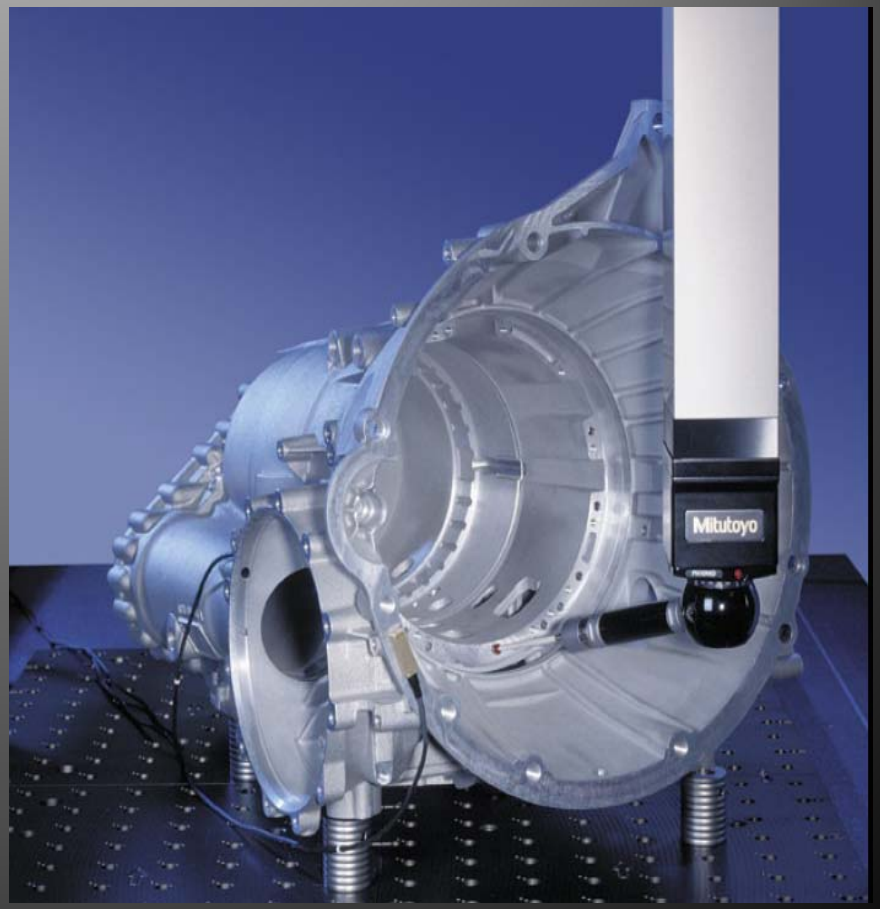
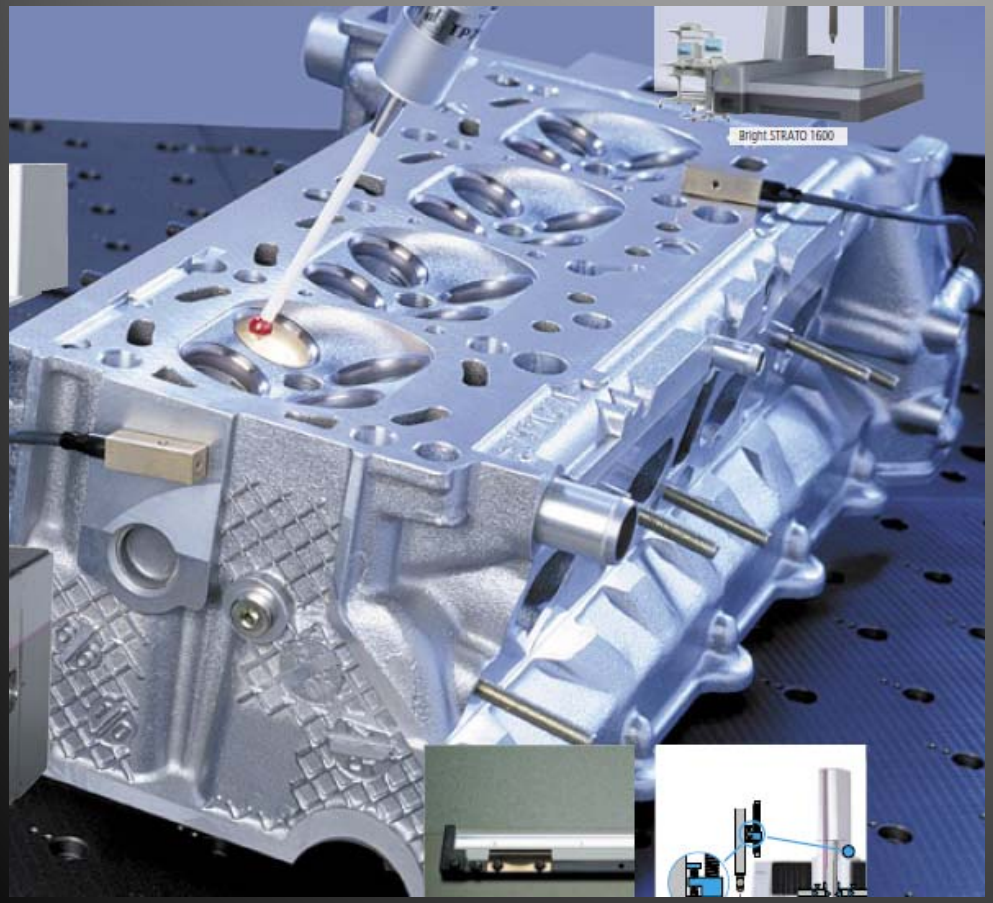
Co ordinate Measuring Machine(CMM)

