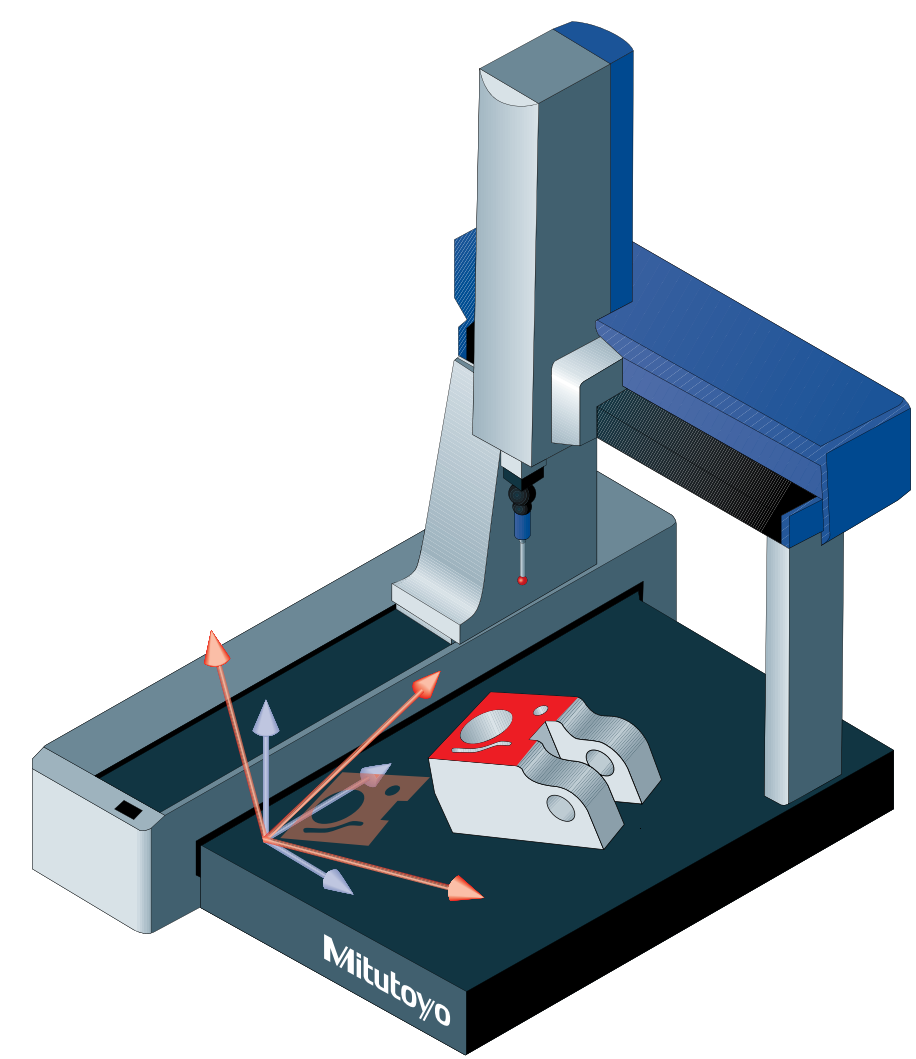
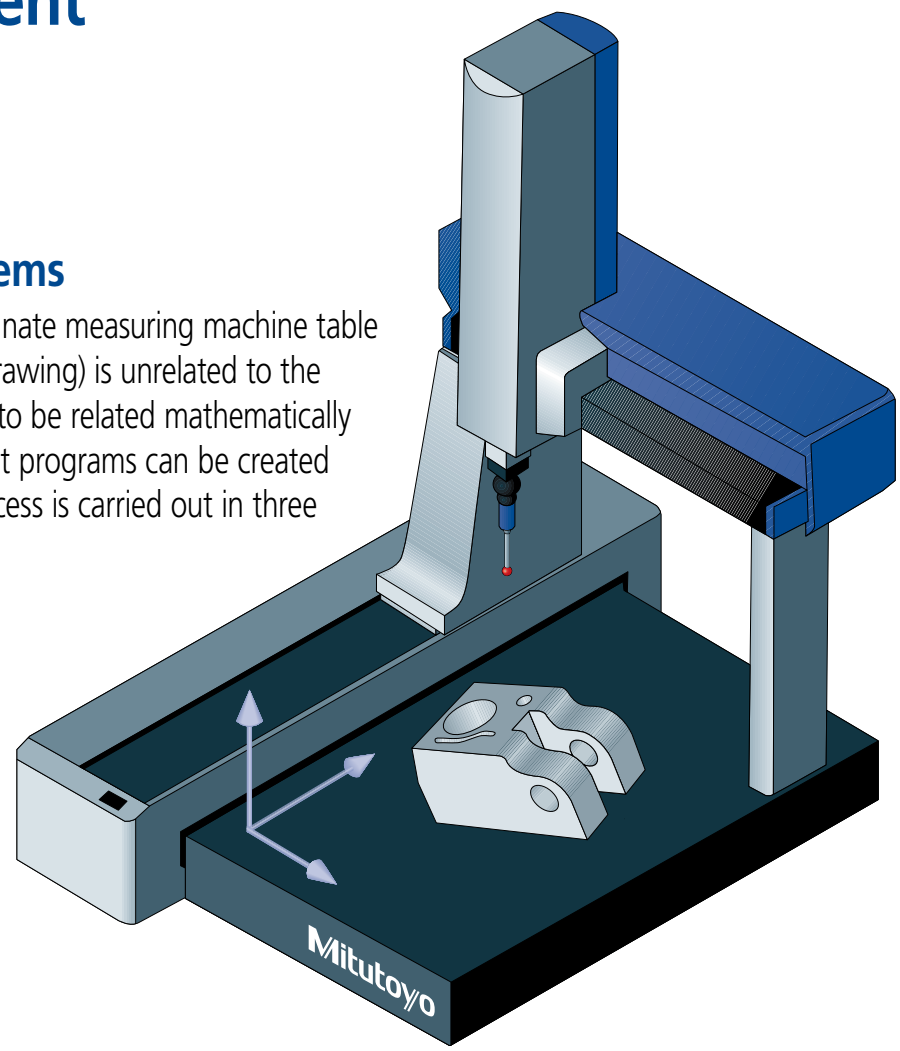


