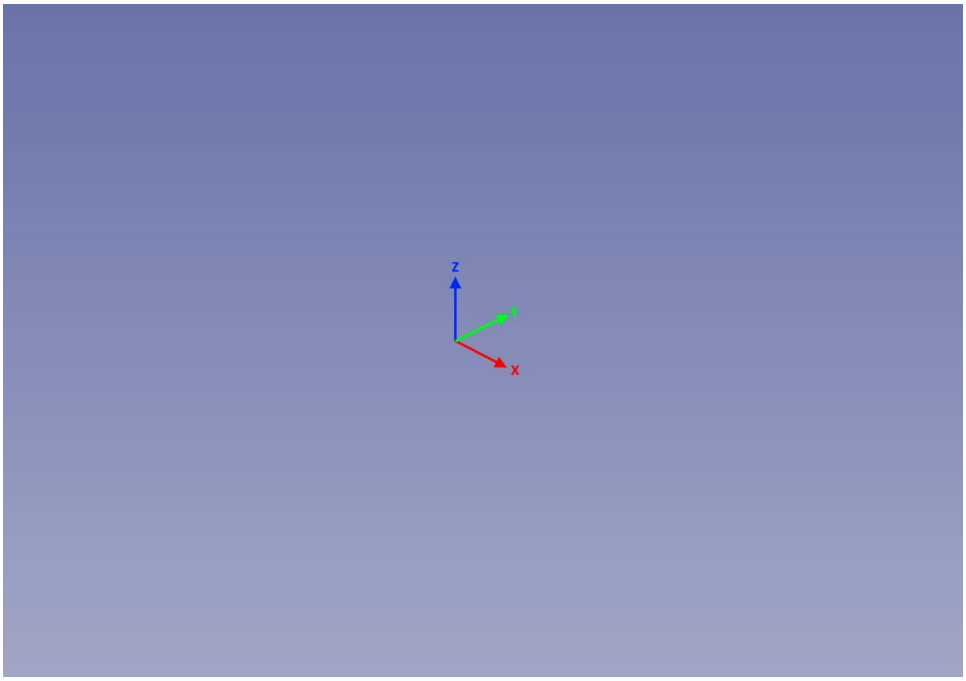
CMM-Manager 3.9

Mirroring

Feature Reference

NIKON METROLOGY | VISION BEYOND PRECISION

The Right Hand Rule



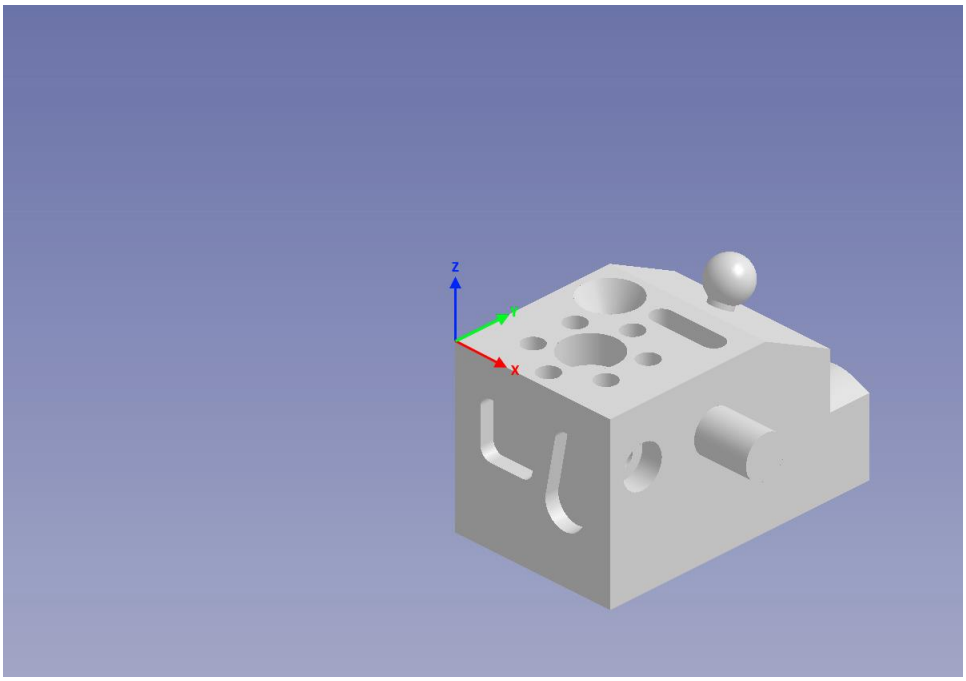
CMM's and inspection programs follow the Right Hand Rule.

- There are three workplanes: XY, YZ, and ZX
- Looking from +Z, Y is CCW from X
- Looking from +X, Z is CCW from Y
- Looking from +Y, X is CCW from Z
-

An axis system that follows these rules is a Right Hand axis system. CMM-Manager *always* works in a Right Hand axis system. *No exceptions*.

