MACHINE TOOLS

Productivity

Productivity can be evaluated

a) According to the volume of removed chips

   $[m^3 \cdot kWh^{-1}]$ or $[kg \cdot kWh^{-1}]$

b) According to the size of the machined surface

   $[m^2 \cdot kWh^{-1}]$

c) Depending on the number of items produced per time unit

   $[pcs \cdot min^{-1}]$ or $[pcs \cdot h^{-1}]$

Basic calculations of machine time

- Turning

$$t_s = \frac{L}{n \cdot s}$$

L – lenght, n – revolution, s – feed per revolution

- Milling

$$t_s = \frac{A}{b \cdot n \cdot s_z \cdot z}$$

A – machined area, b – cutting width, s_z – feed per tooth,
z – Number of cutter teeth

Increasing productivity

- By increasing rpm (increasing the cutting speed)
  - Increasing the power of the machine
- By increasing feed a_f
  - Increasing the rigidity of traverse and of the whole work space

$$F = p \cdot a_f \cdot a$$

p – specific cutting resistance

a_f – feed

a – depth of chip

Development trends

- Increase engine power
  - 15 ~ 80 kW
- Increasing the speed spindles
  - 4000 – 15 000 rpm
- Increase speed feeds
  - 200 – 1000 $mm \cdot min^{-1}$

Stepless rpm control,

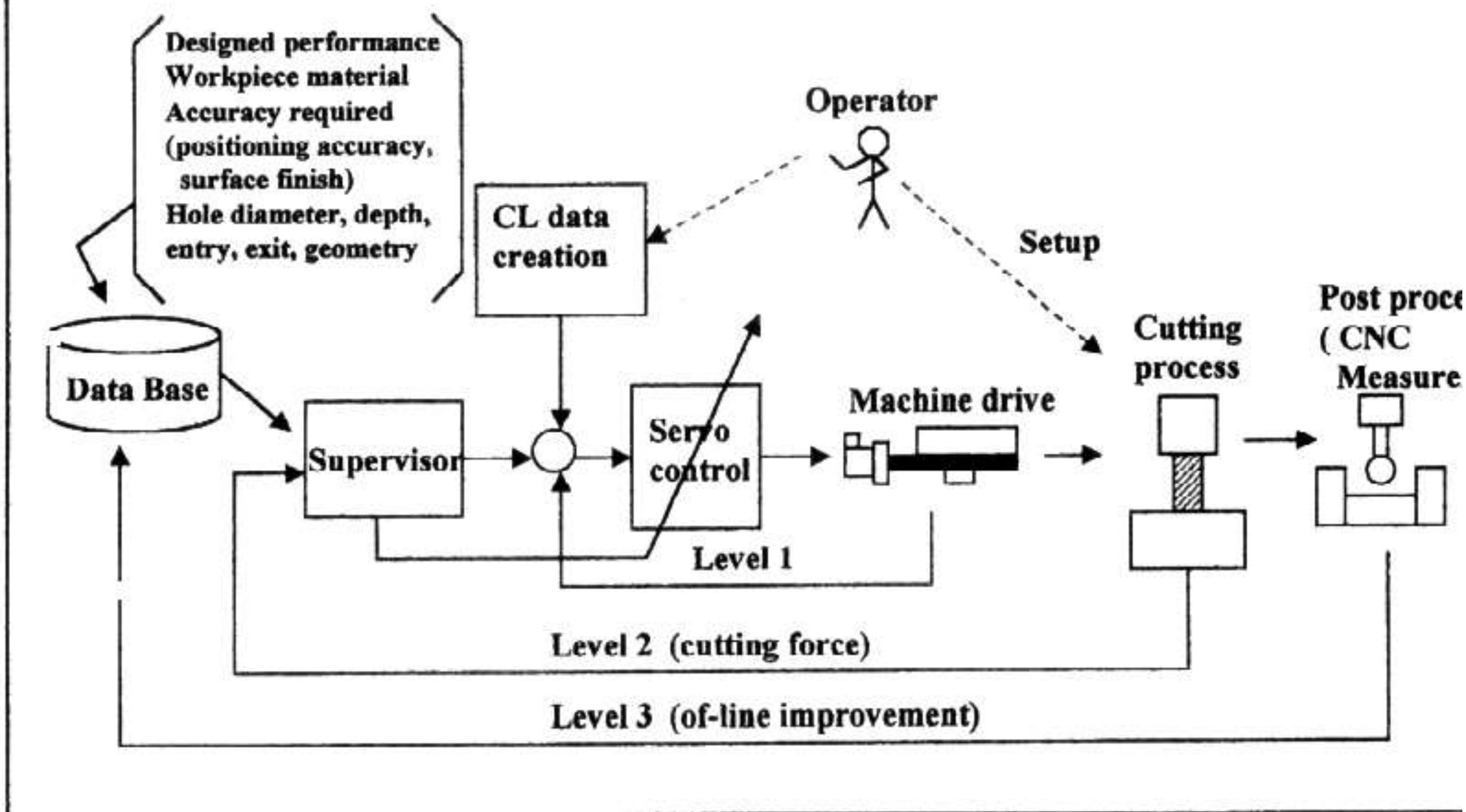
Powerful cutting tools,

Damage identification of tools,

Powerful cooling, lubrication,

Chip removal.

