Section 5: CrossSection Tool

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Objective

CrossSection Tool

- Learn about extracting features
- Implement Measurements and Computations
- Understand the power of the tool in a 3D world

❖ Lab: Create a CrossSection tool to measure angle and height of part.

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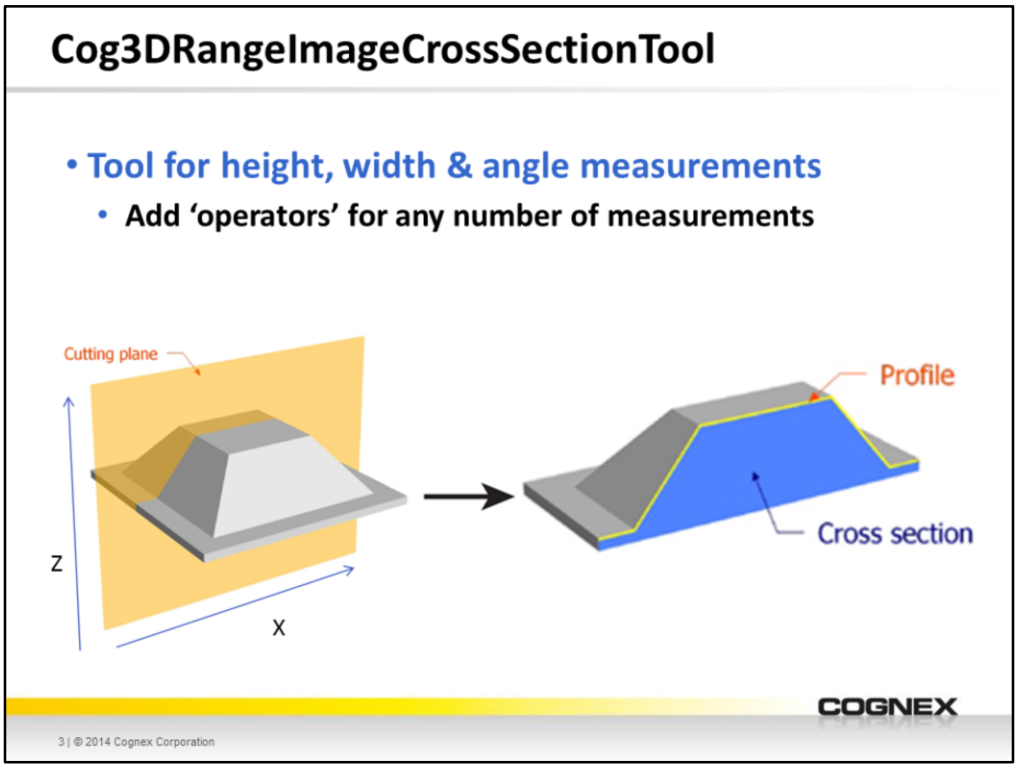
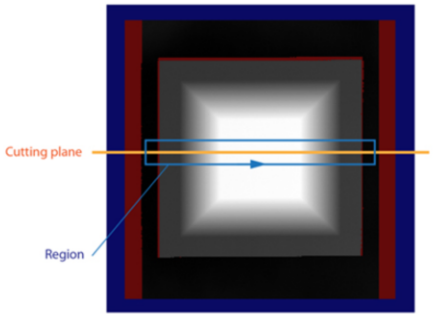


The CrossSection tool performs a cut through a specified section.

As a result you get a profile where you can perform many kinds of measurement operation.

Size & Position of Cross Section

- Place region so that it traverses
  - Orthogonal to profile you want to extract
- Region height specifies averaging
  - Larger regions for stable results



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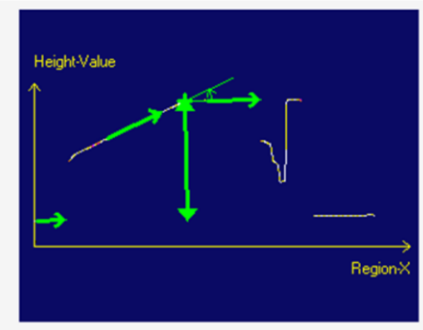
Using the CrossSection has been made very easy and flexible.

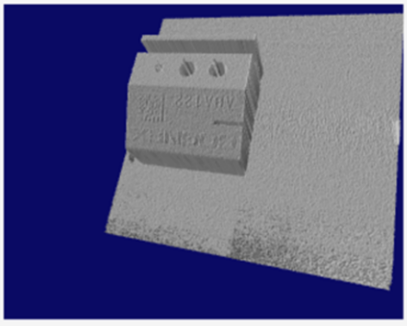
You simply place and size the tool as if it is a caliper tool where you traverse the area where you want to make the “slice.”

The height of the tool will specify the amount of averaging.
The smallest region you can take is 1 pixel high.
Generally you want to avoid a 1 pixel tall region because it would be very susceptible fluctuating averages.

Cog3DRangeImageCrossSectionTool

- A CrossSection tool is used to obtain a profile of the part at a specific plane
- We will use the cross section tool to measure:
  - Height
  - Angle





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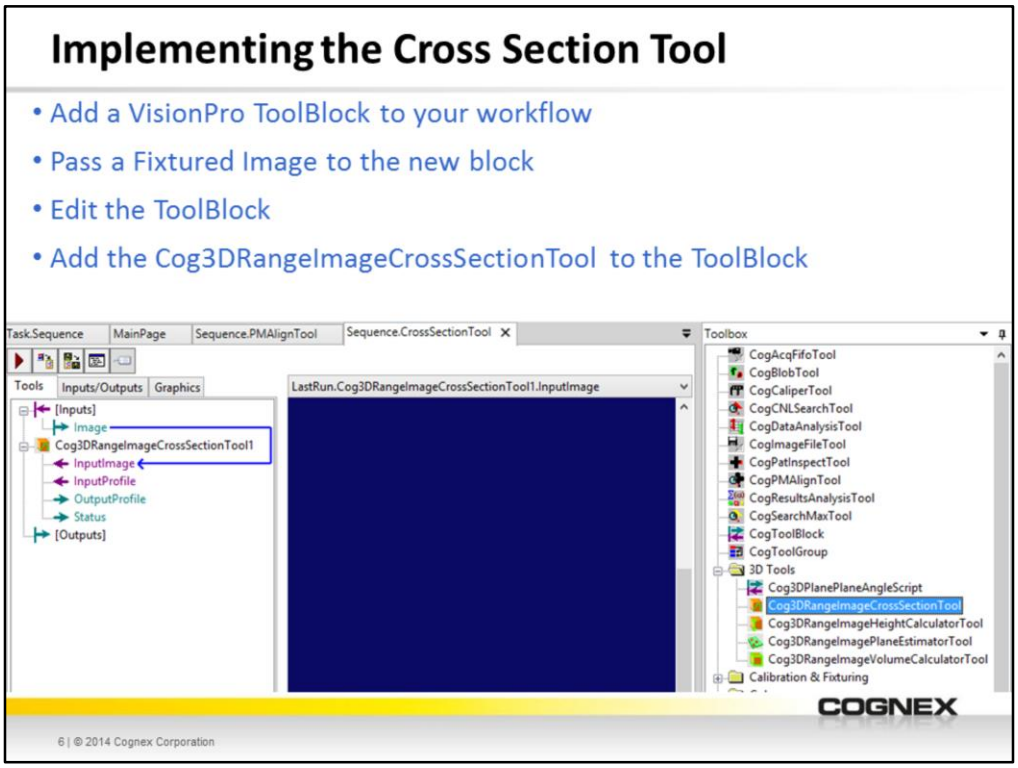
We can easily and accurately measure height and angle, but first we must start with some simple features like the top line and the angled line.

