk file when an explicit command is received to avoid replacing permanent settings with temporary trial data.

Table 5-9: Process Files

Process Files	Description
New	Creates a new **Process** both in memory and on the flash disk. Once created, **Processes** must have **Paths** assigned to them.
Remove	After confirmation, deletes the highlighted **Process** file from memory and the flash disk.
Run	Executes the highlighted **Process**. This is the same operation performed by the Operator Control Panel. *Note - this operation requires that the **Process** be saved prior to execution.
[ ] Disable Dispense	If checked, disables the operation of the dispenser syringes when a **Process** is executed. This is useful for running an entire dispense **Process** without dispensing any fluid.

When a **Process** is selected in the "Process Files" list, the **Paths** assigned to the **Process** are displayed in the "Process Contents" display. New **Paths** can be added to the selected **Process** using the "Available Paths" list.

Table 5-10: Processes & Paths

Process List & Available Paths	Description
Insert	Inserts the **Path** highlighted in the "Available Paths" list into the **Process** above the highlighted **Path** in the "Process Contents."
Append	Appends the **Path** highlighted in the "Available Paths" to the end of the "Process Contents" list.
Remove	Removes the **Path** highlighted in the "Process Contents" from the list. This does NOT remove the **Path** file from memory or the flash disk, it just removes a reference to it in the **Process**.
Save	Saves any changes made to the currently selected **Process** to its flash disk file. Once saved, you can use the "Run" operation or the Operator Control Panel to execute the **Process**.

Path and Node Editor Sub-Panel

When the **Edit** tab is clicked and the **Path Editor** button is clicked, the panel pictured below is displayed in the bottom right of the Edit page. The Path Editor provides the tools for creating, managing and modifying **Paths** and their **Nodes**.
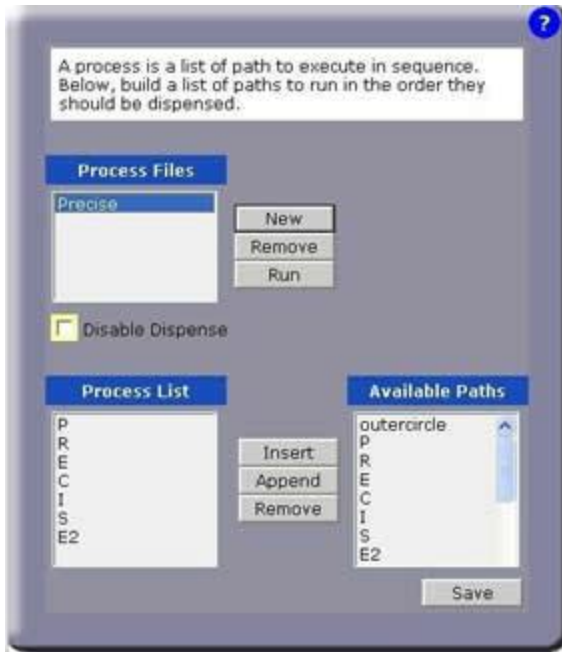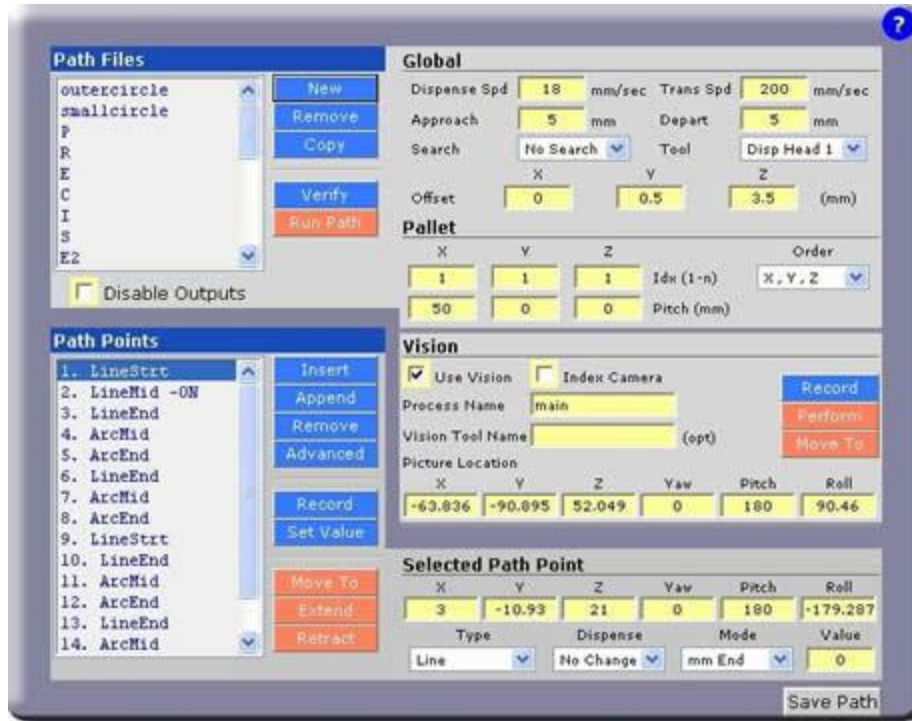
Figure 5-9: Path Editor

The "Path Files" list displays the names of the **Paths** that have already been created. Each **Path** is preserved in its own file on the flash disk. Guidance Dispense automatically loads the data for a **Path** back into the controller's memory when it is required for editing or execution. However, modified **Path** data is only stored to a disk file when an explicit command is received to avoid replacing permanent settings with temporary trial data.

Table 5-11: Path Files

Path Files	Description
New	Creates a new **Path** both in memory and on the flash disk. Once created, **Paths** must have **Nodes** added to them. This function displays a pop-up that prompts whether a new **Path** is simply to be created (which is assigned a single **Node**) or whether a new **Path** should be created and a series of **Nodes** taught. In teach mode, the user can create and define the position for **Nodes** by clicking a pop-up button or using the teach buttons on the Air Dispense unit.
Remove	After confirmation, deletes the highlighted **Path** file from memory and the flash disk.
Copy	Makes a copy of the selected **Path**. The operator to enter a new **Path** name.
Verify	Performs a verification check on the selected **Path**. This test includes verifying that all of the **Nodes** in the **Path** satisfy the rules and that the Z height of all **Nodes** is sufficiently high. This function is provided to allow **Paths** to be pre-checked since this test is automatically performed when a **Path** is executed.

Path Files	Description
Run Path	Executes the highlighted **Path**. The operator is prompted to run the entire **Path** or one step at a time. The step-by-step mode allows individual line/arc operations to be executed along the **Path** and assists in debugging. In step-by-step mode, the dispenser output is automatically disabled.
[ ] Disable Dispense	If checked, disables the operation of the dispenser syringes when a **Path** is executed. The dispenser output signal is re-directed to the "Free" teach button light on the Air Dispenser. This is useful for dry running a **Path** and fine-tuning **Nodes** while receiving visual feedback on the dispensing commands.

The "Global" section of this panel specifies parameters that affect the entire **Path** and are not specific to a particular **Node**.

Table 5-12: Global

Global	Description
Dispense Spd	Specifies the speed (in mm/sec) of the syringe tip while it is dispensing fluid.
Trans Spd	Defines the transition speed (in mm/sec) of the syringe tip while it is moving between **Nodes**. Anytime that fluid is not being dispensed, this speed is applied to optimize the overall cycle time.
Approach/Depart	Defines distance (in mm) that the dispensing head will moved above the first and last **Node** positions when performing the dispensing **Path**.
Search	Enables the Z-Search mode. If "use probe" is selected, prior to performing the dispense path, the robot will move to the first **Node** in the path and search down. When the surface is detected, the "Z" height of the dispense **Path** is automatically adjusted (based on the "Z-Search" settings). This operation is only performed once per path cycle.
Tool	Specifies the dispense head that will be used. This is important as it determines the digital output that is operated to dispense fluid. In addition, the proper syringe dimension and mounting offset is applied based on the definition of the Dispense Head.
Offset X, Y, Z	Defines a fixed offset that is applied to the position of each **Node** in the **Path** when the **Path** is executed. It is also applied during teaching or editing of the **Path** points. This operation allows fine tweaking of a **Path** without having to edit individual path points.

The "Pallet" section permits a **Path** to be repeated in a 1, 2 or 3 dimensional rectangular grid that is relative to the **Path's** reference frame. This can be utilized to repeat a dispensing pattern at each position in a pallet.

Table 5-13: Pallet

Pallet	Description
X, Y, Z Idx (1-n)	Defines which dimensions will be repeated and how many times they will be repeated. By default these values are all set to "1" to indicate that repeating is NOT enabled. If a **Path** is to be repeated on a standard pallet, these values represent the number of rows (X), columns (Y) and stacks (Z) in the pallet. In addition to setting these value, the "Pitch" must also be properly set.
X, Y, Z Pitch (mm)	Specifies the distance (in mm) between adjacent rows, columns or stacks.
Order	Selects the order in which the 3 dimensions will be indexed. When a pallet is enabled (indicated by having the 'Idx' values > 1) an order of operation is applied based on this setting.

The "Vision" section enables PreciseVision to dynamically compute a reference frame that replaces all of the components of the **Global Frame** except for its Z height. When enabled, a user defined PreciseVision Vision Process is automatically executed at the start of the **Path**. If PreciseVision cannot locate the reference frame or if a visual part inspection indicates that a part is not acceptable, **Path** execution will be terminated with an error.

Table 5-14: Vision

Vision	Description
[ ] Use Vision	If checked, enables using PreciseVision to generate the **Path's** reference frame.
[ ] Index Camera	If checked, automatically indexes the position of an arm-mounted camera based on the "Pallet" settings. This allows a grid of loosely fixtured parts to be addressed using a single **Path** pattern. Each time the pallet is indexed, the arm-mounted camera will be positioned to the next pallet location for the picture point and the vision system will be called again. If not checked and a pallet is enabled, PreciseVision will only be called at the first pallet location. All subsequent pallet **Paths** will use the original vision frame. This is useful for fixed mounted cameras or parts that are fixed accurately in a tray but where the tray is placed in the robot's work area in a coarse position.
Process Name	Defines the required name of the PreciseVision Vision Process that is executed to determine and return the **Path** reference frame.
Vision Tool Name	Optionally defines the name of a vision tool that is part of the PreciseVision Vision Process. By default, the last tool executed by PreciseVision computes and returns the value of the required reference frame. However, if a tool name is specified in this parameter, its reference frame value is returned and utilized instead.
Picture Location (X,Y,Z,yaw,pitch,roll)	Defines the position where the robot should be moved to prior to calling PreciseVision to execute the Vision Process. If all of the components are set to "0" (the default), then the picture point stored in the Vision Configuration is used instead. This picture point is taught relative to the **Global Frame**. If this position is specified, its Z component is forced to match that of the original camera calibration point defined in the Vision configuration.

Vision	Description
Record (button)	Records the Picture Location where the robot must be moved to prior to executing the Vision Process. This function automatically looks at the position stored in the Vision Configuration and sets the new point to the same Z height. For arm-mounted cameras, it is important that the Z height be constant to maintain the same field-of-view and scaling.
Perform (button)	Moves the robot to the Picture Location and performs the Vision Process. This assists in debugging the Picture Location and Vision Process. This must be executed prior to manually teaching **Path** points relative to the vision-generated frame of reference.
Move To (button)	Moves the robot back to the Picture Location. This is useful for debugging the Vision Process in PreciseVision.

The "Path Points" section displays and manages the list of **Nodes** defined in the currently selected **Path**. Specific data for the **Node** selected in this list is displayed in the "Selected Path Point" section.

Table 5-15: Path Points

Path Points	Description
Path Point List View	Provides a scroll list of all the **Nodes** defined in the selected **Path**. This list also displays any errors in the **Path**. If any error is detected, the list is displayed in Red. The **Node** causing the problem includes a "*" prior to its name. Use the "Verify" operation to get more descriptive details of the problem. When the **Node** list display is generated, **Node Types** are automatically assigned more descriptive names based upon the **Node** rules. For example, the first ARC **Node** will be labeled "ArcMid" and the second will be labeled "ArcEnd."
Insert/Append/Remove (buttons)	Allows **Nodes** to be easily added and removed to/from the selected **Path**.
Advanced	Allows advanced **Node** add/remove operations. These include "Copying" and "Removing" a range of **Nodes** and the ability to add more **Nodes** using the teach buttons on the Air Dispenser. These operations make is very easy to duplicate a section of a **Path** or remove unwanted areas of a complex **Path**.
Record (button)	Records the current position of the robot relative to the current reference frame and stores the value in the select **Node**.
Set Value	Simultaneously sets or increments a position component (X, Y, Z, Yaw, Pitch, Roll) for a range of **Nodes**. This is very useful for adjusting all or part of a **Path** to have the same "Z" value. Alternately, an offset can be added to a position component for a range of **Nodes**.
Move To (button)	Moves the robot directly to the selected **Node** position taking into account the current reference frame. If no special frame is in effect, the **Global Frame** will be utilized. If the **Path** is relative to vision results, the position will be relative to the last generated Vision Process reference frame. *Note - care should be taken when clicking this button. If the **Global Frame** has been re-taught improperly or Dispense Head dimensions or mounting have been changed, it could lead to needle damage.

Path Points	Description
Extend/Retract (buttons)	Extends or retracts the selected dispense head if it is equipped with a pneumatic slide. These buttons provide a convenient way to operate the head digital I/O.

The "Selected Path Point" section displays the detailed information for the **Node** that is selected in the "Path Points" list.

Table 5-16: Selected Path Points

Selected Path Point	Description
X,Y,Z,yaw,pitch,roll	Displays the coordinates of the selected **Node** relative to the **Path's** reference frame. These values represent the relative position and orientation of the **Node** with respect to either the **Global Frame** or the frame generated by PreciseVision depending on the **Path** settings.
Type	Displays the **Node Type** for the current **Path** point.
Dispense	Selects if the dispense operation is turned on/off/nochange. Nochange will leave the current state of the output for the dispenser unchanged. On/Off will turn on or off the output of the dispense head.
Mode	For Line and Arc **Nodes**, specifies when the dispense operation change defined by the "Dispense" parameter is put into effect. • %Start/End - Change occurs at a percentage of the distance from the start or end of the motion to the **Node**. • mm Start/End - Change occurs at a distance in mm from the start or end of the motion to the **Node**. "mm End" is the default setting and the most common case. • Sec Start/End - Change occurs at a fixed time in seconds from the start or end of the motion to the **Node**. For Pause and Dot **Nodes**, this parameter is ignored. For Path Break **Nodes**, this parameter indicates the "mm Above" height.
Value	Defines the decimal number that is the numerical portion of the "Mode" specification. For example, if the Mode is "mm Start," this parameter defines the distance in mm from the start of the motion to the **Node** when the dispense operation change takes place.
Save Path (button)	Saves the currently selected **Path** to the flash disk. The user can make changes to a **Path** without saving. Once debugging is completed, use this button to permanently alter the **Path**.

NOTE: All changes to a **Path** will be lost if a different **Path** file is selected before the changes are saved to the flash disk. Anytime a **Path** is modified a "Path modified" box will be displayed next to the "Save Path" button to indicate the file on the flash is NOT up to date.

Configuration Web Page

Configuration -- Main Web Page

The Configuration page is displayed when the **Configuration** tab in the Navigation bar is clicked. This page provides a number of utilities for defining system configuration and setup parameters. For example, this page has a step-by-step process for defining the **Global Frame** and a panel for configuring the digital IO signals that control the air dispenser and its teaching buttons.
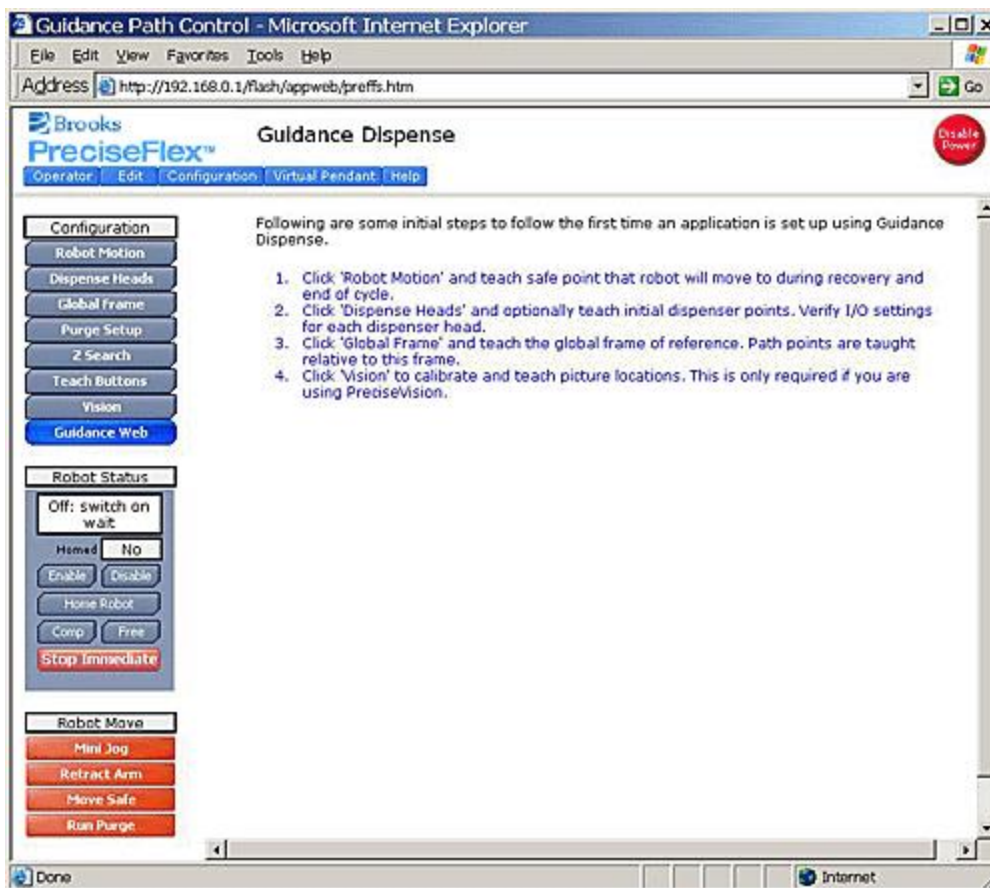
 Figure 5-10: The Configuration Page

When this page is first displayed, the right panel presents a brief summary of important setup processes that should be executed. The three lists on the left select the configuration panel to be display and provide convenient access to buttons for enabling motor power and moving the robot.