The concept of intelligent machining centers



Adaptive control of machining processes

Principle - adaptive control system based on information on the machining process changing cutting conditions.

a) Limit system - cutting force is measured

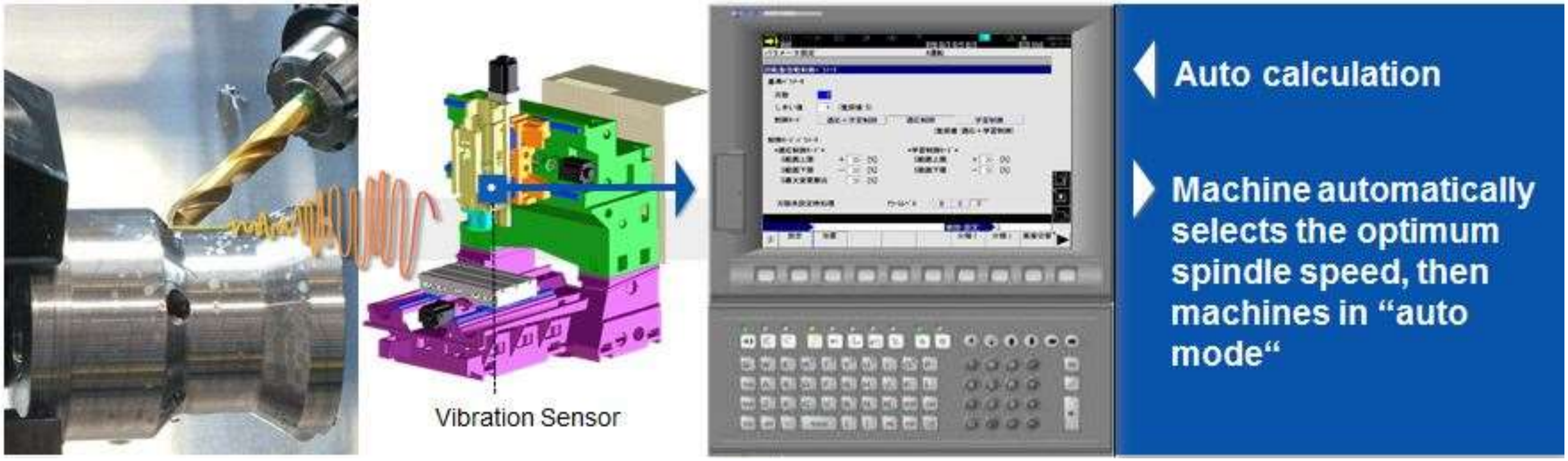
changes M_k, feed or infeed

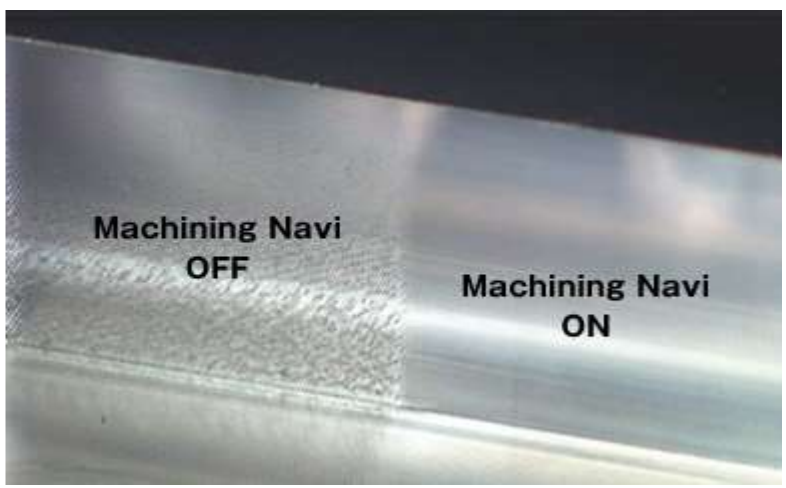
b) Optimization system

Cutting conditions are governed to achieve minimum production costs.

