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COORDINATE MEASURING MACHINE (CMM)

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Abstract: **With the advent of numerically controlled machine tools, the demand has grown for some means to support this equipment. There has been growing need to have an apparatus that can do faster first piece inspection and many times, 100% dimensional inspection. The Coordinate Measuring Machine (CMM) plays a vital role in the mechanization of the inspection process. Some of the CMMs can even be used as layout machines before machining and for checking feature locations after machining. Coordinate measuring machines are relatively recent developments in measurement technology. Basically, they consist of a platform on which the work piece being measured is placed and moved linearly or rotated. A probe attached to a head capable of lateral and vertical movements records all measurements. Coordinate measuring machines are also called measuring machines. They are versatile in their capability to record measurement of complex profiles with high sensitivity (0.25 μm) and speed. In this unit, we will discuss the principle and the working of a Coordinate Measuring Machine (CMM).**

Keywords: **Tramming, Stylus, Axial length measuring accuracy, Probe, DMIS.**

1. INTRODUCTON

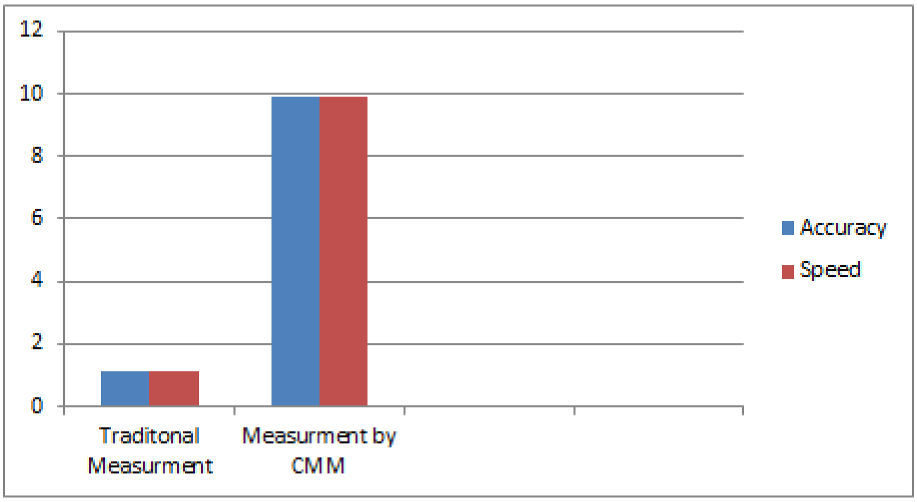
A **coordinate measuring machine** (CMM) is a device that measures the geometry of physical objects by sensing discrete points on the surface of the object with a probe. Various types of probes are used in CMMs, including mechanical, optical, laser, and white light. Depending on the machine, the probe position may be manually controlled by an operator or it may be computer controlled. CMMs typically specify a probe's position in terms of its displacement from a reference position in a three-dimensional Cartesian coordinate system (i.e., with XYZ axes). In addition to moving the probe along the X, Y, and Z axes, many machines also allow the probe angle to be controlled to allow measurement of surfaces that would otherwise be unreachable. The typical 3D "bridge" CMM allows probe movement along three axes, X, Y and Z, which are orthogonal to each other in a three-dimensional Cartesian coordinate system. Each axis has a sensor that monitors the position of the probe on that axis, typically with micrometer precision. When the probe contacts (or otherwise detects) a particular location on the object, the machine samples the three position sensors, thus measuring the location of one point on the object's surface. This process is repeated as necessary, moving the probe each time, to produce a "point cloud" which describes the surface areas of interest.

A common use of CMMs is in manufacturing and assembly processes to test a part or assembly against the design intent. In such applications, point clouds are generated which are analyzed via regression algorithms for the construction of features. These points are collected by using a probe that is positioned manually by an operator or automatically via Direct Computer Control (DCC). DCC CMMs can be programmed to repeatedly measure identical parts; thus an automated CMM is a specialized form of industrial robot.

