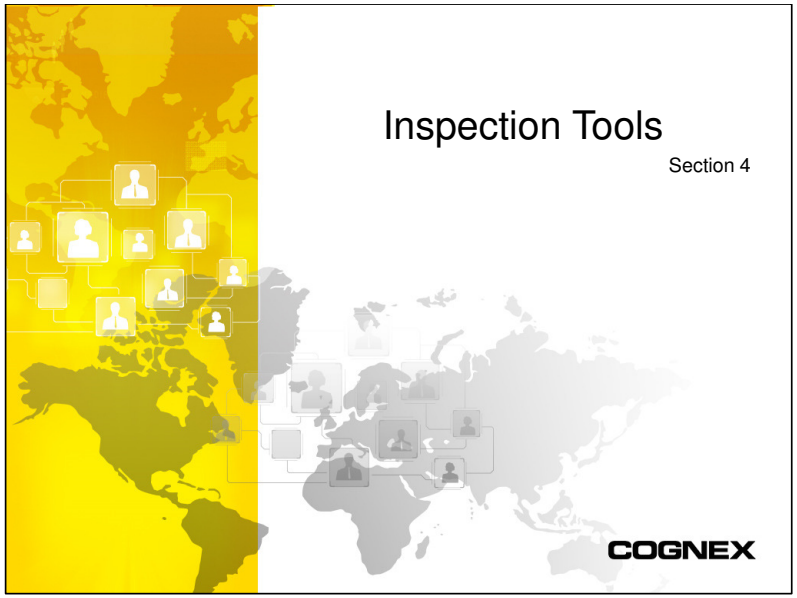
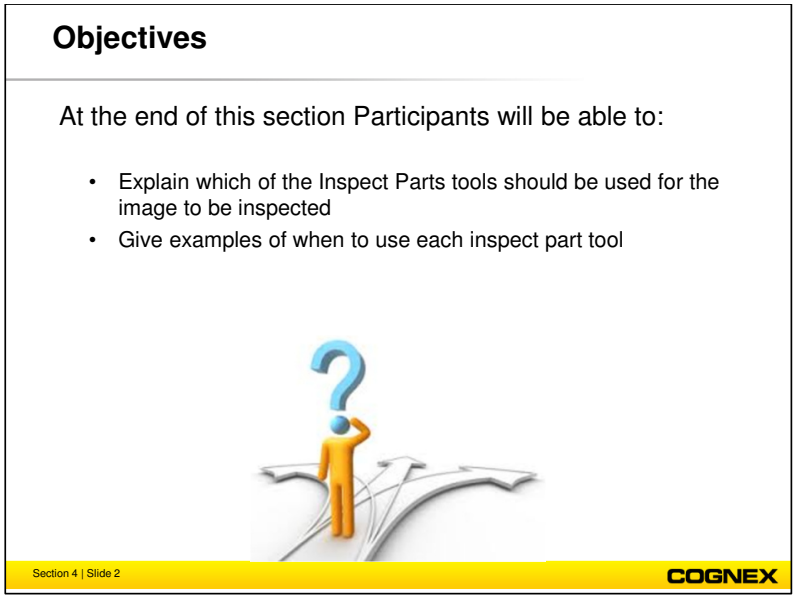


The fourth section of the In-Sight EasyBuilder Standard training will focus on **Inspection Tools**.

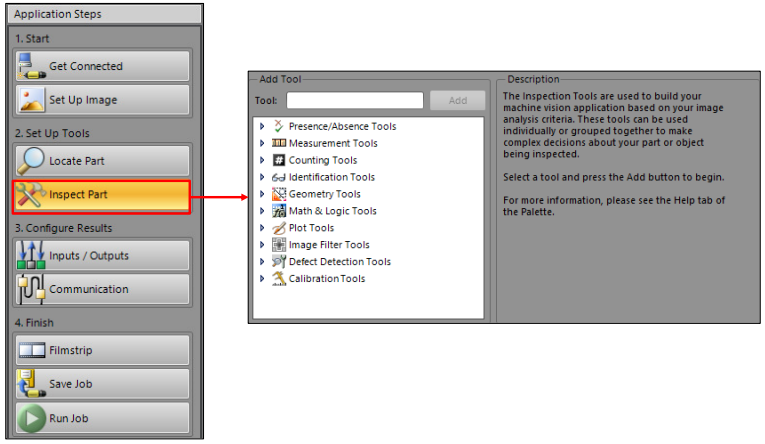
The **Inspection Tools** are found under the Inspect Part Application Step in the EasyBuilder application.
The Inspect Part step is used to assemble and configure the Inspection Tools that will be used to build your job.