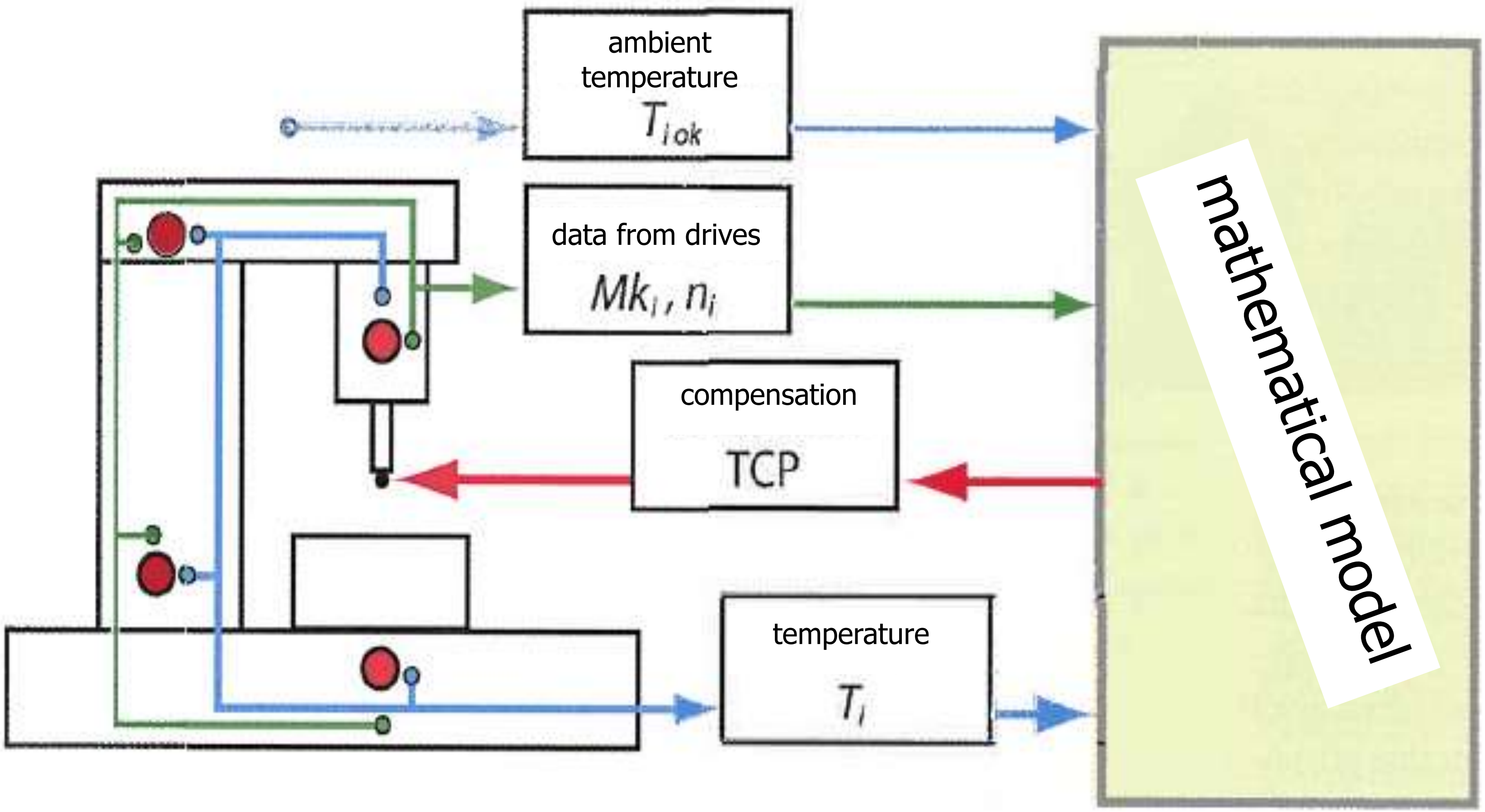
Additionally, there is monitored e.g. tool wear, surface finish.