When a button in the "Configuration" list is clicked, the corresponding panel is displayed to the right. In the following sections, the operation of each of these panels will be described in detail. The following table contains a brief summary of these panels.

Table 5-17: Configuration

Configuration	Description
Robot Motion	Defines the "Safe Location," robot speeds used during various motions and the minimum Z height for all automatic motions.
Dispense Heads	Defines the mounting position and dimensions of the two dispense heads (syringe tips) and the digital IO signals that control their operation.
Global Frame	Defines the reference frame that all **Node** locations are defined with respect to by default.
Purge Setup	Defines the position to which the robot is moved to purge a syringe and the duration of the purging operation.
Z-Search	Defines the parameters for searching for the Z height of a surface using the "Z-Contact Sensor." The computed correction in the Z height will be applied to all **Node** locations in a **Path**.
Teach Buttons	Defines the digital IO signals assigned for the teach buttons on the Single/Dual Control Air Dispenser.
Vision	Defines the interface parameters necessary for using PreciseVision with GD. This includes the vision PC's IP address and the location to which the robot is moved to take a picture during the camera calibration process.
Guidance Web	Launches a new web window and displays the standard GUI for the PreciseFlex Guidance Controller. Access to this interface is provided for completeness and should not be required during normal operation of the system.

The Robot Status list contains a variation of the motor power control and homing items available in the Operator Control Panel. In addition, it provides buttons for assisting in manually positioning the robot. This list and the following list are very useful for manually moving the robot to define key locations necessary for the configuration operations.

Table 5-18: Robot Status

Robot Status	Description
<System State>	
Homed	
Enable	See the section on Enabling Motor Power and Homing the Robot for a description of these buttons and fields.
Disable	
Home Robot	
Comp	Places the robot back into computer control mode (to permit automatic execution) if the robot is currently in manual control mode.

Robot Status	Description
Free	Places the robot into manual control mode and "free's" all of the axes. Free'd axes can be positioned by grabbing the robot and manually moving them into position.
Stop Immediate	Immediately decelerates and stops the robot if it is in motion and turns off all dispenser output signals. Then, the operator is prompted to determine if the robot should be retracted and moved to the Safe Location.

The Robot Move list provides a number of convenient means for repositioning the robot and purging the syringes.

Table 5-19: Robot Move

Robot Move	Description
Mini Jog	Opens up a miniature version of the Virtual Manual Control Panel in a separate window. This panel can remain open while jogging and teaching points in the editor.
Retract Arm	If a **Process** is not executing, moves the robot in the world Z direction to the Z height of the Safe Location. This is convenient for clearing an error or debugging an operation.
Move Safe	If a **Process** is not executing, moves the robot in the world Z direction to the Z height of the Safe Location followed by a horizontal motion to the Safe Location.
Run Purge	Displays a pop-up window that can move the robot to the designated "Purge" position and turn on the specified dispense head(s). This is used to verify that the heads are working or to clear the needles. See Purge Setup for additional information.

Robot Motion and Safe Location Sub-Panel

When the **Configuration** tab is clicked and the **Robot Motion** button is clicked,, the panel pictured below is displayed in the bottom right of the Configuration page. This panel defines the "Safe Location," robot speeds used by various motions and the minimum Z height for all automatic motions.

 Figure 5-11: Safe Location Sub-Panel

The Safe Location is a position where the robot can be moved to be clear of all obstacles in the work cell. When a **Process** begins execution, the robot is always moved to the Safe Location before going to the first **Node**. After the motion to the last **Node**, the robot is returned to the Safe Location before the **Process** terminates.

Motions to the Safe Location are always performed in two steps:

- Retracts the robot to the Z height specified by the Safe Location.

- Moves horizontally to the Safe Location.

> **NOTE:** The Z height of the Safe Location is particularly important since the robot moves to the Safe Location by first retracting to this Z height and then moving horizontally to the Safe Location. Also, other operations, like Purging, also use this Z height for moving safely through the workspace.

Table 5-20: Safe Location

Safe Location	Description
Teach Safe Point	Records the current location of the robot as the value of the Safe Location.
Move Safe Point	Moves the robot to the safe point. This is convenient for placing the robot into a known location.

The "General Motions Settings" contains speed and acceleration specifications that apply when the system is moved automatically during training (e.g. Purge and Move Safe operations) and when the robot is moving between **Paths**. While executing a **Path**, the transit and dispensing syringe tip speeds are explicitly specified as parameters to the **Path**.

Table 5-21: General Motion Settings

General Motion Settings	Description
Run Speed (% max)	Defines the speed (as a percentage of the robot's maximum nominal speed) of motions when executing a **Process** but not following a **Path**.
Edit Speed (% max)	Defines the speed (as a percentage of the robot's maximum nominal speed) for automatic motions performed during training and debugging, e.g. Purge motions and moving to the Safe Location.
Accel/Decel (% max)	Defines the acceleration and deceleration (as a percentage of the robot's maximum nominal values) for all motions except when following a **Path**.
Accel Ramp (seconds)	Defines the acceleration/deceleration ramp times (s-curve profiling) for all motions except when following a **Path**.

Whenever the robot is moved automatically both during training and when executing a **Process**, the destination of each motion is tested to ensure that it is not too low relative to the Z height of the **Global Frame**. This is a precaution to prevent a syringe tip from being inadvertently driven into the deck.

Table 5-22: Path Verify Test

Path Verify Test	Description
Z path node test	Defines the minimum Z height relative to the **Global Frame** for the destination of all automatic motions. Any motion that attempts to go below this value will be terminated and flagged as an error. To disable this test, a large negative values should be entered.

Path Verify Test	Description
Save	Updates the motion settings saved on the flash disk.

Safety Zones

For all robot types, "Safety Zones" can be defined that disable motor power and halt the motion of the robot if its tool center point (TCP) violates the requirements of a user defined 3D volume.

Types of Safety Zones

These 3D safety zones can be used to:

1. Approximately model the volume of stationary objects or personnel working areas to prevent the robot from inadvertently entering this volume and causing a collision ("keep out zones").

2. Reduce the normal working volume of the robot to prevent the robot from reaching beyond prescribed boundaries and causing a collision ("stay within zones").

3. Verify that the robot's TCP speed (when in a specified volume) is below a specified limit so that the robot can be safely decelerated and stopped before it might pin an operator's hand to a hard surface with too high a force ("speed restrict zones").

As currently implemented, the "keep out zones" and "stay within zones" are provided as general safety features, but they do not meet the stringent Category 3 safety standards that require fail safe redundant logic. However, the "speed restrict zones" do provide the requisite redundancy and are in the process of being Category 3 certified. The "keep out zones" and "stay within zones" are collectively referred to as "uncertified zones" and the "speed restrict zones" are referred to as "certified zones".

The supported zone shapes are rectangular volumes, cylinders and spheres. To define a safety zone, the type of safety zone must be specified along with its origin and dimensions.
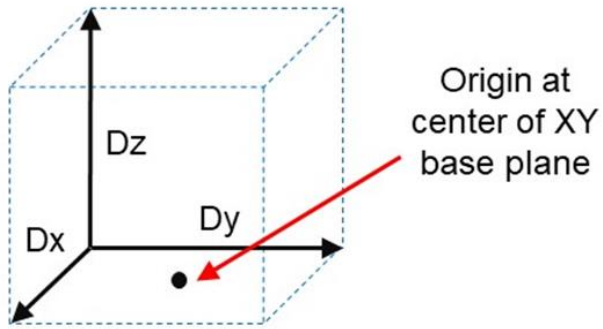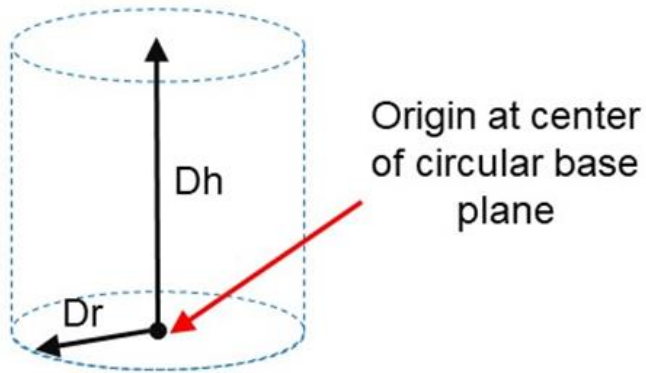
Figure 5-12: Rectangular Volume
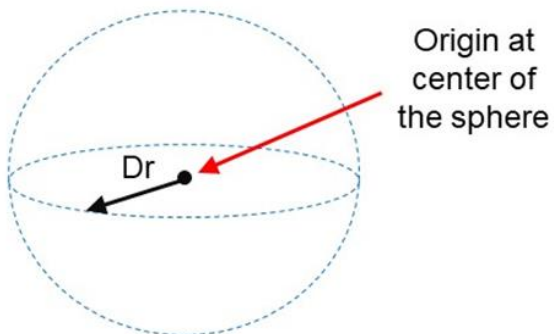

Figure 5-13: Cylinder

Figure 5-14: Sphere

For increased generality, uncertified zones can be arbitrarily positioned and rotated in all three dimensions. Due to implementation limitations, certified zones must be non-rotated rectangular volumes, which can be arbitrarily positioned. Up to 10 zones can be defined for each robot and any mix of certified and uncertified can be specified. Due to safety requirements, any new or modified zone specifications only go into effect after the controller is rebooted.

Safety Zone Violation Detection and Clearing

Uncertified safety zones are active in the following circumstances:

- Continuously during program-controlled motions of all types (straight line or arc Cartesian and joint interpolated).
- Continuously during manual (jog) control modes: World, Tool and Joint, but not free.
- Motion planning (final destinations only).
- Location object.KineSol method during conversions to either Cartesian or joint Locations.

Certified safety zones are only active during program-controlled motions (of all types) since this is the only circumstance where higher TCP speeds are possible.

When motor power is enabled and the robot's TCP is in violation of an uncertified safety zone, a program-controlled motion cannot be initiated. This condition can be cleared by disabling motor power and manually repositioning the robot or by manually jogging the TCP in World, Tool or Joint modes, so long as the jog motion reduces the safety zone violation distance. That is, jogging motions that increase the violation of a safety zone are not permitted.

> **NOTE:** Safety zone testing is based on the TCP of the robot. Therefore, it is very important that the position of the tool center point relative to the robot's tool mounting flange is set correctly. Please see the Robot.Tool property for information on defining the TCP.

Certified Speed Restrict Safety Zones

While the uncertified safety zones perform conventional tests on just the position of the TCP, there are two certified safety zones and these perform special tests to detect if the speed of the TCP exceeds a limit while the TCP is within the zone. The first certified safety zone tests if the Z downward speed of the TCP exceeds a specified limit. This safety zone was implemented for the PreciseFlex 400 and PreciseFlex 3400 robots since their only intrinsically non-safe motion is a high-speed downward Z motion that could trap a person's hand between the tooltip and a fixed object or horizontal surface. The second certified safety zone tests if the horizontal, XY planar, speed of the TCP exceeds a specified limit. This test was developed for the PreciseFlex™ DD robots since robots can generate excessive speeds when moving horizontally.

For both of these tests, in order to satisfy the computational redundancy requirement of the Category 3 safety regulations, the shapes of these safety zones are limited to non-rotated rectangular volumes.

Please consult the user manuals for these PreciseFlex™ robots for when speed restrict safety zones must be defined to safely operate these mechanisms.

Configuring Safe Zones

Up to 10 safety zones can be defined per robot. Each of these zones is specified by filling in one of the Parameter Database IDs 16900 to 16909, which are labeled "Safety Zone: type, x/y/z/y/p/r, dim 1/2/3". Any combination of certified and uncertified safety zones can be specified. Each of these DataIDs consists of an array of 10 numbers and the first value defines the safety zone "type". Any DataID that has a zero "type" is ignored. Table 5-23 describes the possible safety zone types:

Table 5-23: Safety Zone Types

Safety Zone Type	Description
0.	Undefined safety zone
1.	Rectangular volume, keep out zone
2.	Cylinder, keep out zone
3.	Sphere, keep out zone
4.	Rectangular volume, stay within zone
5.	Cylinder, stay within zone
6.	Sphere, stay within zone
7.	Non-rotated rectangular volume, Z downward speed restrict zone
8.	Non-rotated rectangular volume, XY speed restrict zone

Table 5-24 describes the safety zone DataIDs. When any of these DataIDs are modified, the controller must be rebooted for the change to be put in effect.

Table 5-24: Data IDs

DataID	Parameter Name	Description
16900 to 16909	Safety Zone: type, x/y/z/y/p/r, dim 1/2/3	Each safety zone definition consists of an array of 10 values. The first value is the safety zone "type". The next six values define the position of the origin of the volume of interest and its orientation. This is specified as a standard Location value: x, y, z, yaw, pitch, roll. The final three values define the size of the volume of interest. For the permitted shapes, this is interpreted as: volume: Dx, Dy, Dz Cylinder: Dh, Dr, 0 Sphere: Dr, 0, 0 For example, for a downward Z non-rotated rectangular volume speed restrict safety zone, a single DataID should be specified as follows: 7, x, y, z, 0, 0, 0, Dx, Dy, Dz Where x, y, z are the coordinates of the center of the base of the rectangular volume and Dx, Dy, Dz are the dimensions of the volume, all in mm.

In addition, the DataID in must be initialized to establish the maximum speed limits for the certified safety zones:

Table 5-25: Data IDs

DataID	Parameter Name	Description
2740	Certified safety zone, max Z/XY spd mm/sec	These parameters define the maximum speeds that are permitted for the Certified Speed Restrict Safety Zones. The first value is the maximum downward Z speed (when within the safety zone) in mm/sec. Since this is a downward speed, it should be a negative value and defaults to -200. The second value is the maximum permitted speed in the horizontal XY plane (when within the safety zone), and defaults to 200 mm/sec.

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Dispense Heads Sub-Panel

When the **Configuration** tab is clicked and the **Dispense Heads** button is clicked, the panel pictured below is displayed in the bottom right of the Configuration page. This panel defines the mounting position and dimensions of the two dispense heads (syringe tips) and the digital IO signals that control their operation.

Figure 5-15: Dispense Heads Sub-Panel

It is permissible to teach a **Path** and repeat the **Path** without knowing the dimensions or mounting position of the syringe heads. But, if GD does know this information, if a syringe and needle size changes or if a syringe needle bends, GD can automatically adjust the robot motions so that the new syringe tip will follow the previously taught **Path**. In addition, if two syringes are used, the **Nodes** taught with one syringe can be easily repeated by the other syringe.

To simplify the training of the dimensions and mounting of the syringe tips, you must select a "Reference Point" in the work cell *that does not move*. Then, to teach the dimensions and mounting of a different syringe tip, you only need to move that tip to the same Reference Point and click a button. GD will compute the required information and will automatically put this data into effect each time the syringe tip is selected.

> **NOTE:** Once the Reference Point value is taught, it should not be changed. If this value is re-taught with a syringe tip that is a different size or is mounted in a different position on the robot, it will alter the result of any syringe tips that are taught with respect to this new Reference Point and any formerly taught **Paths** will be incorrect.

Table 5-26: Reference Point

Reference	Description
Rec Reference	Records the value of the Reference Point. *Dispense head #1 must be used to teach this location.*
X, Y, Z, Yaw, Pitch, Roll	Displays the coordinate values of Reference Point. *These should not be altered once they are taught.*
Move To	Displays a pop-up window that can move a syringe tip to the Reference Point or to a position above this location.

Once the Reference Point is established, the dimensions and mounting of either dispense head can be taught or re-taught simply by moving the desired syringe tip to the Reference Point and pressing the Rec Offset button. The following data pertains to each of the dispense heads.