ASSESSING GEOMETRICAL DEVIATIONS

Workpiece alignment

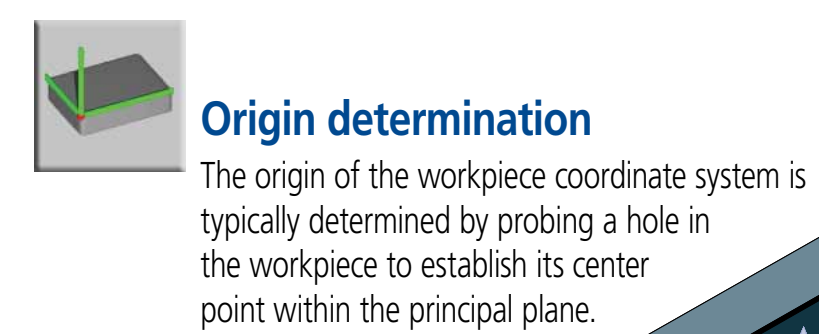
Relating the coordinate systems

When a workpiece is loaded onto a coordinate measuring machine table its coordinate system (as defined on the drawing) is unrelated to the machine system. These two systems have to be related mathematically within the controlling software so that part programs can be created as if they were physically aligned. This process is carried out in three steps as described below.



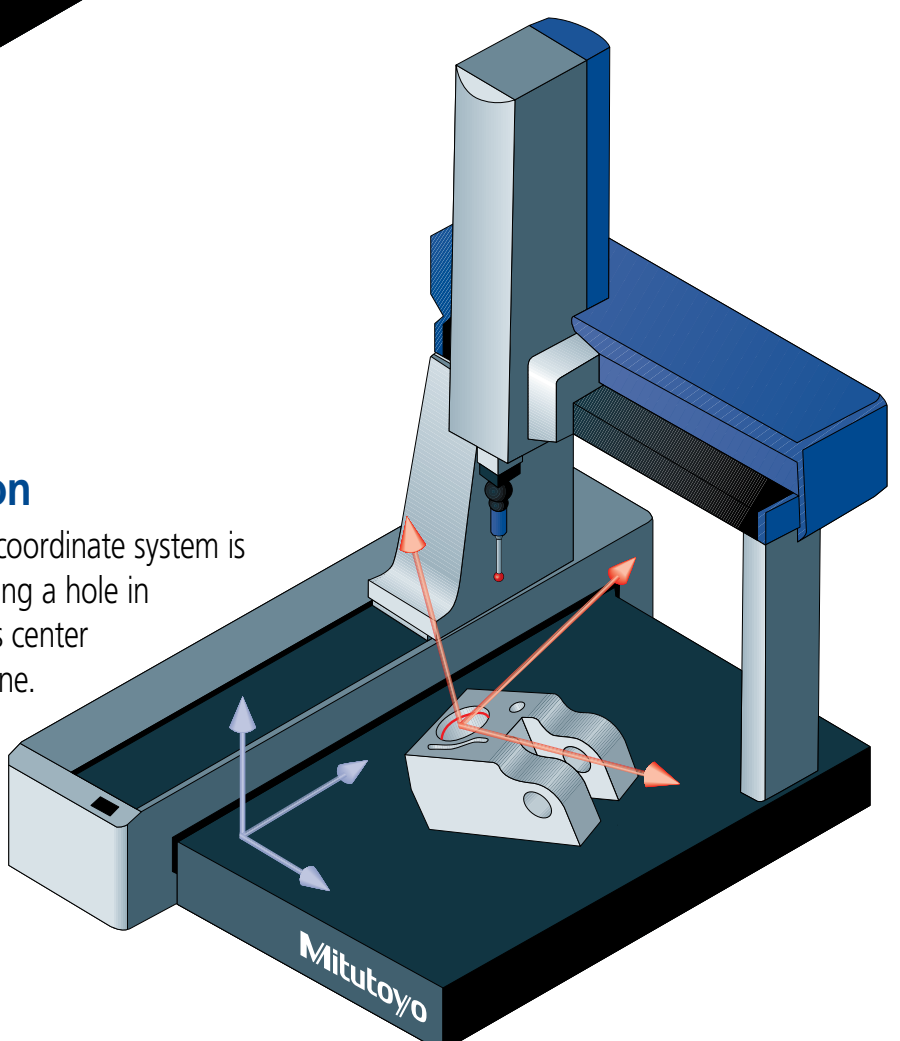
Spatial orientation

The orientation of a principal plane of the workpiece is typically determined, by probing that plane and calculating the normal vector.