Objectives:

- Familiarize yourself with parts of a CMM.
- Understand the principle and the working of a CMM.

Table 1: Graph between Traditional measurements vs. CMM



2. METHODOLOGY

Now a days Industries are leading to devolpe new technologies. And to improve the quality of product, Inspection is must.

The CMM (Coordinate Measuring Machine) is one of the way for measuring the dimensions of manufacturing product to confirm that the product is manuactured according to design or note.

Earlier days the methods wich were used for inpection or measurment were time consuming and they were not give accurate results. So the productivity of products were decrease.

The methodology used for this paper is by Servey By visiting the industries which are recently manufacture the CMM

1. Main Structure

The machine incorporates the basic concept of three coordinate axes so that precise movement in x, y, and z directions is possible. Each axis is fitted with a linear measurement transducer. The transducers sense the direction of movement and gives digital display. Accordingly, there may be four types of arrangement

Cantilever

The cantilever construction combines easy access and relatively small floor space requirements. It is typically limited to small and medium sized machines. Parts larger than the machine table can be inserted into the open side without inhibiting full machine travel. Figure shows a cantilever structure.

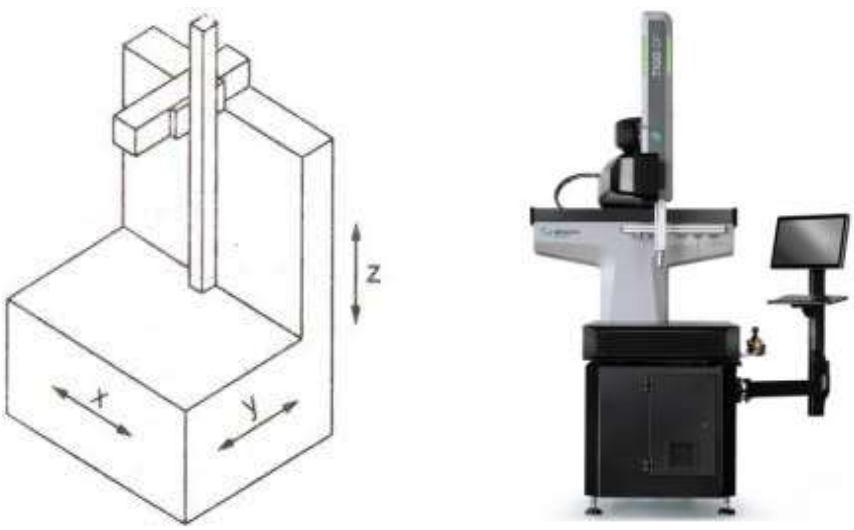


Fig 2.1: Cantilever CMM

Bridge Type

The bridge arrangement over the table carries the quill (z-axis) along the x-axis and is sometimes referred to as a travelling bridge. It is claimed that the bridge construction provides better accuracy, although it may be offset by difficulty in making two members track in perfect alignment. This is by far the most popular CMM construction. Figure shows a bridge structure.