ME0403- Metrology and Quality Control

Complex Jobs to be measured



Complex Jobs to be measured



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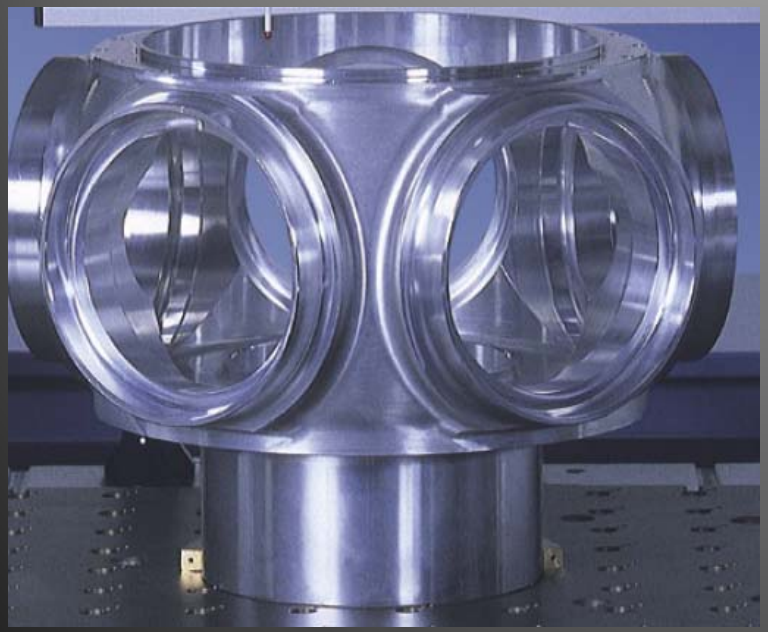
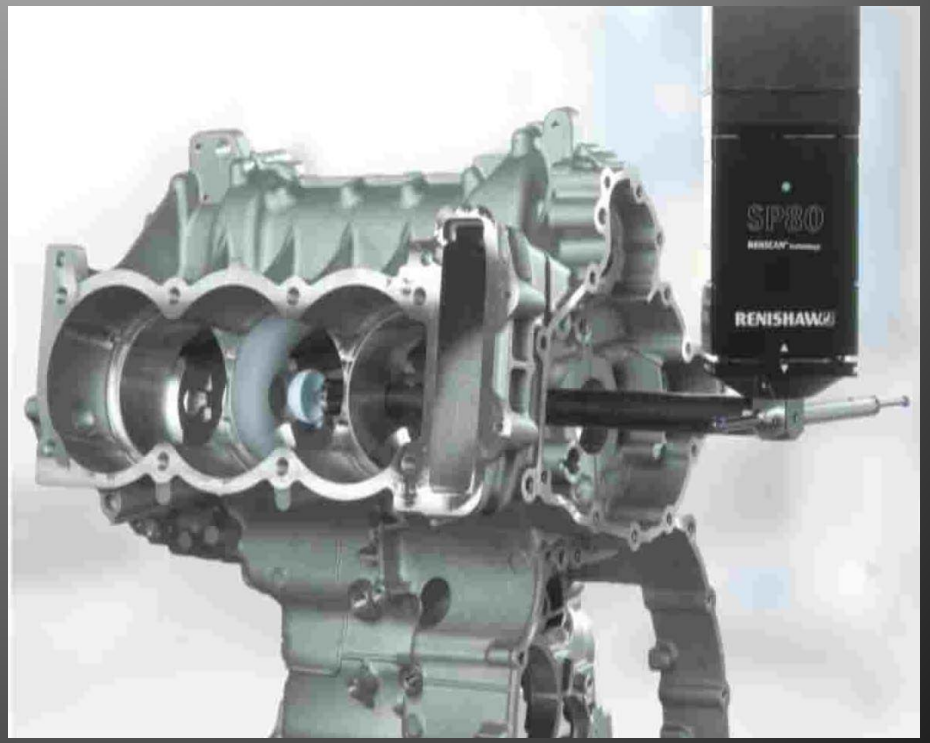




Functions of CMM

- To measure the actual size of w/p comparison with desired shape and evaluation of metrological information such as
  - Size
  - Form
  - Location
  - Position
- Actual size is obtained by probing the surface at discrete measuring points. Every pt is expressed in terms of its x,y,z coordinates