Once we have those, we can use those simple features to calculate the angle between them.

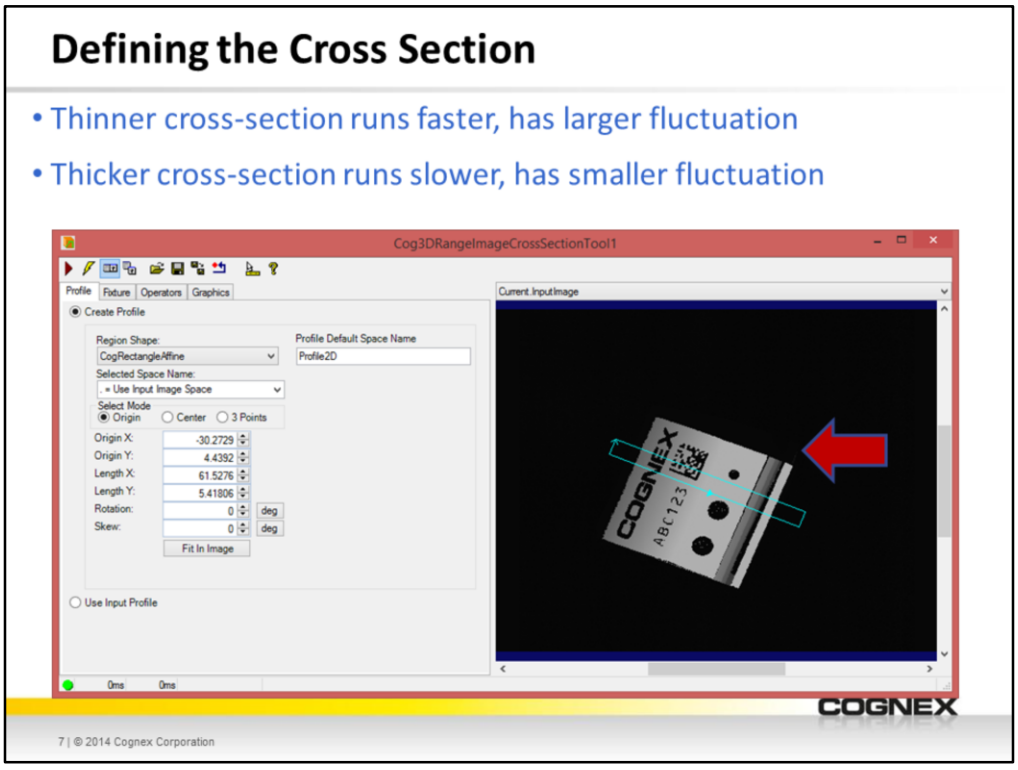


To implement a Cog3DRangeImageCrossSectionTool:

1) Add a new vision tool block to your sequence
2) Rename it “CrossSectionTool”
3) Connect the output image from the PMAlignTool block
4) Run the sequence once

Get used to naming your blocks descriptively and consistently.

This is a good habit to get into early on so that when you make more complex applications, it will be easier to navigate them.



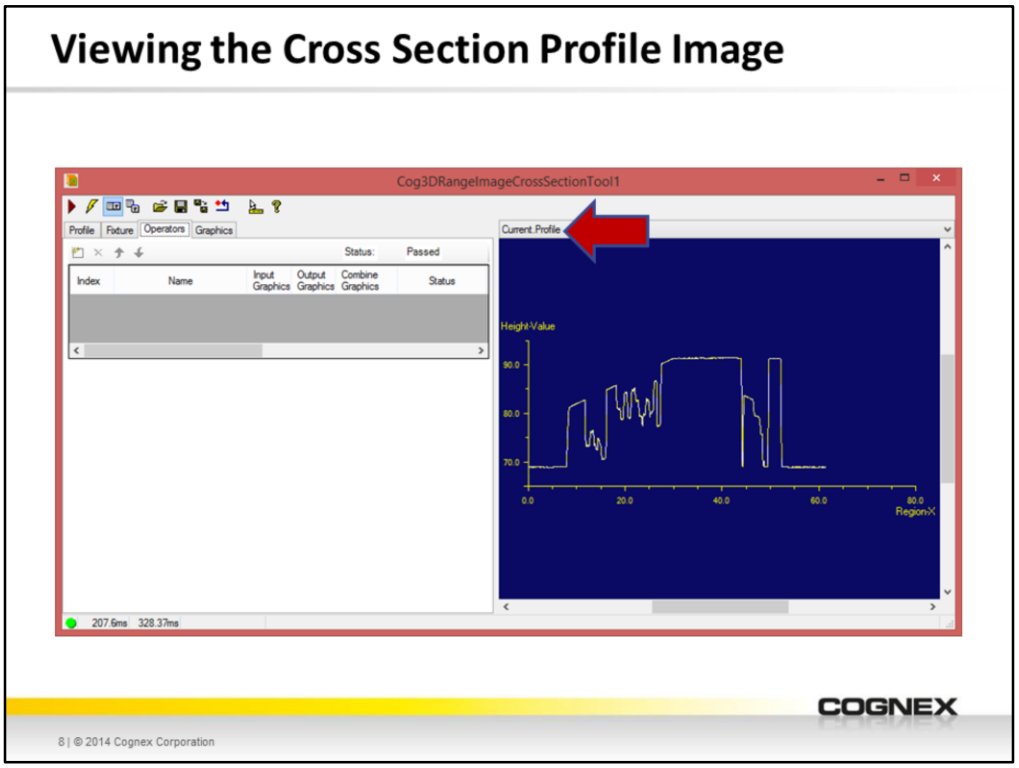
Setting the region allows you to choose where you will slice through.

- The thinner you make it, the faster it will run, but the more susceptible to noise or minor variations.
- The thicker you make it, the better you will cancel out minor variations and noise, but it will take a little longer to execute.

For this part and the details we are looking to extract, we recommend the region pictured as the cross section.

Make sure you are on the Current.InputImage to place the region.

The only choices for the Region Shape is an Affine Rectangle or the Entire Image.



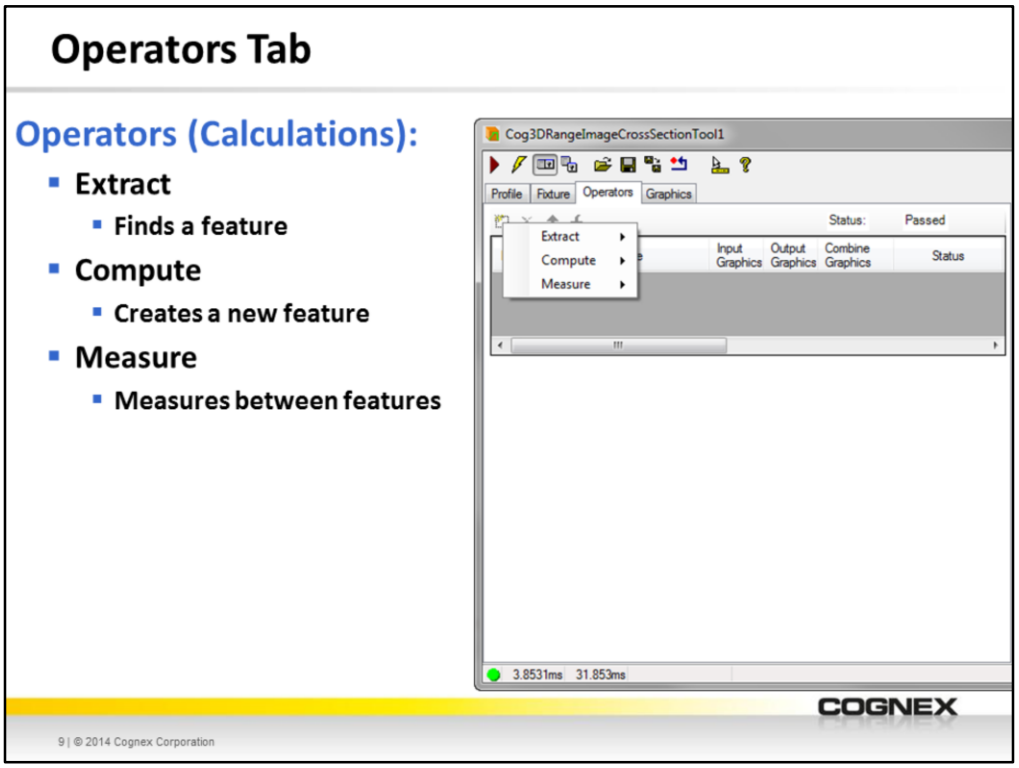
Once you select your region and run the tool, you can see the profile the tool has generated.