Table 5-27: Dispense Heads

Head 1 or 2	Description
Rec Offset	Computes the dimension and mounting data for a dispense head when the syringe tip is positioned at the Reference Point.
X, Y, Z, Yaw, Pitch, Roll	Displays the computed coordinate values for the dispense head. Initially, the values for head #1 will all be close to 0.
Move To	Displays a pop-up window that can move a syringe tip to the Reference Point or to a position above this location.
Extend Signal	Defines the number of the Digital I/O signal that controls the extension and retraction of the sliding syringe clamp. When this signal is asserted, the slide is extended.
Dispense Signal	Defines the number of the Digital I/O signal that applies air pressure to the syringe. When this signal is asserted, fluid is dispensed.
Extend/Retract	Turns the Digital I/O signal that controls the syringe slide off or on. This allows for debugging the dispense head locally on this page.
On/Off	Actuates the dispense signal. This operation allows for debugging the dispense fluid.
Save	Saves all dispense head information to the flash disk.

Global Frame Sub-Panel

When the **Configuration** tab is clicked and the **Global Frame** button is clicked, the panel pictured below is displayed in the bottom right of the Configuration page. This panel specifies the reference frame that all **Node** locations are defined "with respect to" by default.
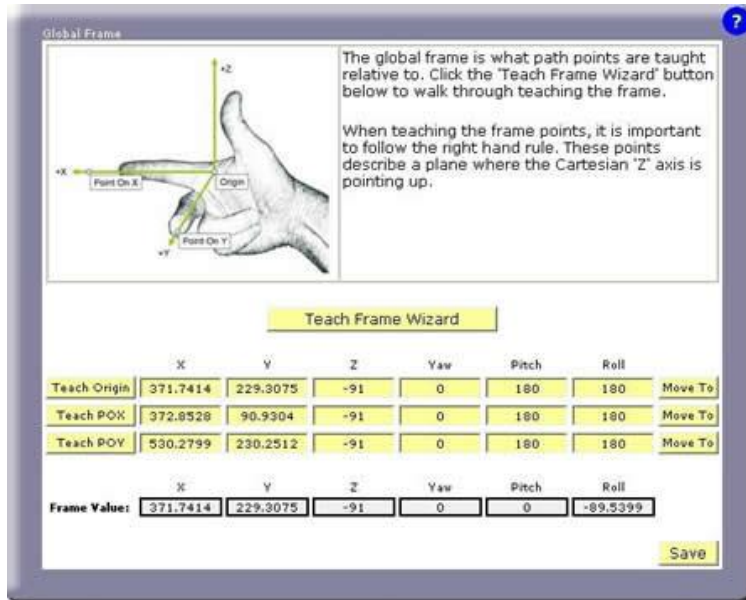

Figure 5-16: Global Frame Sub-Panel

Node locations are always defined with respect to a reference frame. If vision is being used, the vision results dynamically supersede all of the coordinates of the **Global Frame** except for its Z height.. If no special reference frame is in effect, **Node** locations are automatically defined relative to the complete **Global Frame**.

> *NOTE:*   The **Global Frame** should be defined as soon possible to ensure that all **Node** locations are correctly recorded.

This panel displays the current value of the **Global Frame**. This value is automatically computed from the X, Y, Z coordinates of three locations that point at the following features of the reference frame:

- The origin (0,0,0) of the reference frame.

- Any position along the X-axis of the reference frame.

- Any position that is in the X-Y plane of the reference frame and generally along the Y-axis.

> ***NOTE:*** As soon as the X, Y or Z coordinate of any of the three locations is altered, the **Global Frame** is immediately recomputed and the new value will be reflected in the location of all **Nodes** that are relative to this reference frame.

Table 5-28: Global Frame Descriptions

Global Frame	Description
Teach Frame Wizard	Launches the step-by-step wizard for teaching the three locations that define the **Global Frame**. As a convenience, the "Line" and "Free" buttons on the Air Dispenser can be used in place of the wizard's "Record" button and the Virtual Manual Control Pendant. At the end of this operation, the new frame value is automatically saved to the flash disk.
Teach Origin	
Teach POX	Displays a pop-up that permits one of the three locations to be set equal to the current location of one of the syringe tips.
Teach POY	
X, Y, Z, Yaw, Pitch, Roll	Displays the three sets of location coordinates and permits them to be edited.
Move To	Displays a pop-up window that can move the robot to the associated location or to a position above this location.
Save	Saves the frame value to the flash disk.

Purge Setup Sub-Panel

When the **Configuration** tab is clicked and the **Purge Setup** button is clicked, the panel pictured below is displayed in the bottom right of the Configuration page. This panel defines where the robot is moved to purge the two dispense heads and the duration of the purge operation.
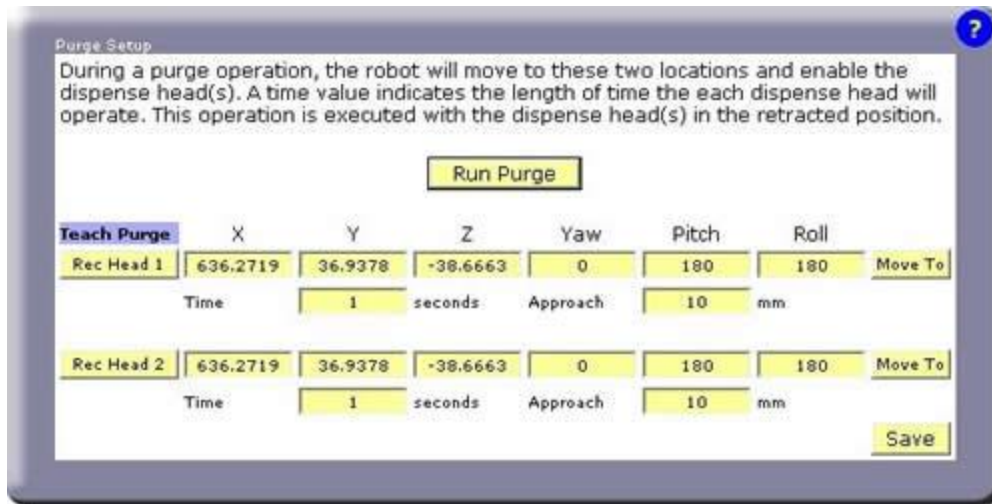
Figure 5-17: Purge Setup Sub-Panel

The purge operation is a pre-defined process that safely moves the robot to a designated position and dispenses fluids for a specified period of time. This function can be manually invoked from a number of pages and is used to test if a syringe is operating properly and to clear the needle. The purge operation performs the following steps:

- Retracts the robot to the Z height specified by the Safe Location.

- Moves to the "Approach" position that is the specified number of mm above the purge position.

- Moves to the purge position with the syringe slide in the retracted position.

- Turns on the syringe air supply for the specified number of seconds.

- Retracts the robot to the Z height specified by the Safe Location.

- Moves horizontally to the Safe Location.

For this function, the speed and acceleration of the robot is defined by the Robot Motion parameters. For each syringe head, the following fields and buttons are defined.

Table 5-29: Purge Parameters

Purge Parameters	Description
Run Purge	Executes the purge operation as defined above. This is the same function that is available on a number of other panels.
Rec Head #	Records the current position of the robot (with no tool enabled) for the selected dispenser head.
X, Y, Z, Yaw, Pitch, Roll	Displays the purge location coordinates and permits them to be edited.
Move To	Displays a pop-up window that can move the robot to the purge position or to a position above this location.

Purge Parameters	Description
Time	Specifies the duration that the syringe is purged in seconds.
Approach	Defines the "Approach" height above the purge location.
Save	Saves the purge settings to the flash disk.

Z-Search Sub-Panel

When the **Configuration** tab is clicked and the **Z-Search** button is clicked, the panel pictured below is displayed in the bottom right of the Configuration page. This panel defines the parameters for searching for the Z height of a surface using the "Z-Contact Sensor."
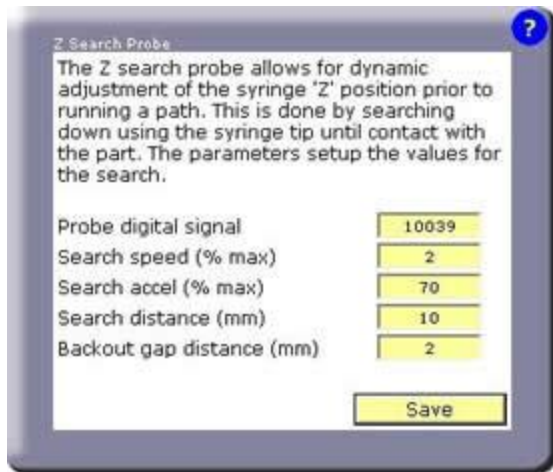
Figure 5-18: Z-Search Sub-Panel

The Z-Search is an option that can be selected for any **Path**. When enabled, at the start of the **Path**, GD samples the Z-Contact Sensor to locate the height of the work surface at the first **Node** position. The correction between the actual height and the Z height of the first **Node** is dynamically applied to all **Nodes** in the Path.

If a **Path** has Z-Search enable, at the start of the **Path**, the syringe tip will be controlled as follows:

- Moves to the "Approach" position above the first **Node**.

- Moves down in Z at the "Search speed" and "Search accel" traveling a maximum "Search distance."

- Monitors the "Probe digital signal" and stops when the signal becomes TRUE.

- Retracts the syringe at 25% of the "Search speed" until the "Probe digital signal" is FALSE. This permits a faster "Search speed" while still obtaining an accurate height reading.

- Computes the difference between the first **Node's** Z position and the detected Z position minus the "Backout gap distance."

- Moves to the first **Node** position and all subsequent **Nodes** in the **Path** applying the Z correction and the X/Y/Z offset defined in the Path Editing Page to all **Nodes**.

Normally, the Z offset specified in the Path Editing Page is utilized to move the entire **Path** up to the proper height above the work surface to correctly dispense the fluid.

Table 5-30: Z-Search Settings

Z-Search Settings	Description
Probe digital signal	Defines the Digital I/O signal number for the contact probe. This signal becomes TRUE when the surface is detected. This defaults to 10039, which is the DIN signal normally connected to the Z-Contact Sensor.
Search speed (% max)	Defines the speed (as a percentage of the robot's maximum nominal speed) for the search motion.
Search accel (% max)	Defines the acceleration (as a percentage of the robot's maximum nominal acceleration) to be used during the search motion.
Search distance (mm)	Defines the maximum distance in mm that the robot is permitted to move during the search. If this distance is exceeded, the search will fail and will generate an error.
Backout gap	Defines the distance in mm between where the slide is fully extended and where the slide is retracted sufficiently to trigger the contact sensor.
Save	Saves the settings to the flash disk.

Teach Buttons Sub-Panel

When the **Configuration** tab is clicked and the **Teach Buttons** button is clicked, the panel pictured below is displayed in the bottom right of the Configuration page. This panel defines the system digital input and output signals that return the state of the three buttons on the PreciseFlex Single/Dual Control Air Dispenser and control their backlights. *These settings should not have to be changed once a system is wired and the hardware configuration has been debugged.*
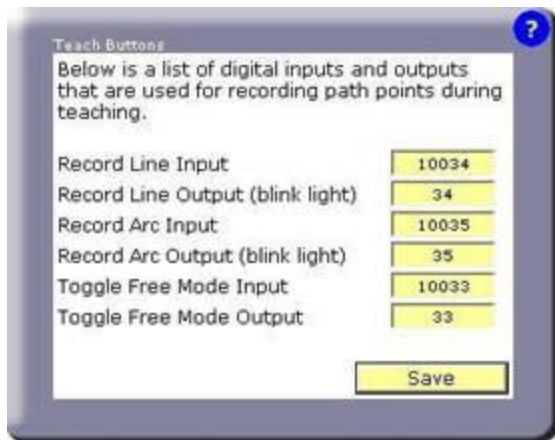

Figure 5-19: Teach Buttons Sub-Panel

If you are using a PreciseFlex Air Dispenser mounted on a PrecisePlace robot, the DIO signals should be set as shown in the picture above. These are signals that are provided by the robot's ZIO board that is mounted next to the Z-axis motor. If you do not have a PreciseFlex Air Dispenser you can configure these signals to connect to your own button box. These buttons and lights are a programming convenience and are not needed for the proper operation of the GD application program. *If any of these signals are not present, their signal number should be set to 0 to avoid generating a runtime error.*

Table 5-31: Teach Buttons

Teach Buttons	Description
Line Input/Output	Defines the DIO signals that are TRUE when the green **create "Line" Node** button is clicked during teaching and that is set TRUE to turn on this buttons backlight.
Arc Input/Output	Defines the DIO signals that are TRUE when the blue **create "Arc" Node** button is clicked during teaching and that is set TRUE to turn on this buttons backlight.
Toggle Free Mode Input/Output	Defines the DIO signals that are TRUE when the red **Free** button is clicked to place all of the axes into manual control "Free" mode and that is set TRUE to turn on this buttons backlight.
Save	Saves the DIO signal assignments to the flash disk.

Vision Sub-Panel

When the **Configuration** tab is clicked and the **Vision** button is clicked, the panel pictured below is displayed in the bottom right of the Configuration page. This panel defines the interface parameters necessary for using PreciseVision with GD.
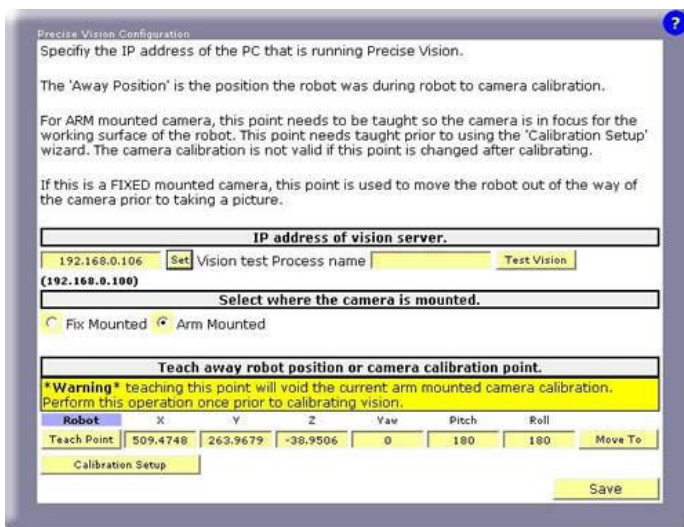

Figure 5-20: Vision Sub-Panel

Guidance Dispense contains built-in support for communicating with a PC that is executing PreciseVision. When GD requires vision to compute a frame of reference, it sends PreciseVision a command over Ethernet to execute a vision process. Typically, the vision process will consist of an Acquisition tool (for taking a picture) and just a few tools for determining the position and orientation of the object of interest. The results of the final tool are automatically returned to GD and dynamically replace all of the components of the **Global Frame** with the exception of its Z height.

In order for GD to communicate with PreciseVision, it requires the Ethernet IP address of the PC.

Table 5-32: IP Address of Vision Server

IP Address of Vision Server	Description
IP Address of vision server	Specifies the IP address of the PC executing PreciseVision. This address is used by GD to issue commands to PreciseVision and retrieve data. This address can normally be found on the PC by viewing **My Network Places** → **Network Connections**→ **Local Area Connection** → **Status**. By default, this is assumed to be 192.168.0.100. If you have executed the software installation procedure for PreciseVision, this value will already be properly set.
Vision Test Process Name	Defines the name of a PreciseVision process that can be executed to test that the communication connection is correct. Typically, you should create a test process that just consists of an Acquisition tool and a Fixed Frame tool positioned anywhere in the window. The value of this parameter is NOT SAVED to the flash disk.
Test Vision	When clicked, sends a message to PreciseVision to execute the "Vision Test Process." If the communication channel is operating, the PreciseVision display will show that the process has been executed and GD will display the X & Y position of the vision result (normally the position of the Fixed Frame). If the IP address is incorrect, GD might hang for 1-2 minutes before the system times out.

The following radio buttons select how the camera is mounted. Fix mounting the camera above the robot is advantageous if a large field of view is desired and you want to take pictures when the robot is out of the work area. An arm-mounted camera is preferred if you require higher resolution since a smaller field of view can be used but you can still cover a large area by having the robot move the camera around the workspace.

Table 5-33: Camera Mount

Select Camera Mount	Description
Fix Mounted	Indicates that the camera is mounted in a fix location above the work surface of the robot. The camera does not move.
Arm Mounted	Indicates that the camera is mounted to the Z-axis of the robot. The camera must be moved back to the original picture position during camera calibration.

In order for PreciseVision to return position coordinates and orientation angles that can be used by the robot, the relationship been where the camera is looking (i.e. its field of view) and the coordinates of the robot must be determined. This relationship is computed by performing a "Robot Vision Area Calibration." The following parameters are used for this procedure.

NOTE: For arm-mounted cameras, if the position defined in the following data is altered after the calibration is completed, the calibration will be invalid and must be computed again.