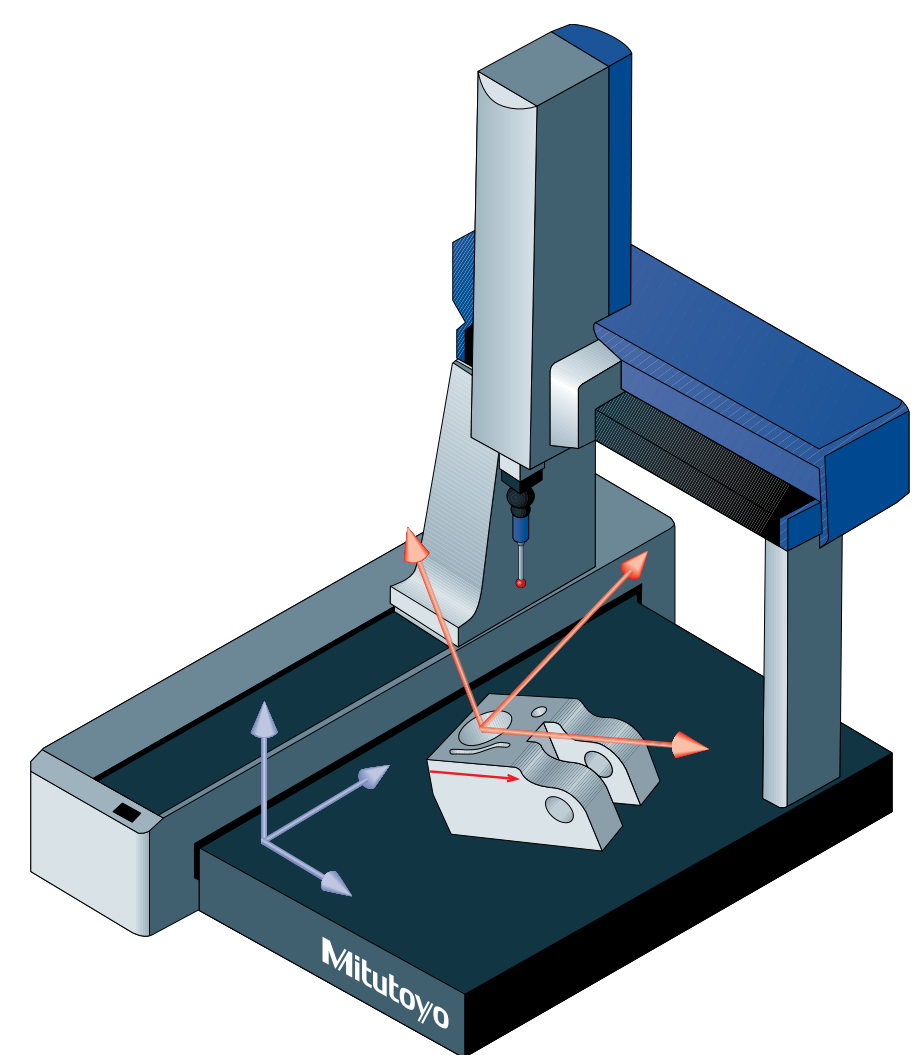
Origin determination

The origin of the workpiece coordinate system is typically determined by probing a hole in the workpiece to establish its center point within the principal plane.



Axial alignment

The direction of a principal axis of the workpiece coordinate system is typically determined by probing a lateral surface in a straight line. The positive direction of the axis to be related corresponds to the vector direction of this line.