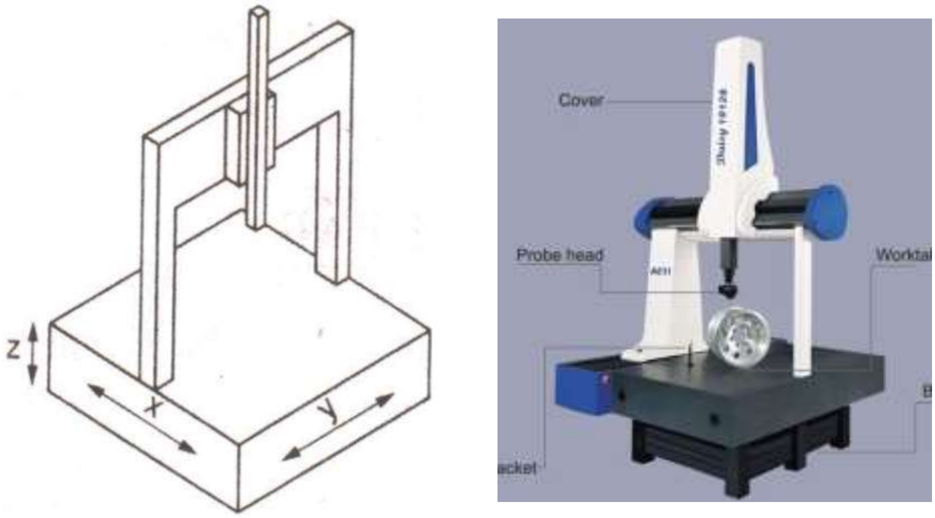


Fig 2.2: Bridge Type CMM

Column Type

The column type machine is commonly referred to as a universal measuring machine rather than a CMM. These machines are usually considered gage room instruments rather than production floor machine. The direction of movements of the arms is as shown in Figure. The constructional difference in column type with the cantilever type is with x and y-axes movements.

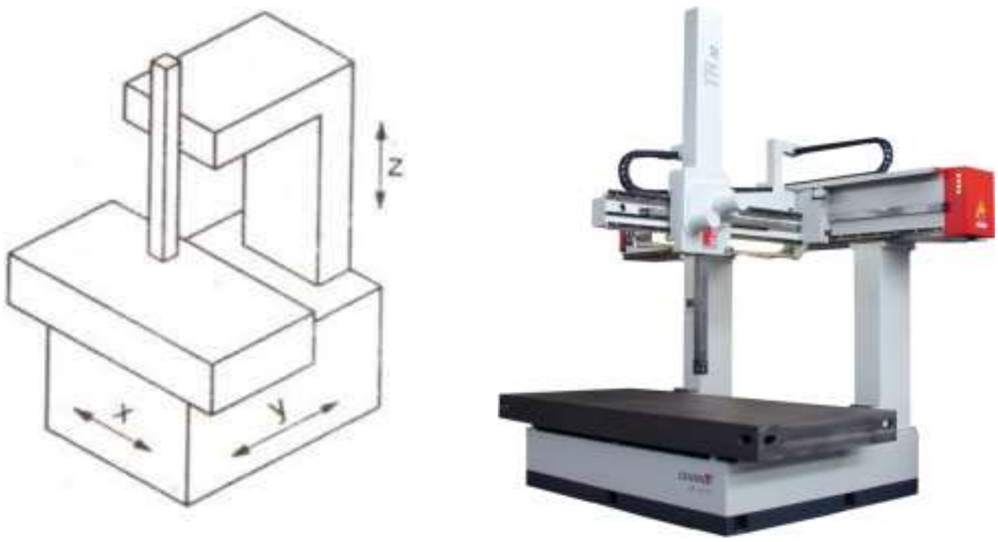


Fig 2.3: Column Type CMM

Gantry

In a gantry type arrangement, arms are held by two fixed supports as shown in Figure. Other two arms are capable of sliding over the supports. Movements of the x, y and z-axes are also as shown in Figure. The gantry type construction is particularly suited for very large components and allows the operator to remain close to the area of inspection.