Select the Current.Profile image from the image pull-down menu.

You will use this to extract features of interest and calculate measurements.

Note the colors used in creating the Profile:

White: many points were used in the creation on the line segment. It is continuous.
Yellow: a lot of points were used though there is still some estimation. The beginning and ending point of the segment can be trusted.
Pink: not many points were used or varied widely. Not very good to use with measurements. Some operators may ignore these points.
Brown: best estimate. Used to sometimes connect segments. Should not be used in any measurements.



The Operators Tab offers quite a few options for extraction, computation, or measurement of features on the resulting 2D profile

Extract – Derives an "object"

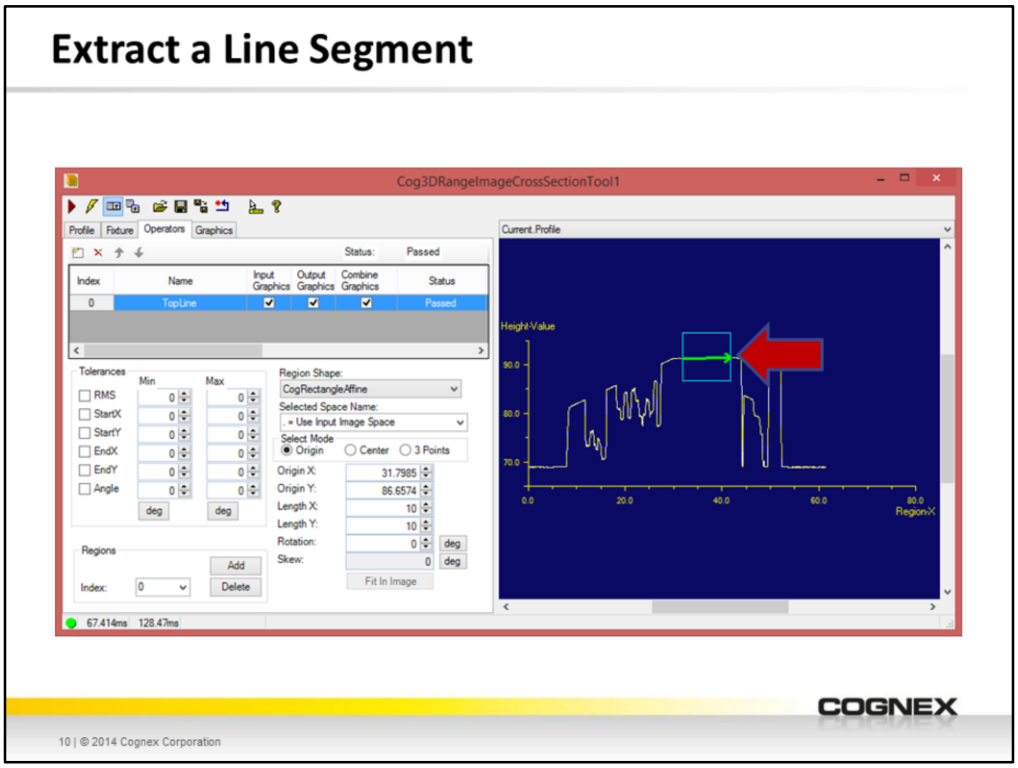
- Line Segment - straight edge
- Point – can be top, bottom, left, right, or average
- Corner – creates intersection as derived from the ImageSharpness tool
- CircleFit – creates a calculated best fit circle given a portion or complete circle

Compute – takes information that was extracted in order to create a new structure

- IntersectLineLine – computes the intersection point of two line segments
- PointLineSegment – computes a point on a given line segment (such as Middle, Start, or End)
- MidPointPoint – computes the midpoint between two given points
- LineSegmentPointPoint – computes the line segment between two given points
- NearestPoint – given a point and a line segment, it will compute the nearest point on that line or line segment
- PointAreaResult – TDB
- PointCircle – given a circle, it will calculate the center point of the circle

Measure – calculates measurements from given objects or structures

- AngleLineLine – measures the angle between two line segments
- DistancePointPoint – measures the distance between two points
- DistancePointLine – measures the distance between a point and a line or line segment
- Area – measures the area above or below other extracted features

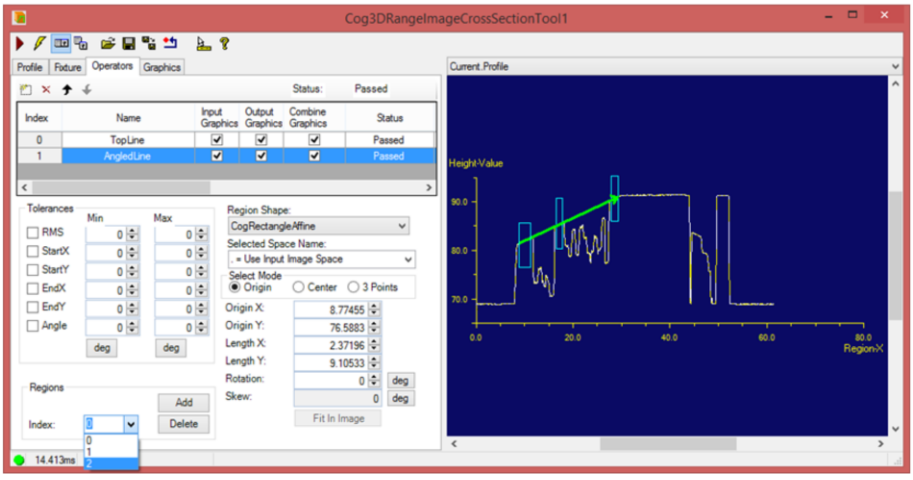


The region needs to contain the line segment wanted. Orientation on the region does not matter.

