Determination of True Position, of a Threaded Hole, Using a Coordinate Measuring Machine

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Agenda

- *Introduction*
  - *ASME Y14.5-2009 Requirements*
- *Problem*
  - *Curved or Irregular Surfaces*
- *Tests*
  - *Evaluation of Various Methods*
- *Conclusion*

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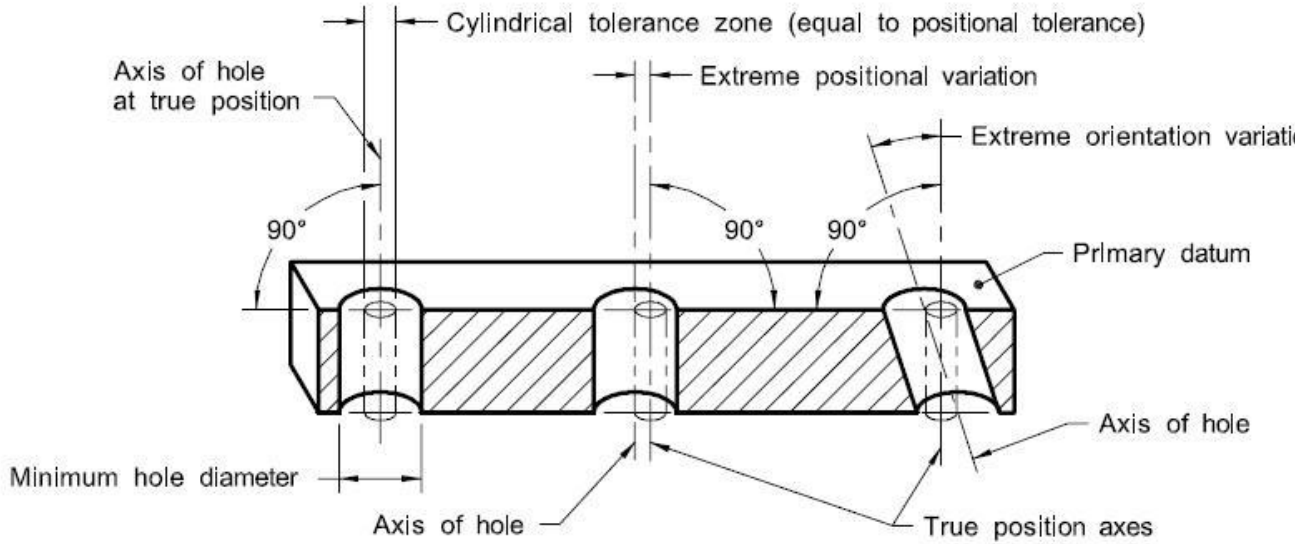
How should the position be established?

- *ASME Y14.5-2009*
  - *Section 2.9*
    - *"Each tolerance of orientation or position and datum reference specified for a screw thread applies to the axis of the thread derived from the pitch cylinder."*