Table 5-34: Camera Calibration

Camera Calibration Point	Description
Teach Point	Records the current robot position as the position that the robot will be moved to when a picture is taken during the calibration process.
X, Y, Z, Yaw, Pitch, Roll	Defines the position that the robot will be moved to when a picture is to be taken during the calibration process. For a fixed mounted camera, this position should move the robot out of the way so it does not block the camera field of view. For an arm-mounted camera, this should position the camera over the calibration target and at the proper Z height to produce the correct size for the field of view. This position should be defined before performing the calibration procedure and only altered if you want to re-execute this procedure.
Move To	Displays a pop-up window that can move the robot to the picture taking position or to a position above this location.
Calibration Setup	Opens a small dialog that assists in performing the calibration procedure. This window should be kept on the desktop while performing the procedure. During an arm mounted camera calibration, this dialog is used to move the camera back to the picture taking position.
Save	Saves the vision settings to the flash disk.

Virtual Pendant -- Main Web Page

The Virtual Manual Control Pendant (VMCP) page is displayed in its own browser window when the **Virtual Pendant** tab in the Navigation bar is clicked. The VMCP provides the same functionality available from a hardware Manual Control Pendant, i.e. the ability to manually move the robot in various modes and display the current robot position.
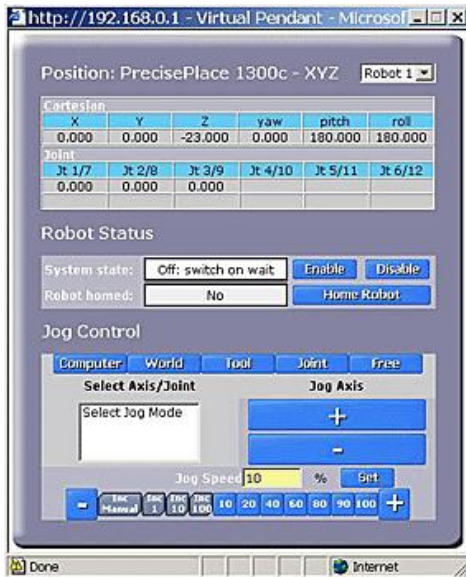
Figure 5-21: Virtual Manual Control Pendant

The "Positions" section at the top of the panel displays the location of the currently selected syringe tip and the position of each of the robot's axes.

Table 5-35: Position Display

Position Display	Description
X, Y, Z, Yaw, Pitch, Roll	Displays the position and orientation of the currently selected syringe tip in Cartesian coordinates. The X, Y and Z are in millimeters. The three angles are in degrees and are a set of Euler angles. These angles correspond to a Yaw rotation about world Z-axis (rotating to the left and right along the horizon), followed by a Pitch rotation about the new Y-axis (tilting to look up into the sky or down into the ground), followed by a Roll rotation about the new Z-axis (rotating to the left and right about the new vertical axis).
Jt 1/7 ... Jt 6/12	Displays the current position of each of the axes of the robot in millimeters or degrees as appropriate.

The "Robot Status" section in the middle of the panel contains items for controlling motor power and robot homing.
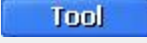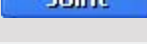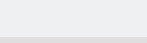
Table 5-36: Robot Status

Robot Status	Description
System State Robot Homed Enable Disable Home Robot	See the section on Enabling Motor Power and Homing the Robot for a description of these buttons and fields.

The "Jog Control" section at the bottom of the panel is used to move the robot in various manual control modes. Prior to jogging the robot, motor power must be enabled and the robot must be "homed."

To move, you first select a mode, then an axis or coordinate, then a speed and finally press the "+" or "-" key to move the axis in the positive or negative direction. Releasing the "+" or "-" key or changing modes terminates the motion.

Table 5-37: Jog Control

Jog Control	Description
Computer	Disables Jog Control and permits GD to take control of the robot and automatically move its axes. This mode should always be selected when you have finished moving the robot in jog mode.
World	Moves all of the axes of the robot in a coordinated fashion such that the selected syringe tip travels in a straight-line path along or rotates about the X, Y, or Z axes of the robot's world reference frame.
Tool	Similar to World mode except that the reference frame is determined by the selected syringe's orientation. For example, since the Z-axis of the syringe normally points down, a positive motion in tool Z will move the syringe down.
Joint	Moves individual axes one at a time. Even if an axis is beyond its limit stops, this mode can be used to drive the axis back into the working range.
Free	Allows one or more axes to be taken out of position control mode to permit the axis to move freely. For lightweight robots, this allows the operator to grip an axis and manually repositioned it.
<Select Axis/Joint>	Displays the axes that can be moved for the active jog control mode. An axis must be clicked in order to select it to be moved.
Jog Speed %	Specifies the speed that the axis will move, specified as a percentage of the maximum manual control speed. The speed can be entered numerically, incrementally changed with the speed "+" and "-" keys or by clicking one of the numbered speed keys. The "Inc" keys move the axis by a small step and then stop rather than moving continuously. This is convenient for making fine position adjustments.

Jog Control	Description
Jog Axis ("+", "-")	Moves the selected axis in the positive or negative direction at the selected speed. For Free mode, multiple axes can be simultaneously free'd by selecting the axis number and pressing the "+" key. Pressing the "-" key or selecting a different jog mode un-frees an axis.

Help -- Main Web Page

The Help Panel is displayed when the **Help** tab in the Navigation bar is clicked. This page provides links to abbreviated online versions of much of the help information that is available in this chapter plus the tutorial examples.
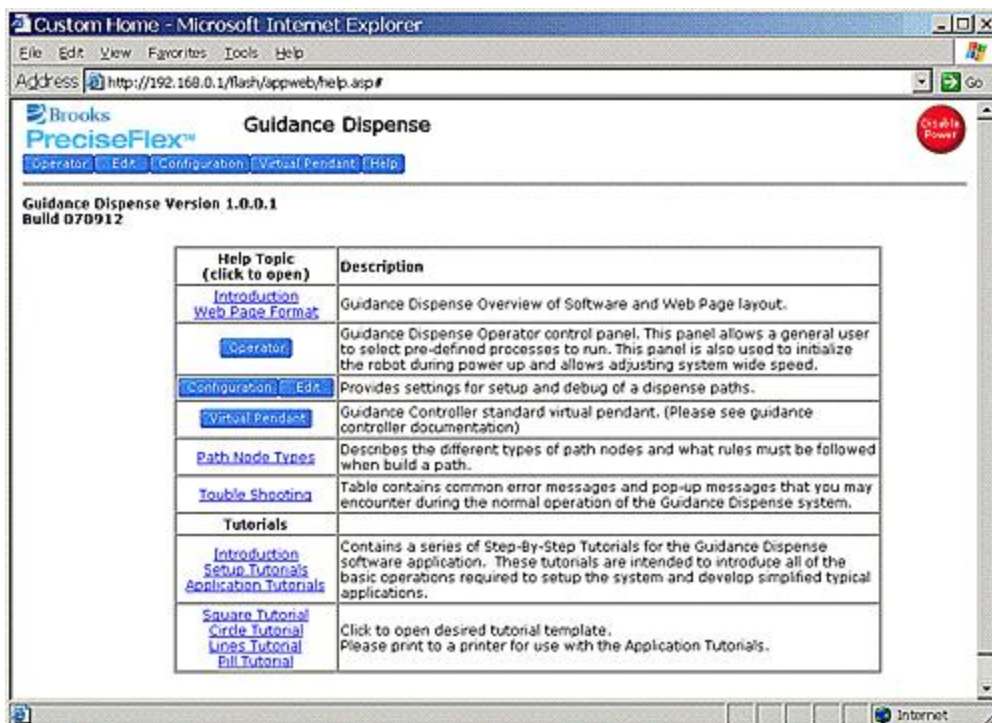
Figure 5-22: Help

6. Step-By-Step Tutorials

Tutorials Introduction

This chapter contains a series of Step-By-Step Tutorials for the Guidance Dispense software application. These tutorials are intended to introduce all of the basic operations required to setup the system and develop simplified typical applications.

These tutorials are organized into two groups:

- Setup Tutorials. These introduce all of the steps necessary to operate the system and initialize parameters that define the dispensing tools and workspace. *These tutorials should always be executed in the order they are presented* since they initialize data that is inter-dependent. In general, these tutorials only have to be executed once until the tooling or some element of the work cell is modified.

- Application Tutorials. The first tutorial is a complete, basic example. This is followed by a series of modifications of the basic example. These variations can be executed in any order.

Before performing these tutorials, ensure that the following has already been completed.

- A PC has been interfaced to the robot and a web browser can display the graphical user interface of the robot controller. If this has not been completed, see the Setup and Installation chapter of this manual.

- The Guidance Dispense software has been installed on the controller and has been started. This information can also be found in Setup and Installation.

- You have reviewed the Hardware and Software Introduction chapters of this manual. A thorough understanding of the content of these sections is not required since much of what you read will become clearer as you perform the tutorials. However, a understanding of the basic operation of the hardware and the concepts and nomenclature of the software will be very helpful.

⚠ **DANGER**	
Before operating your robot, ensure that the following steps have been performed: (1) the robot has been properly mounted; (2) all required safety interlocks have been installed and tested; and (3) power has been connected. For the PrecisePlace robots, this information is provided in the *"PrecisePlace 2300/2400 Robot, Hardware Introduction and Reference Manual"*.	⚡

Begin with the Setup Tutorials and execute them in order.

Setup Tutorial 1: Enabling Power and Homing

The first step in operating the system is to "enable power" and "home" the robot. Enabling power provides power to the motors. Homing establishes the absolute 0 position of each axis so that previously taught motions can be exactly repeated. Many robots lose track of their axes 0 positions when power to the controller is turned off. Homing reestablishes the 0 references using whatever technique is appropriate for the axes, e.g. pressing into a hard stop, engaging a limit switch, reading special encoder tracks, etc.

As a convenience, power enable/disable and homing buttons are provided on a number of different web panels (e.g. the Operator Control Panel, the Virtual Manual Control Pendant (VMCP), the Robot Status section of Edit and Configuration Pages). All of these buttons perform the same functions. For this example, we will use the Operator Control Panel.

Step	Action
1.	Open the Operator Control Panel by clicking **Operator >**. If you have started a newly loaded system that has not had all of the configuration data defined, there will be a number of benign error messages displayed in the "System Messages" window.
2.	Click **Clear Messages** to eliminate the clutter of the old messages (This step is not required to enable power). Then press **Enable** to turn on power to the motors. The **System state** will transition from **Off: switch on wait** to **GPL Ready** to indicate that motor power has been successfully enabled.
3.	Click **Home Robot** to establish the zero position for each of the axes. This operation *will move the robot* and may take a minute or two to complete.

When the homing successfully completes, the "Robot homed" field will change to "Yes." Once completed, homing does not have to repeated until the robot controller is powered down, no matter how many times motor power is enabled and disabled.

Setup Tutorial 2: Manually Moving the Robot

In many of the following tutorials, you will be required to manually position the robot. GD provides several ways of accomplish this (e.g. the Red "Free" button on the Air Dispenser, the Virtual Manual Control Pendant (VMCP), the optional hardware Manual Control Pendant, and the Robot Status and Mini Jog panel on the Edit and Configuration Pages). All of these methods. provide an equivalent or subset of the capabilities of the VMCP that will be discussed in this section.

Open the Virtual Manual Control Pendant by clicking **Virtual Pendant >**.
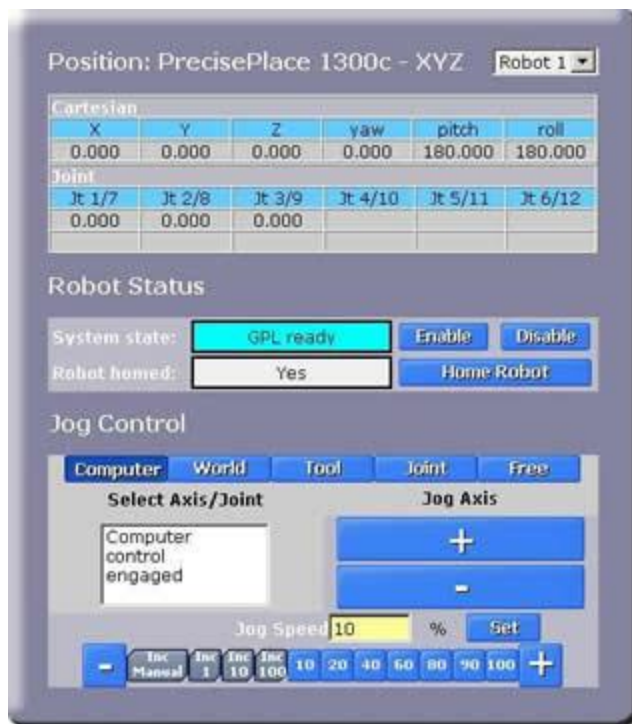
Figure 6-1: Virtual Manual Control Pendant

The VMCP will appear in its own browser window. The upper section of the VMCP provides a dynamic display of the robot's current location. The lower area contains the "Jog Control" section whose modes are summarized in the following table. Prior to jogging the robot, motor power must be enabled and the robot must be "homed."

Table 6-1: Jog Control

Jog Control	Description
Computer	Disables Jog Control and permits GD to take control of the robot and automatically move its axes. This mode should always be selected when you have finished moving the robot in jog mode.
World	Moves all of the axes of the robot in a coordinated fashion such that the selected syringe tip travels in a straight-line path along or rotates about the X, Y, or Z axes of the robot's world reference frame.
Tool	Similar to World mode except that the reference frame is determined by the selected syringe's orientation. For example, since the Z-axis of the syringe normally points down, a positive motion in tool Z will move the syringe down.
Joint	Moves individual axes one at a time. Even if an axis is beyond its limit stops, this mode can be used to drive the axis back into the working range.
Free	Allows one or more axes to be taken out of position control mode to permit the axis to move freely. For lightweight robots, this allows the operator to grip an axis and manually repositioned it.

To move a single axis in manual mode, perform the following procedure:

Step	Action
1.	Click **Jog Control > Joint**.
2.	Select a joint to move, e.g. **Joint 1**.
3.	Select a slow speed initially, e.g. **10**.
4.	Move the axis in the positive or negative direction by holding down the **+** or **-** keys.

The World and Tool modes operate in the same fashion. The Free mode is a bit different in that multiple joints can be freed at once and the speed setting is not used. For this mode, each time you select an axis and press the "**+**" the axis is freed until you press the "**-**" key to place the axis back into position control mode.

In Joint, World and Tool modes, if any of the "**INC**" speeds are selected, the robot will move a discrete increment and then stop instead of moving continuously. If you release the "**+**" or "**-**" key and press it again, the robot will move another increment. This is very convenient for fine positioning the robot.
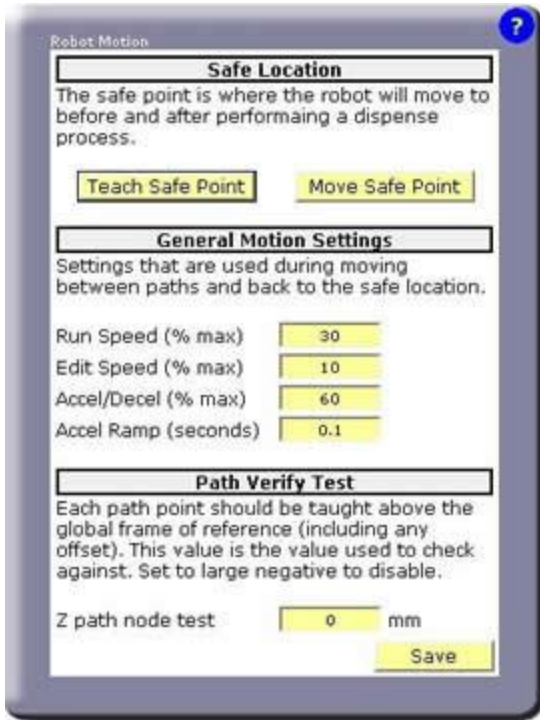
Try to move the robot in each of the manual modes and at various speeds to get a feel for the virtual pendant. When you are done practicing manual control, click **Jog Control > Computer**. This disables Jog Control and permits GD to automatically move the robot when required.

For additional experience, you should try to move the robot using the alternate interfaces, i.e. the optional hardware Manual Control Pendant, and the Robot Status and Mini Jog panels on the Edit and Configuration Pages.

Setup Tutorial 3: Teaching the Safe Location

When a **Process** begins execution and after it is completed, the robot is automatically moved to a fixed Safe Location. This safeguard helps to avoid inadvertent crashes with obstacles in the workspace. In addition, some standard operations, such as Purging syringes also move to this location for the same reason. The Safe Location should be set to a position that is always clear of obstacles and that generally positions the robot out of the way.