At the end of this section Participants will be able to:

- Explain which of the Inspect Part tools should be used based upon the image to be inspected
- Give examples of when to use each inspect part tool

Inspection Tools



Section 4 | Slide 3 COGNEX

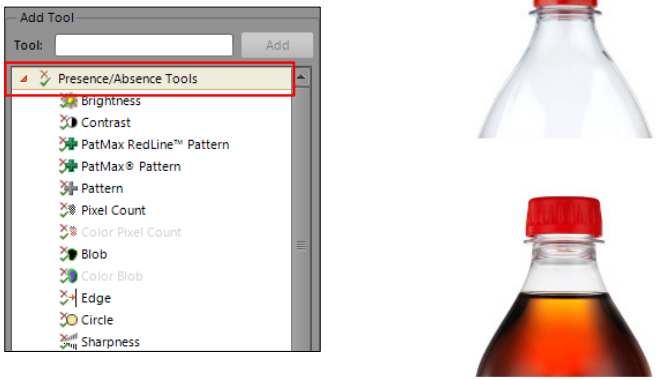
The **Inspection Tools** are used to build your machine vision application based on your image analysis criteria. These tools can be used individually or grouped together to make complex decisions about your part or object being inspected. EasyBuilder categorizes tools into function / tasks as opposed to the tool itself.

Select a tool and press the **Add** button to begin.

- **Presence/Absence** – Check if the feature is present
- **Measurement** – Gauging and measuring features
- **Counting** – Determine the number of instances of a part
- **Identification** – Finds Barcodes, 2D Codes, OCV/OCR, Patterns, ID and Color ID
- **Geometry** – Makes lines, points, or angles
- **Math & Logic** – Math functions, logic and trend
- **Plot** – Draw text and shapes on the image
- **Image Filter** – Alter the image to manipulate the features
- **Defect Detection** – Finds defects on edges and beads
- **Calibration** – Advanced calibration functions

In this section we will focus on the **Presence/Absence**, **Measurement**, **Counting** and **Geometry Tools**.

Inspect Part – Presence/Absence Tools



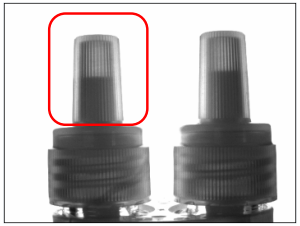
Section 4 | Slide 4 COGNEX

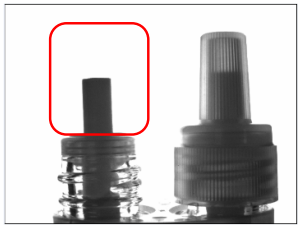
The **Presence/Absence** Tools are used to qualify whether or not a feature is present or absent in the image. Select a tool and press the **Add** button to begin.

How does the tool report the presence/absence value of the part?

- **Brightness** – Looks at an average greyscale value of the pixels in the region.
- **Contrast** – Looks at the difference between the mean greyscale value above the threshold and the mean greyscale below the threshold.
- **PatMax Pattern** – Uses the PatMax algorithm, based upon a trained representation of that pattern.
- **Pattern** – Looks for a pattern feature, based upon a trained representation of that pattern.
- **Pixel Count** – Based upon the number of the white or black pixels in the region.
- **Color Pixel Count** – Based upon the number of the white or black pixels in the region.
- **Blob** – Determines whether or not a blob feature is present or absent.
- **Color Blob** – Determines whether or not a blob feature is present or absent.
- **Edge** – Looks for linear edge features that fall within the specified parameters.
- **Circle** – Looks for circular edge features that fall within the specified parameters.
- **Sharpness** – Determines whether or not an image is focused properly, based upon the image sharpness score within the region.

Brightness Tool





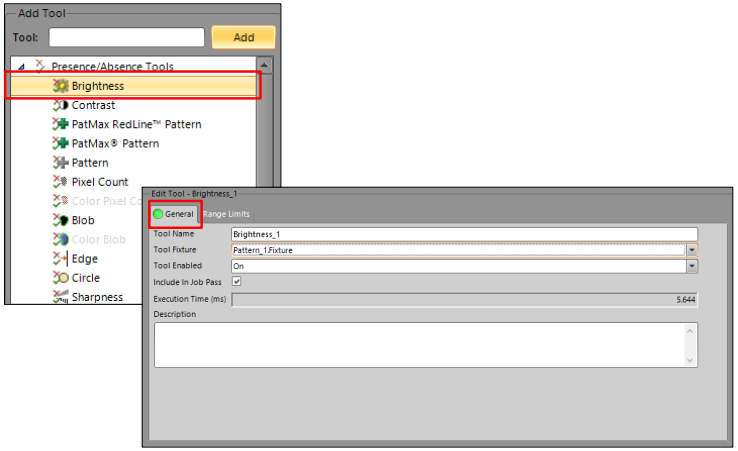
Section 4 | Slide 5 COGNEX

The **Brightness** Tool determines whether or not a feature is present or absent based upon an average grayscale value (i.e. brightness) value of the pixels in the region, and reports that value.

The Brightness tool is useful in situations where the feature of a good part is much darker or lighter than the feature on a bad part. Increases or decreases in a feature's brightness are a good indication of a part or object's presence or absence. For example, whether or not a dark or light-colored bottle cap is present or absent can quickly be measured by the brightness within the region.

To use the Brightness tool - select the tool, click the **Add** button and place the region on the part to be inspected.