Requirements per ASME Y14.5M-2009



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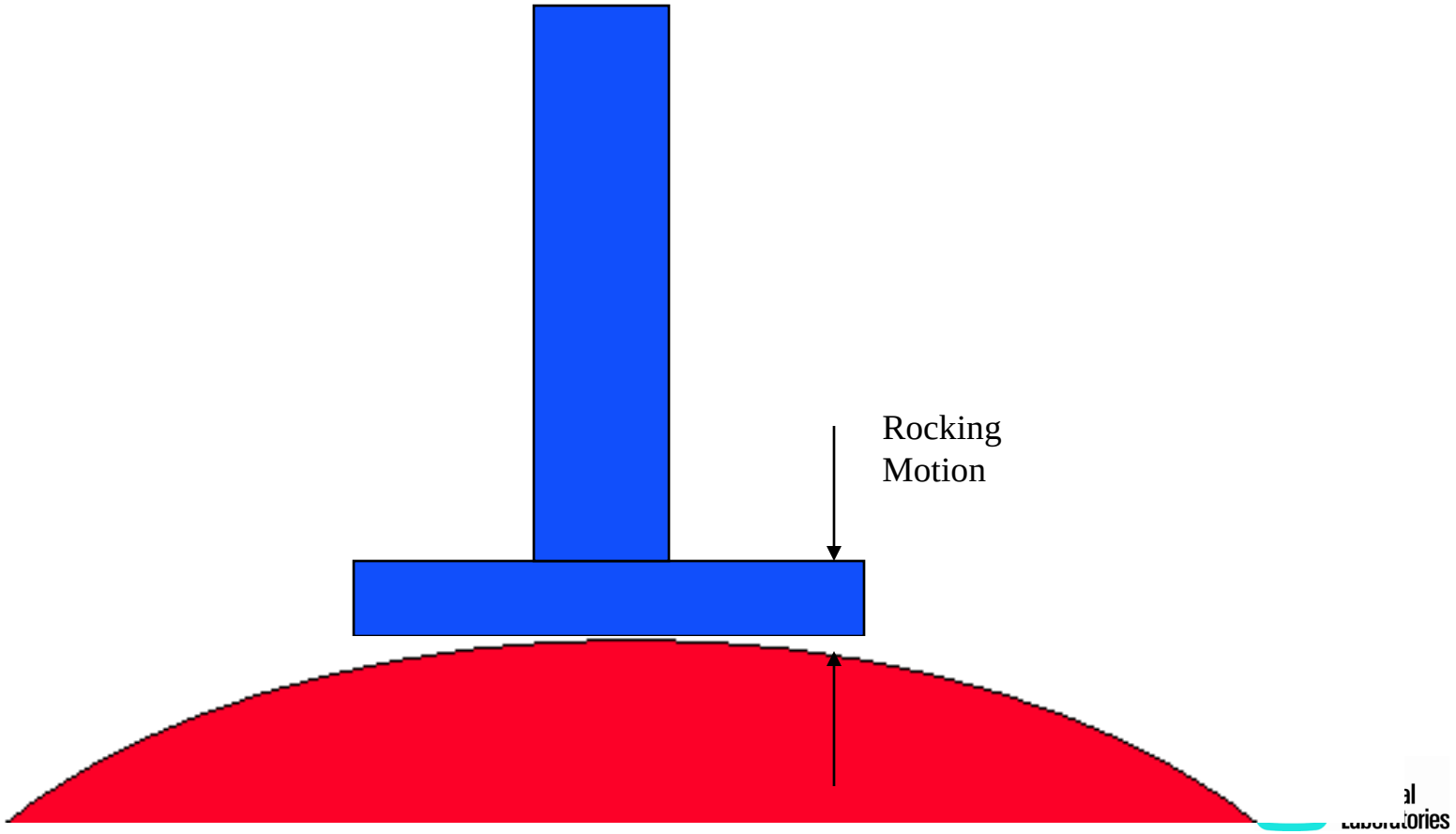
Coordinate Measuring Machine (CMM) Methods

- *Probing a threaded/cylinder gage*
  - *Issues*
    - *$ - Cost of gage*
    - *Inconvenience of installing (time = money $)*
    - *Establishing pitch cylinder*
- *Direct probing of the thread form*
  - *Issues*
    - *Chips, burrs*
    - *Proper establishment of the pitch cylinder*

Problem

- *Standard cylinder gage is influenced by the surface the hole is located on.*



Initial Tests

- *Evaluate commonly used techniques*
- *Perform R & R tests using various techniques on a nominally flat surface*
  - *Test pieces having a 2 inch outside diameter with ¼”-20 UNC thread in center*