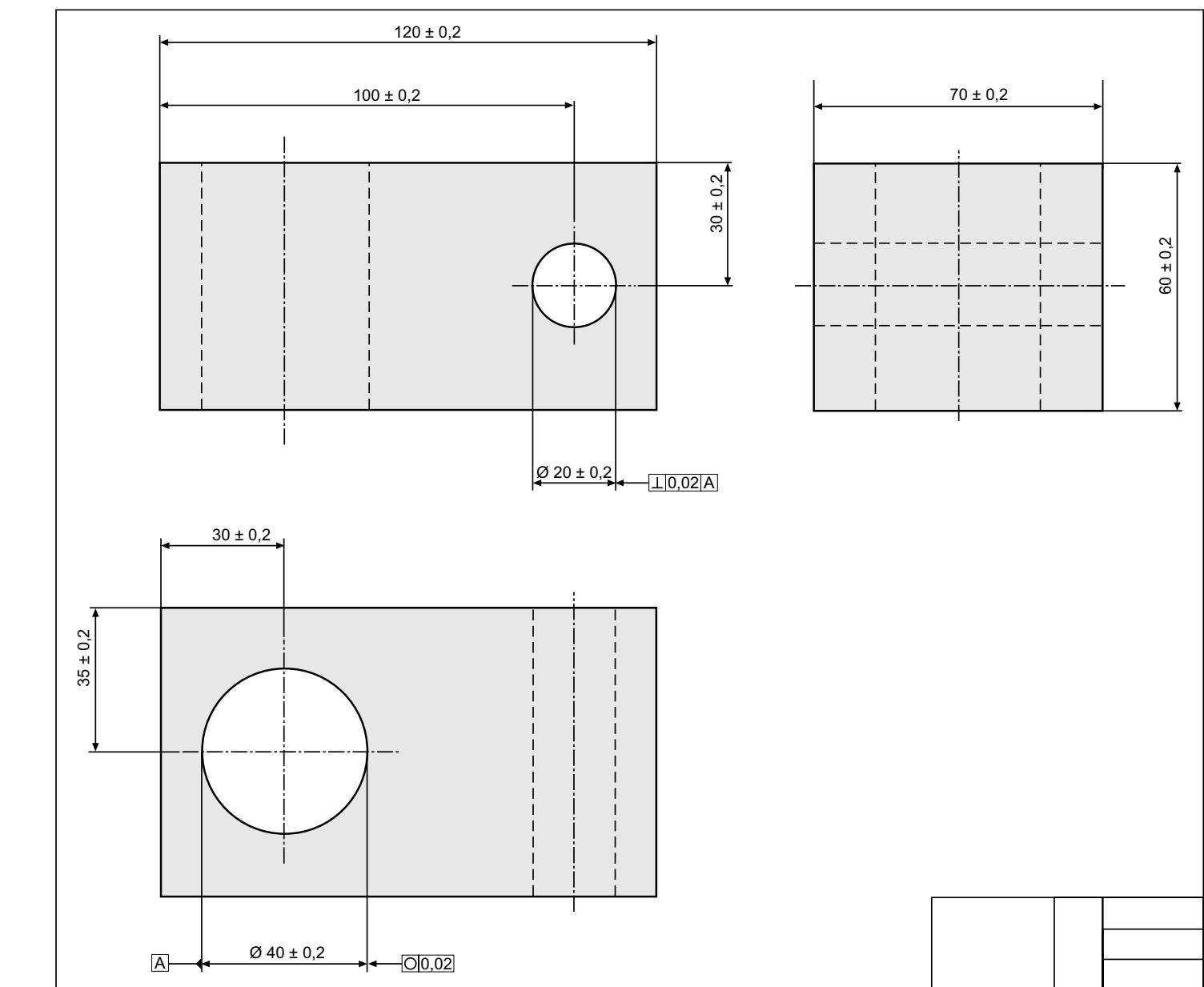


Characteristic Symbol*	Definition	Geometrical Tolerancing*	Test Method	Result
	Roundness Roundness deviation is the difference in radii between two concentric circles constructed to touch and enclose the extracted circumferential line. A feature is tolerated by limiting the deviation to a value t .			
	Cylindricity Cylindricity deviation is the difference in radii between two coaxial cylinders constructed to touch and enclose the extracted cylindrical surface with minimum separation. A feature is tolerated by limiting the deviation to a value t .			
	Flatness Flatness deviation is the distance between two parallel planes constructed to touch and enclose the extracted plane surface with minimum separation. A feature is tolerated by limiting the deviation to a value t .			
	Profile (Line) Line Profile deviation is the distance between two lines each parallel to, and equidistant from, the nominal profile line that touch and enclose the extracted profile line. A feature is tolerated by limiting the deviation to a value t .			
	Profile (Surface) Surface Profile deviation is the distance between two surfaces each parallel to, and equidistant from, the nominal surface that touch and enclose the extracted surface. A feature is tolerated by limiting the deviation to a value t .			
	Perpendicularity (Plane to Axis) Plane-to-Axis Perpendicularity deviation is the distance between two parallel planes perpendicular to the datum axis constructed to touch and enclose the extracted plane surface with minimum separation. A feature is tolerated by limiting the deviation to a value t .			