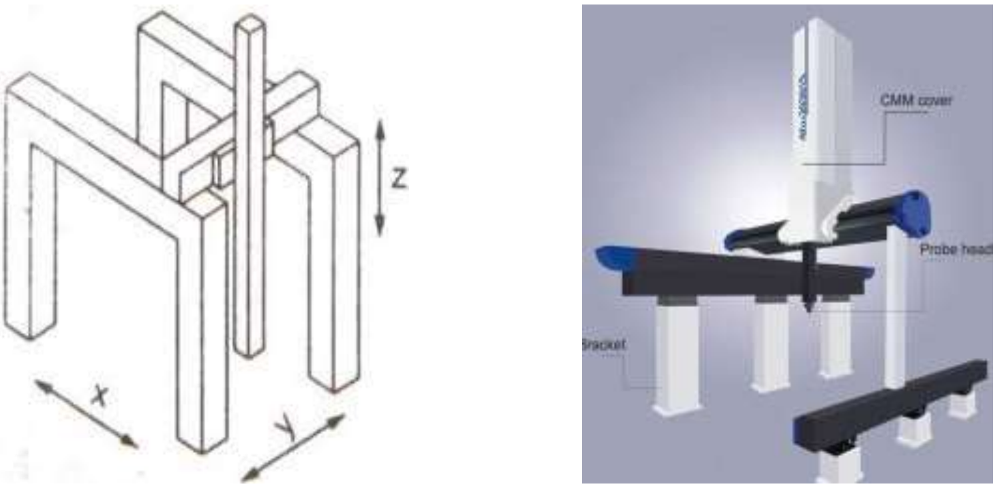


Fig 2.4: Gantry Type CMM

Horizontal CMM

Figure shows the construction of a horizontal structure. The open structure of this arrangement provides optimum accessibility for large objects such as dies, models, and car bodies. Some horizontal arm machines are referred to as layout machines. There are some horizontal machines where the probe arm can rotate like a spindle to perform trimming operations. Tramming refers to accurate mechanical adjustment of instrument or machine with the help of tram.

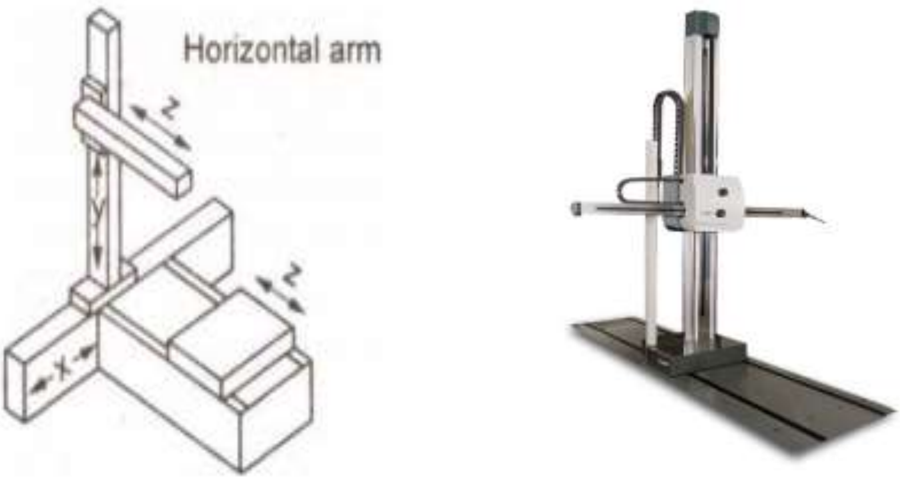


Fig 2.5: Horizontal Type CMM

3. PROBING SYSTEM

It is the part of a CMM that sense the different parameters required for the calculation. Appropriate probes have to be selected and placed in the spindle of the CMM. Originally, the probes were solid or hard, such as tapered plugs for locating holes. These probes required manual manipulation to establish contact with the work piece, at which time the digital display was read. Nowadays, transmission trigger-probes, optical transmission probes, multiple or cluster probes, and motorized probes are available.

Inductive and Optical Transmission Probes:

Inductive and optical transmission probes have been developed for automatic tool changing. Power is transmitted using inductive linking between modules fitted to the machine structure and attached to the probe. Figure shows a schematic of the inductive transmission probe. The hard-wired transmission probe shown is primarily for tool setting and is mounted in a fixed position on the machine structure.