Brightness Tool – Parameters



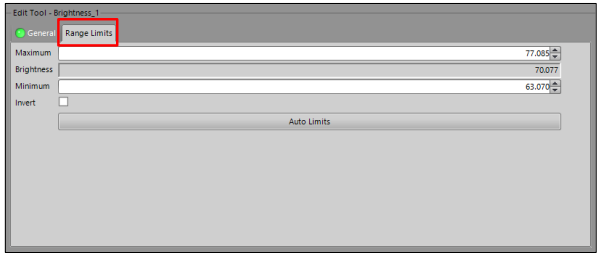
Section 4 | Slide 6 COGNEX

The **Brightness** tool determines whether a feature is present or absent, based on an average greyscale (i.e. brightness) value of the pixels in the region and reports that value. After the tool's region has been set and accepted, you can begin customizing and fine-tuning the tool for your application. The settings pane of the Brightness Tool consists of the following tabs:

General Tab

- **Tool Name** – Defines the name of your inspection tool, which will be utilized in configuring the results (Inputs, Outputs, and Communication); the default name is 'Brightness_1' (as more Brightness Tools are added the number at the end will increase). You can customize your tool by giving it a name that is associated with your particular application.
- **Tool Fixture** – Defines a fixture for the tool. This control is only enabled if another tool that defines a fixture has already been added. (Defaults to most recent successful locator tool.)
- **Tool Enabled** – Defines when and whether or not the inspection tools should run (default setting in On). Select Off is you want to disable the tool or select Input if you want the tool tied to a specific discrete input line, where it can be turned On or Off. Tying the tool to an input allows a control system, such as a PLC, to determine which tools should run.
- **Include in Job Pass** – Defines whether or not the tool's pass/failure status should be included in the job's overall pass/fail status; by default, it is checked and will be included in the job's overall pass/fail status. Uncheck the check box to keep the pass/fail status separate from the other tools in the job. This control should be unchecked if a tool is expected to fail.
- **Execution Time** – Displays the amount of time, in milliseconds, that the tool took to perform its inspection.
- **Description** – Defines a text message that can be associated with the tool (by default the field is blank).

Brightness Tool – Parameters



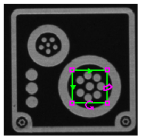
Section 4 | Slide 7 COGNEX

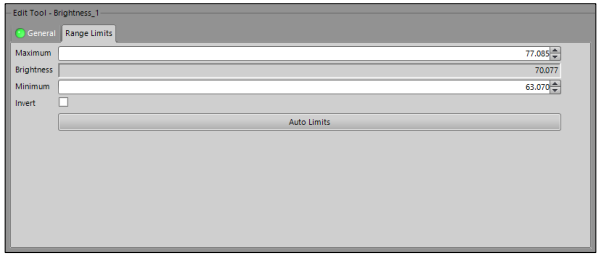
After the tool's region has been set and accepted, you can begin customizing and fine-tuning the tool for your application. The settings pane of the Brightness Tool consists of the following tabs:

Range Limits Tab

- **Maximum** – Defines the maximum acceptable average greyscale value (0 to 255); the tool will create a Smart Limit default based on your image, which you can customize to suit the needs of your application.
- **Brightness** – reports the average greyscale value of the pixels found in the region (0 to 255); values that fall exactly at, or between, the Minimum and Maximum settings are classified as a Pass.
- **Minimum** – Defines the minimum acceptable average greyscale value (0 to 255); the tool will create a Smart Limit default setting based on your image, which you can customize to suit the needs of your application.
- **Invert** Results – Defines whether or not the Pass/Fail logic of the tool should be inverted (default = Off, unchecked)
  - *Unchecked* – Standard results are applied, i.e. the tool result is a Pass if the feature was detected and falls within the Range Limits.
  - *Checked* – Inverts the results, i.e. the tool result is a Fail if the feature was detected and falls within the Range Limits
- **Auto Limits** Button – Defines Limits based on the Smart Limits settings. This button is useful when a parameter has been changed and the limits need to be adjusted, or the tool has been added and no limits have been defined.

Smart Limits





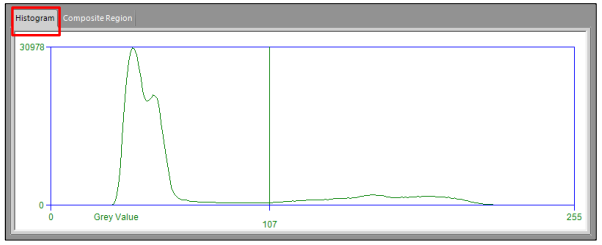
Section 4 | Slide 8 COGNEX

The Inspect Part tools with a Range Limits tab automatically determines the Maximum and Minimum limits.

NOTE: *For best results when using tools with **Smart Limits**, begin by training the tools on your Pass image.*

When a tool with a Range Limit tab is added to your job, the tool automatically examines your image and determines the appropriate Minimum and Maximum limits based on the requirements of the tool. For example, the Maximum and Minimum Range Limits of Distance and Angle Measurement Tools is ± 5% of the Distance and Angle value respectively (Intensity is ±10%), while Counting Tools Range Limits are determined by the number of features found in the initial image.

