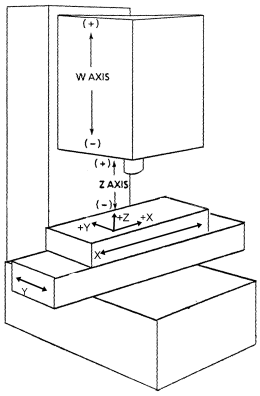
Machine Geometric Modeling

Monarch VMC45 Schematic

Research Journal Point:

Record detailed machine information such as :

Manufacturer, model, serial number, date of manufacture, location, etc. See serial plate on machine.



Defining the Investigation – 1 Scope

- What parameters/relationships are you trying to determine. (use full sentence descriptions)
  - We will be determining the displacement errors throughout a specified working volume of the VMC45, that is, the errors from nominal of the tip of a tool with respect to the table of the VMC45. The machines programmed coordinates will determine the nominal positions within a defined rectangular coordinate system……..

Defining the Investigation – 2 Methodology

- Develop a proper mathematical model, if necessary.
  - *Define the symbolism, assumptions (rigid body, determinism)*
- Use the mathematical model to determine the required metrology. (What don't I know?)
  - *Parameters / Symbolism relationships*
  - *Dependent / Independent variables*
- Specify the instrumentation for determining dependent parameters. (How do I determine what I do not know?)
  - *Symbolic parameter / instrument / arrangement*

Developing the Model-1 Visualization

- Determine the structural loop
- Draw structure block diagram (with written description)
- Determine the metrology loops
  - Linear scales, rotary encoders, reference points
- Add metrology blocks to structure diagram

Developing the Model-2 General Coordinate Systems

- Associate Coordinate Systems with each structural component that is linked with a metrology loop.
- Physically define and relate the coordinate systems at some initial machine state using real machine physical references and states. (home position, coordinates, tool gage plane etc.)
- Incorporate machine knowledge / scope into model (range, initial offsets, machine coordinate symbols, etc) .

Developing the Model-3
Define Symbolism

- Independent variables, expected deviations and other parameters.
  - Commanded coordinates (X_c, Y_c, Z_c, W_c)
  - Laser measured displacements (X_L, Y_L, Z_L)
  - Actual displacements (X_A, Y_A, Z_A)
  - orientation errors, $\varepsilon_{xy}(Y_c)$ etc.
  - lateral error motions, $\delta_{xy}(Y_c)$ etc.
  - positioning errors $\delta_{xx}(X_c)$ etc.
  - Temperatures (Ambient T_A, Scales T_X….)
  - Offsets, $X_{o,}$ etc

Developing the Model-4
Relationships via Symbolism

- Incorporate independent variables, expected deviations and other parameters between coordinate systems into physical model symbolism.
- Consider X carriage motion
- Ideal model $x\vec{O}_F = X_A = -X_C$
- Developed real model with parameter to be determined
- . $x\vec{O}_F = -\left[X_c \cdot \left(1+\alpha_{xs}\cdot(T-20)\right)+\delta_{xx}(X_C)\right] = X_A$
- Ideal Measurement $X_A = X_L$
- Real measurement $X_A = X_L \cdot [1+\alpha_L(T,H,P)]$
- Determination of parameter

$$\delta_{xx}(X_C) = -X_L \cdot \left[1+a_L(T,H,P)\right] - X_c \cdot \left[1+\alpha_{xs}\cdot(T-20)\right]$$