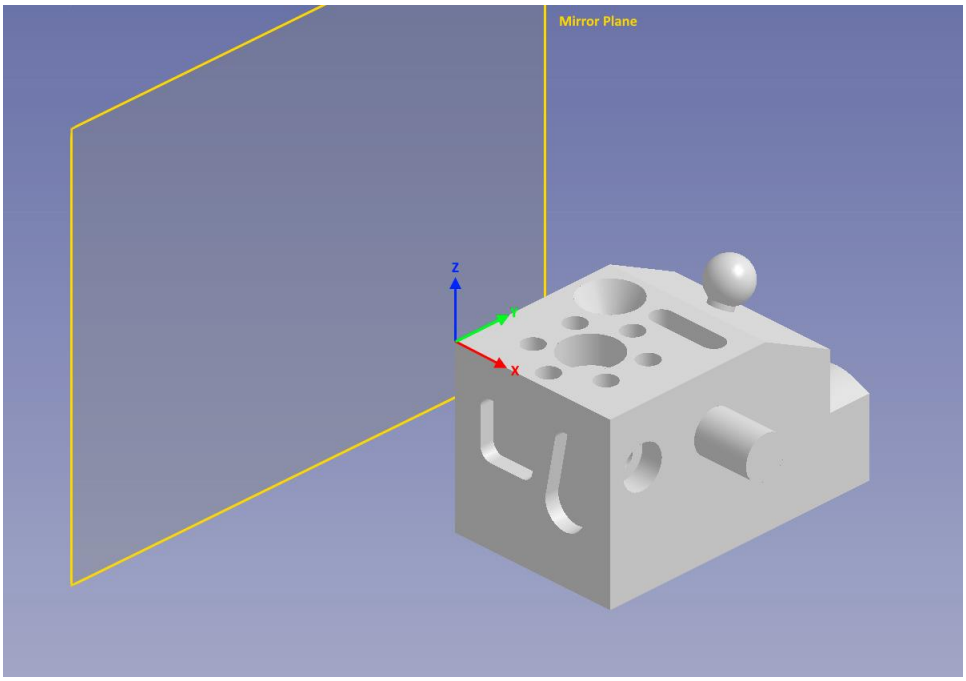
What does that mean for mirroring…?

The Right Hand Rule and CMM-Manager Mirroring



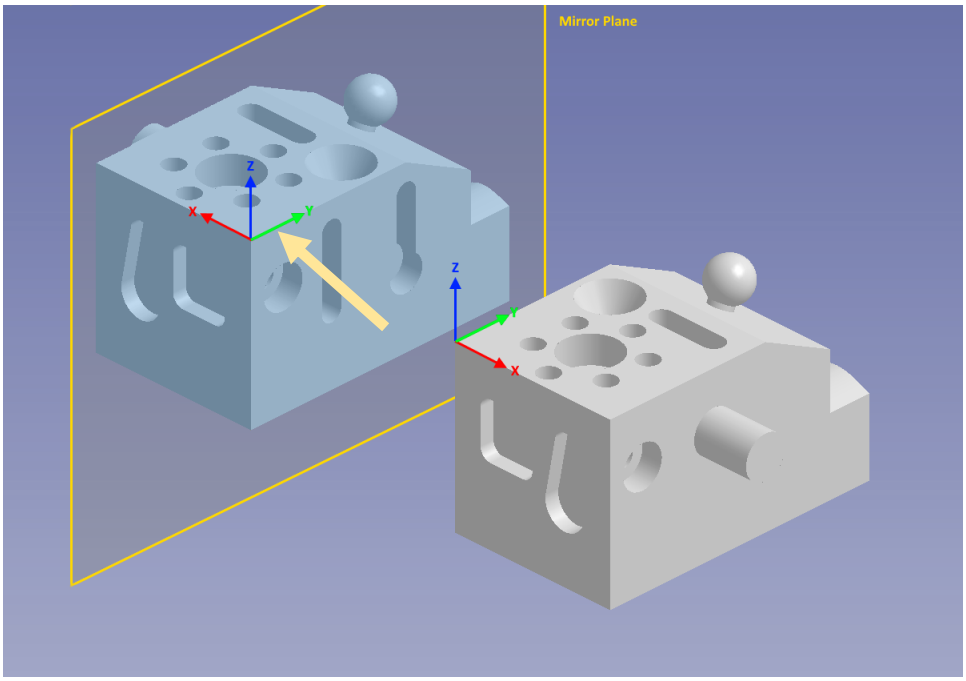
Using the IQTrainingPart model as an example:

The coordinate (axis) system is defined at the corner of the part and is a RH (Right Hand) axis system.



This example will demonstrate a part, which has been mirrored around the YZ plane. A mirror has been drawn to help with this visualization.

When performing program mirroring, this visualization concept, along with the following rules, is critical to successful mirroring.