	Perpendicularity (Axis to Axis) Axis-to-Axis Perpendicularity deviation is the distance between two parallel planes perpendicular to the datum axis constructed to touch and enclose the extracted axial line with minimum separation. A feature is tolerated by limiting the deviation to a value t .			
	Parallelism (Plane to Plane) Plane-to-Plane Parallelism deviation is the maximum difference in distance between the extracted plane surface and the datum plane. A feature is tolerated by limiting the deviation to a value t .			
	Symmetry (Plane to Plane) Two-Plane Symmetry deviation is the maximum distance between the extracted median surface and the datum plane. A feature is tolerated by limiting the deviation to a value $t/2$.			
	Angularity (Plane to Plane) Angularity deviation is the maximum difference in distance between the extracted plane surface and a plane arranged at the theoretically exact angle to the datum plane. A feature is tolerated by limiting the deviation to a value t .			
	Position (Line to Axis) Line-to-Axis Positional deviation is the maximum distance between the extracted median line and the datum axis. A feature is tolerated by limiting the deviation to a value $t/2$.			
	Coaxiality Coaxiality deviation is the maximum radial distance between the axial line of the extracted cylindrical surface and the datum axis over the length of the evaluation range. A feature is tolerated by limiting the deviation to a value $t/2$.			
	Run-out (Radial) Radial Run-out deviation is the maximum difference in radii of an extracted circumferential line centered on the datum axis. A feature is tolerated by limiting the deviation to a value t .			