Brightness Tool – Parameters



Section 4 | Slide 9 COGNEX

After the tool's region has been set and accepted, you can begin customizing and fine-tuning the tool for your application. The settings pane of the Brightness Tool consists of the following tabs:

Histogram Tab

- The X-axis of the graph represents the total number of greyscale values (0 to 255, or 256 total shades of grey).
- The Y-axis of the graph represents the number of pixels at a given greyscale value, and the scale is established by displaying the greyscale value with the greatest number of pixels.
- The three blue vertical lines indicate the Minimum, Brightness and Maximum pixel greyscale values, respectively.

Results

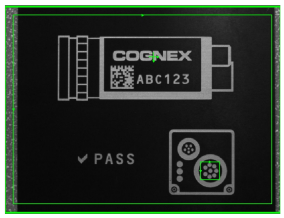
Section 4 | Slide 10 COGNEX

The Brightness tools determines whether or not a feature is present or absent based upon an average grayscale value and reports that value.

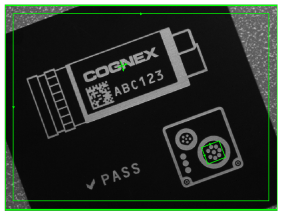
- The first image has low Brightness – showing that the bottle cap is present. This means that image one is a good part and will Pass.
- The second image has high Brightness – showing that the bottle cap is missing. This means that image two is a bad part and will Fail.

You will notice that there is also an Edge Tool that has been applied to this job.

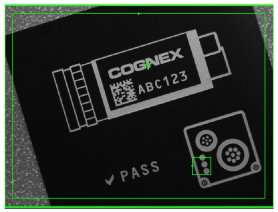
Why Fixture?



Initial Set Up



Fixtured



Not Fixtured

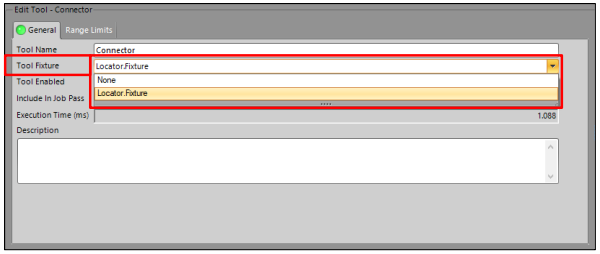
Section 4 | Slide 11 COGNEX

When a feature is used as a fixture during an inspection, the In-Sight camera will first search for the feature; once the feature has been located, the feature's position serves as a reference point for the other vision inspection tools, which use the position of the feature to orient their regions.

When choosing a feature to use for your inspection, consider the following guidelines to ensure the best results:

- If you're not using a fixture, ensure that the feature is present in roughly the same location in every image, or the region is large enough to account for the expected movement of the feature.
- The brightness tools is useful in applications where the feature being inspected is all one greyscale value when present (for instance, black), and the opposite when absent.

How to Fixture

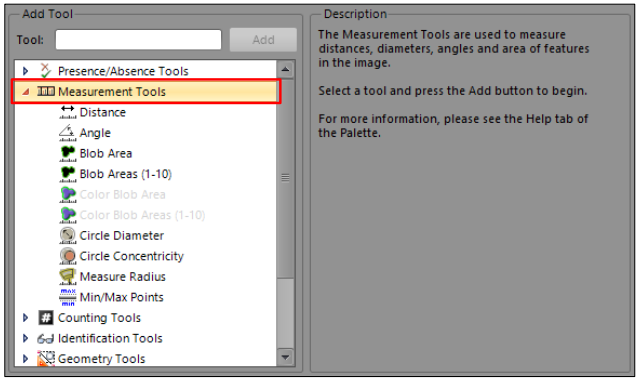


Section 4 | Slide 12 COGNEX

Once you have set up one or more locator tools, EasyBuilder will give you a choice of what locator tool should be used for each inspection tool. You can select **None** if you do not want to fixture a tool.

EasyBuilder will fixture to the Locator Tool automatically.

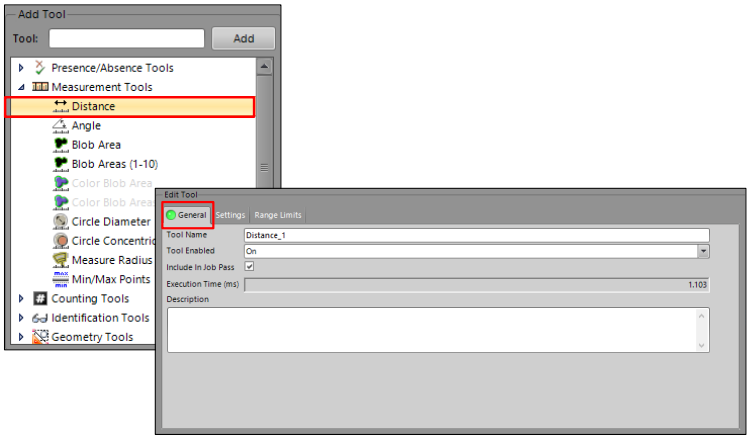
Inspect Part – Measurement Tools



The **Measurement Tools** are used to measure distances, diameters, angles, and area of features in the image. Measurement tools output quantitative information either in pixels (CCD) or real world units (Scale - mm, Inches, etc.) when the image is calibrated to real-world units in Set up Image.