NOTE: The Z height of the Safe Location is particularly important since the robot moves to the Safe Location by first retracting to this Z height and then moving horizontally to the Safe Location. So, the Z height should be above the highest obstacles in the workspace.
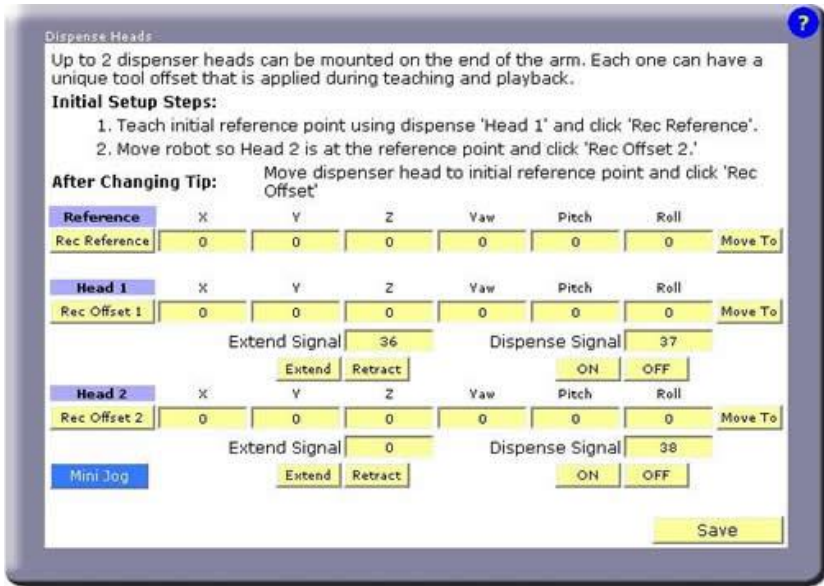
Step	Action
1.	To define the Safe Location, open **Configurations > Robot Motion**.

Step	Action
2.	Manually position the robot at the location that you have selected for the Safe Location taking special care in selecting the proper Z height.
3.	Click the **Teach Safe Point** button.
4.	When asked to "Record Safe Position," press **Yes**.
5.	If you are asked "File Exists: Okay to Delete," press **Yes**.

This position will automatically be used whenever the system needs to move the robot to a height or position that is clear of obstacles and out of the way. To verify the Safe Location, a user can manually move the robot to another position and then press the "Move Safe Point" button.

Setup Tutorial 4: Teaching the Dispense Heads

While it is permissible to teach a **Path** and repeat the **Path** without knowing the dimensions or mounting position of the syringe heads, this is not the recommended procedure. If GD is taught this information, if a syringe and needle size changes or if a syringe needle bends, GD can automatically adjust the robot motions so that the new syringe tip will follow the previously taught **Path**. In addition, if two syringes are used, the **Nodes** taught with one syringe can be easily repeated by the other syringe.

Step	Action
1.	To define the Dispense Heads, open **Configurations > Dispense Heads**

Step	Action
2.	To simplify training the dimensions and mounting of syringes, you must select a "Reference Point" in the work cell *that does not move*. Then, to teach the dimensions and mounting of a different syringe tip, you only need to position that tip at the same Reference Point and click a button. GD will compute the required information and will automatically put this data into effect each time the syringe is selected. ***NOTE:*** *Once the Reference Point value is taught, it should not be changed. If this value is re-taught with a syringe tip that is a different size or is mounted in a different position on the robot, it will alter the result of any syringe tips that are taught with respect to this new Reference Point and any formerly taught* ***Paths*** *will be incorrect.* Manually move syringe tip #1 to the position you have selected as the "Reference Point."
3.	Click **Record Ref** and **Yes** to confirm.
4.	To compute the initial offset for head #1, without moving the robot, press **Rec Offset 1** and **Yes** to confirm.
5.	If you have a second syringe head, manually position it at the Reference Point.
6.	To compute the initial offset for head #2, click **Rec Offset 2** and **Yes** to confirm.
7.	Click **Save** to store the results on the flash disk.
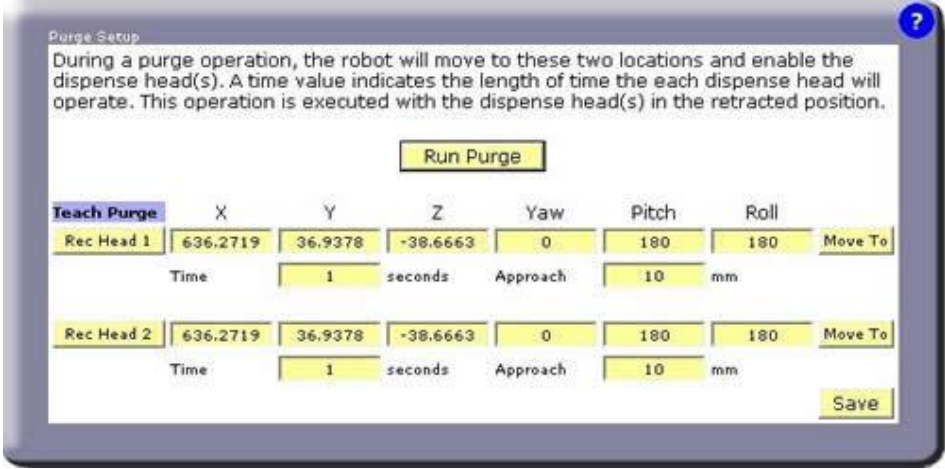
You have now successfully taught the dimensions and mounting information for the dispensing heads. Whenever you select to use a head, this information will automatically be put into effect by GD.

If at anytime you either change one of the syringes, adjust the mounting of a syringe clamp or bend a syringe tip, perform the following procedure to re-train the new dimensions and mounting information.

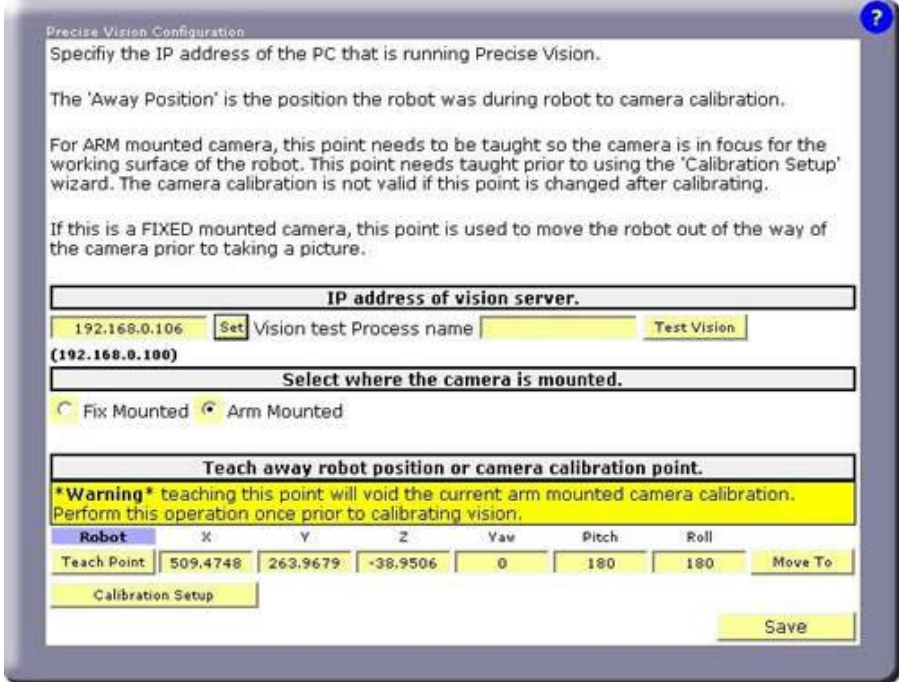| Step	Action
1.	Manually move the syringe tip to the position you have selected as the "Reference Point."
2.	To compute the new offset, press **Rec Offset** for the desired head and press **Yes** to confirm.
3.	Click **Save** to store the results on the flash disk.

Setup Tutorial 5: (Optional) Teaching the Purge Locations

To execute the manual Purging sequence later to either test the operation of the syringes or to clear the needles, the locations where the robot is to purge the syringes must be taught. The purging operation can be manually initiated from the Operator Control Panel, the left panel of the Edit or Configuration pages or from the Purge Setup panel. If you do not want to execute purging, this exercise can be skipped.

Step	Action
1.	To define the Purge Locations, open **Configurations > Purge Setup**.
2.	Manually position the robot at the location that you have selected to purge the first syringe.
3.	Click **Rec Head 1**.
4.	If you are asked to "Overwrite current position," press **Yes**.
5.	Fill in the purging Time and the height that the robot should Approach the purge location.
6.	Repeat for the second syringe head if it is being used.
7.	Click **Save** to store the results on the flash disk.

You have successfully taught the syringe Purge Locations. They will automatically be used whenever the Purge operation is invoked.To verify the locations, you can manually move the robot to another position and then press "Move To." To test purging, press "Run Purge."

Setup Tutorial 6: (Optional) Vision Interfacing and Calibration

If your system includes PreciseVision, the following procedure must be performed to interface GD to Vision and to compute the calibration data that translates vision results into coordinates useable by GD.

Step	Action
1.	To access the PreciseVision setup panel, open **Configurations > Vision**. This procedure assumes that you have already installed PreciseVision on a PC, connected the camera, and established the Ethernet link between PreciseVision and your robot controller. If not, refer to the "Supported Hardware and Software Installation" chapter of the *Precise Vision Machine Vision System Introduction and Reference Manual* before continuing this tutorial.
2.	To verify that the communications link is properly working, within PreciseVision, create a Vision Process named **"Gd_test"** that only contains a camera Acquisition tool.
3.	In the "Vision test Process name field," enter **"Gd_test"** (without quotation marks) .
4.	Click **Test Vision**.

If the communication link is operating properly, you will see a new picture in PreciseVision's camera window. If this does not occur, re-execute the Software Installation processes in the PreciseVision manual.

If your camera is **fixed mounted** (i.e. not attached to the robot), perform the following procedure:

Step	Action
1.	Check the **Fixed Mounted** radio button.
2.	Manually move the robot to the position that you would like it to move to when GD automatically takes a picture during a dispensing **Process**. This should be selected so that the robot and its shadow do not interfere with the picture.
3.	To record this position, press **Teach Point** and press **Save** to store the results on the flash disk.
4.	Execute the **Robot Vision Area Camera Calibration** procedure described in the PreciseVision manual.

If your camera is **arm-mounted** (i.e. it is attached to the robot), perform the following procedure:

Step	Action
1.	Check the **Arm Mounted** radio button.
2.	Manually move the robot so the camera is over the area where you want to perform the calibration process. *It is very important that the Z height be correct so that the camera's field of view is properly focused.* This Z height will be used when GD automatically takes a picture during a dispensing **Process**.
3.	To record this position, press **Teach Point** and press **Save** to store the results on the flash disk.
4.	To get step-by-step information on performing an arm-mounted camera calibration, Click **Calibration Setup** and follow its instructions. *NOTE:* For arm-mounted cameras, if the taught robot position is altered after the calibration is completed, the calibration will be invalid and must be re-computed.

This completes the PreciseVision setup and camera calibration procedure.
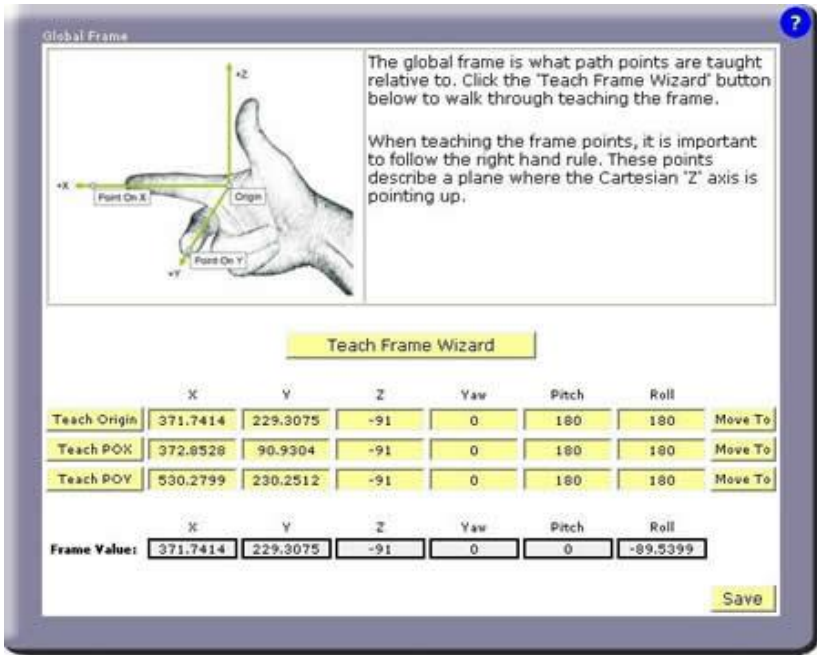
Application Tutorial 1: Basic Application Example

After having completed the Setup Tutorials, we are now ready to develop our first dispensing application. In general, the Setup Tutorials will not have to be re-executed unless the tooling or some element of the work cell is modified.

In the last section of this chapter, the Sample Applications Templates contain four example dispensing patterns. Print the *"Template #1: Sample Square Path"* and secure it to the robot's work surface. This template contains the square dispensing pattern that we will train in this tutorial.

STEP 1: TEACH THE GLOBAL FRAME
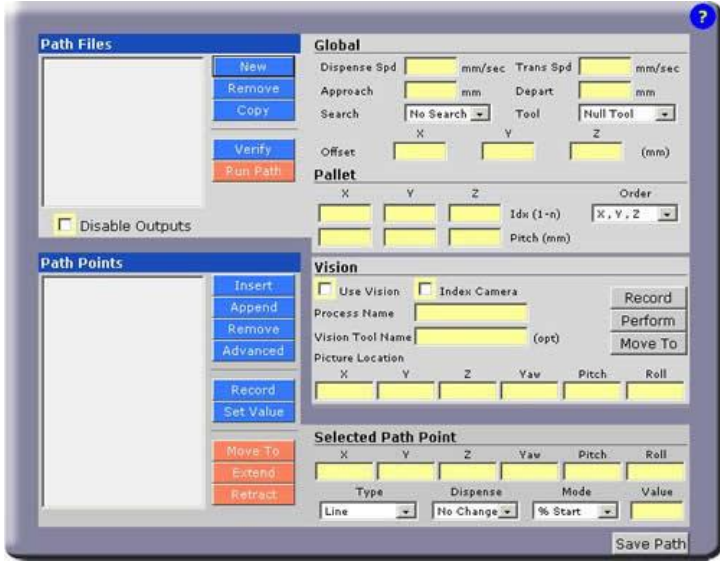
All **Node** locations are defined relative to a reference frame. In the absence of a special frame, **Node** locations are defined relative to the **Global Frame**. The value of this frame can be left unchanged, but it is good form to always start an application by setting this frame to a meaningful value. For this tutorial, we will align the **Global Frame** with the X & Y axes drawn on the template.
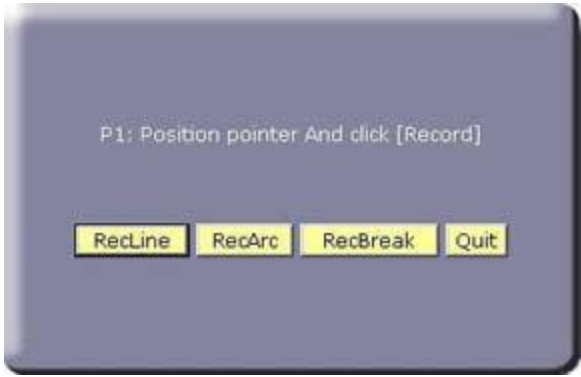
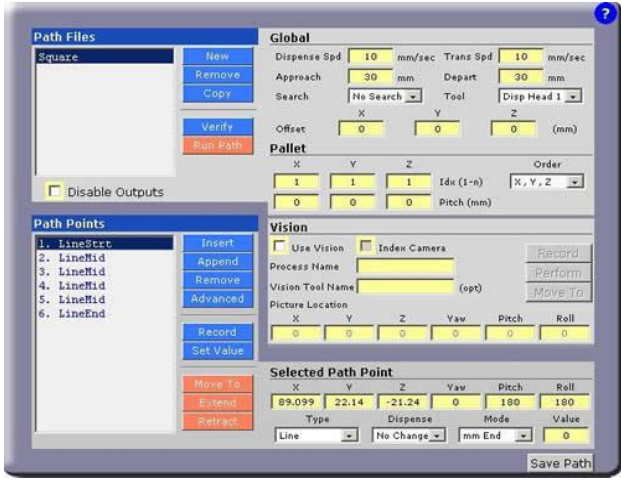| Step	Action
1.	Open the **Global Frame** definition panel **Configuration > Global Frame**. Within GD, frames are defined by specifying three points: the origin of the frame, a point on the X-axis and a point roughly on the Y-axis.

Step	Action
2.	Execute the frame teaching aid by clicking **Teach Frame Wizard** and confirm that you want to continue by clicking **Yes**.
3.	When asked, select the head that you will use during this Wizard by clicking **Head_x**.
4.	When asked to record the Origin, Point On X and Point On Y, manually position the selected syringe tip at the points on the template marked "Origin," "POX," and "POY" and click the **Record** button at each position. (As a convenience, the **Line** button on the Air Dispenser can be used in place of **Record** and its **Free** button can be used to manually position the robot).
5.	Click the **Save** button to store the results on the flash disk. Respond **Yes** when asked if it is okay to delete the existing file.

STEP 2: CREATE A NEW "PATH" AND TEACH ITS "NODES"

A **Path** contains a sequence of positions (**Nodes**) that defines the motion of the syringe tip and specifies when dispensing is turned on and off. A single **Path** can only define the actions for a single syringe head. Normally, **Paths** are kept relatively short since multiple **Paths** can be combined into the final dispensing **Process** that is executed. Given the simplicity of this example, we only need to create a single **Path** to define the desired dispensing operation.