Tolerance can be used to filter potential candidates. Specify the tolerances for the extracted line segment:

RMS - the root mean squared perpendicular error between the line and all of the points in the region
StartX - X coordinate of starting point of the line segment
StartY - Y coordinate of starting point of the line segment
EndX - X coordinate of ending point of the line segment
EndY - Y coordinate of ending point of the line segment
Angle - angle of line segment

Multiple Regions in One Operator



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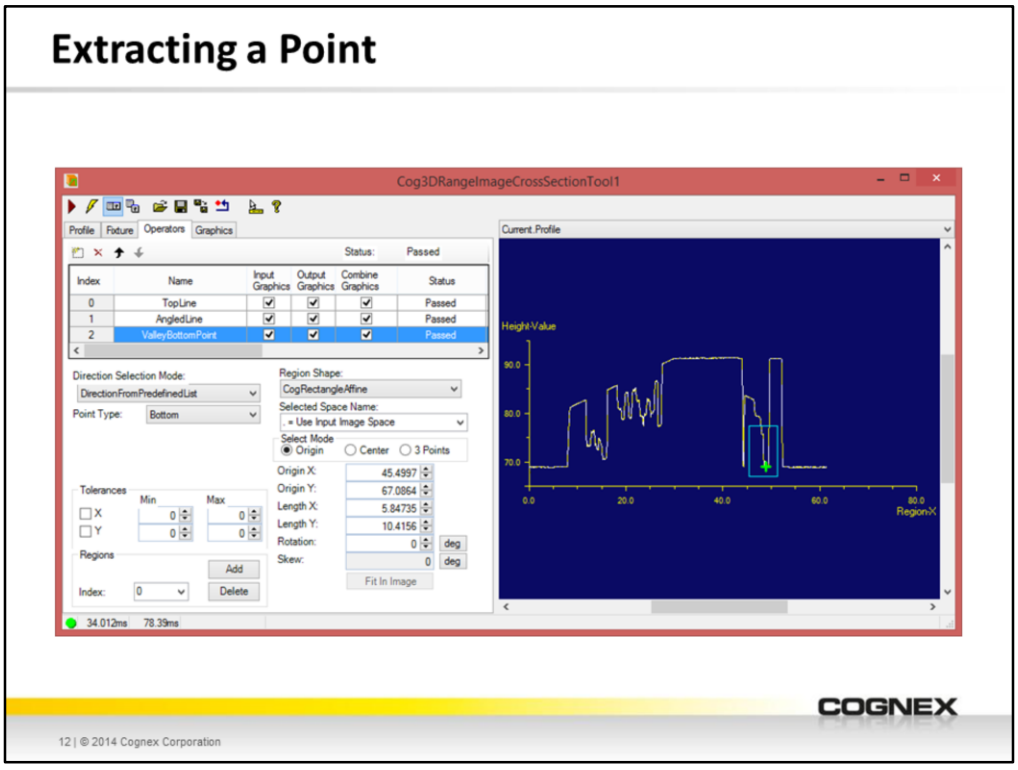
We can add additional regions if we want to get more of an average over multiple sections. This can be useful if the profile has poor data over certain areas or need to do some averaging of line segments.

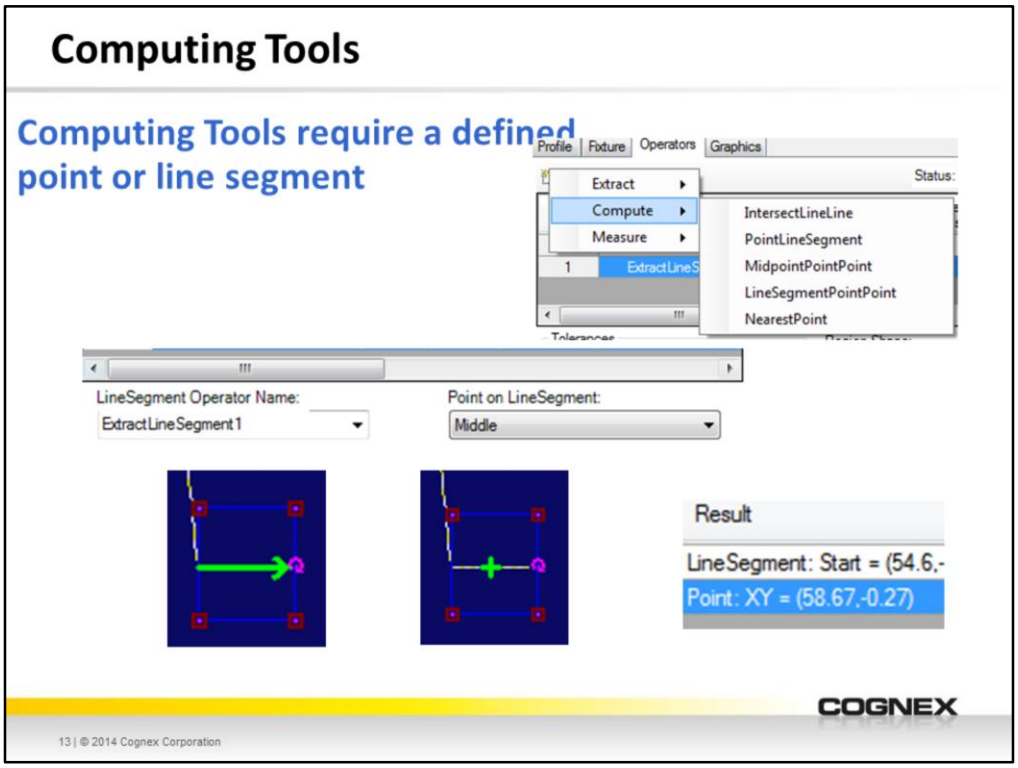


In this case we have place the point around the valley of the part and selected Bottom as the point type so it selects the bottom most point.

The PointType can be one of the following:

Top - extracts the topmost point, that is, the point with the highest Y coordinate
Bottom - extracts the bottommost point, that is, the point with the lowest Y coordinate
Left - extracts the leftmost point, that is, the point with the lowest X coordinate
Right - extracts the rightmost point, that is, the point with the highest X coordinate
Average - extracts the average point, that is, the average position of all points within one or more profile regions

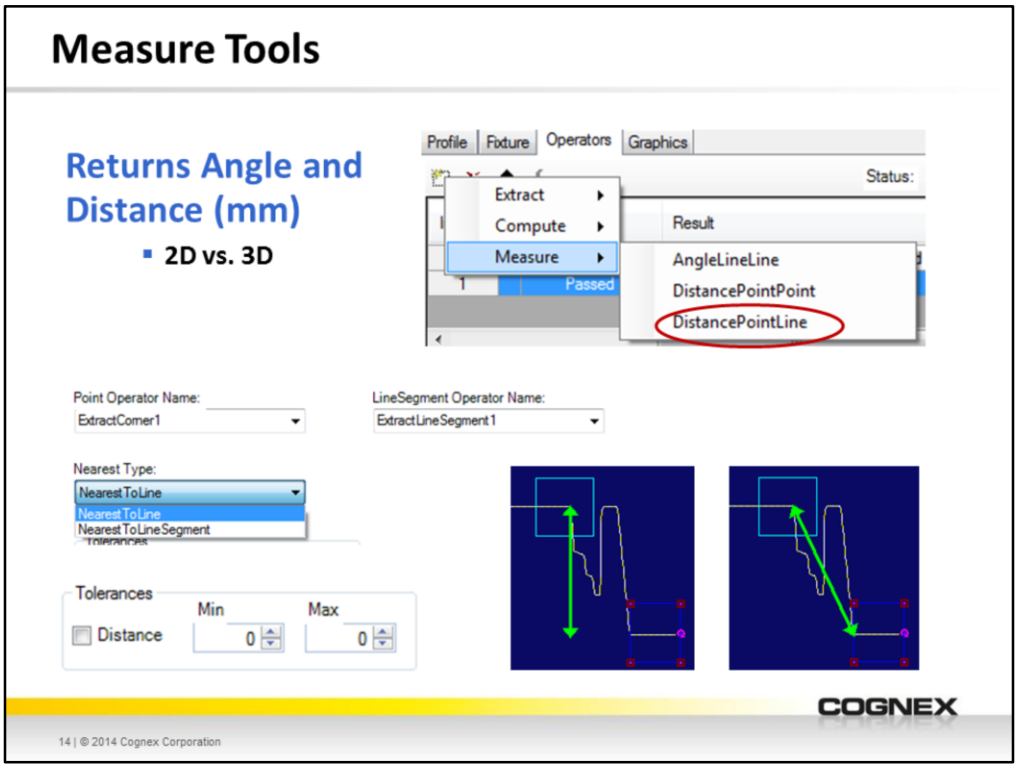
Tolerance can be used to filter potential results.