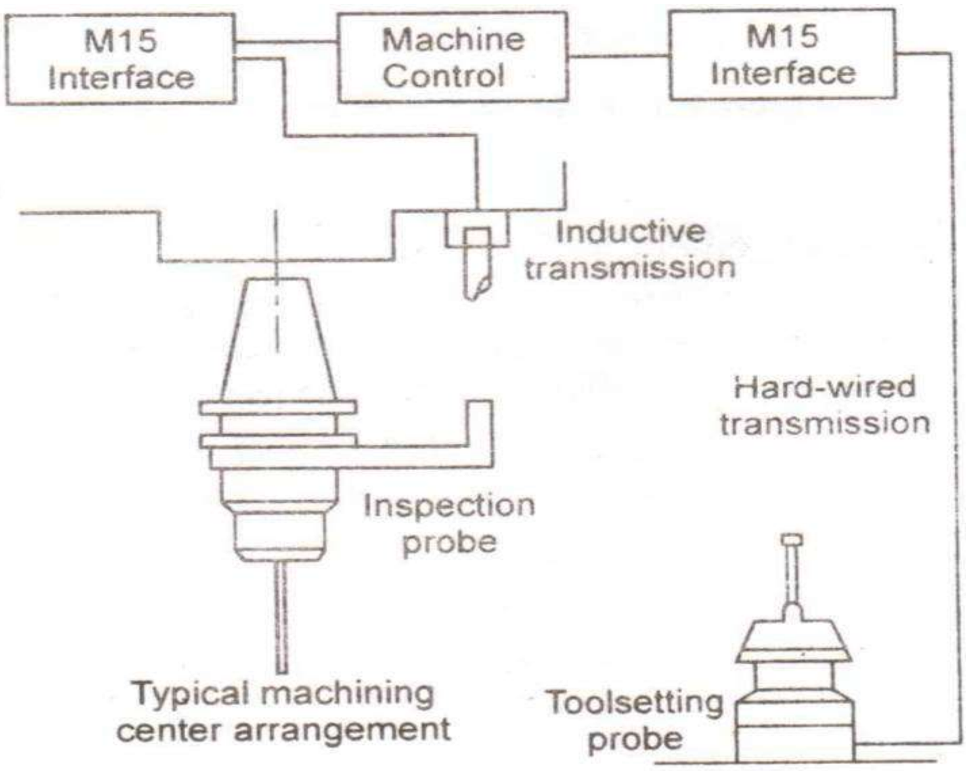


Fig 3.1: Inductive Probe System and Automatic Probe Changing

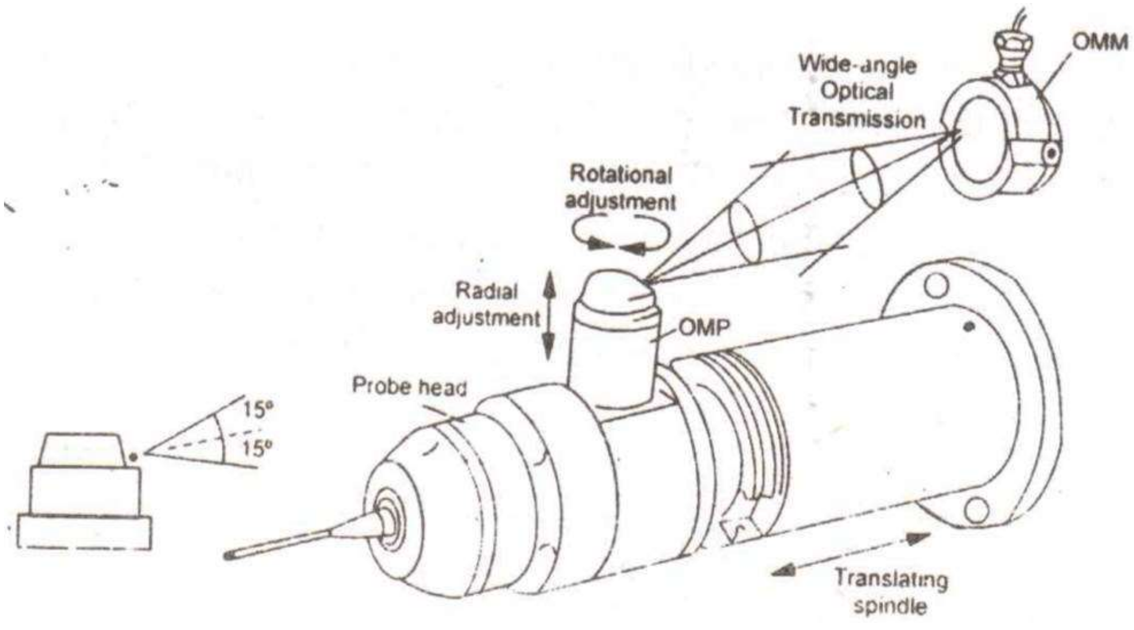


Fig 3.2: Optical transmission Probe

Motorized Probe

Motorized probe, 48 positions in the horizontal axis, 15 in the vertical axis can be programmed for a total of 720 distinct probe orientations. Figure shows some typical applications for motorized probe. It shows that with a range of light weight extensions, the head can reach into deep holes and recesses. The second diagram shows that head of the probe