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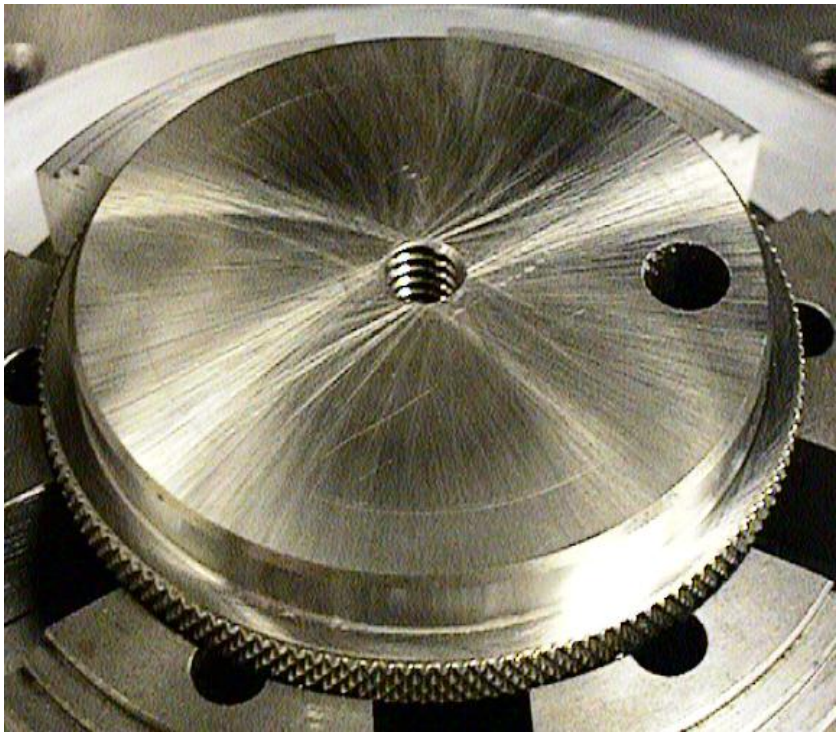
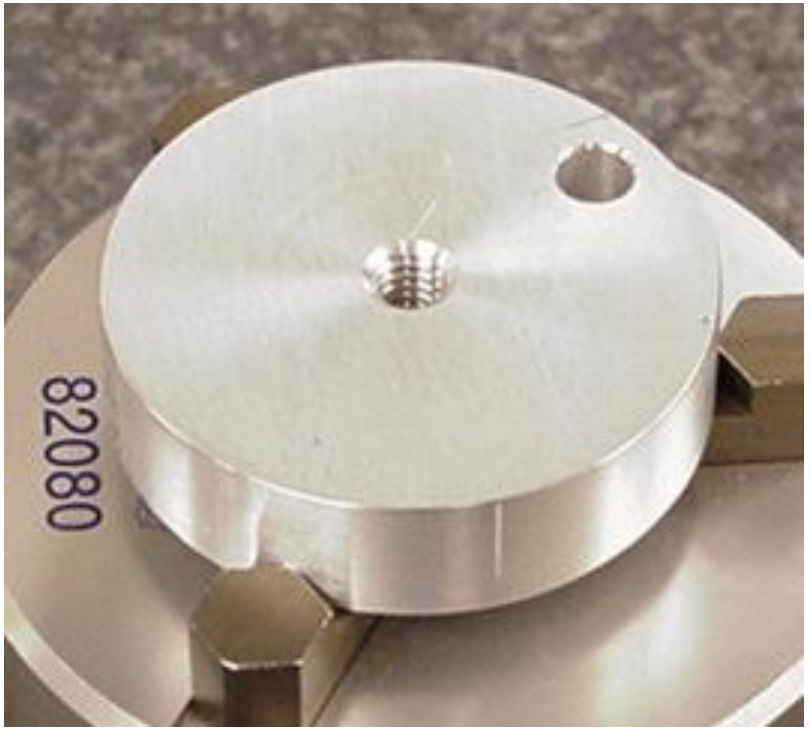
Test Pieces