Step	Action
1.	Open the Path Editor panel, **Edit > Path Editor** .

Step	Action
2.	The top of the panel is for managing and defining **Paths**. The middle right section is utilized when a **Path** is defined relative to the results from PreciseVision. The bottom is for managing and defining **Nodes** (positions) in the currently selected **Path**. We will use a wizard to create the new **Path** and to create and record the positions of its **Nodes**. To create the Path, under **Path Files**, click **New**.
3.	A pop-up window will display that asks *"Create new path file or Teach new path file?."* Clicking **CreateNew** will create a new **Path** but will not define any **Nodes**. To create the **Path** and to create and teach the **Node** positions, click **TeachNew**.
4.	When requested, enter the name of the new **Path** as "**Square**" (with no quotes).
5.	When prompted, specify the dispense head you will use for training and to dispense by clicking either **Head_1** or **Head_2.**
6.	The pop-up panel from the teach wizard will now ask you to teach the position for the first Node in the new Path. P1: Position pointer And click [Record] RecLine RecArc RecBreak Quit From this wizard, you can teach the positions of **Line,Arc**, and **Break Path Nodes**. Other **Node Types** can be inserted later. Also, the **Types** of the taught **Nodes** can be subsequently modified.
7.	Using any of the manual control methods, position the syringe tip at **P1** on the template. It is normally easiest to have the syringe tip lightly touch the template. The Z heights of the positions can be adjusted individually or as a group later.
8.	Create the first **Node** as a **Line Type** and record its position by either clicking the **RecLine** button in the pop-up or clicking the green **Line Button** on the Air Dispenser.
9.	Repeat the process for the other positions, **P2**, **P3**, **P4**, **P5** and **P6**.

Step	Action
10.	Terminate position teaching by clicking **Quit**. The editor panel should now resemble the following: Note that although you taught 6 **Line Nodes**, when displayed, the first **Node** is a series of straight-line motions is labeled "LineStrt" and the final **Node** is labeled "LineEnd." This is automatically done by GD to make the list of points more understandable.

STEP 3: EDIT NODE AND PATH PROPERTIES

If you click on a line in **Path Points**, the **Node's** position relative to the **Global Frame** is displayed at the bottom right together with other information about the **Node**. Currently each **Node** is a **Line Type** and has dispensing turned off.

Using the buttons next to the **Node** display, you can edit the **Path** by adding or deleting **Nodes**, recording new position values, etc. The "Set Value" button permits a coordinate value to be changed in a group of **Nodes**. The "Advanced" button permits a group of **Nodes** to be copied or deleted or for new **Nodes** to be inserted using the teaching method.
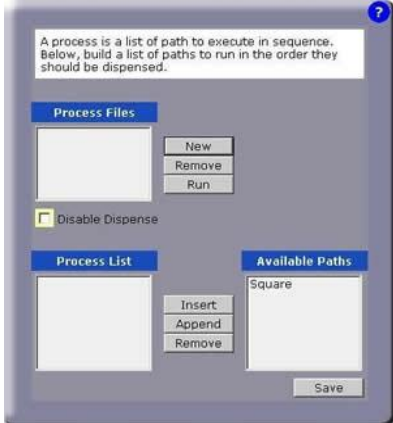
Before executing this Path,the user must edit a few properties

Step	Action
1.	To turn on dispensing at the first **Node**, in "Path Points," click on **"1. LineStrt"** and in "Selected Path Point" data, pull-down the list of options below "Dispense" and select **Turn On**.

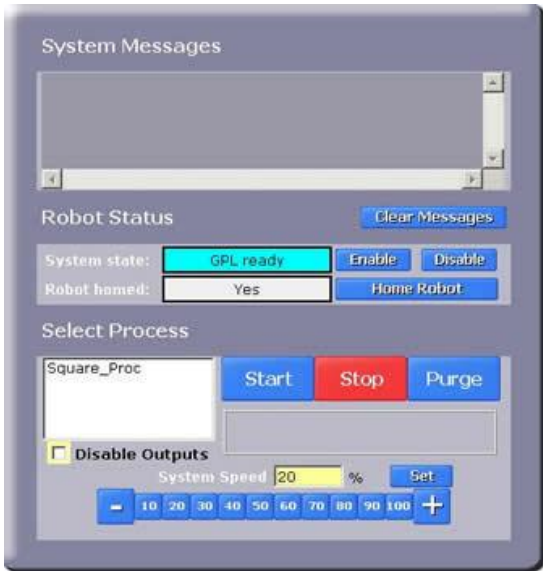| Step	Action
2.	To turn off dispensing at the final **Node**, in **Path Points**, click on **"6. LineEnd"** and in **Selected Path Point** data, open the drop-down list of options below **Dispense** and select **Turn Off** To the right of the **Dispense** drop-down list, you will see the **Mode** and **Value** fields. These fields have different interpretations for the different **Node Types**. For the **Line** and **Arc Nodes**, these values control when dispensing is turned on or off relative to the start or end of the motion. In this example, since the motions for P1 and P6 overlap slightly, these field can be used to delay turning on dispensing or to turn it off early.
3.	Modify the parameters that apply to the Path overall.In the **Path** Global data, change the **Dispense Spd** and the **Trans Spd** to **5** mm/sec. This reduces the nominal speeds when fluid is and is not dispensed.
4.	Set the **Approach** and **Depart** heights to **50** mm. This increases that height that the robot will move above the first and last **Nodes** when starting and ending the **Path**.
5.	Set the **Z** value of the **Offset** to **10**. This will lift all of the **Node** positions by 10 mm. Once the **Path** has been verified, this value can be reduced to obtain the correct distance between the syringe tip and the surface to properly dispense the fluid.
6.	Click the **Save Path** button to save the changes and respond **Yes** to the confirmation.

STEP 4: CREATE THE PROCESS

To assist in debugging, it is possible to execute a single **Path** directly from the Path Editing panel. But, since our entire **Process** will consist of one **Path**, we will directly move to creating and executing the full application.

Step	Action
1.	Open the Process Editor panel, **Edit > Path Editor**.

Step	Action
2.	To create the Process, click **New**.
3.	When requested, enter the new process name as **"Square_Proc"** (without quotation marks) and click **OK** to confirm.
4.	In **Process Files**, click on **Square_Proc**. In **Available Paths**, click on **Square**.
5.	To add the Square **Path** to the Square_Proc **Process**, click **Append**.
6.	Click the **Save** button to save the changes to the flash disk, and click **OK** to confirm.

This completes the creation of the **Process**. If we had more **Paths** to add, they would appear in the **Available Paths** list and could be appended as well.

STEP 5: EXECUTE THE PROCESS

Step	Action
1.	Open the Operator Control panel, **Operator >** .

Step	Action
2.	In order to execute the Process, motor power must be enabled and the robot must already be homed as indicated in the "Robot Status." In the Select Process area, the overall speed of the robot can be reduce for testing. Reduce the speed of all robot motions by clicking the **10** % speed button.
3.	To inhibit dispensing fluid during testing, check the **Disable Outputs** box.
4.	Select the application to run by clicking on **Square_Proc** and click the **Start** to begin execution.

Congratulations! You have just developed and executed your first dispensing application with Guidance Dispense.

At this time, we suggest that you try running the application at various speeds and adjusting the Z height of the **Path** offset with the dispense outputs enabled until you achieve a good, consistent dispensed fluid pattern.

For additional practice, you should print out the remaining three examples in the Sample Applications Templates and program these test patterns as well. Each sheet has the list of **Nodes** that should be trained to produce the test pattern.
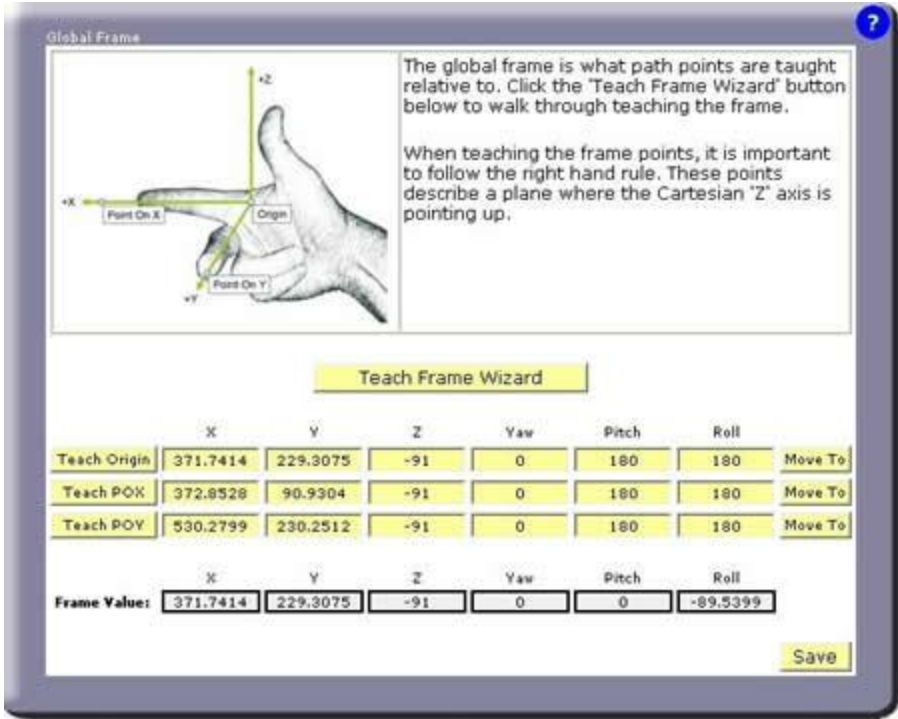
Application Tutorial 2: Adjusting for Base Shifts and Rotations

This tutorial demonstrates that if the base of a dispensing **Path** has been shifted and/or rotated, the **Global Frame** can be adjusted to compensate all of the **Path's Node** positions.

This training example requires that Application Tutorial 1 has already been completed and builds upon its results.

For any of the sample templates, execute the **Process** again to verify that the dispensing path is accurately being followed.

Step	Action
1.	Shift and rotate the sample template on the work surface and secure it again.

Step	Action
2.	Open the **Global Frame** definition panel, **Configuration > Global Frame**. We now need to re-teach the **Global Frame** and realigning it with the X & Y axes drawn on the template. Since all of the **Node** locations have been defined with respect to this reference frame, once the **Global Frame** is updated, all of the **Node** locations will be automatically compensated.
3.	Execute the frame teaching aid by pressing **Teach Frame Wizard** and confirm that you want to continue by clicking **Yes**.
4.	When asked, select the head that you will use during this Wizard by clicking **Head_x**.
5.	When asked to record the Origin, Point On X and Point On Y, manually position the selected syringe tip at the points on the template marked "Origin," "POX" and "POY" and click the **Record** button at each position.
6.	Press the **Save** button to store the results on the flash disk. Respond **Yes** when asked if it is okay to delete the existing file.
7.	Execute the **Process** again and verify that the dispensing path is once again following the pattern on the shifted and rotated template.

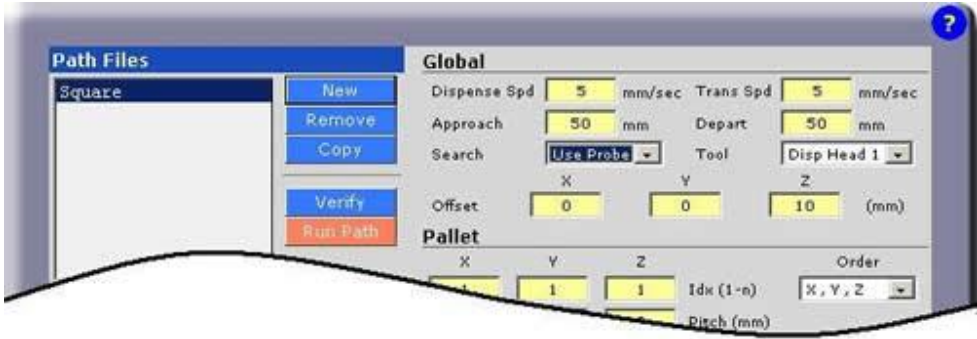# Application Tutorial 3: Automatic Z Height Adjustment

If your system is equipped with a Z-Contact sensor or similar device that can detect the Z height of a surface, this tutorial illustrates how this sensor can be used to adjust the Z heights of all of the **Nodes** in a **Path**. When enabled, GD will perform a Z-Search as follows:

- Moves to the "Approach" position above the first **Node** of a **Path**.

- Moves down in Z until the sensor is tripped.

- Computes the difference between the first **Node's** Z position and the detected Z height.

- Moves to the first **Node** position and all subsequent **Nodes** in the **Path** applying the Z correction and the X/Y/Z offset defined for the **Path**.

When a Z-Search is performed, the **Path** Z Offset value is utilized to adjust the height of the **Path** after the correction is applied. For example, if the Z Offset is set to 0, after the surface is detected, the Z height of the first **Node** would be set to the height of the surface and all subsequent **Nodes** would be corrected accordingly. Typically, the Z Offset is set to be equal to the gap desired between the surface and the syringe tip.

This training example requires that Application Tutorial 1 has already been completed and builds upon its results.

For any of the sample templates, execute the Process again to verify that the dispensing path is accurately being followed.

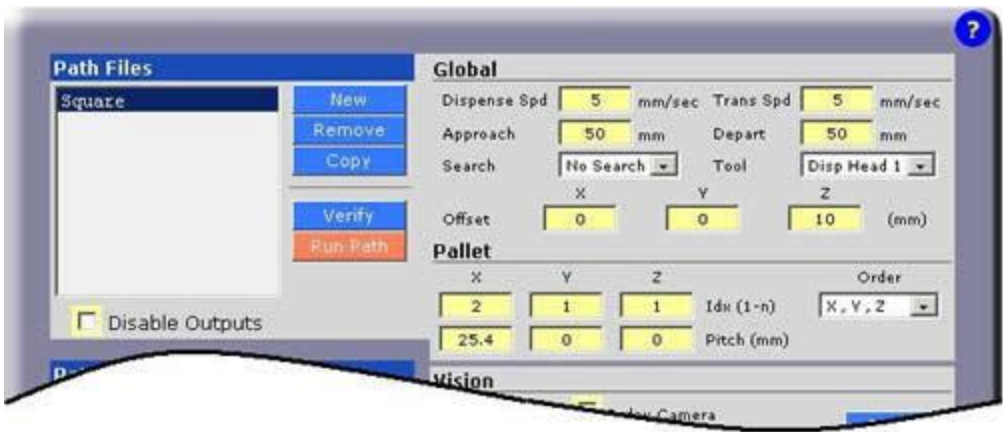| Step	Action
1.	Open the Path Editing panel: **Edit > Path Editor** .
2.	Select the **Path** for the template that you are using for this tutorial.
3.	Enable the Z-Search for this path by setting the Search pull-down to **Use Probe**.
4.	For testing purposes, increase the height of the Path so it is well off the surface by setting the Z Offset value to **10** mm.

Step	Action
5.	Click the **Save** button to store the results on the flash disk. Respond **Yes** when asked if it is okay to delete the existing file.
6.	Execute the **Process** again and confirm that the syringe tip contacts the surface and then backs off 10 mm.
7.	In the Path Editor, reduce the value of the Z Offset and re-execute the **Process** until the **Path** height is correct and the fluid is being correctly dispensed.
8.	To verify that the Z-Search is operating correctly, manually adjust the height of the template and execute the **Process** again.

Application Tutorial 4: Repeating a Path in a Grid Pattern

Once a **Path** has been created, it is very easy to have the **Path** repeated in a 1, 2 or 3 dimensional grid pattern. This is useful for dispensing fluid on parts that are stored in a pallet or for repeatedly stepping a fixed distance and duplicating a dispensing pattern.

NOTE: This training example requires that Application Tutorial 1 has already been completed and builds upon its results.

For any of the sample templates, execute the Process again to verify that the dispensing path is accurately being followed.

Step	Action
1.	Open the Path Editing panel: **Edit > Path Editor** . A **Path** is always indexed along the major axes of its reference frame. For example, if a **Path** is relative to the **Global Frame**, you can step in the positive or negative direction of its X, Y or Z axes. You cannot step diagonally. However, since you are free to select the orientation of the reference frame for a Path, this does not impose a significant limitation. By default, the number of "Pallet" indices (Idx) is 1, which means do it once and don't step.

Step	Action
2.	Select the **Path** for the template that you are using for this tutorial.
3.	Change the number of Pallet indices (Idx) in **X** to "**2**." This will repeat the pattern once by stepping once in the X direction.
4.	To specify an index step size of 25.4mm, change the **X Pitch** to **25.4**.
5.	Click the **Save** button to store the results on the flash disk. Respond **Yes** when asked if it is okay to delete the existing file.
6.	Execute the **Process** to view the results.

Since we are only indexing in one dimension, the order in which we index the X, Y, and Z values is immaterial. However, if we did specify more than one indexing direction, the "Order" pull-down could be change to re-order which axis we indexed along first.

This completes the modifications for repeating a **Path**.