*Following ISO 1101:2012

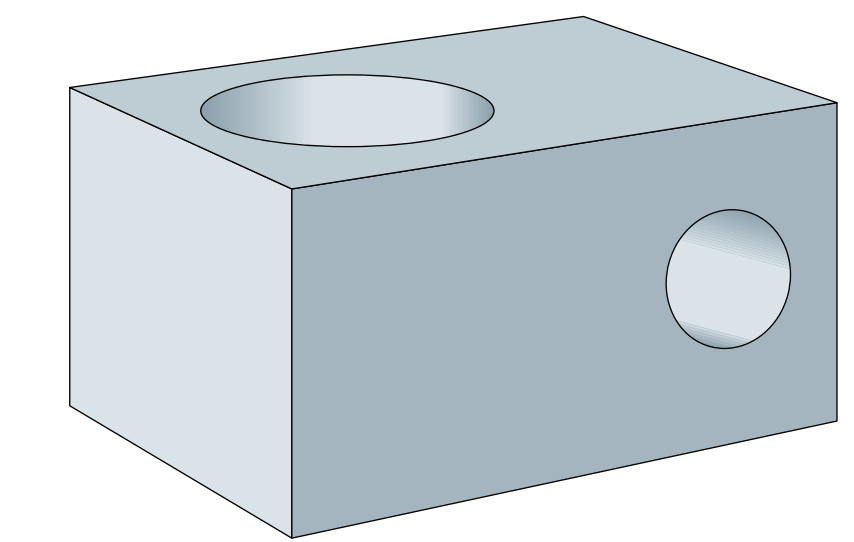
— Reference Element — Extracted Geometry