- **Distance** – computes the distance between any two input features and reports the calculated distance.
- **Angle** – computes the angle between two edge features.
- **Blob Area** – measures the area of the largest found blob feature and reports the size do the largest blob. This tool is used to measure a single blob.
- **Blob Areas (1 – 10)** – measures the area of the largest blob feature and reports the size of the largest blob. This tool is used to measure up to 10 blobs.
- **Color Blob Area** – measures the area of the largest found blob feature and reports the size do the largest blob. This tool is used to measure a single blob.
- **Color Blob Areas (1 – 10)** – measures the area of the largest blob feature and reports the size of the largest blob. This tool is used to measure up to 10 blobs.
- **Circle Diameter** – used to measure the diameter of a circular feature.
- **Circle Connectivity** – used to measure the distance between the centers of two circular features.
- **Measure Radius** – used to define a curved edge feature and construct a reference line and point to represent the axis of the curve. The tool reports the radius of the curve.
- **Min/Max Points** – measures the position of edges and determines which edge points are closest and furthest from either the found edge of the region defining the edge. Once the edge has been identified, the tool constructs a best-fit line or circle over the edge feature. The tool then reports the edge points that are closest and furthest from the best-fit line or circle.

Distance Tool

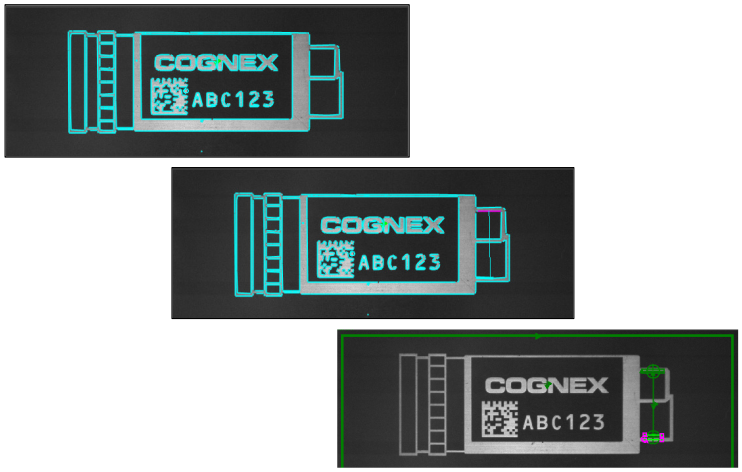


The **Distance Tool** measures distance between any two features (edges, circles, patterns and/or blobs); reports the distance in pixels (unless the image was calibrated in Set up Image, and a Pass if the reported is within the specified limits, a Fail if it is outside of the limits.

The Distance Tool is useful in situations where you need to accurately gauge a part or object. For example, determining the distance between the ends of a part or the center-to-center distance between two holes.

Click the **Add** button to begin.

Smart Features



Section 4 | Slide 15 COGNEX

Certain Location and Inspection tools automatically extract the relevant features from your image, based on the selected tool, allowing you point and click selection of the appropriate features for your inspection. When one of these tools is added to your job, the tool automatically examines your image and determines which features match the requirements of the tool.

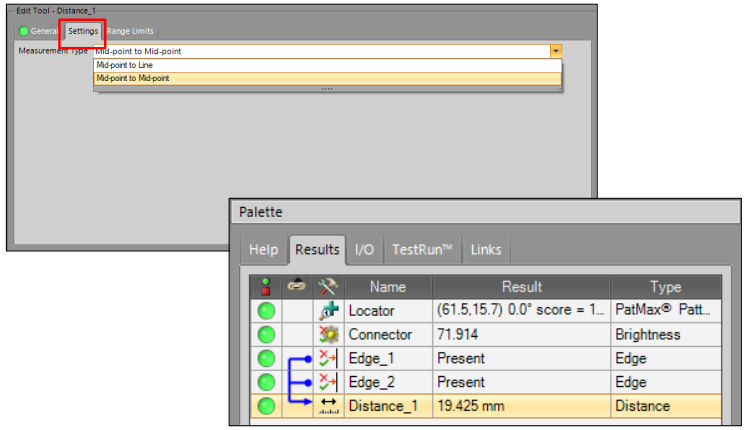
If a feature hasn't been previously defined it will be highlighted in light blue, while existing features (such as patterns, blob centroids, distances, edges or circles defined by other Locate or Inspect Part tools) are highlighted in green.

Simply click on the feature that you'd like to use, and EasyBuilder will automatically create the appropriate region, if one hasn't already been defined.