Application Tutorial 5: Using Machine Vision

If your system is equipped with PreciseVision, the application of machine vision in GD is very straightforward. PreciseVision dynamically computes the reference frame for a **Path** and this reference frame is used in place of all of the components of the **Global Frame** except for its Z height. If PreciseVision cannot locate the reference frame or if it performs an inspection operation that indicates that a part is not acceptable, it will return an error that will stop execution of the GD **Process**.

After the Vision Interfacing and Calibration tutorial is performed, all communication with PreciseVision and the translation of all results into coordinates that can be applied to **Paths** is automatically handled by GD.

The procedure for developing a vision based dispensing application can be summarized as follows:

Step	Action
1.	As with the Basic Application Tutorial, start by teaching a **Global Frame**. This reference frame should be selected keeping in mind that vision will need to generate the same frame.
2.	Follow the same procedures as before and create and define dispensing **Nodes**, **Paths** and a **Process**.

Step	Action
3.	After your **Process** has been debugged, create a Vision Process in PreciseVision that can dynamically locate and return the same reference frame as the **Global Frame**.
4.	Flag any desired **Paths** to indicate that they are relative to the vision reference frame instead of the **Global Frame**.
5.	Execute your new vision-based dispensing application.

The new steps in this procedure will be described in this tutorial. Prior to reading this material, you should familiarize yourself with the basics of applying PreciseVision.
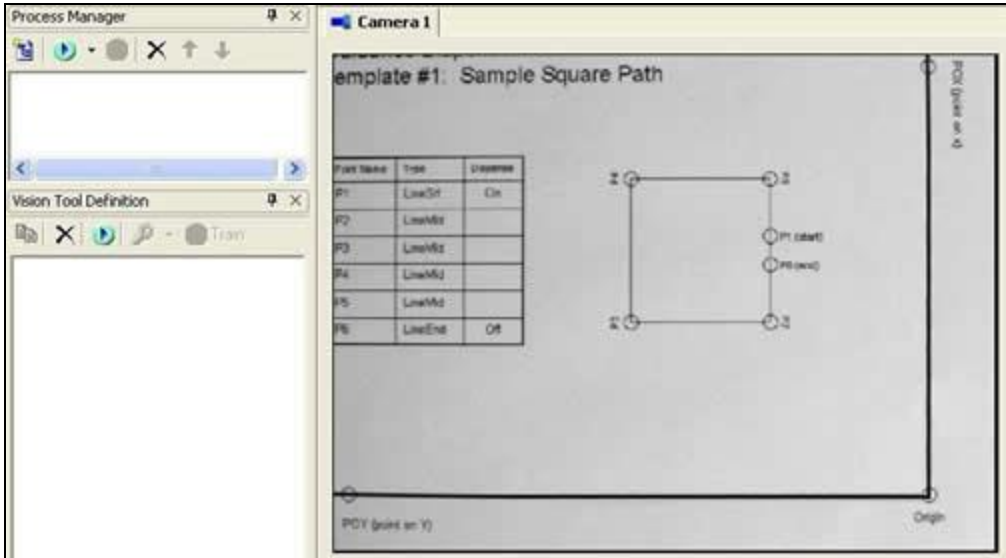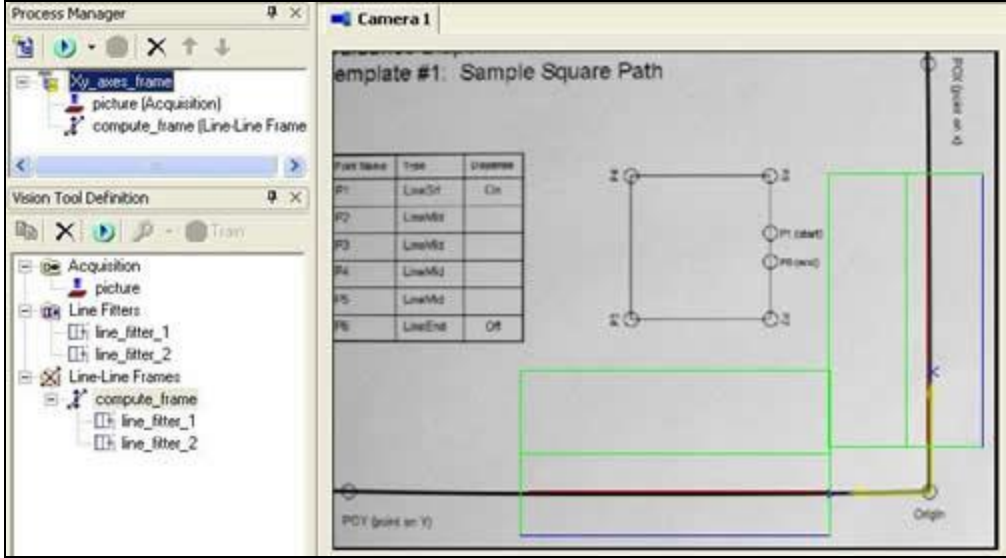
This training example requires that Application Tutorial 1 has already been completed and builds upon its results.

For any of the sample templates, execute the **Process** again to verify that the dispensing path is accurately being followed.

In this tutorial, pictures of the Square template will be presented for illustrative purposes, but any of the other templates can be used as well. To mimic the manual training of the **Global Frame**, we will be training vision to locate the positions of the lines drawn on the template for the X and Y axes. In a real application, coordinate axes are rarely present. Instead, features such as distinct edges with an included corner or fudicial marks can be selected for both the manual **Global Frame** definition and the automated vision identification.

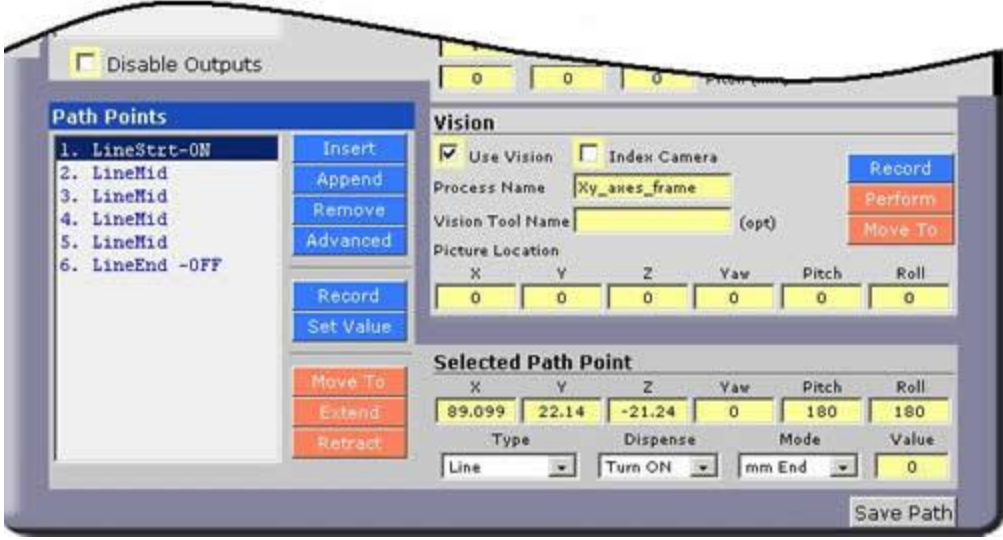Start by illustrating how PreciseVision is trained to locate the X and Y axis lines.

Step	Action
1.	Position the dispensing template below the camera. It is not necessary to accurately position the template in the camera's field of view. All that is required is that a portion of the X & Y axes are visible.
2.	If the camera is mounted on the robot, ensure that its Z height is the same as the calibration point in the GD Vision panel. You can use **Move To** on the Vision panel to correctly set the Z height.

Step	Action
3.	Using PreciseVision, take a picture by selecting **File > Acquire New Image**.
4.	In PreciseVision, create a new Vision Process named **"Xy_axes_frame."**
5.	Create and add to this Vision Process an Acquisition Tool followed by a Line-Line Frame Tool.
6.	Create two Line Fitter Tools and provides these as the inputs to the Line-Line Frame Tool.
7.	Position the first Line Fitter to locate the X-axis and the second Line Fitter to locate the Y-axis of the template.

This Vision Process will take a picture and determine the two lines that best fit the X and Y axes of the template. Then, a reference frame is computed whose origin is the intersection of the two line fitters and who's X-axis is aligned with the results of the first Line Fitter.

This completes the vision training. The Xy_axes_frame Vision Process can now be executed by Guidance Dispense whenever the template reference frame needs to be located.

Returning to Guidance Dispense, we must now mark the dispense **Path** as being relative to the vision results in place of all of the components of the **Global Frame** except for its Z height.

Step	Action
1.	Open the Path Editor by clicking **Edit > Path Editor**
2.	Select the **Path** for the template that you are using for this tutorial.
3.	Flag this **Path** as being relative to a vision result by checking **Use Vision**.
4.	Specify the Vision Process to be executed to locate the reference frame by entering "**Xy_axes_frame**" (without quotation marks) into the **Process Name** field.
5.	The Vision Tool Name can be left blank since we just want the results from the last vision tool that is executed, the Line-Line Frame tool.
6.	If the camera is mounted on the robot and you want to move the camera to a position other than the point where the camera was calibrated, manually move the camera to the correct position and Z height and press **Record**.
7.	Click Save to store the results on the flash disk.

This completes the extra steps necessary to develop a vision based dispensing application! Your previously created **Process** can be executed as before. As a test, try displacing and slightly rotating the template to verify that the **Path** is being dynamically updated.

Sample Application Templates

The following are a series of sample Paths. These should be printed out and used in connection with the Tutorials presented earlier in this Chapter.

Guidance Dispense Tutorial
Template #1: Sample Square Path

Point Name	Type	Dispense
P1	LineSrt	On
P2	LineMid	
P3	LineMid	
P4	LineMid	
P5	LineMid	
P6	LineEnd	Off
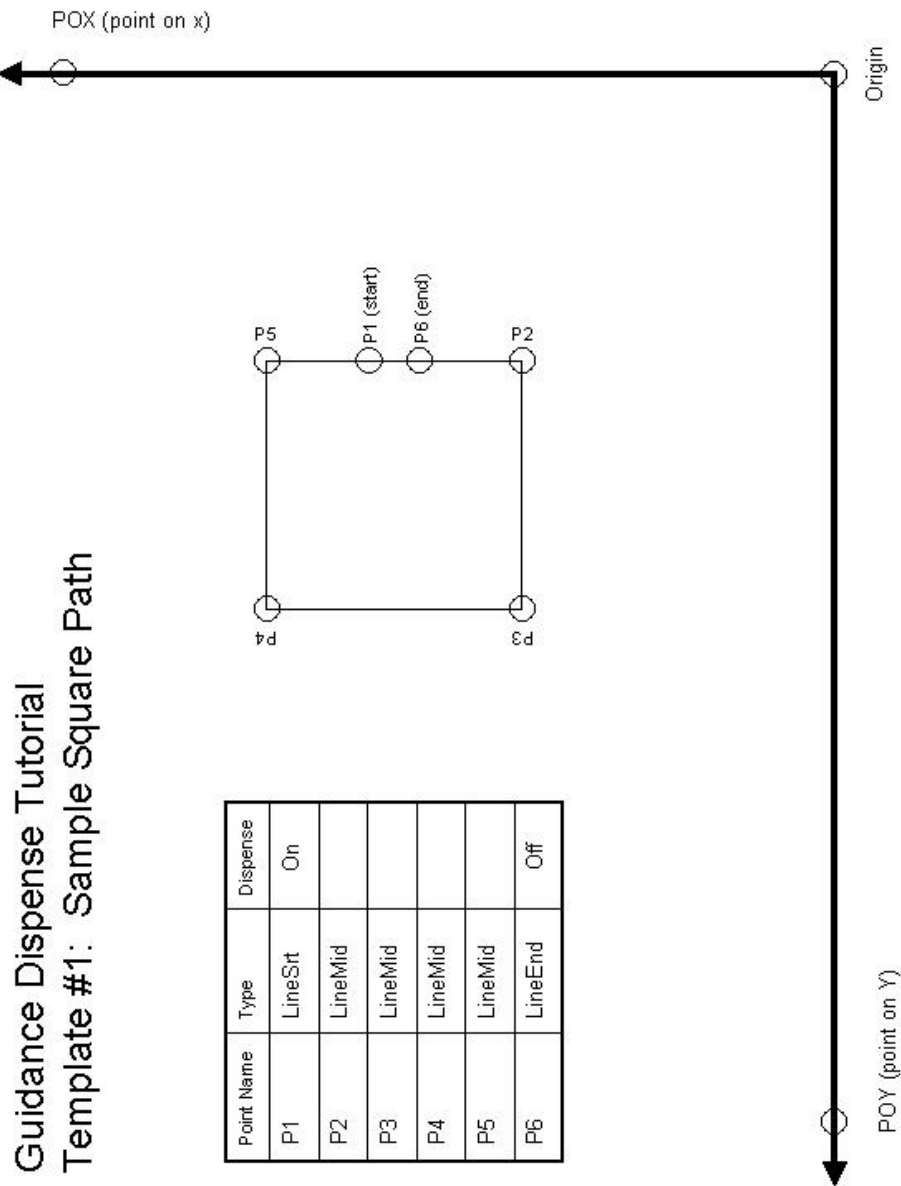
Figure 6-2: Template #1: Sample Square Path
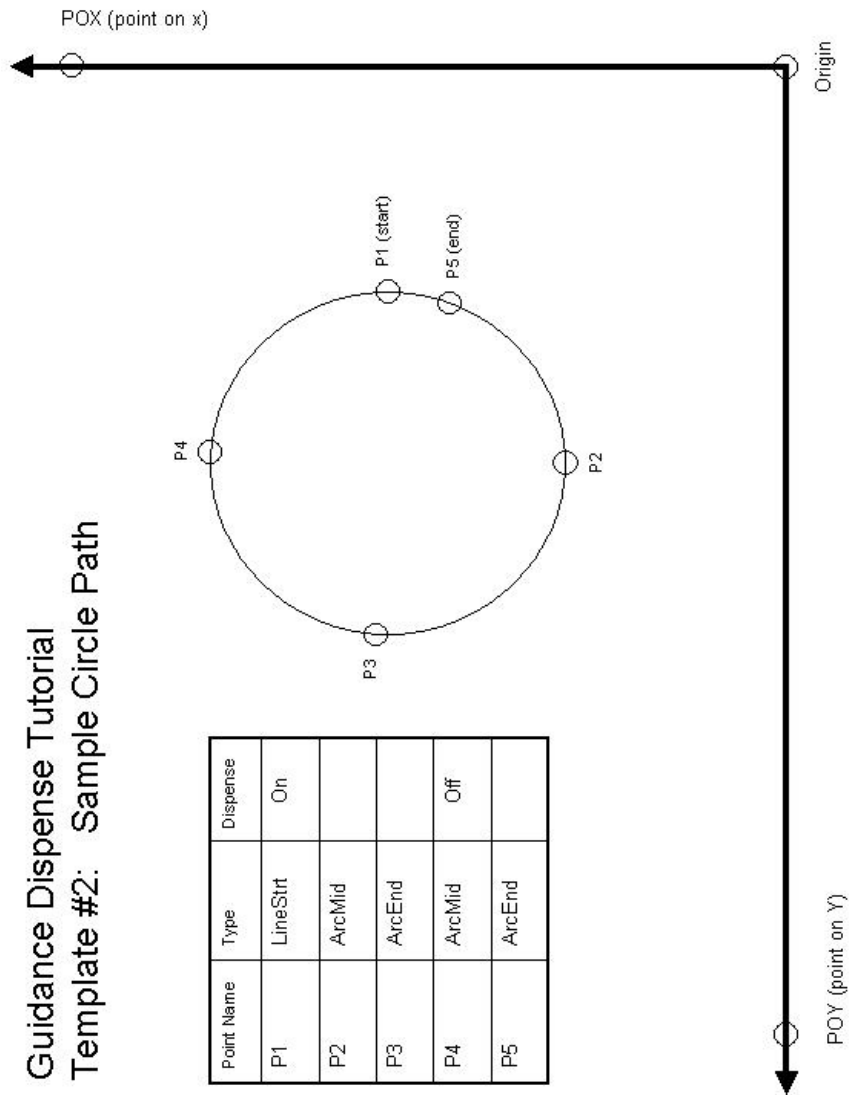
Figure 6-3: Template #2: Sample Circle Path

Guidance Dispense Tutorial
Template #3: Sample Parallel Line Path

Point Name	Type	Dispense
P1	LineStrt	On
P2	LineEnd	Off
- PATH BREAK -	1mm above	
P3	Start	On
P4	LineEnd	Off
- PATH BREAK -	1mm above	
P5	Start	On
P6	LineEnd	Off
- PATH BREAK -	1mm above	
P7	Start	On
P8	LineEnd	Off

