ROHINI

COLLEGE OF ENGINEERING AND TECHNOLOGY

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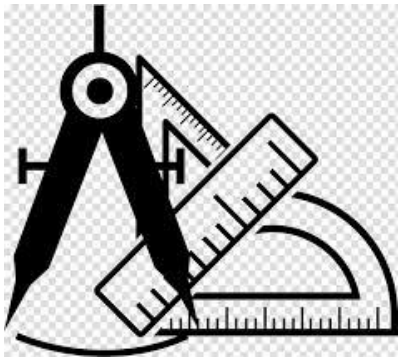
DEPARTMENT OF MECHANICAL ENGINEERING

24ME403 - METROLOGY & MEASUREMENTS

Dr. A. ARUL MARCEL MOSHI,

ASSOCIATE PROFESSOR / MECH.



UNIT V: ADVANCES IN METROLOGY

CO5: To inspect the quality control in Manufacturing Industries with advances in Measurement.

Adaptive Machining

Limitations of conventional machining:

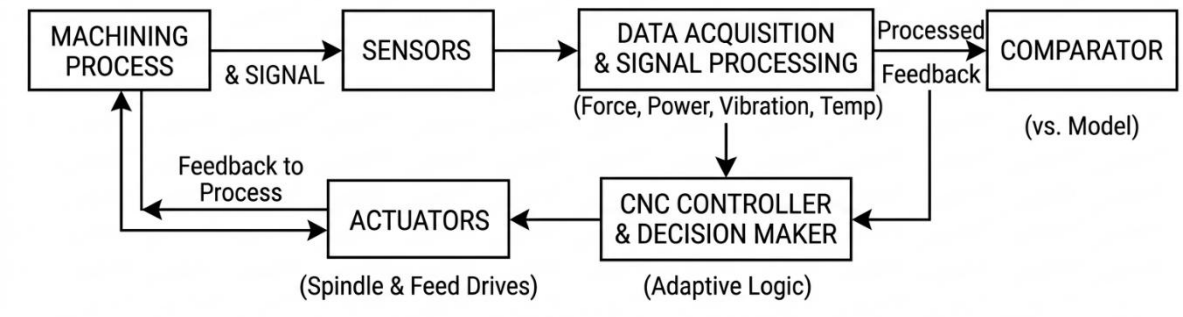
Conventional Computer Numerical Control (CNC) machining operates on an open-loop or programmed basis. The tool follows a pre-defined path at fixed speeds and feeds, assuming ideal conditions. However, real-world variables like material hardness variations, tool wear, vibration (chatter), and thermal expansion cause deviations from this ideal. Conventional methods cannot react to these changes, leading to inefficiencies, poor surface finish, or tool breakage.

Adaptive machining overcomes this by creating a closed-loop system where the process continuously monitors itself and adjusts parameters in real-time.

Working principle of Adaptive machining:

The core of adaptive machining is a cycle of Sense, Compare, Decide, and Act.

Schematic diagram of Adaptive control loop:



Step-by-step working:

Step 1: **Sensing**: Sensors (dynamometers for force, accelerometers for vibration, power transducers for spindle load) continuously monitor the cutting process.

Step 2: Comparison: The measured data (e.g., actual cutting force) is sent to the controller, where it is compared against a pre-defined optimal model or threshold value stored in memory.

Step 3: Decision (The "Adaptive" Logic): If an error or deviation is detected (e.g., force is too high), the control algorithm calculates the necessary corrective action. This could involve reducing feed rate, varying spindle speed, or modifying the toolpath.

Step 4: Action: The CNC controller instantly sends new commands to the machine's actuators (spindle motor and axis drives) to implement the correction, bringing the process back to the optimal state.

Advantages of Adaptive machining over Conventional machining:

- **Increased productivity**: Material removal rate is maximized safely.
- **Reduced downtime & cost**: Prevents catastrophic failure and optimizes tool life usage.
- **Improved quality & reliability**: Ensures consistent surface finish and dimensional accuracy.
- **Labor efficiency**: Frees up operators to focus on other tasks.
- **Reduced cycle times**: Minimizes non-productive machining time.