CMM system components

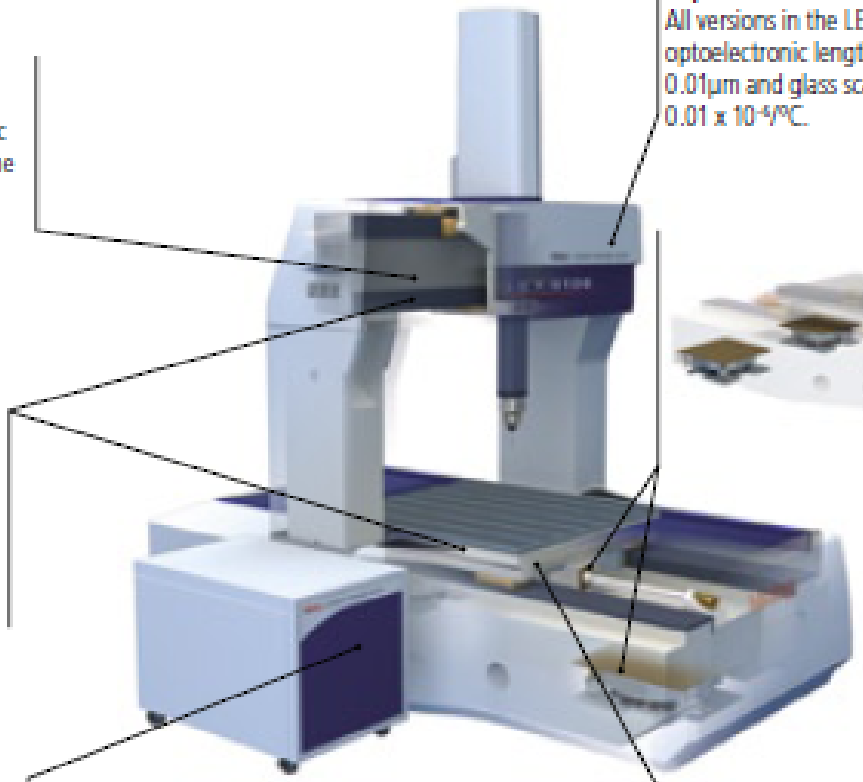
- Mechanical Setup with 3 axes movement & the displacement transducer
- Probe head to probe the work piece in a spatial direction
- Control Unit
- Computer with software to calculate & represent the results

Mechanical Set up

Air bearings on all axes
Self-adjusting air bearings on all axes enable outstanding smoothness, speed and precision in movement. They form the basis for absolute measuring accuracy.

Thermally stable glass scales with "zero" thermal expansion
All versions in the LEGEX series are equipped with the new optoelectronic length measuring system with a resolution of 0.01µm and glass scales with a thermal expansion coefficient of 0.01 x 10^{-6}/°C.

Exceptional geometrical and kinematic accuracy
The excellent geometrical and kinematic accuracy of LEGEX machines is due to the fixed-portal principle.



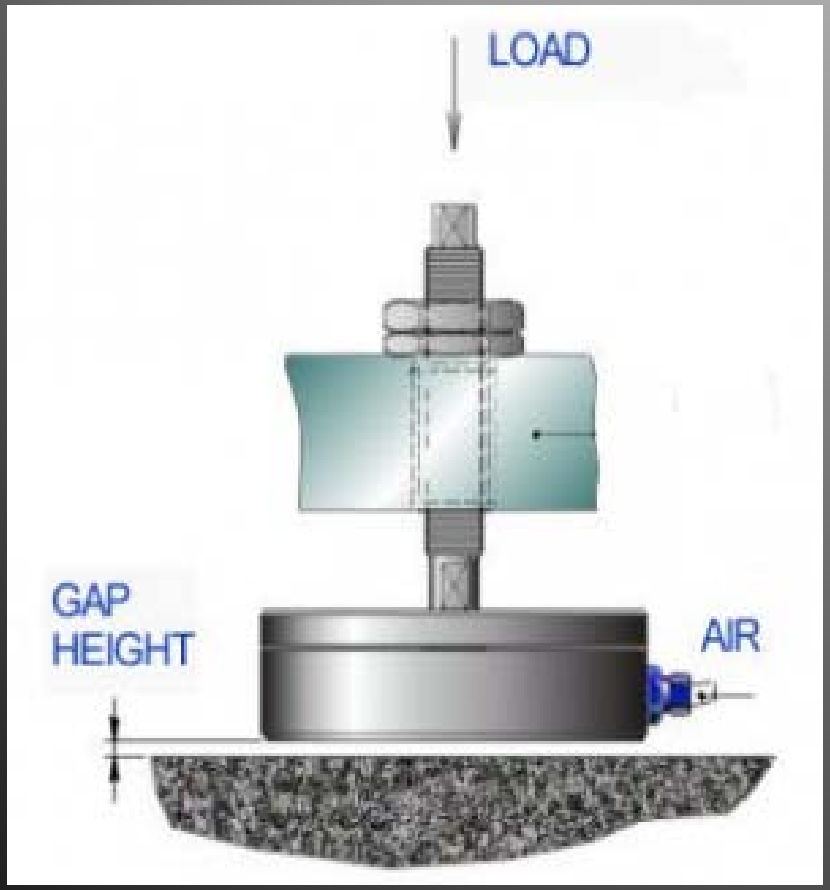
Low-vibration system provides reassuring reliability
Self-levelling high-performance shock absorbers make LEGEX machines reassuringly reliable, even when the floor itself shakes and vibrates.

Faster and more accurate with ceramic-coated guides
The LEGEX versions of the 500 series and upwards come standard with ceramic coating of the Y and X guides as well as the sleeve.