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Various Types Plug Gage

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Split Thread Gage

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Tapered Thread Gage

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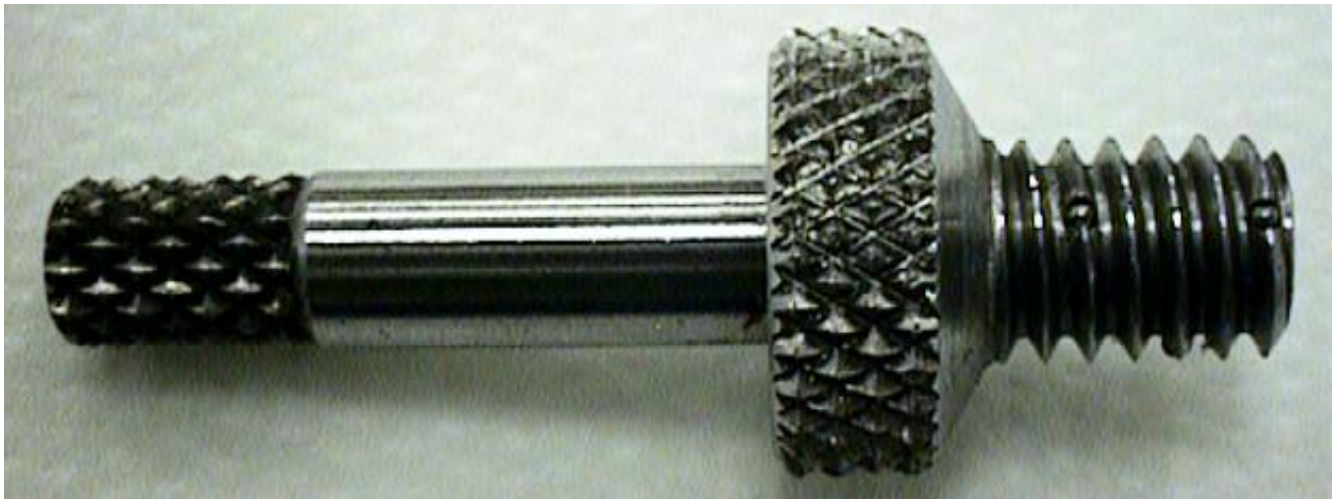
Expanding Ball Gage



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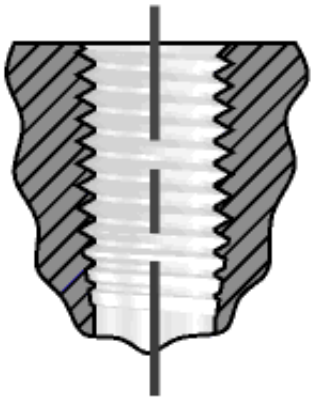
Expanding Ball Gage



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R&R Test Parameters

- *Establish intersection points of cylinder axis with Datum A (top surface) and at –0.5” below Datum A*
- *Record X & Y position at both intersection points*
  - *Should show repeatability of not just Datum A location, but of the cylinder orientation (tilt).*