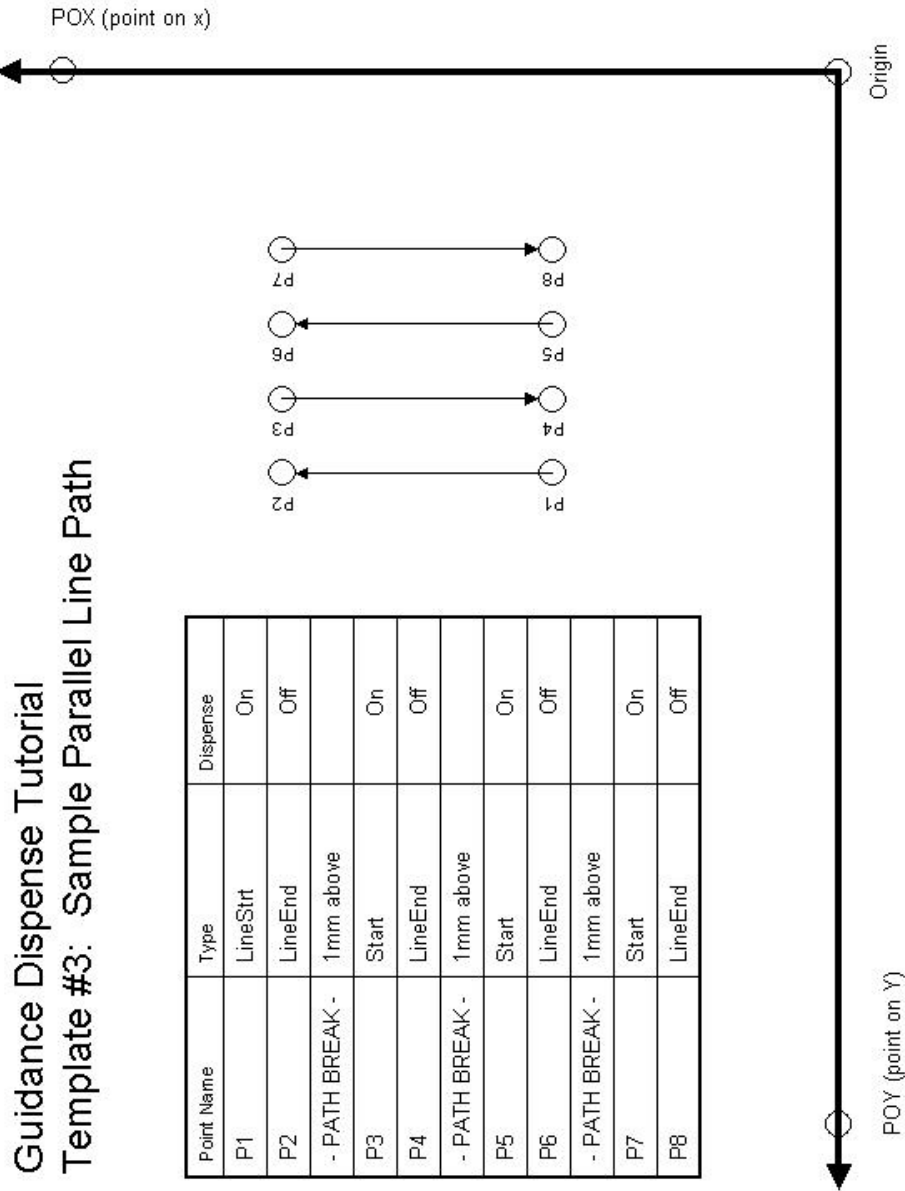**Figure 6-4: Template #3: Sample Parallel Line Path**
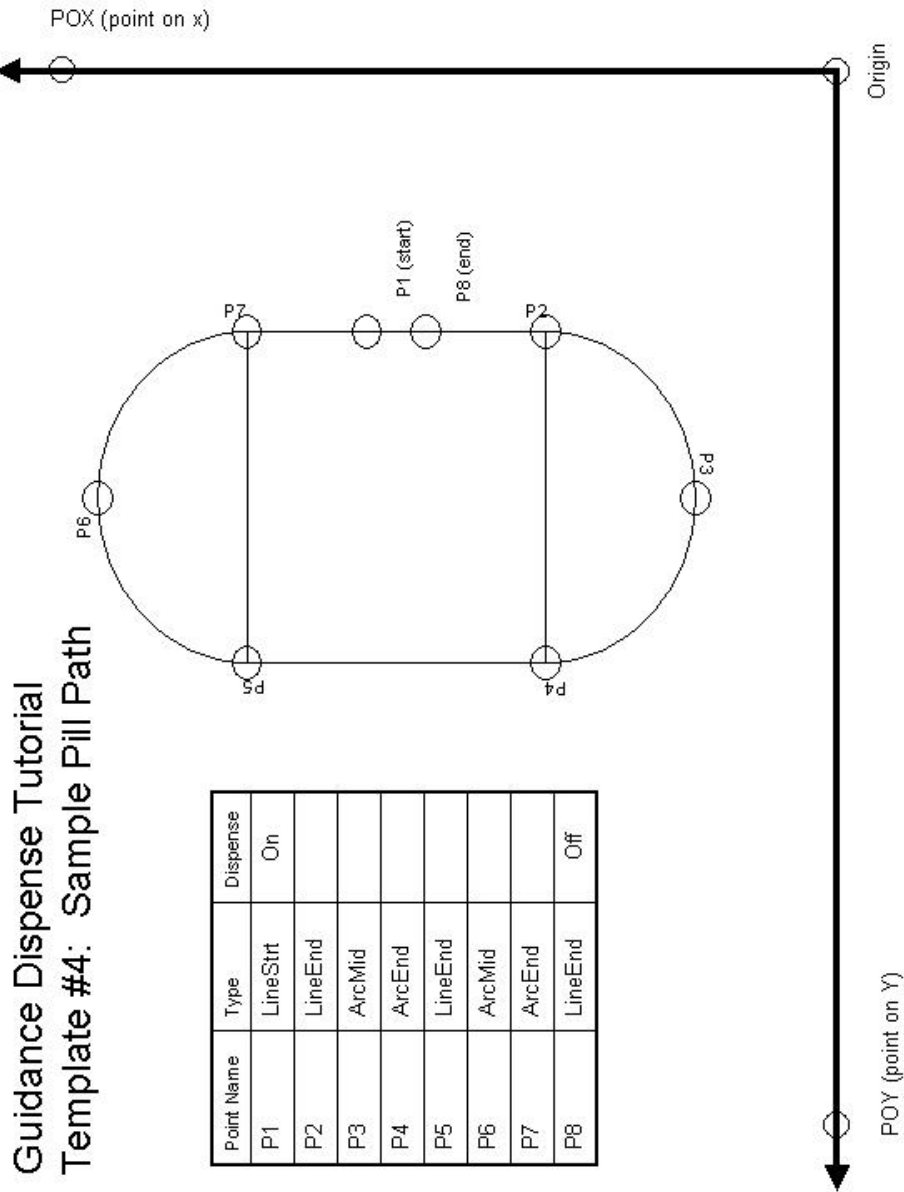
Figure 6-5: Template #4: Sample Pill Path

7. Reference Information

Dual Control Air Dispenser Pneumatic Connections

The Dual Control Air Dispenser controls the air lines for the two syringes and the pneumatic actuator for the vertical slide for the first syringe clamp. For each syringe, this device provides two pressure regulators: one to control the positive pressure utilized to dispense the fluid from the syringe and a second regulator that supplies air to a venturi device that creates a vacuum in the syringe air line when the positive pressure is turned off. The vacuum assists in withdrawing the syringe plunger to minimizing dribbling of the dispensed fluid.

The picture below illustrates the pneumatic inter-connections between the components of the Dual Control Air Dispenser.

Figure 7-1: pneumatic inter-connections

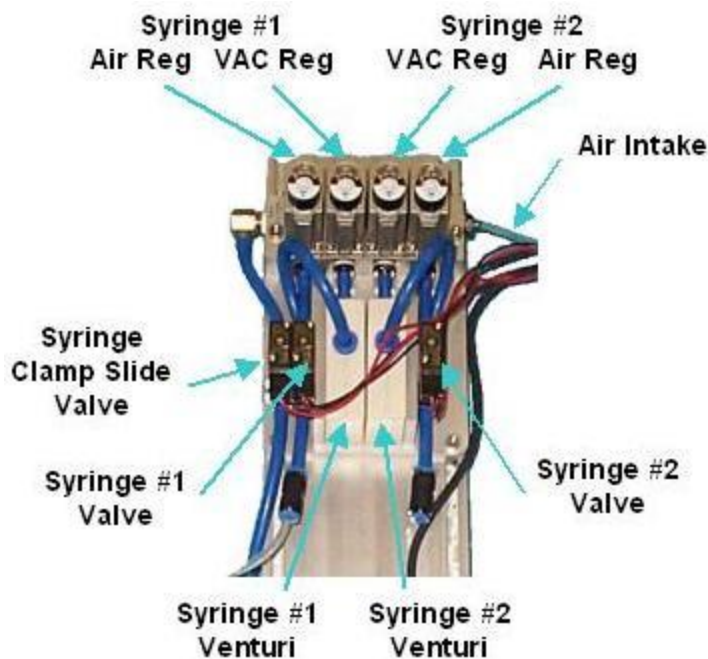The external air pressure input line is on the right of the unit. This air is provided to the four regulators and flows to the left to the hose for the Syringe Clamp Slide Solenoid Valve. The Syringe #1 & #2 regulators provide reduced air pressure to the Syringe #1 & #2 Solenoid Valves. The Syringe #1 & #2 VAC regulators provided reduced air pressure to the Syringe #1 & #2 Venturi components. The Venturi units convert the positive air pressure into a vacuum that is provided to the negative side of the Syringe #1 & #2 Solenoid Valves.

Dual Control Air Dispenser Electrical Connections

The Dual Control Air Dispenser requires a number of electrical connections for the proper operation of this unit. These interfaces include the following:

- Three 24 VDC input signals into the Air Dispenser that operate the three solenoid values (Syringe #1 & #2 Valves and the Syringe Clamp Slide Valve).

- Three dry contacts in the Air Dispenser that indicate if any of the buttons are being clicked (Red Free, Green Line and Blue Arc momentary contact buttons).

- Three 24 VDC input signals into the Air Dispenser that turn on the back lights of the three buttons.

- One sensor output signal from the Air Dispenser that is generated by the Z-Contact sensor on the Sliding Syringe Clamp.

All of these signals are connected to four-pin 3M 37104 series Mini-Clamp Plugs.

Figure 7-2: Four-Pin 3M 37104 Mini-Clamp Plug

The following tables describe how each of the signals are wired to their respective plugs.

Table 7-1: Signals & Plugs

Pin	Push Button with Back Light	Wire Color
1	GND	Black
2	24 VDC supplied to turn on back light. Returned through pin 1.	Gray
3	24 VDC returned by dry contact switch when button clicked.	Green
4	24 VDC power supplied to dry contact switch.	Red

Table 7-2: Signals & Plugs

Pin	Solenoid Valve Control	Wire Color
1	GND	Black
2	24 VDC supplied to open valve. Returned through pin 1.	Red
3	N.A.	Not connected
4	N.A.	Not connected

Table 7-3: Signals & Plugs

Pin	Z-Contact Sensor	Wire Color
1	GND	Blue
2	N.A.	Not connected
3	24 VDC returned by sensor when contact detected.	Black
4	24 VDC power supplied to sensor.	Brown

Interfacing to PrecisePlace Robots

If the Dual Control Air Dispenser is interfaced to a PrecisePlace robot, the electrical connections from the Dispenser should be plugged into the Digital I/O signals provided in the Z-Axis IO board. This board is mounted beneath the cover for the Z-axis motor. The following is a picture of the Z=Axis IO board.

⚠ **DANGER**	
Electrical Shock Hazard	
The Z-Axis IO board contains an optional motor connector that provides a bus voltage of 320 VDC. As such, this board represents a high-risk and should only be accessed when the main AC power to the robot is disconnected.	⚡
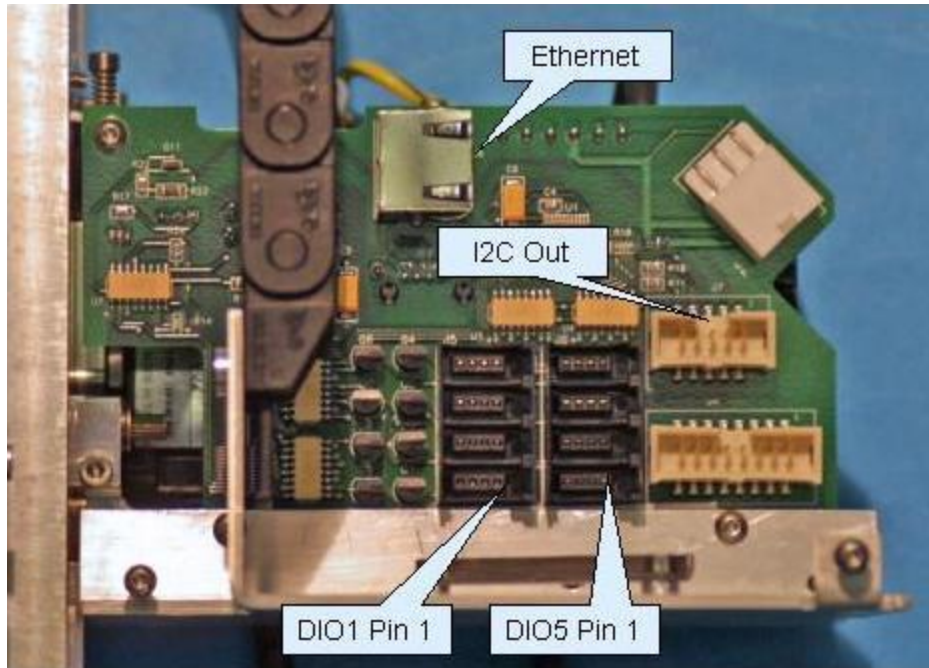
 Figure 7-3: Z=Axis IO Board

The following table defines where each of the Air Dispenser plugs should be connected to the Z-Axis IO board.

Table 7-4: Air Dispenser Plugs & Z-Axis IO Board Connection

DIO Connector	GPL Signal Number	Air Dispenser Plug
1	33 / 10033	Red Free button
2	34 / 10034	Green Line Button
3	35 / 10035	Blue Arc Button
4	36	Syringe Clamp Slide Solenoid Valve
5	37	Syringe #1 Valve
6	38	Syringe #2 Valve
7	10039	Z-Contact Sensor
8		No used

8. Troubleshooting Guide

Guidance Dispense Common Error Messages

The following table contains common error messages and pop-up messages that you may encounter during the normal operation of the Guidance Dispense system. See the **PreciseFlex Library** → **Controller Software** → **Software Reference** → **System Error Codes** for a description of the complete list of error messages that can be generated by the robot control system.

Table 8-1: Error Messages

Error	Description	Corrective Action
Error Messages		
-1006, *Robot already attached*	Can occur when trying to record a position that requires that the dispensing head dimensions be set but another task has control of the robot.	The most common problem is that the virtual MCP is not in Computer mode and is controlling the robot. Be sure to set the virtual MCP to computer mode.
-1046, *Power not enabled*	Can occur any time in response to a request to execute a dispensing **Process**, **Path**, Move Safe, Retract Arm or other robot motion.	Before the robot can be moved, motor power must be enabled. Check that the "System state:" displays "GPL ready" before attempting to move the robot.
-1047, *Virtual MCP in Jog mode*	Can occur any time in response to a request to execute a dispensing **Process**, **Path**, Move Safe, Retract Arm or other automatic robot motion.	The system cannot be in jog mode when attempting to move the robot automatically. Take the system out of jog mode by clicking on the "Comp" button in the "Robot Status" under "Edit" or the "Computer" button in the Virtual Pendant.
-4000, *Cannot connect to vision server*	Can occur in response to a request to execute a dispensing **Process** or **Path** that uses PreciseVision to locate an object.	Before a vision process can be executed, PreciseVision must be running on a PC. The PC IP address must be set in the "Vision Configuration" page.
Vision Operation Failed	During execution of a dispensing **Process** that contains a request to locate an object using PreciseVision, the PreciseVision process has failed due to one of its vision tools not obtaining the expected results.	Check the PreciseVision camera window to see if the proper object is inside the field of view.

 Check to see if the proper PreciseVision project is loaded for the dispensing **Path** being executed.

 Check to make sure the proper lighting is set and on. |
| **Pop up messages** | | |

Error	Description	Corrective Action
Last Command Still Busy ...	Message occurs when clicking on a button or selecting an item in a list in the graphical user interface.	This indicates that the web interface is still processing the last request while a new one is being requested. Only a single request can be performed at a time in the web interface. Try performing the operation again. If this continues to happen for all requests and the robot is idle, make sure the GPL project is loaded and running. See the *PreciseFlex Library* for details on the Guidance Web Interface. Use the Guidance Web interface operator control panel to determine if the "GDispense" project is loaded and running.
Changing points too quickly.	Message occurs when selecting points in the path editor.	When a **Path** node is selected, the web page retrieves the information from the controller and updates the data fields. This operation cannot be interrupted and must be completed. If this message continues to be displayed, try slowing down between selection of points. If the web pages seem to be updating very slowly, check with your network administrator as there could be a problem with the network traffic.
Busy ...	Message never goes away at bottom of web panels.	While the robot is executing a **Process** or **Path**, the "Busy ..." indicator will be displayed. If the indicator never goes away, it could indicate that the GPL project "GDispense" is not executing. See the *PreciseFlex Library* for details on the Guidance Web Interface. Use the Guidance Operator Control panel to determine of the "GDispense" GPL project is executing.