Highly dynamic, flexible digitized drive
The drive control for the LEGEX operates using an extremely powerful 32-bit digital signal processor (DSP). It perfectly controls the digital signals of all control circuits, travel movements, positions and speed for maximum measuring quality.

Outstanding accuracy based on new design principles
The measuring table moves in the Y axis in the base using the "moving table" principle, completely independently from the portal. Outstanding geometrical accuracy ensures that deformation of the base due to load movements is eliminated.

Air Bearing

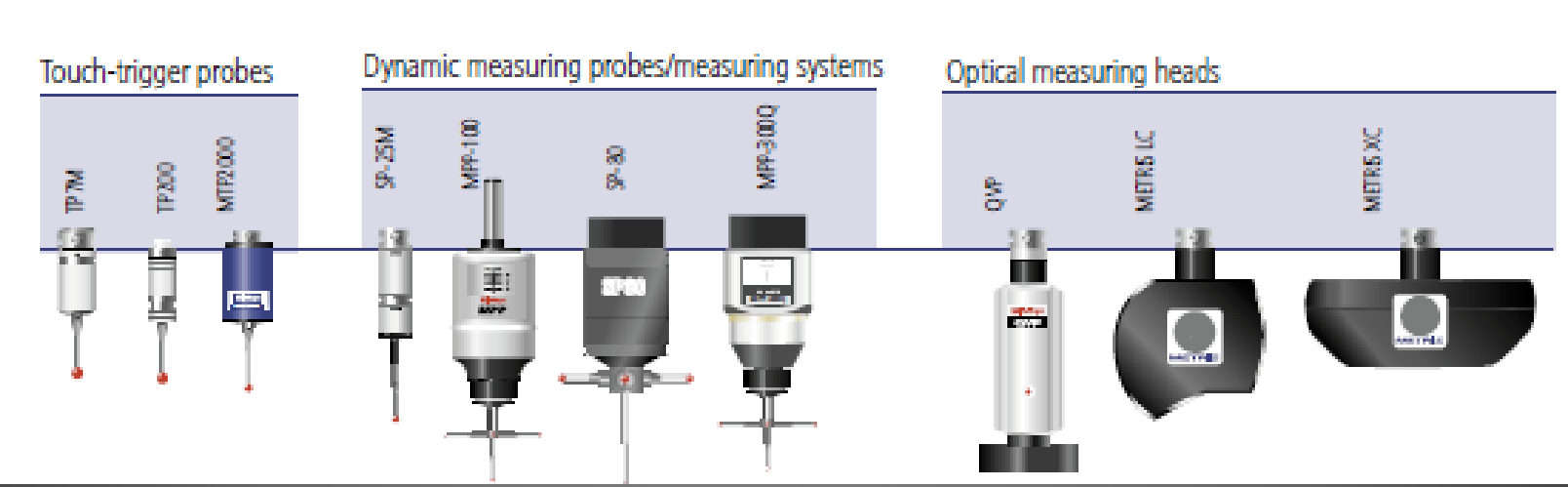


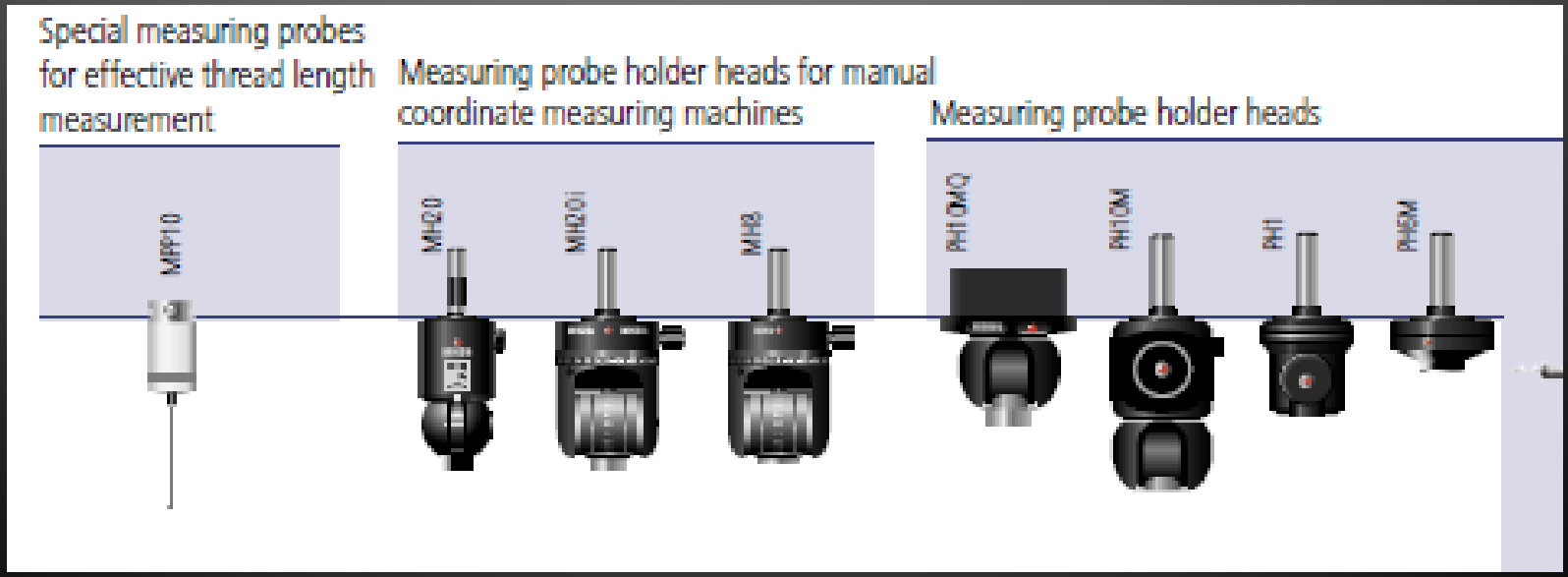
- Being non-contact, air bearings avoid the traditional bearing-related problems of friction, wear, and lubricant handling, and offer distinct advantages in precision positioning and high speed applications.

