Second Generation Sketch Model Error Studies for the Ceramic Samurai

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Purpose:

To provide a relative ranking of machine concepts by their inherent robustness to errors in the bearings.

Method:

Each motion concepts is considered separately. The distance from its Center of Motion (COM) to the point where the tool touches the work piece is calculated. These distances are used by a HTM to calculate the resulting error at the tool tip when a rotational error is applied to the COM.

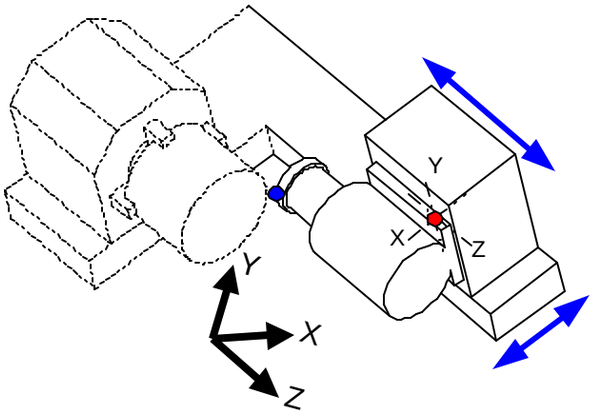
The magnitude of the error applied is the same for all concepts, allowing a relative comparison between them. A magnitude of 0.001 radians is used. This error is several orders of magnitude larger than the actual errors expected in the machine. Using a large error highlights the second order effects in the error motion. These become important in designing very accurate equipment.

The error is applied individually to each axis at the COM, and the induced error for each direction is recorded. Note come concepts have different COMs different axis of rotation.

The worst performing concept is selected as the reference concepts. Its errors are divided by the errors of the other concepts. These ratios now give an indication of the relative magnitude of the errors in each direction due to the error applied about a specific axis.

The Reference Concept:

Grinder, Bottom Mounted
(X or Z direction)

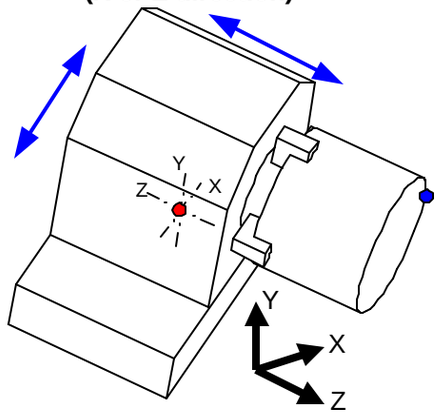


Rotation Error direction about the COM(red dot)	Displacement Errors at Tool Tip (blue dot)		
	X	Y	Z
Pitch Error (X)	N/A	-0.572	0.228
Yaw Error (Y)	0.571	N/A	-0.191
Roll Error (Z)	-0.229	0.19	N/A

The displacements in the table above have little meaning by themselves, but when used in a ratio with the corresponding errors in the other concepts a relative ranking can be accomplished. This ratio is called the **error reduction factor**

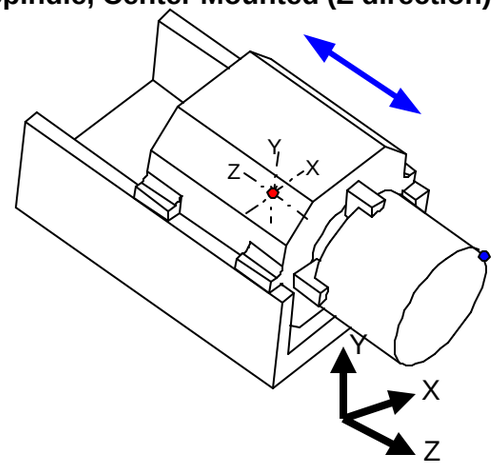
Larger error reduction factors indicate smaller errors

Spindle, Bottom Mounted (X or Z direction)