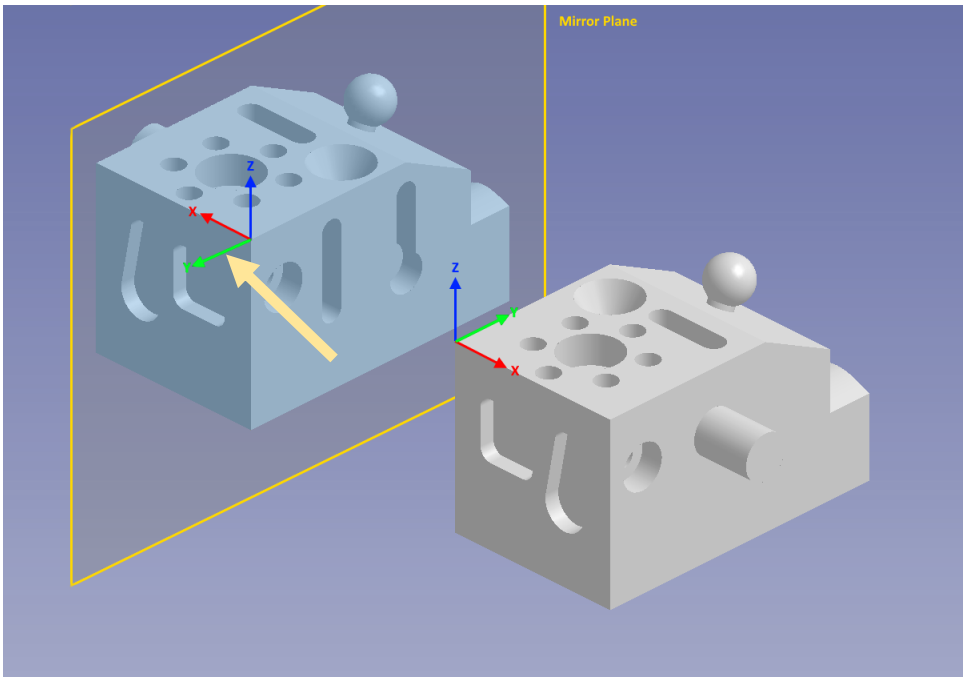


The part can be seen reflected in the mirror.

There is a problem however.

Looking closely at the mirrored axis system, it can be seen that the Y-axis is *CW* from the X-axis (When viewed from +Z). This is not a RH axis system. A truly mirrored part becomes a LH axis system. CMM's and inspection programs work in RH axis systems.

How can this be fixed…?

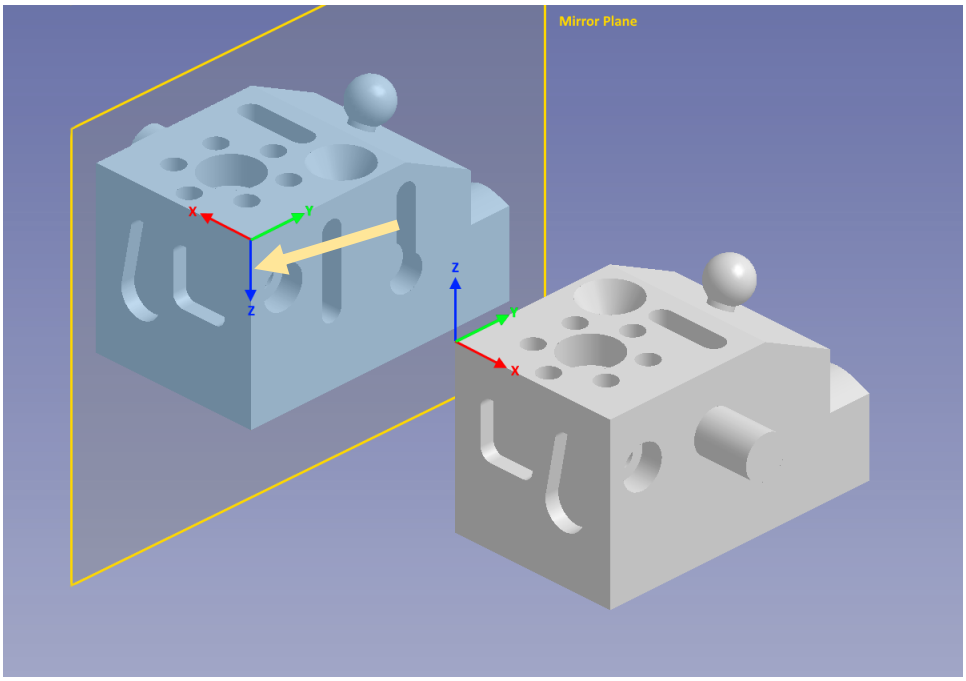


In CMM Inspection, in order to maintain the RH axis rule, the program is *semi*-mirrored. Using the X-axis as the axis we desire to mirror (reversed direction in the mirror) for this example, one other axis *must* also switch direction in order to maintain the RH rule.

For this example, there are two options.

- The Y-axis direction can be reversed restoring the RH rule. (The original axis system has been rotated around the Z-axis by 180 degrees)

Note that visually everything appears as it would in a true mirror - with the exception of the Y-axis. In the mirror image, the Y-axis must be reversed in order to maintain the required RH axis system.