Compute tools allows us to derive a greater selection of options from the ones available in the Extract area. Depending on the compute operation being chosen, a previous extracted line segment, point, or corner will be used. The resulting operator with show its result in the Result area on the table.

This is the list of potential computations from the earlier slide:

- IntersectLineLine – computes the intersection point of two line segments
- PointLineSegment – computes a point on a given line segment (such as Middle, Start, or End)
- MidPointPoint – computes the midpoint between two given points
- LineSegmentPointPoint – computes the line segment between two given points
- NearestPoint – given a point and a line segment, it will compute the nearest point on that line or line segment



Measurement tools will return the measured angles or distances from extracted or computed points and / or line segments. The operator will show which operator types it needs to use and offer a list of potential candidates to be used from previously extracted or computed results.

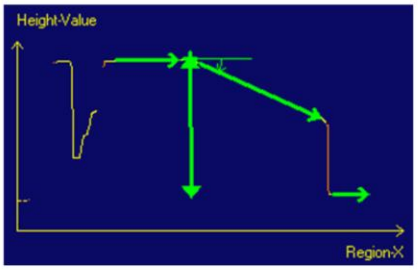
These can be more accurate than a 2D measurement because we can choose where on the part we wish to take the measurement – from a wider base or narrower tip. In the 2D tools such as caliper, it is dependent on the intensity image derived from the tool. There is now concept of depth.

The left image is demonstrating the “NearestToLine” type as it is dropping a perpendicular to the line extrapolated from the line segment tool. The image on the right is using the NearestToLineSegment” type to measure from the given point to the closest point on the line segment. In this case, it is the left most found point of the line segment.

Tolerances are also available for the measurement operators (distance or angle). A distance outside of the tolerance range will result in red arrow as opposed to green.

Combined Graphics of the Operators

LastRun.CombinedGraphics



Profile | Fixture | Operators | Graphics

Status: Passed

Index	Name	Input Graphics	Output Graphics	Combine Graphics	Status	Result
3	AngleTopAngled	☑	☑	☑	Passed	Angle = -0.43 rad -24.92 deg
4	PointLineLine	☑	☑	☑	Passed	Point: XY = (29.8,23.01)
5	DistanceTopBase	☑	☑	☑	Passed	22.43

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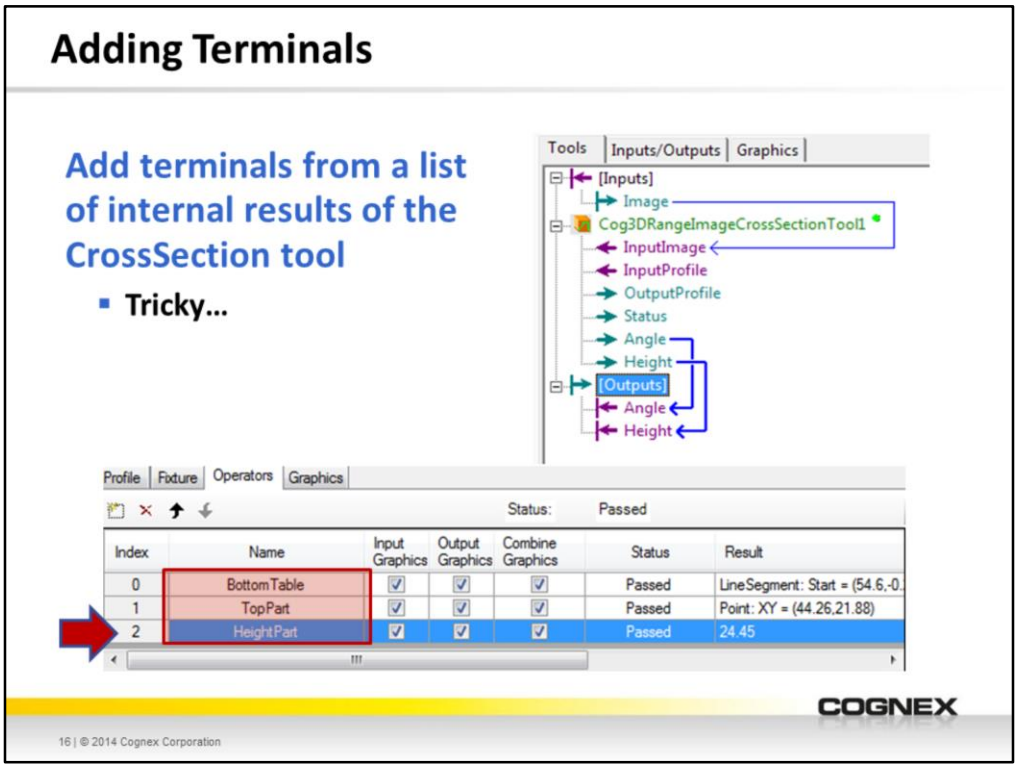
There are many operators to perform measurements. There are many ways how to combine these operators to get a measurement result.
You can view all functioning operator graphics by selecting the LastRun.CombinedGraphics image.

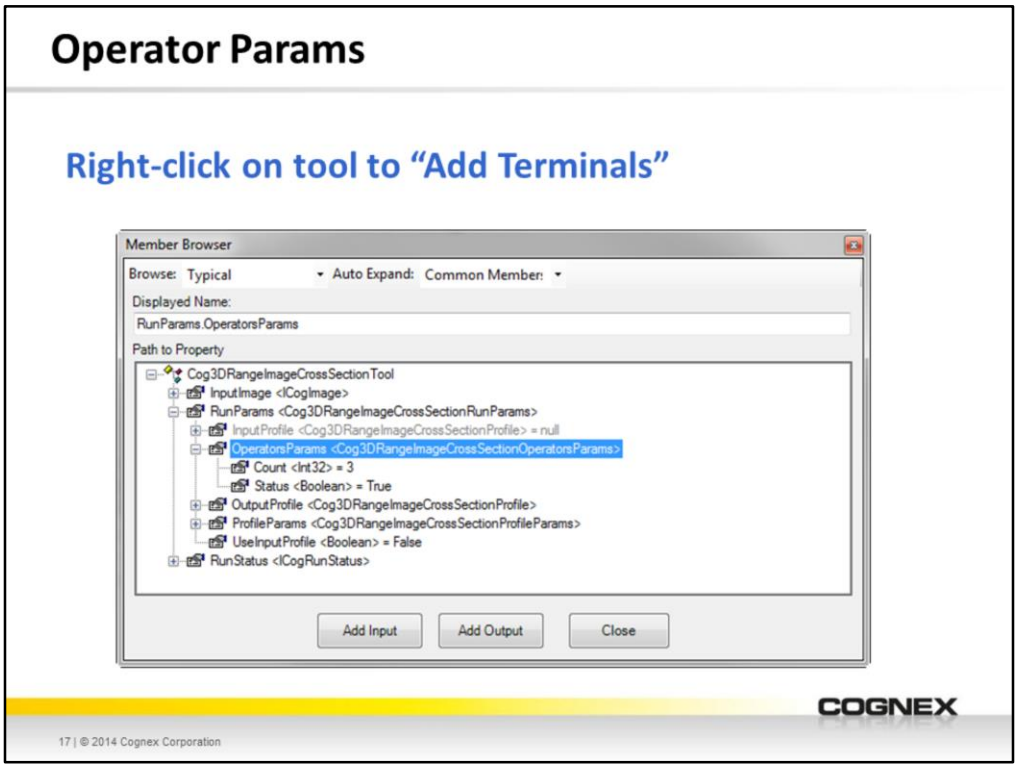
Ideally, you ask the customer how he measures the required measurements using a caliper or CMM machine.