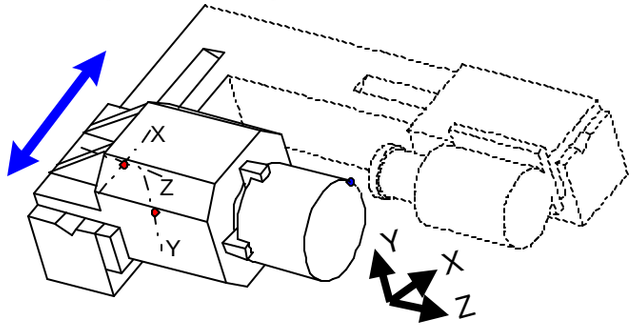
Error Reduction Factors wrt/ Reference Concept			
	X	Y	Z
Pitch Error (X)	N/A	-0.8	1.0
Yaw Error (Y)	**-0.8**	N/A	-2.2
Roll Error (Z)	**1.0**	-2.2	N/A

Spindle, Center Mounted (Z direction)



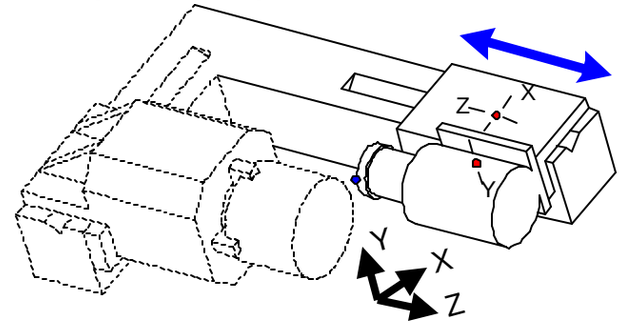
Error Reduction Factors wrt/ Reference Concept			
	X	Y	Z
Pitch Error (X)	N/A	-0.8	-736.3
Yaw Error (Y)	**-0.8**	N/A	-2.2
Roll Error (Z)	**2400**	-2.2	N/A

Spindle, Axtrusion (X direction)



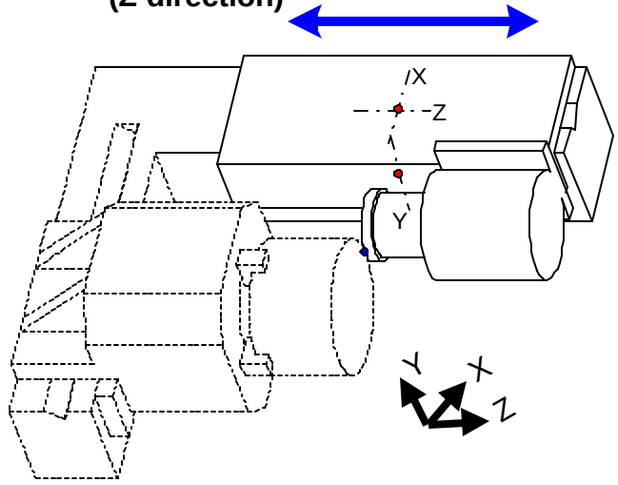
Error Reduction Factors wrt/ Reference Concept			
	X	Y	Z
Pitch Error (X)	N/A	-0.5	-445.5
Yaw Error (Y)	**-0.5**	N/A	-2.2
Roll Error (Z)	**23.9**	-2.2	N/A

Grinder, Short Axtrusion (Z direction)



Error Reduction Factors wrt/ Reference Concept			
	X	Y	Z
Pitch Error (X)	N/A	1.5	1502.6
Yaw Error (Y)	**1.5**	N/A	1.2
Roll Error (Z)	**-897.6**	0.8	N/A

Grinder, Long Axtrusion (Z direction)



Error Reduction Factors wrt/ Reference Concept			
	X	Y	Z
Pitch Error (X)	N/A	∞	0.6
Yaw Error (Y)	¥	N/A	∞
Roll Error (Z)	**-897.6**	0.8	N/A