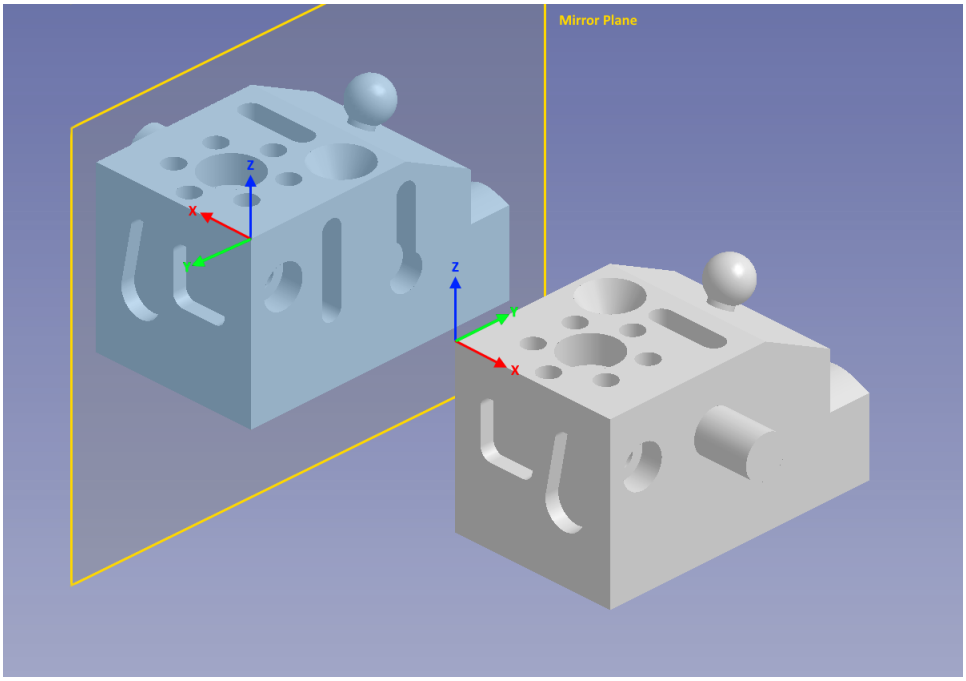
Or –

- The Z-axis direction can be reversed, once again restoring the RH rule. (The original axis system has been rotated around the Y-axis by 180 degrees)

Either way, a 2nd axis must be reversed. *The RH rule must be maintained.*

The selection of the 2nd axis is automatic. How this is determined will be discussed later.

The Practical Effects of Semi-Mirroring



In a (semi-)mirrored program, the sign of the values for the 2nd axis which was reversed in order to maintain the RH rule will be reversed. The values (digits) will be the same, but the sign will be reversed.

In the example in which the Y-axis has been reversed, the sign would be reversed as seen here.

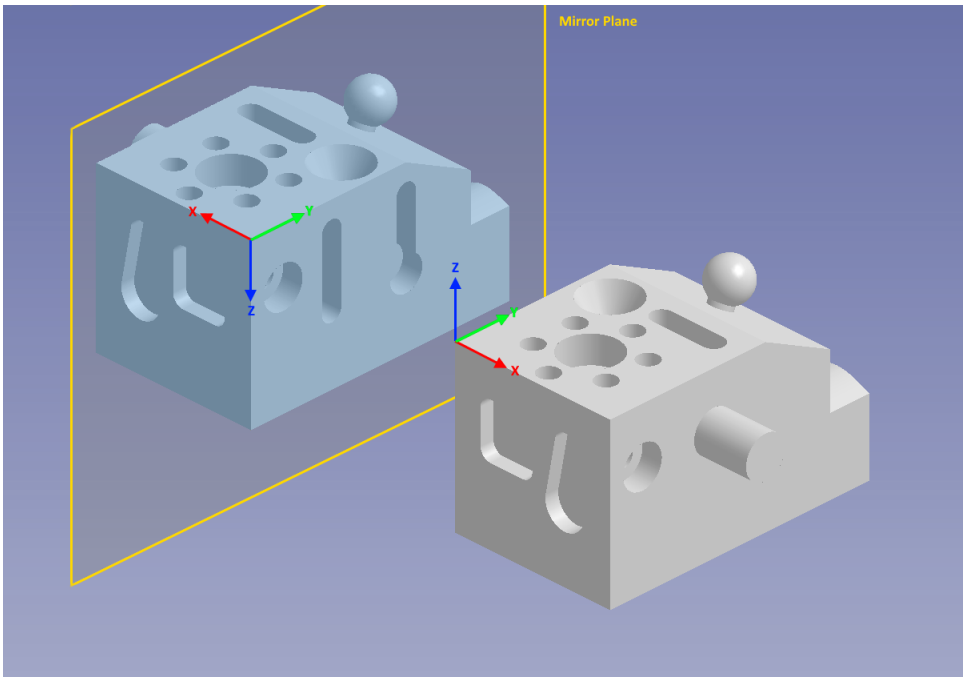
On the original part, the sphere is located at:

X = 1.5000
Y = 3.8050
Z = 0.0447

On the mirrored part, the sphere will be located at:

X = 1.5000
Y = -3.8050 **<- Sign reversed**
Z = 0.0447

This sign reversal is automatically applied as required to all usage instances including reporting.



In the example in which the Z-axis has been reversed, the results will be as shown here.

On the original part, the sphere is located at:

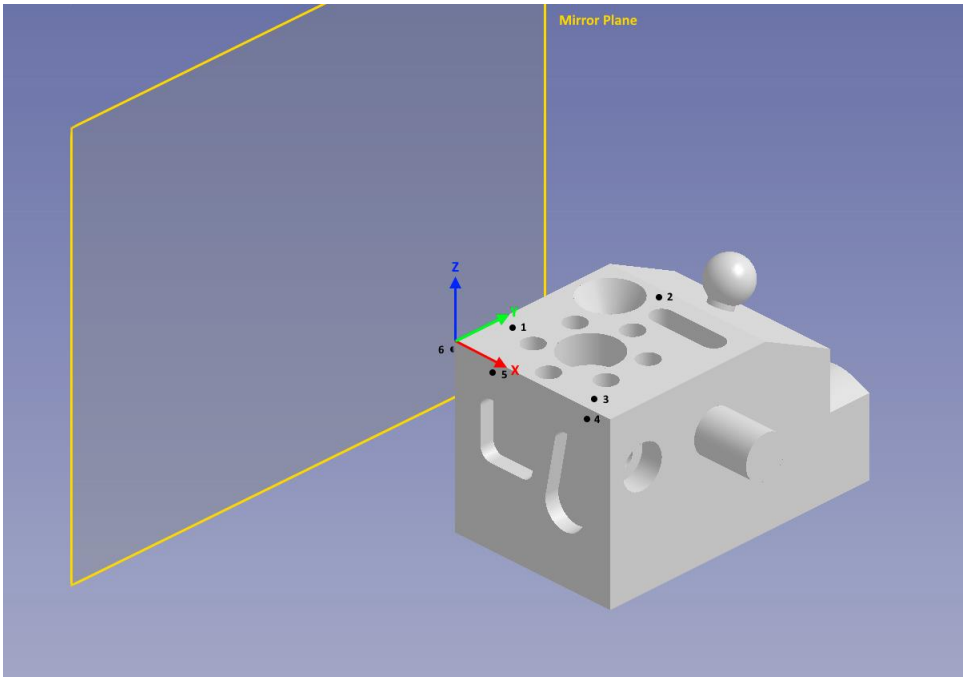
X = 1.5000
Y = 3.8050
Z = 0.0447

On the mirrored part, the sphere will be located at:

X = 1.5000
Y = 3.8050
Z = -0.0447 **<- Sign reversed**

The numbers are the same, but the Z axis *sign* is reversed.

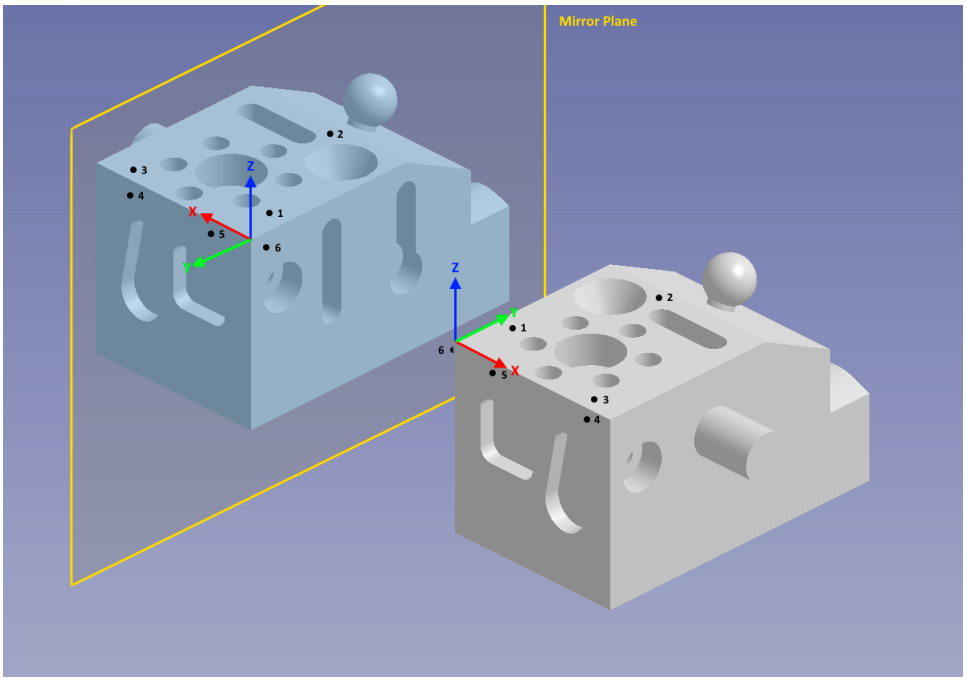
Mirrored Manual Alignments



A simple 3-2-1 (Plane-Line-Point) alignment will be used for this example.

- Three point on top define the primary (Z) axis and Z-axis zero (leveling plane)
- Two points along the front face define the secondary (X) axis and Y-axis zero (anti-rotate axis) *Note: these points were taken in right-to-left order*
- The Y axis is defined by virtue of the fact that Z and X axes are defined. There is only one direction Y can go and still be a RH axis system.
- One point on the left face sets the X-axis zero

This creates a fully defined axis system and the part is ready for inspection.



Note that, other than the Y-axis which had to be reversed in order to maintain a RH axis system, the points are positioned exactly as they would appear in a mirror. *Point order is still in the same (mirrored) relation to the part origin.*

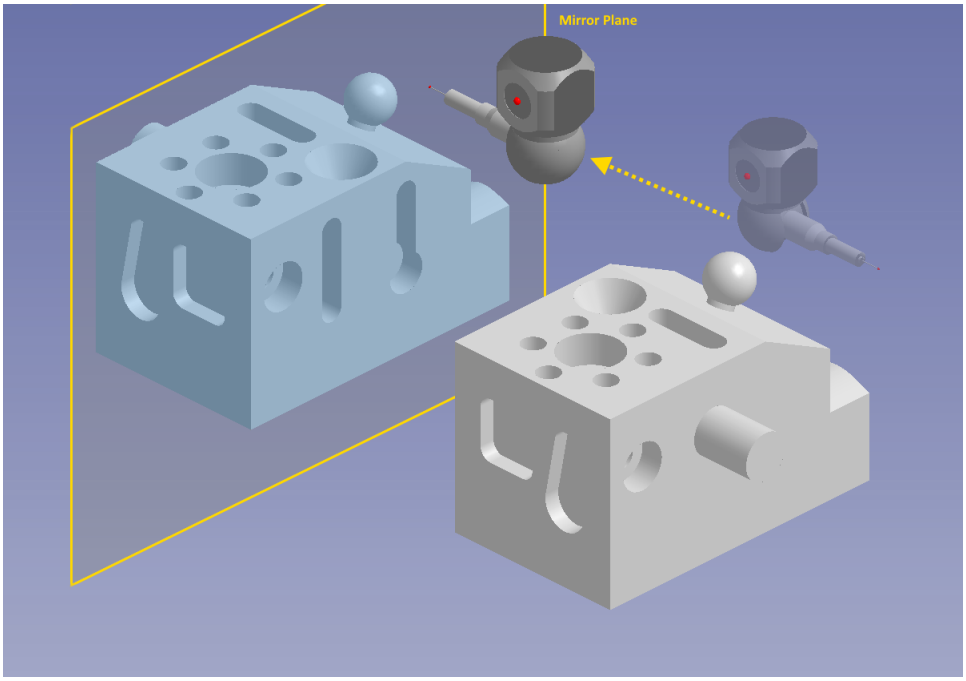
- Three point on top define the primary (Z) axis and Z-axis zero (leveling plane)
- Two points along the front face define the secondary (X) axis and Y-axis zero (anti-rotate axis) *Note: these points were taken in **left-to-right** order*
- The Y axis is defined by virtue of the fact that Z and X axes are defined. There is only one direction Y can go and still be a RH axis system.
- One point on the ***right*** face sets the X-axis zero