NOTE: *If your desired feature does not appear as a Smart Feature selection, do one of the following:*

- *Choose an available Smart Feature, and re-position its automatically created region over the feature that you would like to use instead. Then adjust the tool's parameters until the desired feature is properly detected*
- *First define the feature that you would like to use with a Presence/Absence or Geometry tool. Then re-add the tool and select your defined feature.*

Distance Tool – Parameters



Section 4 | Slide 16 COGNEX

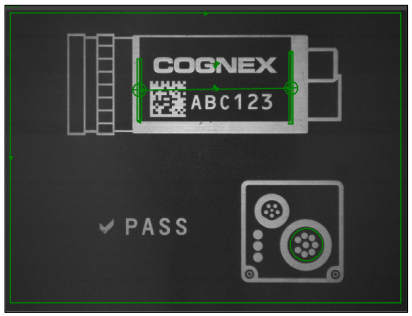
The Distance Tool's **Settings** tab specifies how the distance will be calculated between two edge features:

- Mid-point to Line – measures the perpendicular distance between the edge segments. This is the default setting.
- Mid-point to Mid-point – measures the halfway point between the two end points of two segments.

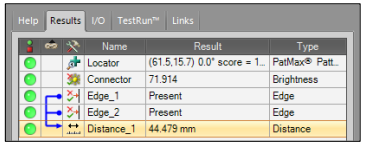
NOTE: *This control is only enabled when measuring the distance between at least one edge feature; otherwise the distance is automatically calculated in the following manner:*

- *Circle to Line – Measures from the center of the circle to the perpendicular intersection of an edge feature or reference line*
- *Point-to-Line – Measures from the point of the perpendicular intersection of an edge feature or reference line*
- *Circle-to-Point – Measures from the center of the circle to the point*
- *Circle-to-Circle – Measures from the center of one circle to the center of another*
- *Point-to-Point – Measures from the two points*

Results



Passing Result



Section 4 | Slide 17

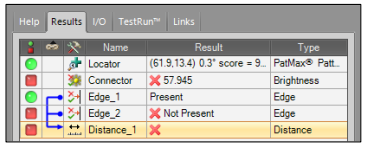
COGNEX

This slide displays the **Results** based upon the distance parameters that were entered for this job.

- The first image has a distance that falls within the set limits, so this job is a Pass.
- The second image has a distance that falls outside of the set limits, so this job is a Fail.

Results

Failing Result



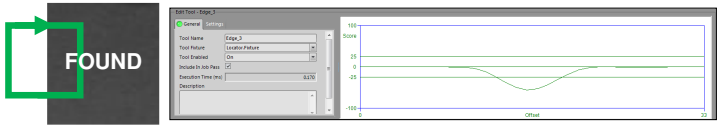
Section 4 | Slide 18

COGNEX

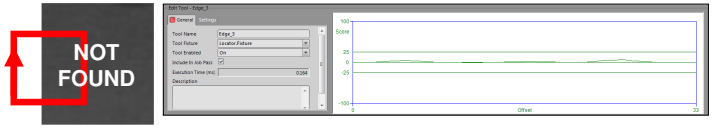
This slide displays the **Results** based upon the distance parameters that were entered for this job.

- The first image has a distance that falls within the set limits, so this job is a Pass.
- The second image has a distance that falls outside of the set limits, so this job is a Fail.

Graphs – Gradient



Arrow must be perpendicular to the edge in order to be found.

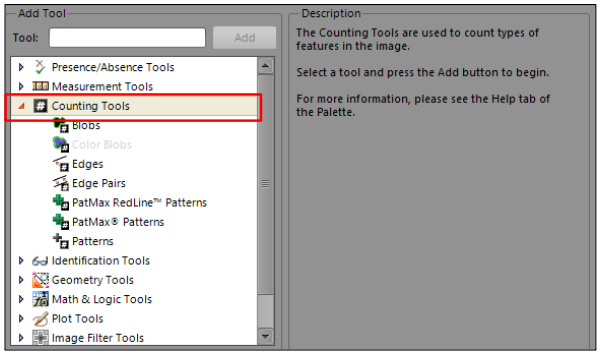


Section 4 | Slide 19 COGNEX

Gradient energy computes image sharpness based on the energy in the local grey-level gradient of the image or the ROI. The local grey-level gradient represents the rate of change in greyscale values for a given area. An abrupt change in greyscale results in a large magnitude in the grey-level gradient and a higher image sharpness scare.

NOTE: *Edge Tools have a specific direction in which they scan (arrow).*

Inspect Part – Counting Tools



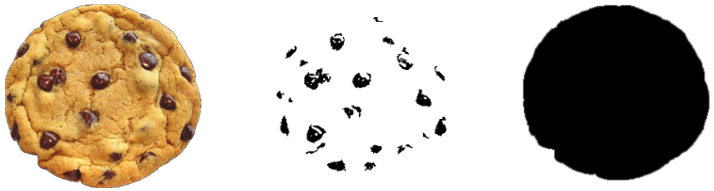
Section 4 | Slide 20 COGNEX

The **Counting Tools** are used to count types of features in the image. Select a tool and press the **Add** button to begin.