Air Bearing

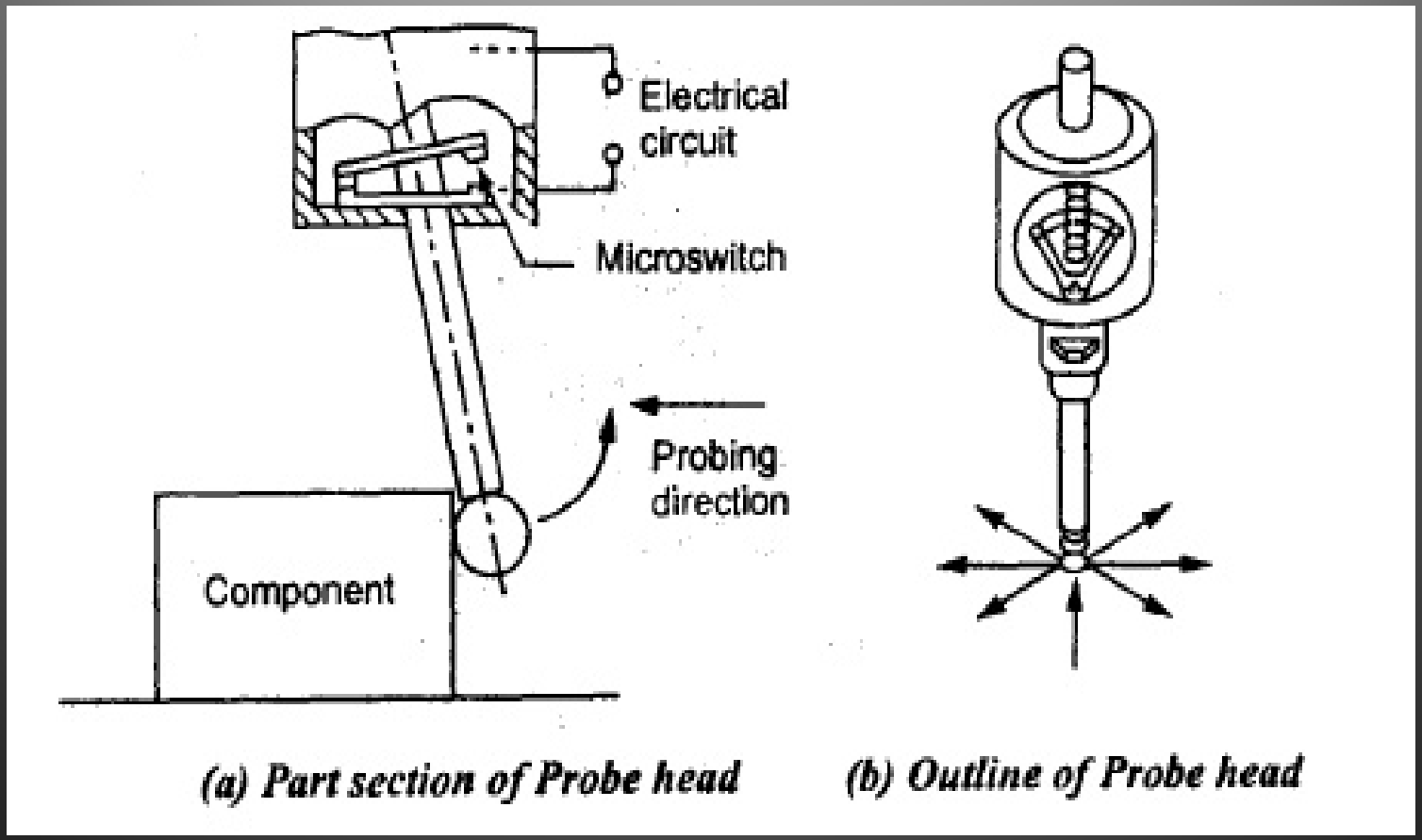
- The fluid film of the bearing is achieved by supplying a flow of air through the bearing itself to the bearing surface.
- Numerous bearing designs exist to ensure uniform pressure is distributed across the entire bearing area.
- The design of the air bearing is such that, although the air constantly dissipates from the bearing site, the continual flow of pressurized air through the bearing is sufficient to support the working loads.