In the same way the final point is now taken on the right side instead of the left, the points for the X-axis line are taken from left-to-right instead of right-to-left. With respect to the origin, the points are still taken *in the same relationship to the origin* - farthest away, then closest.

If the points are not taken in this order, the alignment will not be as expected and the remainder of the program will not function. A RH axis system will still be created, but axis directions may not be as expected.

CMM-Manager does not use the “direction” of the first three points to determine the plane vector direction. The order of the first three points in unimportant. However, it is still a good idea however to get in the habit of measuring the points as indicated here. The order of points may be even more critical in other types of alignments.

Mirrored Probes



As part of the mirror process, CMM-Manager attempts to mirror the probe angles.

If a probe angle of A90B90 is required on the original part in order to measure the slot on the left side (hidden) of the part, a mirror probe angle of A90B-90 would be created to inspect that feature on the mirror part which is now on the right side of the part.

If the required angle does not exist, the user is notified during the mirror process that these probe angles will need to be added.

In some rare cases, mirror probe angles may not be possible and operator intervention will be required in the mirror program (ie: a star probe tip that can't possibly physically reach the mirrored feature)

CMM-Manager Mirroring Notes

What is Mirrored

When a CMM-Manager program is mirrored, the feature nominal values, feature touch points, probe paths, probe angles, reporting, and (optionally) CAD are mirrored.

In most cases, a mirrored CMM-Manager program results in a fully functional program which requires no further editing.

The Mirror Plane and Active Alignment

When a program is mirrored, the mirror operation occurs around *the active alignment.*

If a program with multiple alignments is being mirrored, it is necessary to make sure the curser is on the correct line of the program. If an entire program with multiple alignments is to be mirrored, and the cursor is on the last line of the program, the resulting mirror program will not be as expected. The active alignment is the alignment that is active for the current program line, even though the program is not running.

Care should be taken to ensure the proper alignment is active when performing a mirror operation.

Rules for determining which axis is reversed during mirroring

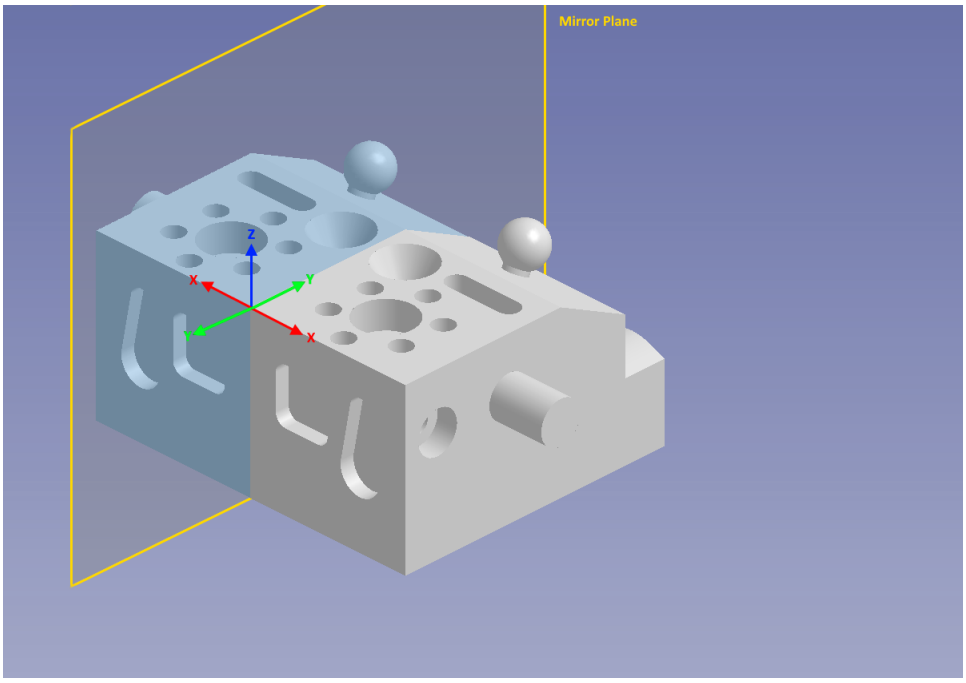
The axis which is reversed (“not mirrored”) is always the tertiary axis. If the primary part and mirror part (and alignments) are viewed in a mirror, the primary and secondary axes will always be as shown in a true mirror. The tertiary axis will be the axis that does not appear truly mirrored as viewed in a true mirror.