is sufficiently compact to be regarded as an extension of the machine quill. This enables the inspection of complex components that would otherwise be impossible or involve complex setups.

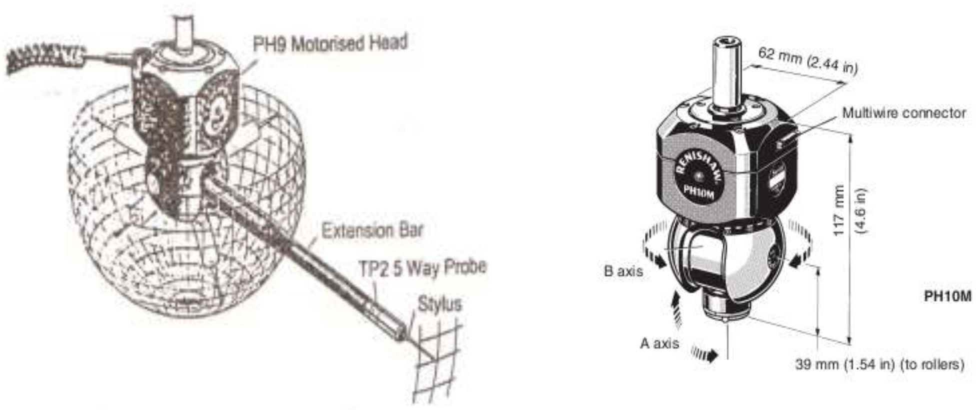


Fig 3.3: Motorized Probe

Multiple Styluses Probe Heads

Wide ranges of styli have been developed to suit many different gaging applications. Some of the different styli available are shown mounted on a multiple gaging head in Figure. The selection of stylus is done based on the application for which the probe is to be used.