Probes and Probe Head

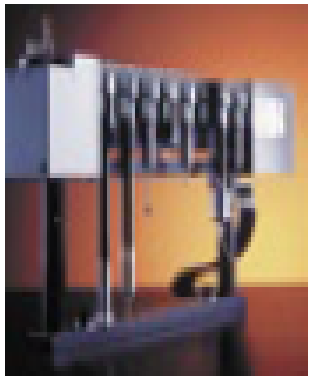
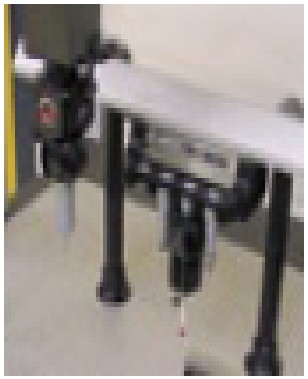




Touch Trigger probe



Probe Changing System

ACR-1	MRS-ACR3	SCRMPP	SCR200	MRS-FCR25
				

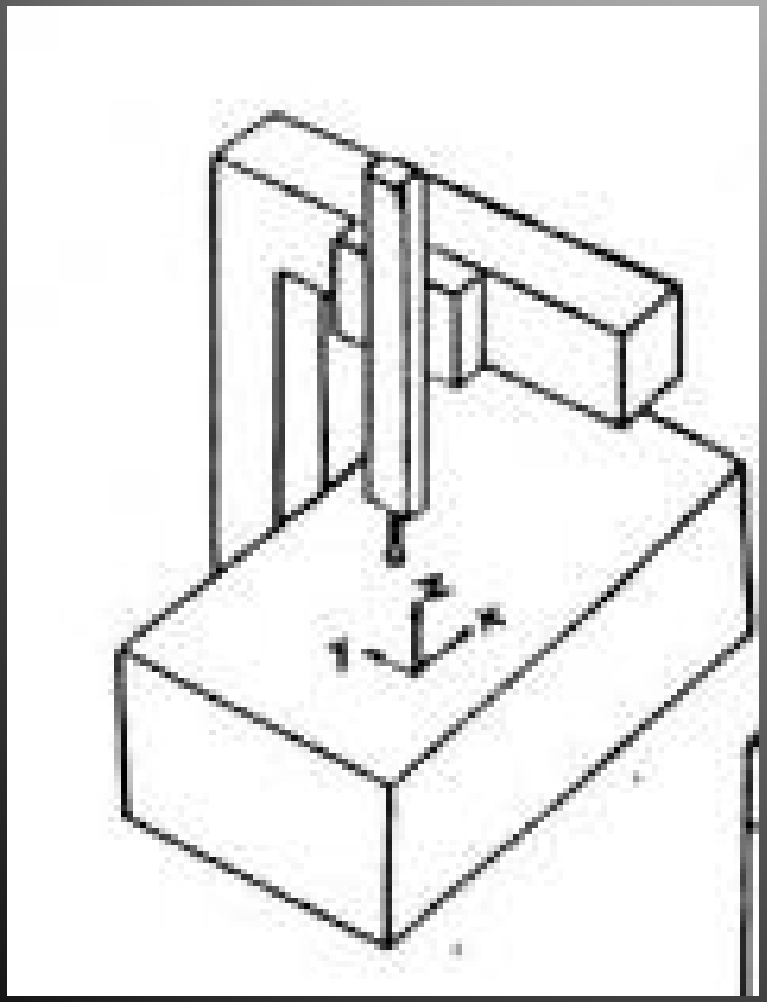
Programming/Measurement with the CMM

- Step 1: Home the CMM
  - establishes global coordinate system(Xm,Ym,Zm)
- Step 2: Qualify the Tip(Calibration of probe tip with respect to probe head)
  - compensates for tip diameter
- Step 3: Align the Part
  - establishes a local coordinate system on the part(Xw,Yw,Zw)
- Step 4: Measure the Part
- Step 5:Representation of measurement results after coordinate transformation into w/p related coordinates system