Workpiece definition and measurement



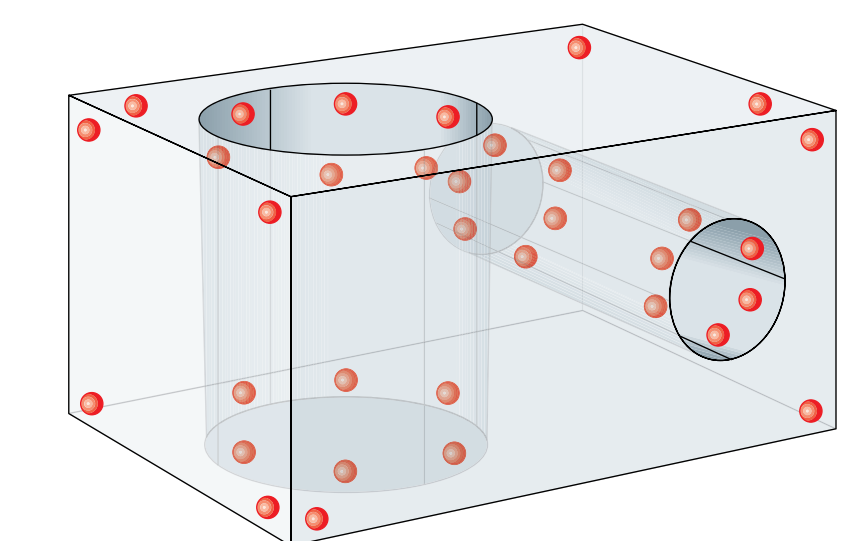
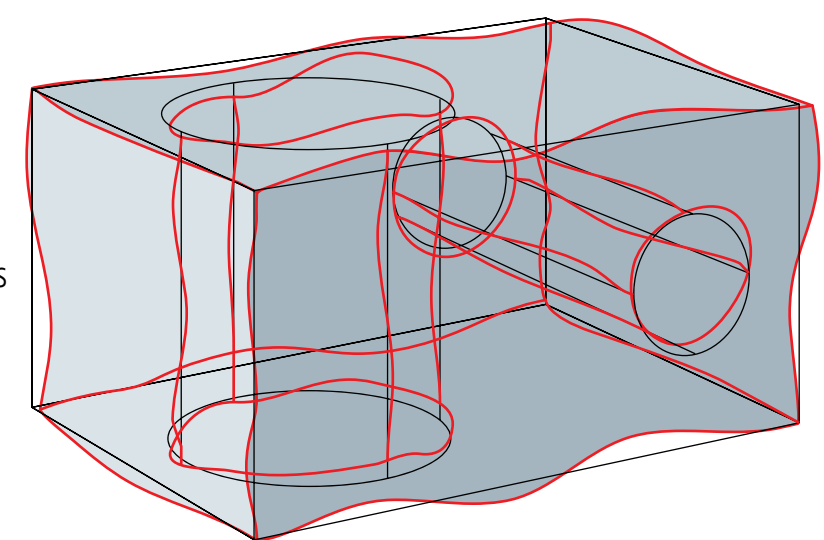
Nominal Geometry

Ideal geometrical form of a workpiece with indication of dimensional and geometrical (and possibly surface) tolerances.



Actual geometry

Actual geometrical form of a workpiece with inevitable dimensional and geometrical deviations as well as surface waviness and roughness.

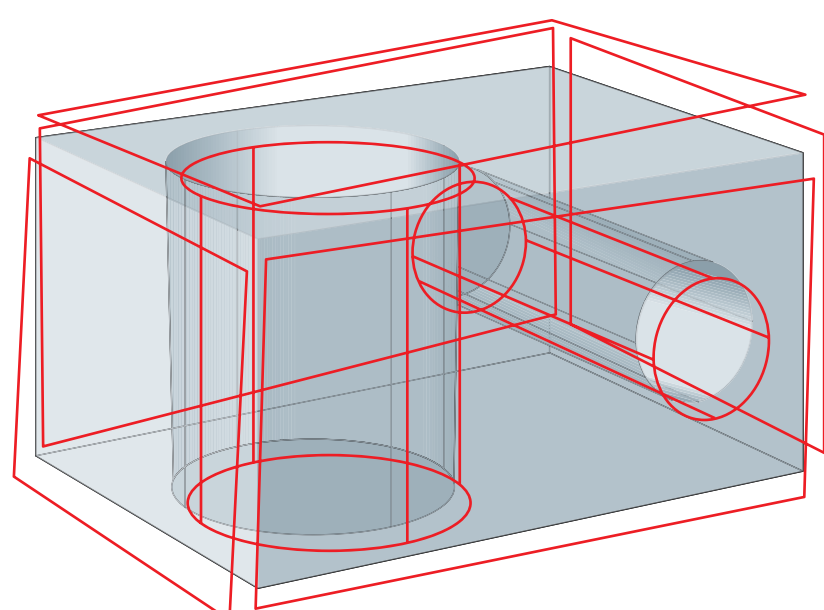


Detected Geometry

Actual description of workpiece geometry determined only from points obtained by probing the features indicated on the workpiece engineering drawing. The detected geometry is used to determine the geometrical deviations.

Assigned Geometry

Assignment by computation of ideal geometrical elements and their parameters from the probed points.



(According to Aukom e.V.)