Try to replicate this process or come up with a better way and you will have good results.



This part may seem a bit more difficult. It is not as simple as choosing the result terminal from the tool.

Before we start looking at the tool's terminals, make note of the index value(s) of the results that we want to see. It is also a good idea to rename each of the operator to make sure we have chosen the correct result.

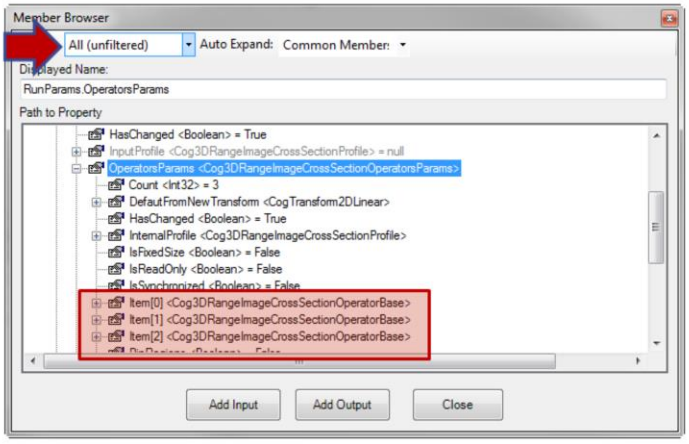


Note that there are no “Results” collection. We might think that our measurements or computations would be considered results – they aren’t. They are considered “Operators”. So to gain access to them, we have to choose the “Operators Params” collection.

Unfortunately, the results we want are not available at the “Typical” Browse level so we need to dig deeper.

Dig Deeper

Browse via All (unfiltered)



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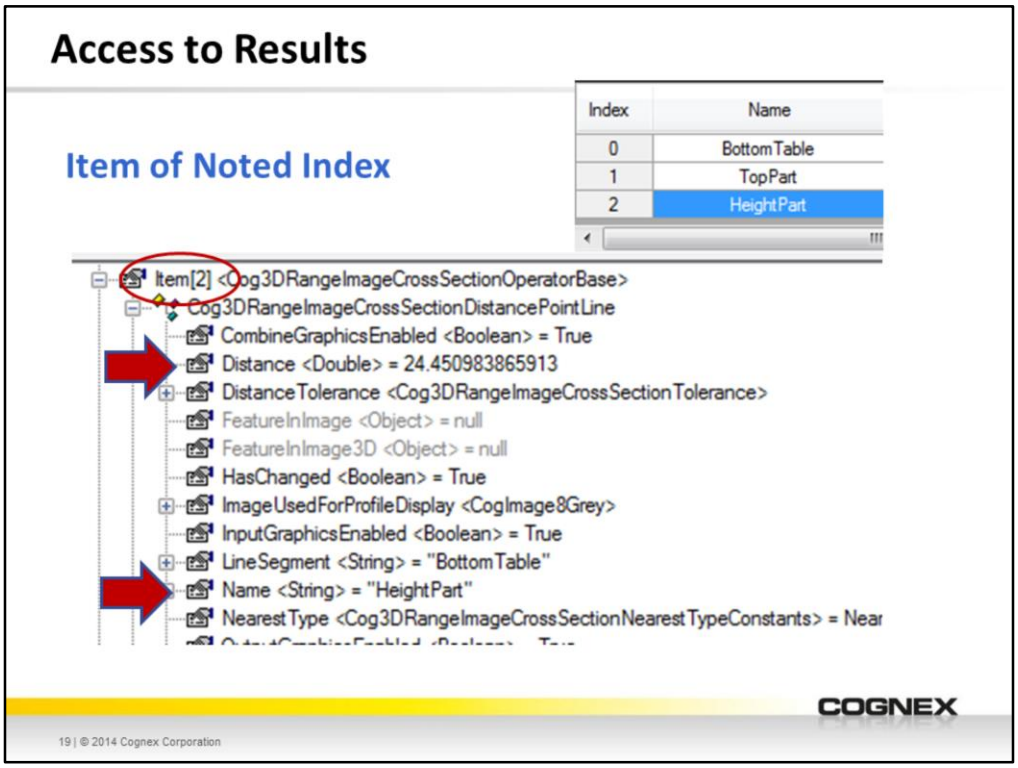
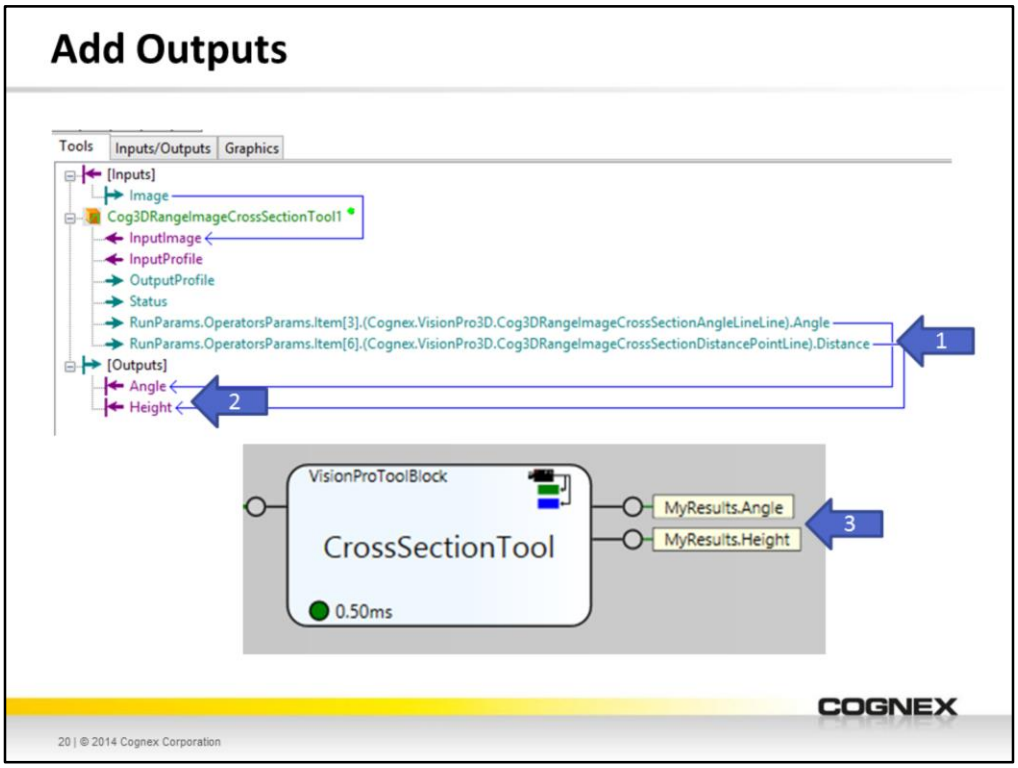
Even when we go to “All (unfiltered)”, the result is still not apparent. Now we need to remember which index we need to open to see further information. The Item enumeration is directly correlated to the index value within the tool.