Adaptive control of machining processes

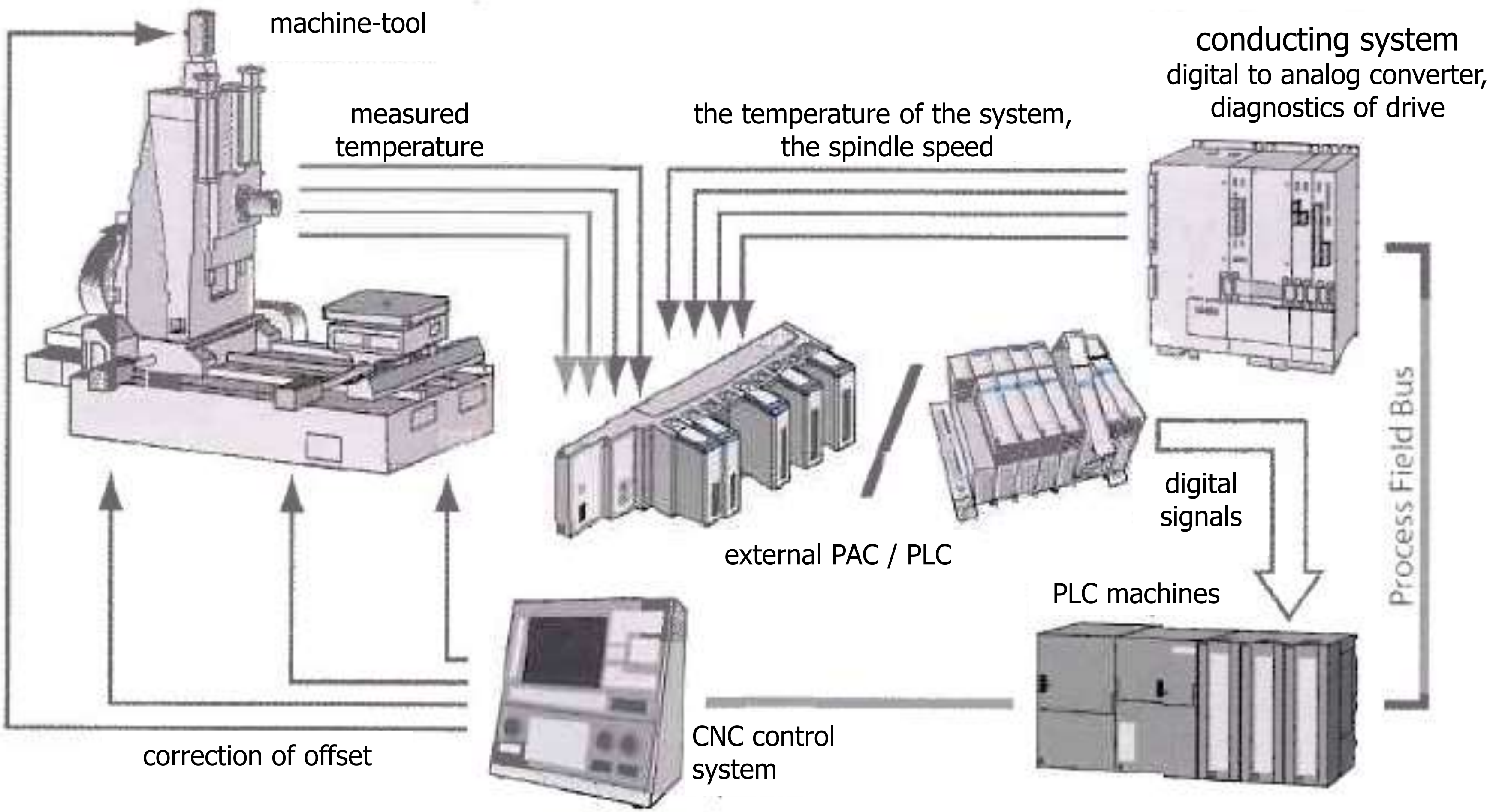




Adaptive control of machining processes



Adaptive control of machining processes



Accuracy of machine tools

- Definition of precision machine tools work
  - Precision machine work is due to dimensional accuracy of workpieces, workpiece shape accuracy and precision of the relative positions of surfaces on workpieces made on the intended machine.

Accuracy of machine tools

- Accuracy of dimension
  - Accordingly comparing the actual and the desired dimensions of the surfaces.
- Accuracy of shape
  - Given the variations in the shapes of individual parts of the workpiece shapes rated.
- Accuracy of surfaces relative position
  - It is determined by variations in the position of two or more surfaces from the nominal.

Accuracy of machine tools

- Machines are divided into accuracy classes
  a) The surface of revolution (Group A)
     I. Accuracy class roundness deviation to 3μm
     II. Accuracy class roundness deviation to 5μm
     III. Accuracy class roundness deviation to 10μm
  b) The planar surfaces (Group B)
     I. Accuracy class flatness to 3μm
     II. Accuracy class flatness to 5μm
     III. Accuracy class flatness to 10μm

Geometric accuracy

- Aligning the machine to the foundation - a solid anchor and measurement:
  a) straightness
  b) directness of movement
  c) flatness of clamping surfaces
  d) parallelism of guide surfaces
  e) perpendicularity of clamping surface to ways
  f) concentricity spindle and tailstock
  g) concentric running fault + front spindle runout

Working accuracy

- Working accuracy tests verify correct operation.

- Measurements include:
  a) test of performance
  b) finishing
  c) positioning accuracy
  d) reliability