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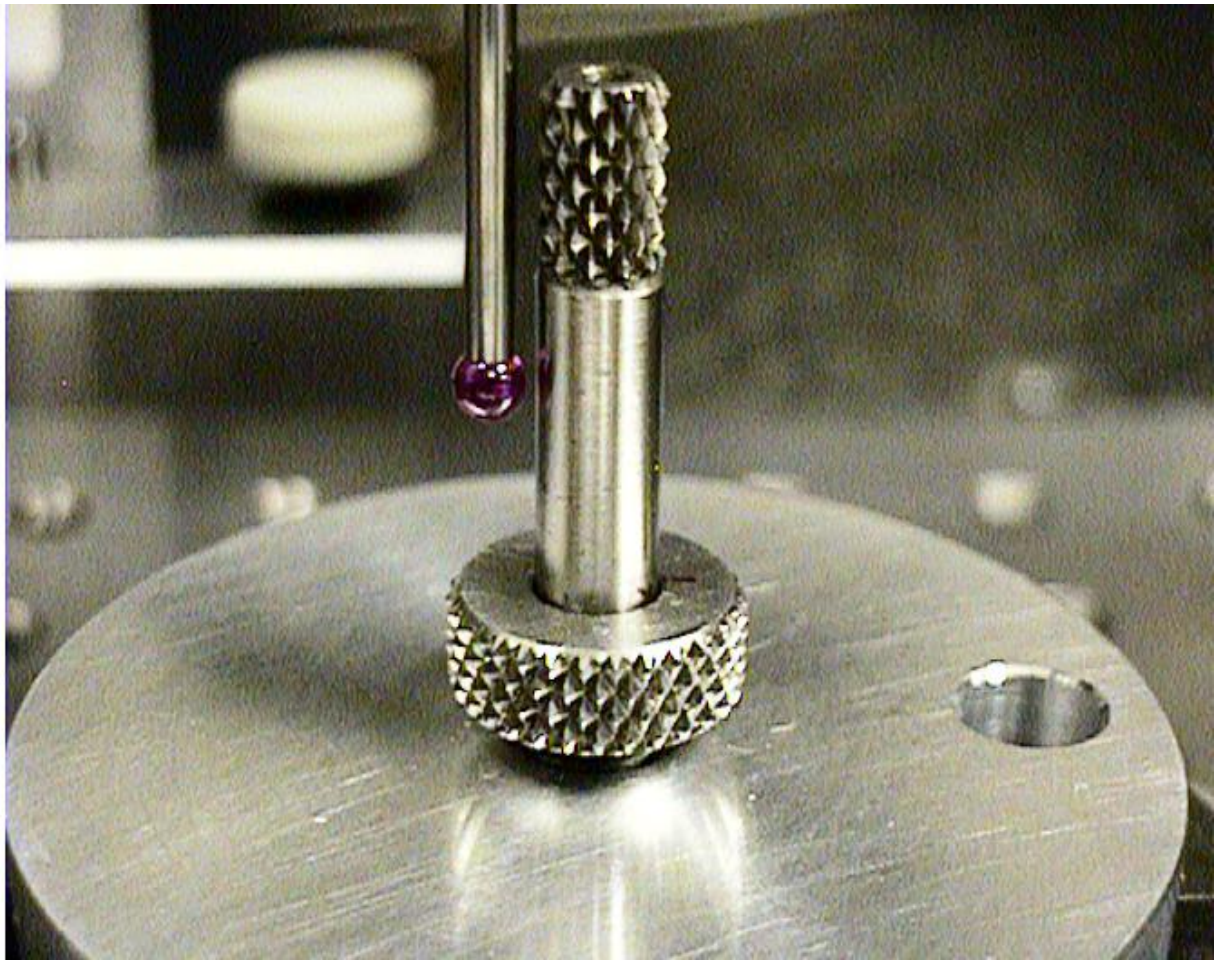
Typical CMM Setup