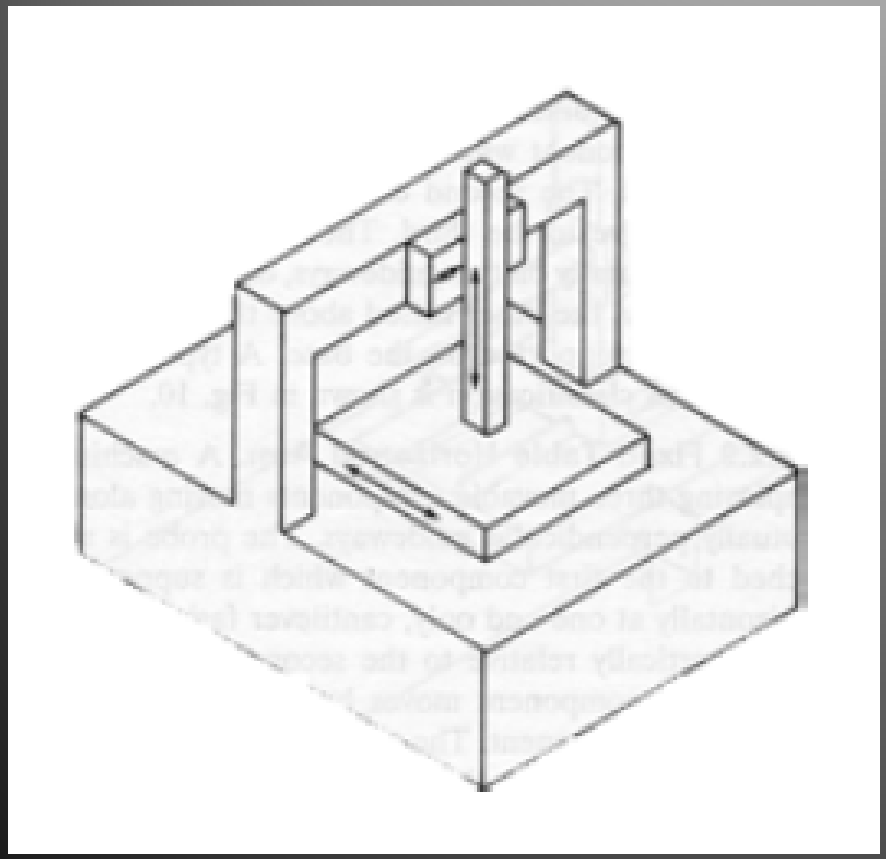
Types of CMM

- Moving bridge
- Fixed bridge
- Cantilever
- Gantry

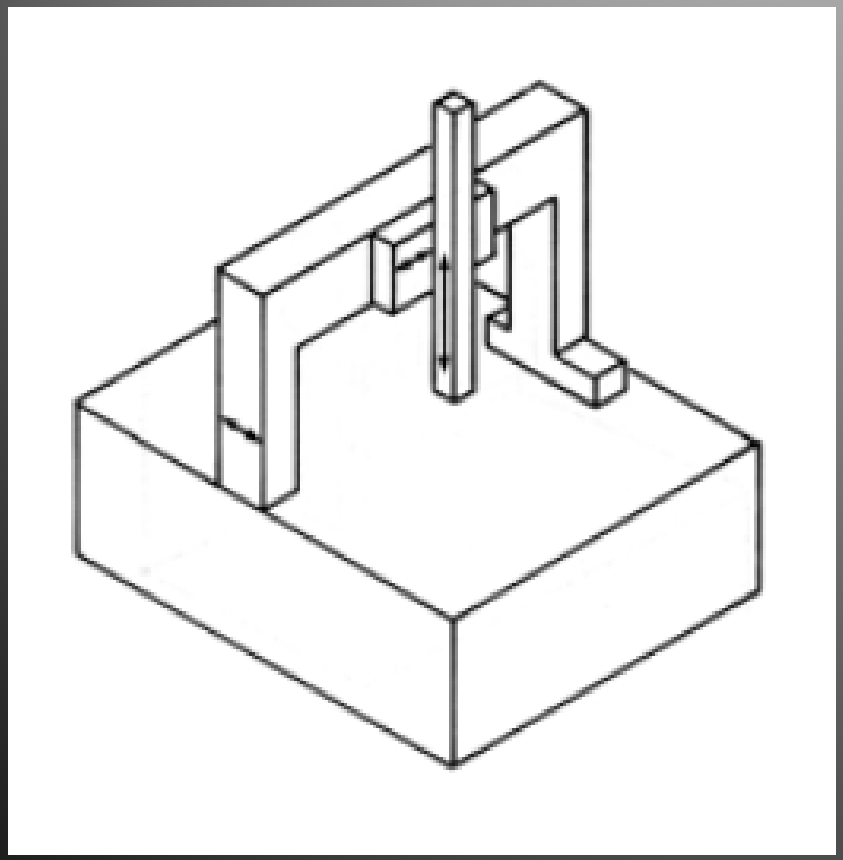
Cantilever CMM(Manual)