The height that we want is at Index 2. So if we open that index, we can see the Distance (that we would make an Output terminal). We can also see the name. By using names, we can easily make sure that this is indeed the value that we want.

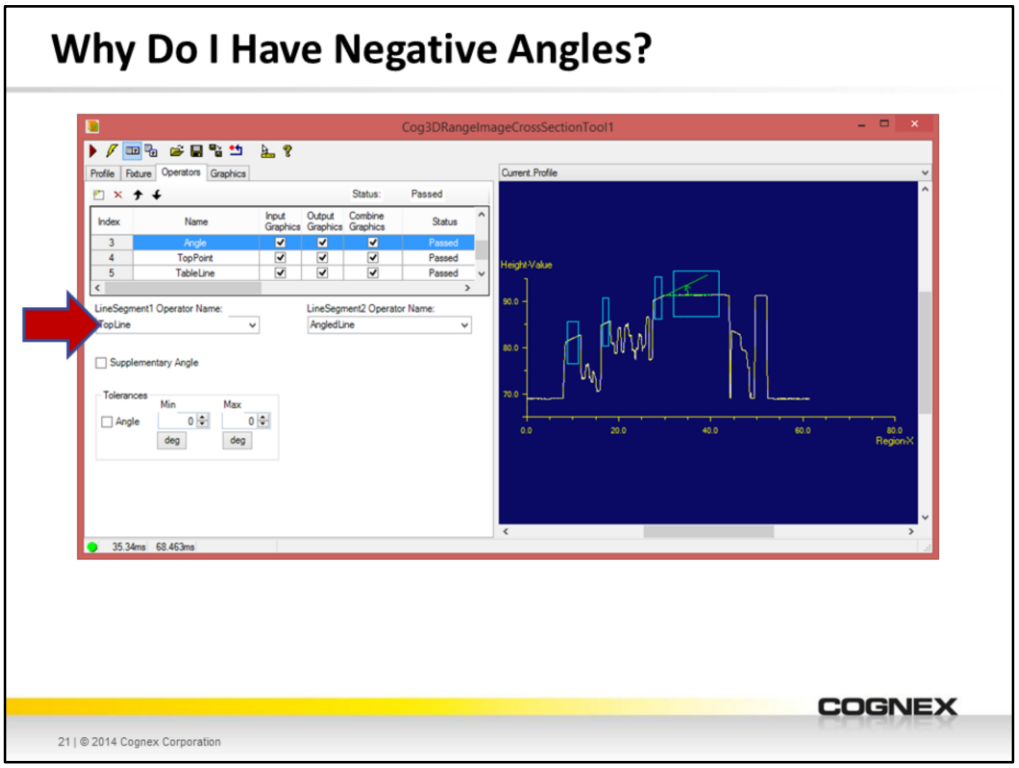


After adding the angle and height as a output terminals, we might want to rename it as opposed to leaving it the very long name from the tool itself.

1) Drag output terminals to the [Outputs] collection
2) Rename them to Angle and Height respectively
3) Verify you now have additional outputs visible at the sequence level and assign them to new tags
    - MyResults.Angle
    - MyResults.Height

This will lend itself to better documentation for the program as well as ease of troubleshooting.

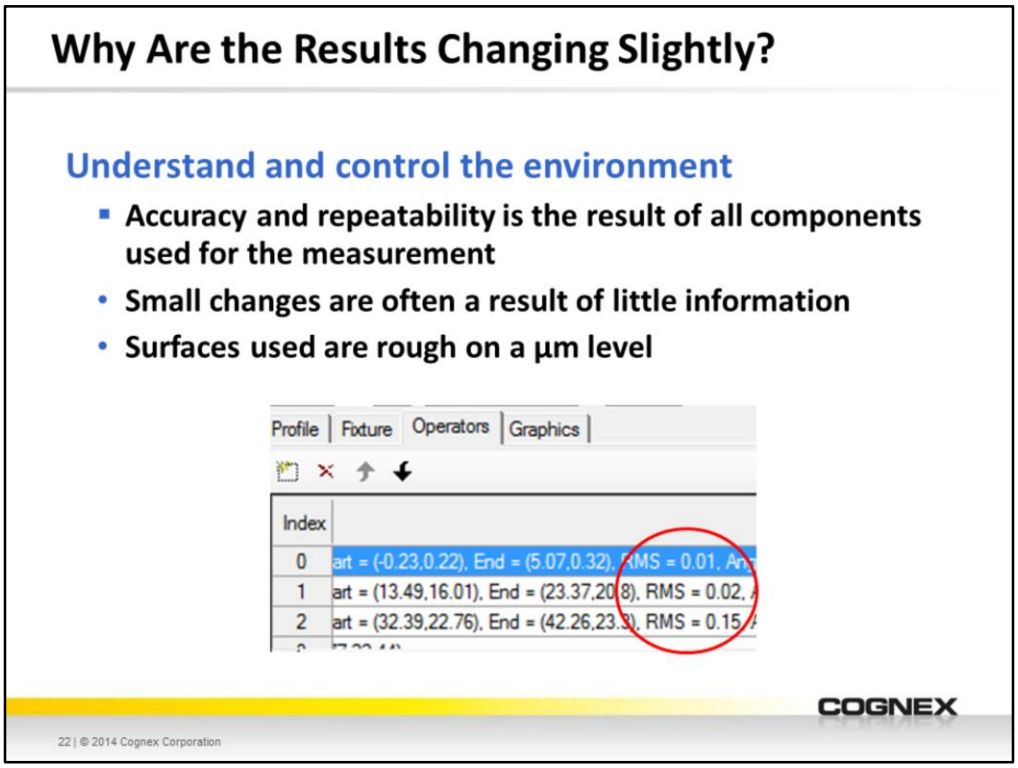
To rename, right-click on the terminal to be renamed and select “Rename”



The order in which the operators are run will alter the results – in particular, angle.

The change this, switch the order in which you are referencing each line segment.

The Supplementary Angle can also be selected in the wrong angle is being chosen. It is (180 – angle).



All components of your vision system contribute to the results.
The repeatability of your results is directly tied to the repeatability of part presentation.

If you can control part presentation, you can control, to a great extent, the repeatability of your results.
Here are some of the things you want to control:

Accuracy and repeatability is the result of all components used for the measurement

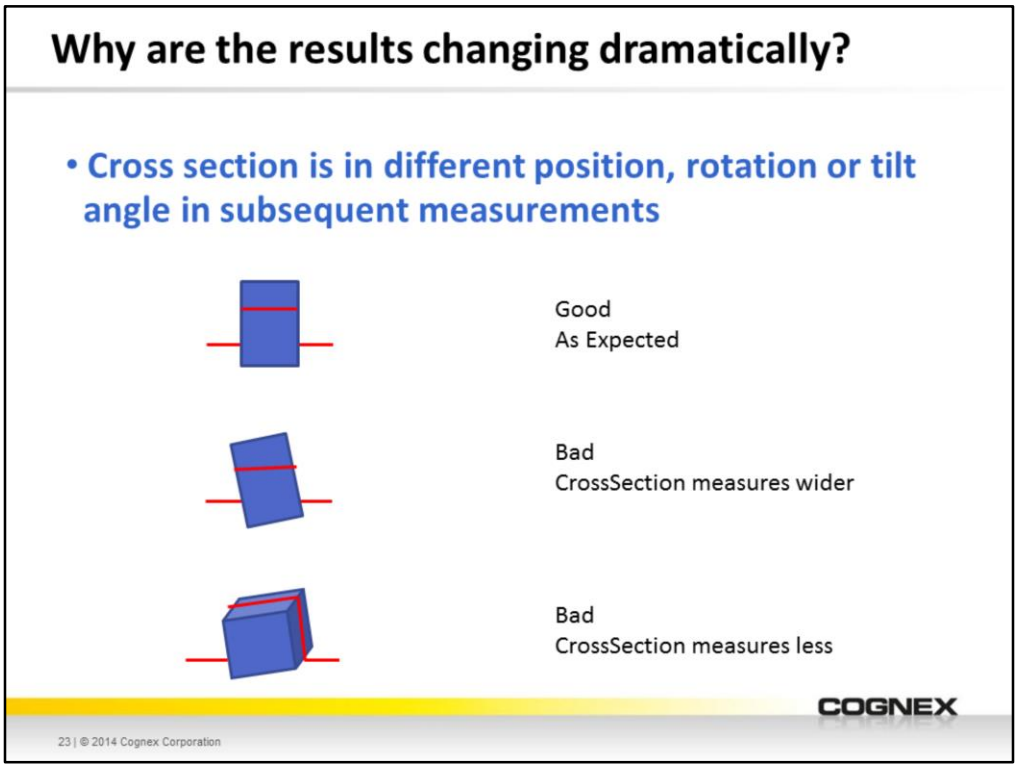
- •Gantry / Slider
- •Profiler
- •Consistency of used surfaces for measurement