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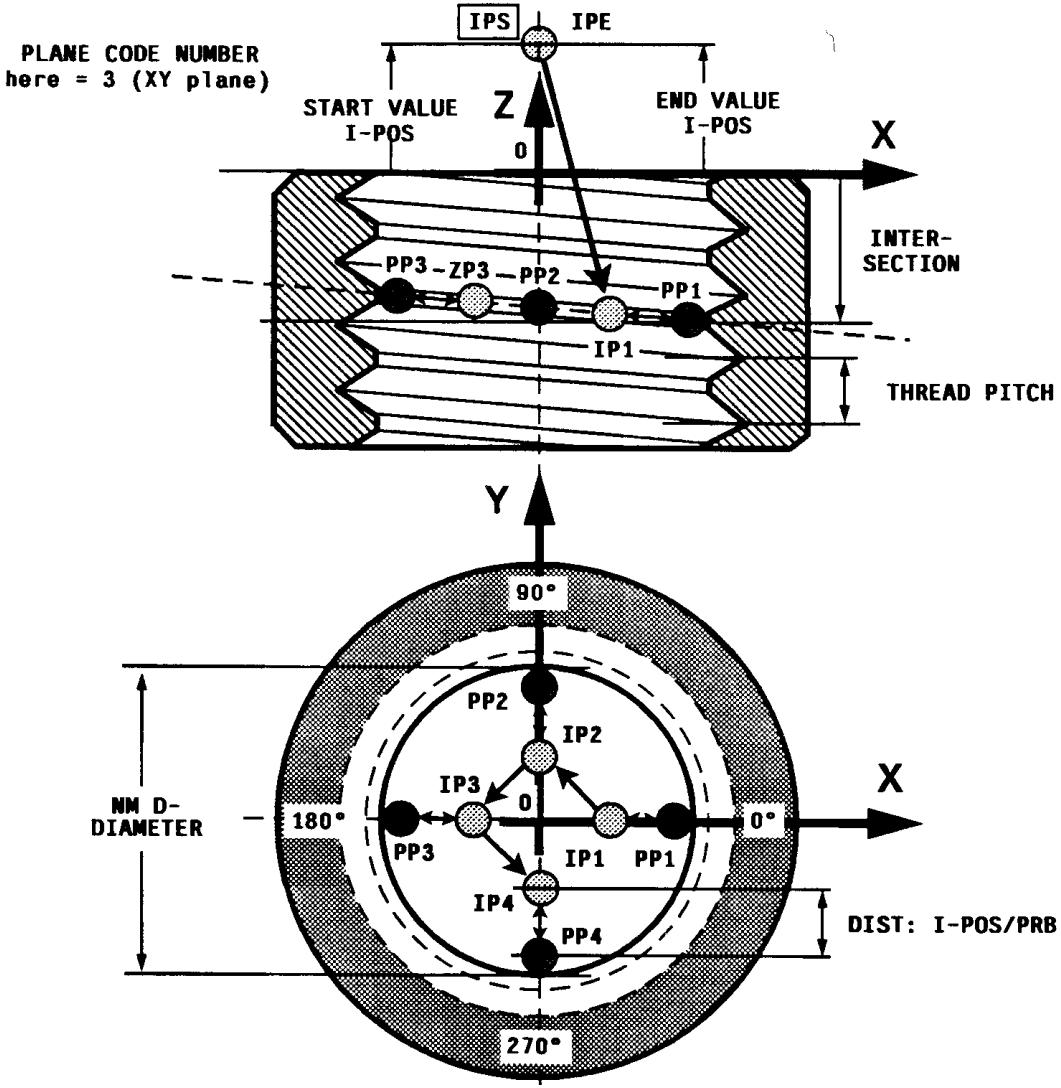
Direct Probing Technique



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Direct Probing using Cylinder Probe

- *Issues*
  - *Taking a 3D requirement and making a 2D measurement*
  - *Assuming many characteristics of the thread form*