- **Blobs** – Counts the number of instances of blob features present in a region of the image.
- **Color Blobs** – Determines whether or not a color blob feature is present or absent.
- **Edges** – Counts the number of edge features present in a region of the image.
- **Edge Pairs** – Counts the number of instances of linear edge pairs present in a region of the image.
- **PatMax RedLine Patterns™** - counts the instances of a pattern feature, using he PatMax RedLine algorithm, based upon a trained representation of that pattern (called a Model).
- **PatMax Patterns** – Counts the instances of a pattern feature, using the PatMax algorithm, based upon a trained representation of that pattern (called a Model).
- **Pattern** – Counts the instances of a pattern feature, based on a trained representation of that pattern (called a Model).

Blobs

- Blob = set of connected pixels with a grayscale value above (or below) a specified threshold
  - in other words, a light shape on a dark background or vice versa



Section 4 | Slide 21 COGNEX

In machine vision terminology, any two-dimensional, variably shaped and similarly shaded group of connected pixels can be referred to as a **Blob**. The process of extracting these blobs from an image, finding them in a region of interest and sorting them based on specific criteria is called blob analysis.

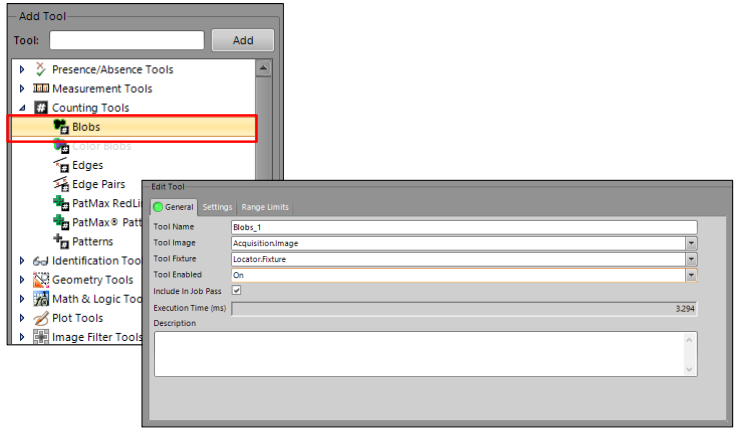
It's best to use the In-Sight Blob tools when the following conditions apply:

- The image is of a two-dimensional object
- The image provides a high contrast between light and dark pixels

When these conditions are met, blob analysis can be extremely useful in the following applications:

- Course gauging applications, such as measuring diameters or dimensions of squares to determine a part's width in a particular orientation.
- First-pass positioning applications, where blob tools are used to quickly locate and place a rough fixture for another tool.
- Presence/absence applications, where the blob tools are used to determine whether or not a blob is present or absent in the image.
- Counting applications, where the blob tools can be set up to count and sort blobs based upon characteristics such as their area or perimeter.

Blobs Tool

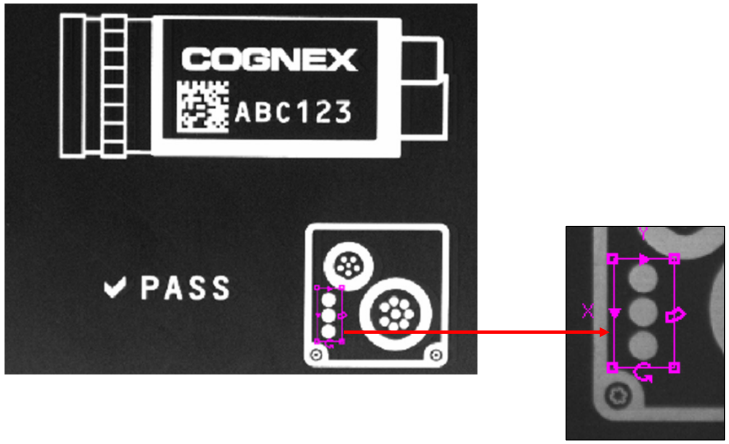


Section 4 | Slide 22 COGNEX

The **Blobs** tool counts the number of instances of blob features present in a region of the image. This tool is one of the faster tools – and is useful in many counting applications, for example, verifying that the correct number of pins are present on a connector, or counting the number of chocolate chips in a cookie.

Click the **Add** button to begin.

Position Region



Section 4 | Slide 23 COGNEX

Position the region directly over the feature you want to count.

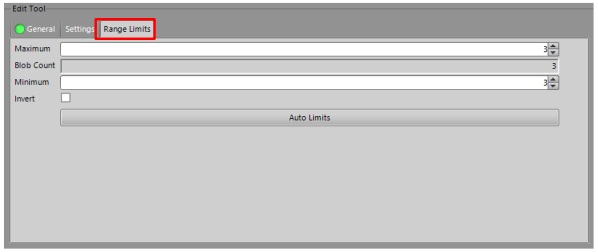
Blobs Tool – Parameters

Section 4 | Slide 24 COGNEX

The Blobs Tool's **Settings** tab contains the following information:

- **Threshold Mode** – Defines the mode for determining the grayscale value that is used to separate blobs from the background. When Auto is select (default = Auto), each time an image is acquired, the tool adjusts fro changes in brightness from image to image. When Manual is selected, you manually enter and adjust the value.
- **Blob Threshold** – Defines the grayscale value that is used to separate blobs from the background (0 – 255, when enabled). This control is Off by default and required that the Threshold Mode be set to Manual is enabled.
- **Blob Color** – Defines the color of the blob (Black, White, or Either; default – Either)
  - Either – There is no blob color requirement.
  - Black – Only returns blobs that are below the Blob Threshold.
  - White – Only returns blobs that are above the Blob Threshold.
- **Boundary** – Defines one of two ways of managing blobs that intersect the blob's region boundary (default = Off, unchecked)
  - Unchecked – Does not include blobs that intersect the region boundary, i.e. the blob must be located entirely within the region to be detected.
  - Checked – Includes blobs that intersect the region boundary, i.e. blobs that intersect, as long as they match the other criteria, are detected.
- **Minimum Area** – Defines a minimum area restriction, in number of pixels (0 to 900000; default = 100), for all blobs whose area is greater than the Minimum Area will be recognized.
- **Maximum Area** – Defines a maximum area restriction, in number of pixels (0 to 900000; default = 100), for all blobs whose area is greater than the Maximum Area will be recognized.

Settings



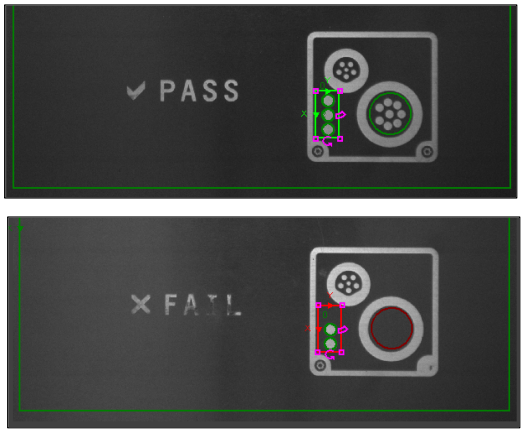
Section 4 | Slide 25 COGNEX

The Blobs Tool's **Range Limits** tab contains the following information:

- **Maximum** – Defines the maximum acceptable number of blobs to detect; the tool will create a Smart Limits default setting based on your image, which you can customize to suit the needs of your application.
- **Blob Count** – Reports the current number of detected blobs (the blobs counts in the image are based on a numerical order where 0 = 1)' values that fall exactly at, or between the Minimum and Maximum settings are classified as a pass.
- **Minimum** – Defines the minimum acceptable number of blobs to detect; the tool will create a Smart Limits default setting based on your image, which you can customize to suit the needs of your application.
- **Invert** Result – Defines whether or not the Pass / Fail logic of the tool should be inverted (default = Off, unchecked):
  - *Unchecked* – Standard results are applied, i.e. the tool result is a Pass if the feature was detected and falls within the specified settings.
  - *Checked* – Inverts the results, i.e. the tool result is a Fail if the feature was detected and falls within the specified settings.
- **Auto Limits** Button – Defines the limits based on the Smart Limits settings. This button is useful when a parameter has been changed and the limits need to be adjusted, or the tool has been added and no limits have been defined.

CAUTION: *Depending on lighting and resolution, blobs can touch each other and create one larger blob.*

Results



3 Blobs = Pass

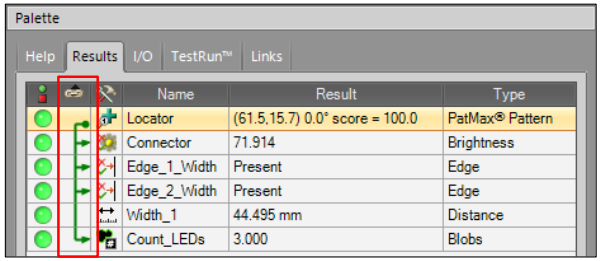
2 Blobs = Fail

Section 4 | Slide 26 COGNEX

This slide displays the **Results** based upon the Minimum and Maximum limits that were entered for this job.

- The first image found 3 blobs, so this job is a Pass.
- The second image only found 2 blobs, so the job is a Fail.

Palette and Dependencies



Section 4 | Slide 27 COGNEX

The arrows in the second column show dependencies, i.e., which tool depends on another. In the example, 5 tools are shown as dependent on the PatMax tool because they are fixtured to it.

Summary

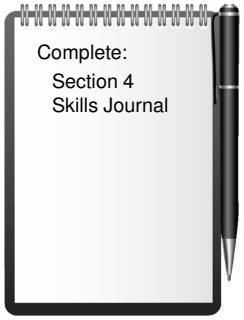
- In EasyBuilder, Inspection tools are classified by the task being performed
- Smart Limits help to place range values for Pass / Fail results
- Smart Features provide point and click, visual access to structures on the part

Section 4 | Slide 28 COGNEX

In this section we covered the following topics:

- Inspection Tools are classified by the task being performed
- Smart Limits help to place range values for Pass / Fail results
- Smart Features provide point and click, visual access to structures on the part

Skills Journal



Lab Exercise

COGNEX

Complete:

Skills Journal (image designed by pngtree)

Lab Exercise