Small changes are often a result of little information

- •Increase the region
- •Increase the resolution

Surfaces used are rough on a µm level

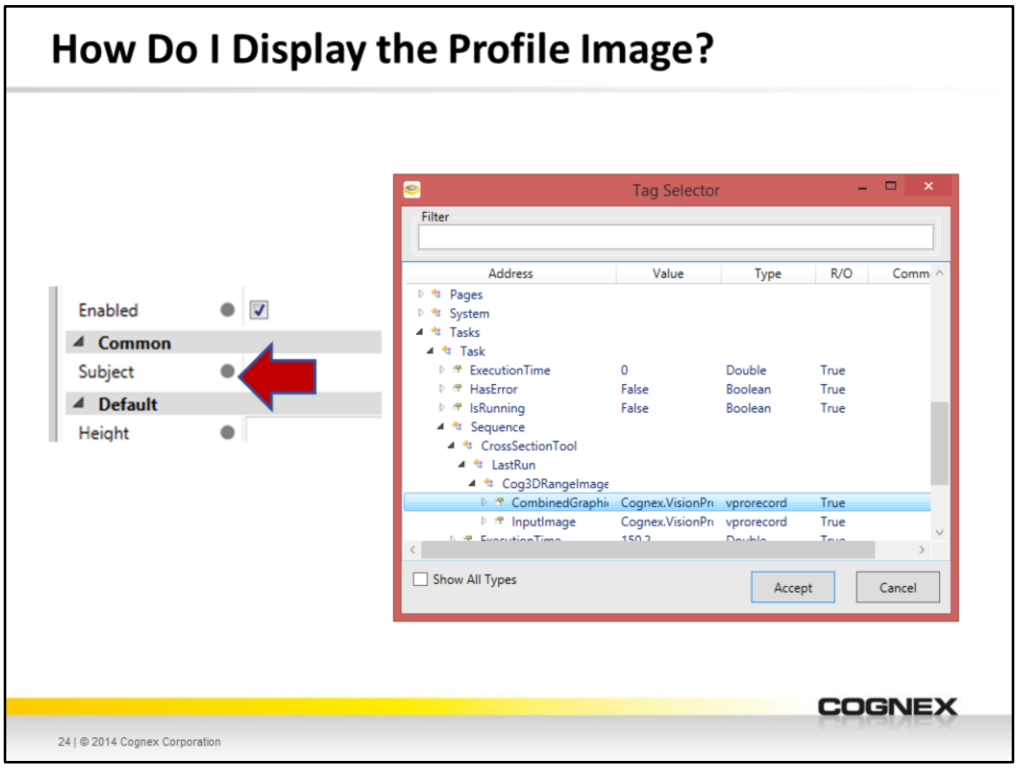
- •Check RMS Value
- •>0.1 you should check surface



All CrossSection tools on the market expect the part to be perfectly positioned in order to get repeatable results.

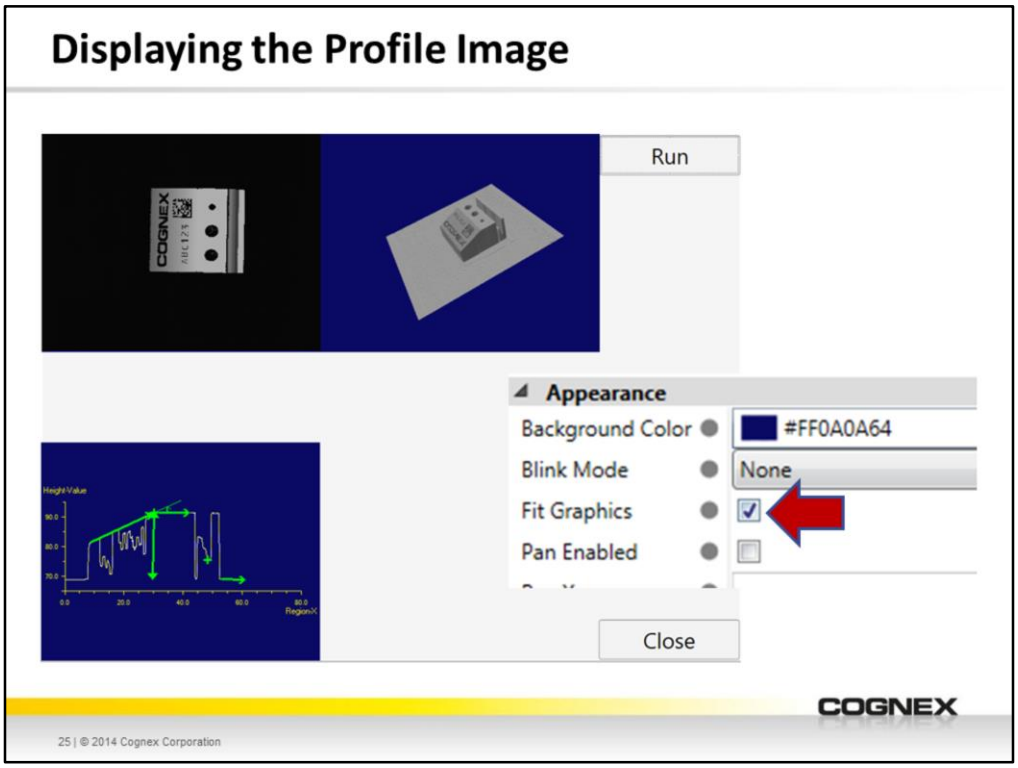
Except for our CrossSection Tool. Since we are looking at an entire image, we can use tools such as PatMax or soon 3D Alignment to put our CrossSection Tool at exactly the same position and measure good results just as we have been doing in the 2D World!

For customers this is a huge benefit, since they can save a lot of cost in the presentation of the parts.



The Profile image is a 2D image so we would use a 2D display to incorporate it onto our HMI display.

When choosing the correct image from the Tool Block, select the “CombinedGraphics” one as opposed to the InputImage. The InputImage would show the part with the outline of the CrossSection Tool’s ROI in green. This is not exactly what we want. We want the image of the 2D lines from which we are taking our computations and measurements.



We need to make sure that we have selected “Fit Graphics”. In the Properties of the display. Otherwise, we will get a black or green gridded image.

Summary

Cog3DRangeImageCrossSectionTool

- Learned about extracting features
- Explored the different Compute and Measurement options available in the tool

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