In the earlier examples, if the front face was used as the plane, the left-hand edge as the line, and a point on top, the tertiary axis would have been the Z-axis and it would be the Z-axis which was then reversed (example two of the two examples).

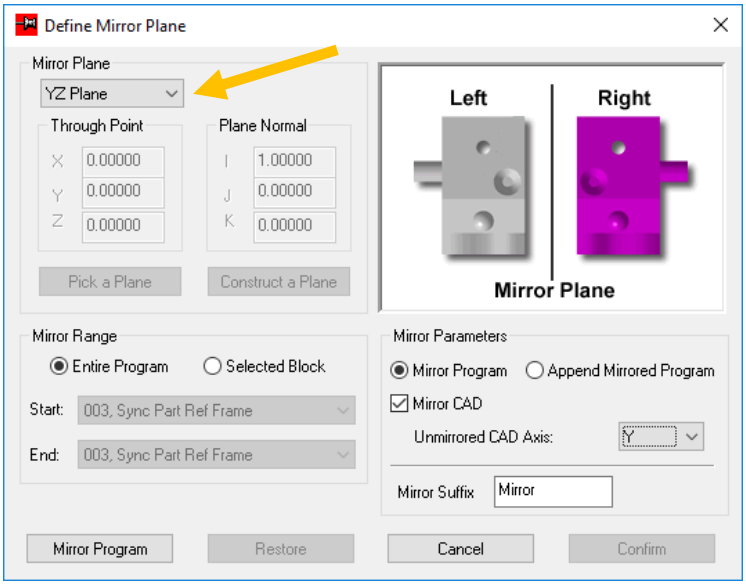
This rule applies to all alignment types, whether the axes are based on physically measured features such as a plane, line, and point, or a best fit type alignment where the axes are determined by a larger group of points which are not necessarily orthogonal or features/planar surfaces. When a best fit type of alignment is created, the programmer still defines the axis priorities and directions based on the data points. Whichever axis was used in that definition as the tertiary will still be the axis which is reversed.

Examples

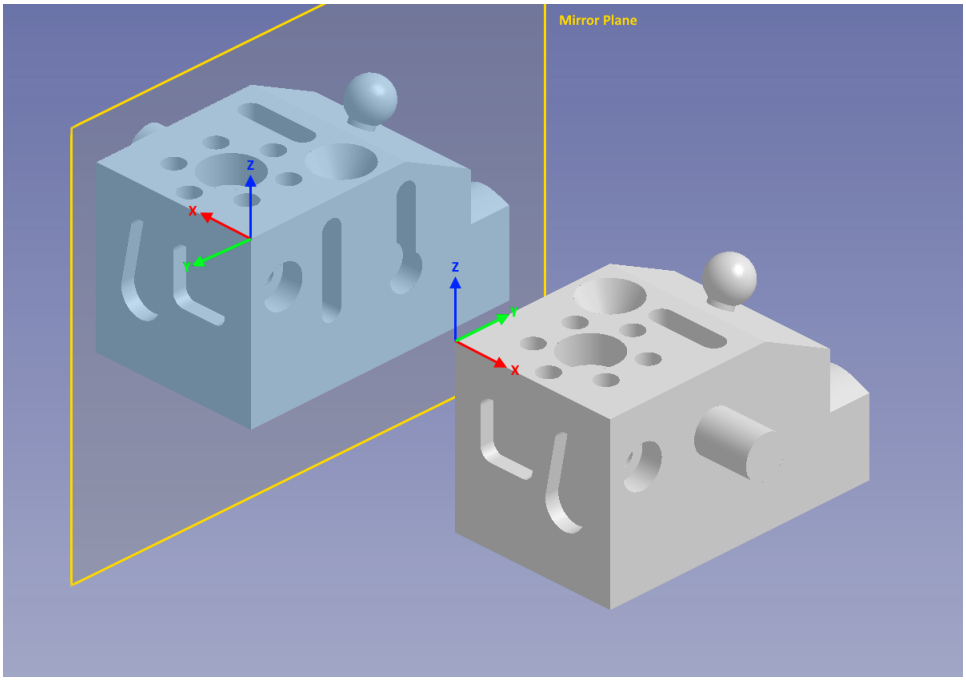
Part Mirrored Around the YZ Plane



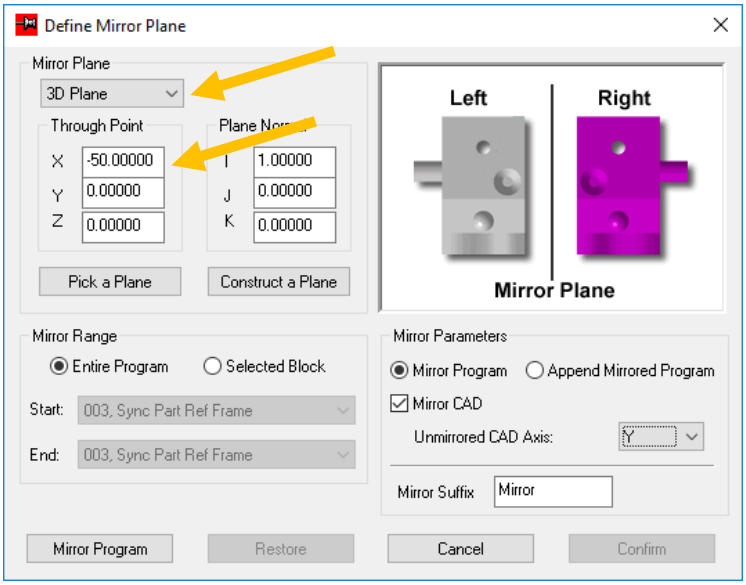
- Create a program for the primary part
- Place the program cursor on line #1 of the program
- Select Program > Mirror from the ribbon bar
- Select YZ as the mirror plane
- Click Mirror Program