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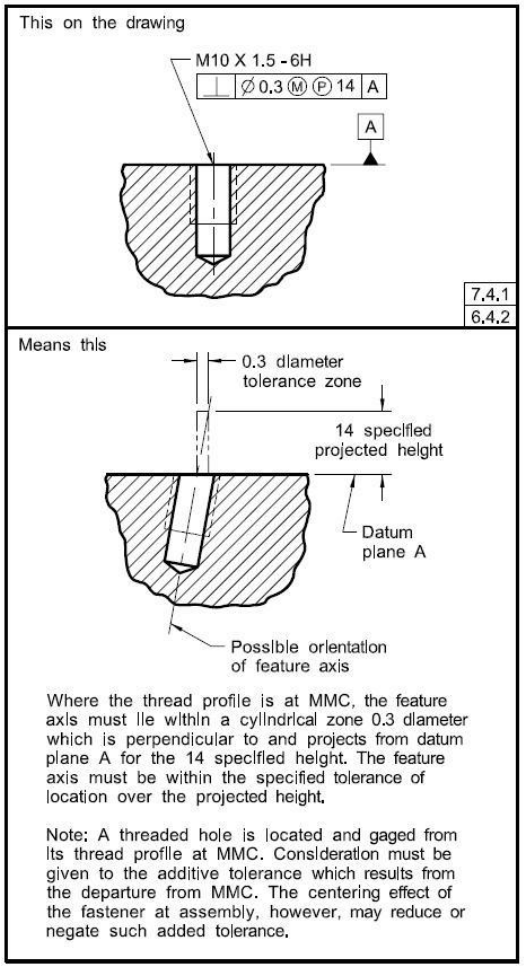
Maximum Material Condition Issues

- *How is MMC applied?*
  - *Additive Tolerance "Bonus"*
  - *Centering Effects?*



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CMM's Used & Specifications

- *Zeiss Prismo (9/12/7)*
  - *3D = 0.000113 inches*
- *Zeiss Contura (7/10/6)*
  - *3D = 0.000097 inches*
- *Zeiss UPMC 550 (CAA)*
  - *3D = 0.000058 inches*

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Zeiss Prismo CMM

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Zeiss Contura CMM

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Zeiss UPMC 550

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Test Results – Steel Test Piece

		Datum A - Z Axis Zero			Projected -0.5 inches Z Axis		
	Axis	Deviation	Std. Dev.	TP Result	Deviation	Std. Dev.	TP Result
Standard Straight Gage	X	-0.00011	0.00002	**0.0003**	-0.00017	0.00003	**0.0005**
	Y	-0.00011	0.00001		-0.00017	0.00006	
Split Gage	X	-0.00016	0.00002	**0.0003**	0.00029	0.00037	**0.0006**
	Y	-0.00001	0.00002		-0.00011	0.00007	
Taperred Gage	X	-0.00017	0.00013	**0.0004**	-0.00029	0.00007	**0.0009**
	Y	-0.00010	0.00007		-0.00037	0.00030	
Expanding Ball Gage	X	0.00004	0.00002	**0.0004**	0.00029	0.00021	**0.0006**
	Y	-0.00019	0.00005		-0.00001	0.00021	
Direct Thread Probing	X	0.00043	0.00103	**0.0009**	0.00094	0.00059	**0.0020**
	Y	-0.00017	0.00001		0.00034	0.00045	

Results In Inches

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Test Results – Aluminum Test Piece

		Datum A - Z Axis Zero			Projected -0.5 inches Z Axis		
	Axis	Deviation	Std. Dev.	TP Result	Deviation	Std. Dev.	TP Result
Standard Straight Gage	X	-0.00082	0.00002	**0.0027**	-0.00088	0.00007	**0.0033**
	Y	0.00110	0.00002		0.00141	0.00063	
Split Gage	X	-0.00018	0.00004	**0.0027**	-0.00061	0.00039	**0.0031**
	Y	0.00132	0.00005		0.00140	0.00010	
Tapered Gage	X	-0.00047	0.00004	**0.0024**	-0.00106	0.00053	**0.0031**
	Y	0.00113	0.00018		0.00112	0.00019	
Expanding Ball Gage	X	0.00029	0.00016	**0.0024**	-0.00061	0.00087	**0.0027**
	Y	0.00117	0.00006		0.00120	0.00016	
Direct Thread Probing	X	0.00080	0.00005	**0.0016**	0.00002	0.00064	**0.0003**
	Y	0.00004	0.00010		0.00014	0.00015	

Results In Inches

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Conclusions

- *No significant difference seen between gage methods.*
- *No significant difference seen between gage methods and direct probing.*
- *Further testing & analysis needed to determine best practice.*

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Questions?

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