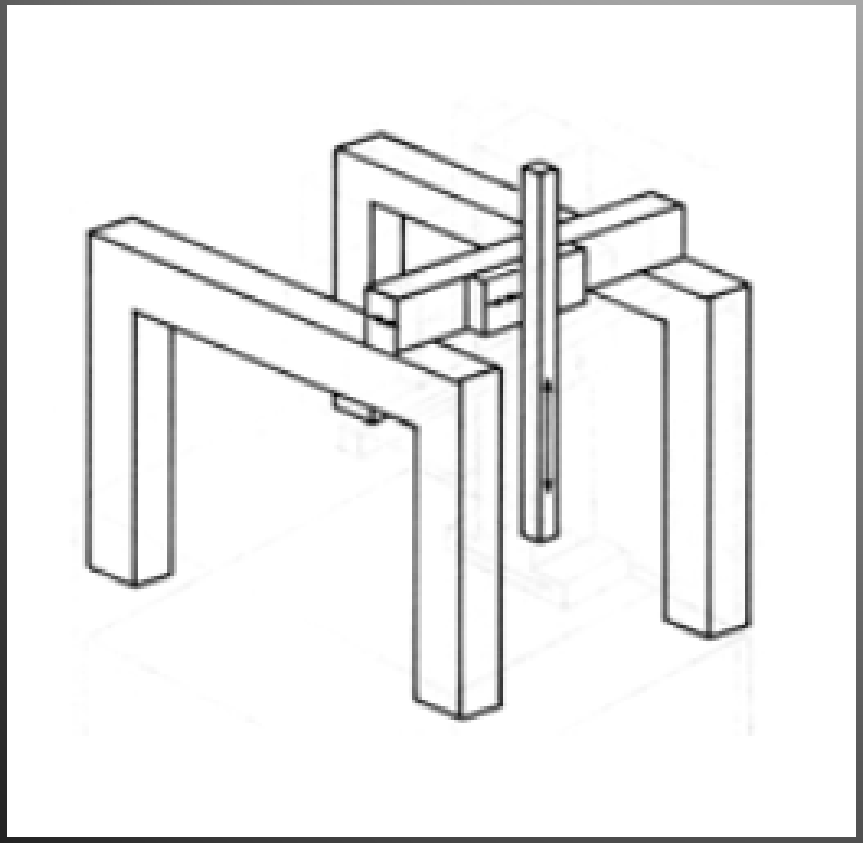
Fixed Bridge CMM



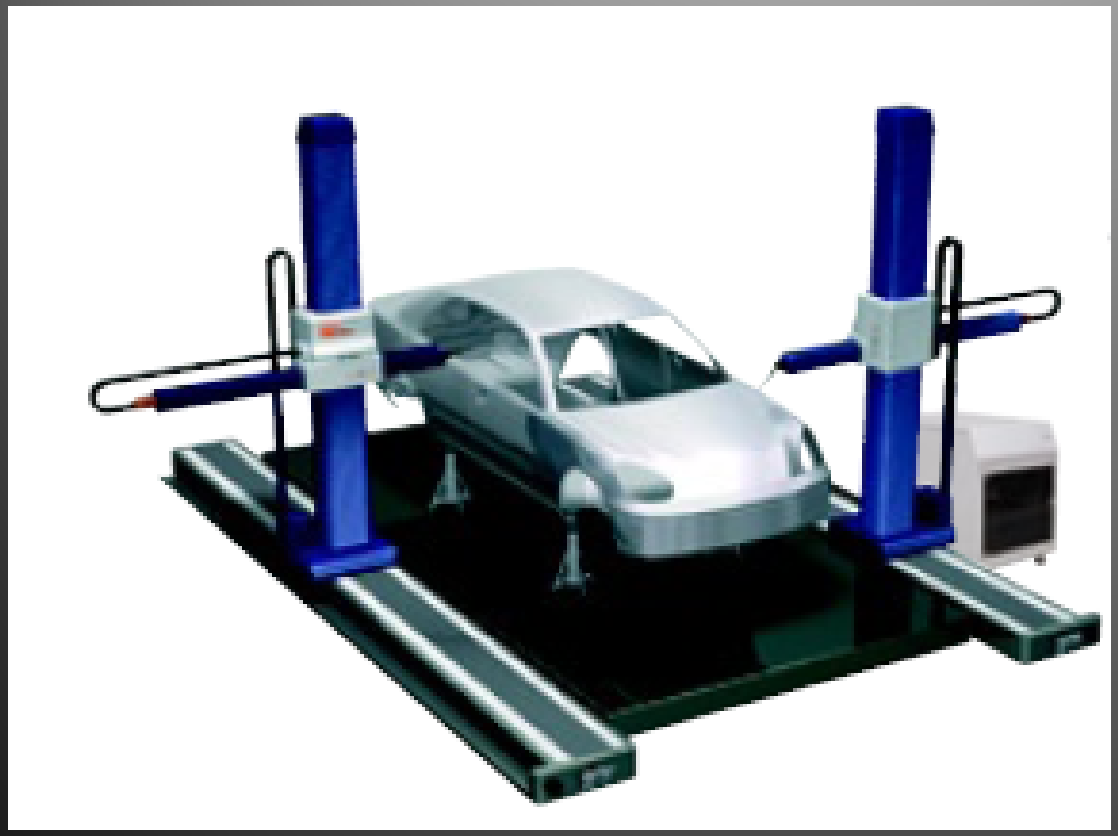
Moving Bridge CMM(Computer Controlled)



Gantry Type CMM



Measuring Ranges



18.11" x 18.11" x 11.81"
(460 x 460 x 300mm)
40.20" x 32.20" x 24.21"
(1021 x 818 x 615mm)

Potential Sources of CMM Error

- **Sources of errors in CMM measurements**
  - spatial errors
  - computational errors.
  - **Spatial errors** are errors in the measured position of a point on the surface of the Work-piece
- **Computational errors** are the errors in the estimated dimensions and form deviations of the work-piece

Spatial Errors

- The accuracy of the components of the CMM – the guide-ways, the scales, the probe system and the qualification sphere.
- The environment in which the CMM operates – the ambient temperature, temperature gradients, humidity and vibration. •
- The probing strategy used – the magnitude and direction of the probe force, the type of probe stylus used and the measuring speed of the probe. •
- The characteristics of the work-piece – elasticity, surface roughness, hardness and the mass of the component.

Computational errors

- The CMM software used to estimate the geometry of the work-piece.
- The precision of the computer used on the CMM.
- The number and relative position of the measured points.
- The extent to which the geometry departs from the ideal geometric form.