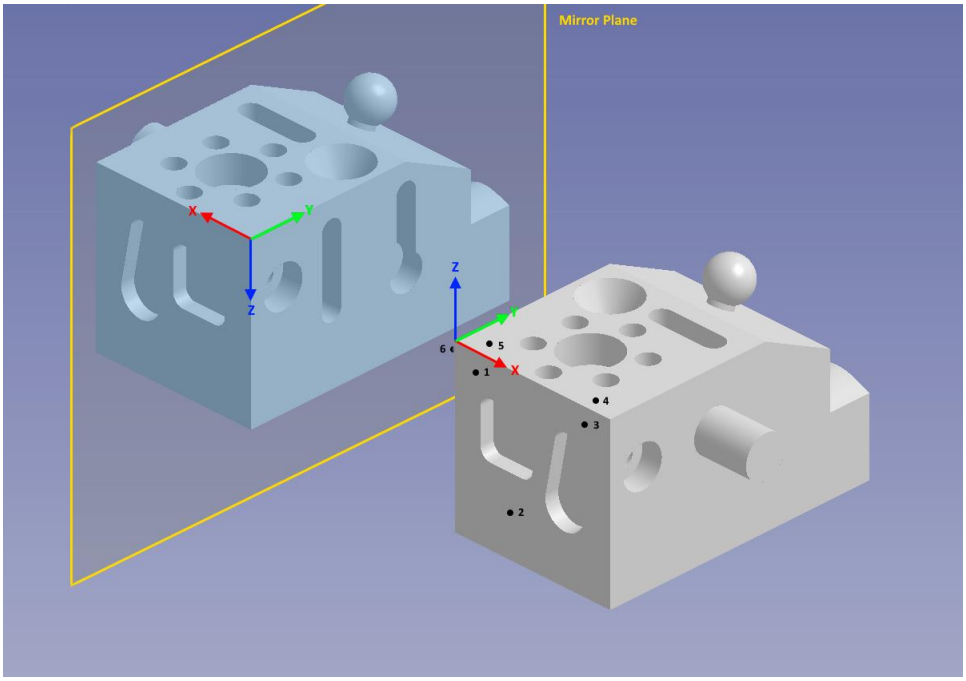
Part Mirrored Around the YZ Plane with an Offset



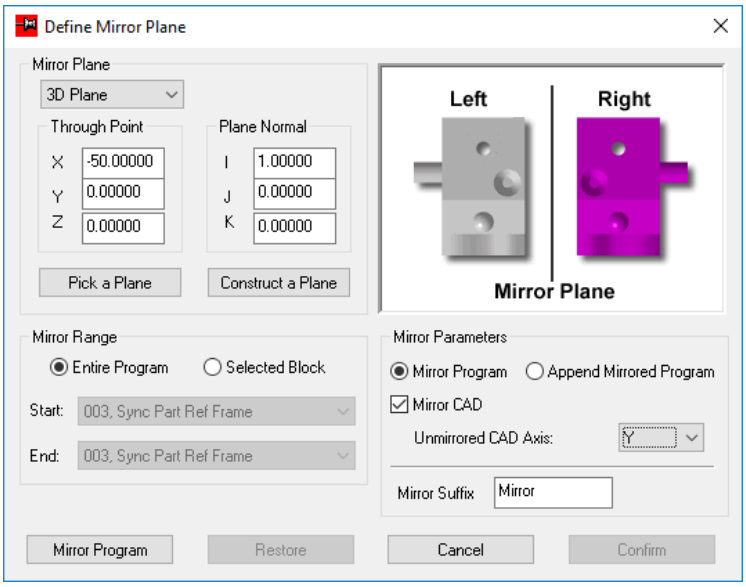
- Create a program for the primary part
- Place the program cursor on line #1 of the program
- Select Program > Mirror from the ribbon bar
- Select YZ as the mirror plane (Presets the values)
- Select 3D instead of YZ
- Enter -50 for the X Through Point value
- Click Mirror Program



Part Mirrored Around the YZ Plane with an Offset and Z as Tertiary



- Create a program for the primary part – Create the alignment so that the Z axis is the tertiary axis *(Remember that the Z axis in this case is defined, not by the last point, but because the plane and line definitions forced the X and Y axis directions. Z can only go one direction and still be a RH axis system!)*
- Place the program cursor on line #1 of the program
- Select Program > Mirror from the ribbon bar
- Select YZ as the mirror plane (Presets the values)
- Select 3D instead of YZ
- Enter -50 for the X Through Point value
- Click Mirror Program



EXAMPLES

TO DO:

- Same part / example, but with car body coordinates. Origin is off the part, and not “square” to the part.
- Example similar to Stanley in Grand Rapids with RPS alignments using tooling balls and the two fixtures have the tooling balls in slightly different positions – requires editing the mirror program but *not* changing the tooling ball location signs!
- How to edit the mirrored program to change the alignment, switching axes.