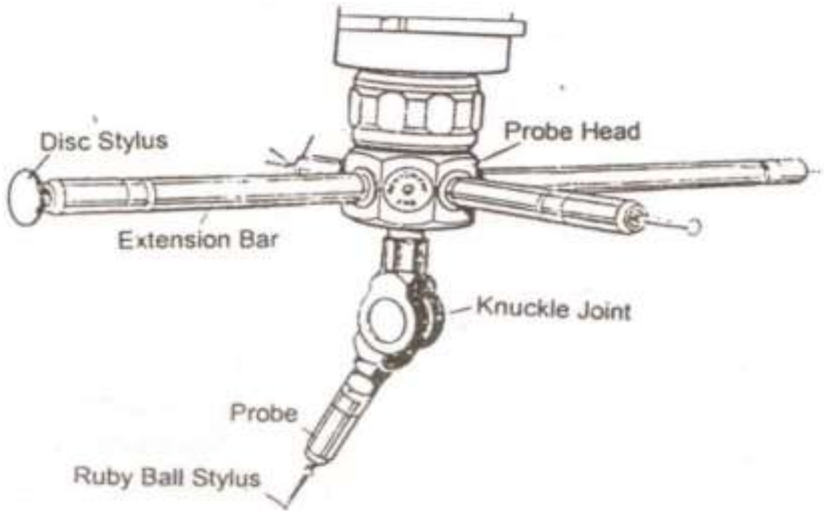


Fig 3.4: Multiple stylus Probe Head

4. MECHANICAL SET-UP

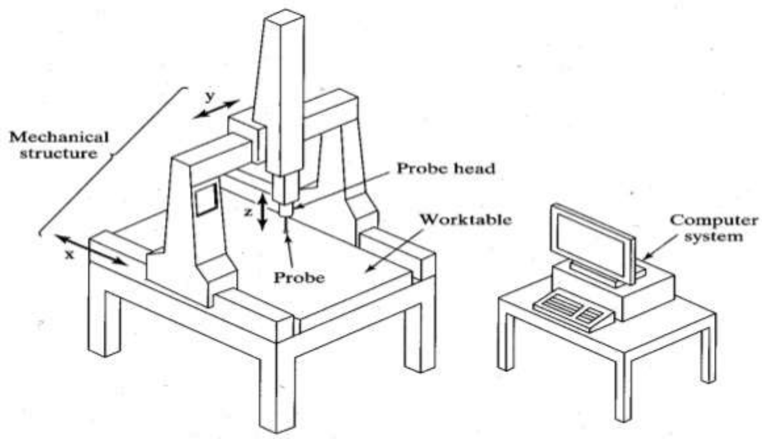


Fig 4.1: CMM Set-Up

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.

Advantages

CMM has got a number of advantages. The precision and accuracy given by a CMM is very high. It is because of the inherent characteristics of the measuring techniques used in CMM. Following are the main advantages that CMM can offer:

Flexibility: CMMs are essentially universal measuring machines and need not be dedicated to any particular task. They can measure almost any dimensional characteristic of a part configuration, including cams, gears and warped surfaces. No special fixtures or gages are required. Because probe contact is light, most parts can be inspected without being clamped to the table.

Reduced Setup Time: Part alignment and establishing appropriate reference points are very time consuming with conventional surface plate inspection techniques. Software allows the operator to define the orientation of the part on the CMM, and all subsequent data are corrected for misalignment between the parts-reference system and the machine coordinates. Single Setup Most parts can be inspected in a single setup, thus eliminating the need to reorient the parts for access to all features.

Improved Accuracy: All measurements in a CMM are taken from a common geometrically fixed measuring system, eliminating the introduction and the accumulation of errors that can result with hand-gage inspection methods and transfer techniques.

Reduced Operator Influence: The use of digital readouts eliminates the subjective interpretation of readings common with dial or vernier type measuring devices. Operator "feel" is virtually eliminated with modern touch-trigger probe systems, and most CMMs have routine measuring procedures for typical part features, such as bores or center distances. In computer assisted systems; the operator is under the control of a program that eliminates operator choice. In addition, automatic data recording, available on most machines, prevents errors in transcribing readings to the inspection report. This adds up to the fact that less skilled operators can be easily instructed to perform relatively complex inspection procedures.

Improved Productivity: The above-mentioned advantages help makes CMMs more productive than conventional inspection techniques. Furthermore, productivity is realized through the computational and analytical capabilities of associated data-handling systems, including calculators and all levels of computers.

5. CONCLUSION

In this paper, coordinate measuring machines are discussed. The paper begins with a description of its part. Next to this, the principle of operation and the working of a coordinate measuring machine are discussed. Special consideration in case of coordinate measuring machines and the possible sources of errors in measurement are also noted down. The paper finishes with the discussion of the advantages of a coordinate measuring machine.

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