Reference Planes

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Reference Planes

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Background

Sir Joseph Whitworth (1803-1887)

Joseph Whitworth invented the first practical method of making and polishing accurate flat surfaces in 1830. This used engineer's blue and three trial surfaces. This led to an explosion of development of precision instruments using his flat surfaces as a basis for further construction of precise shapes.

Flatness

Flatness, the evenness or levelness of a surface, is the degree to which the reference plane corresponds to the theoretically perfect plane. These surfaces, whether large or small, are often called “datum planes,” and the most important one is the surface plate.

The Three Plate Method

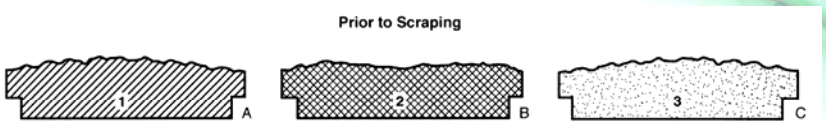


FIGURE 14–3 Greatly exaggerated, this shows the possible surface conformation of three plates after finish machining.

The Three Plate Method

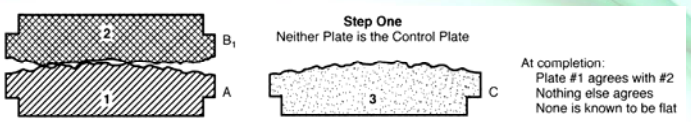


FIGURE 14–4 This step is carried only far enough to get general agreement between #1 and #2.

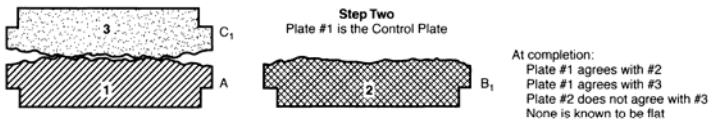


FIGURE 14–5 At the completion of this step, both #2 and #3 will have picked up #1's error.

The Three Plate Method

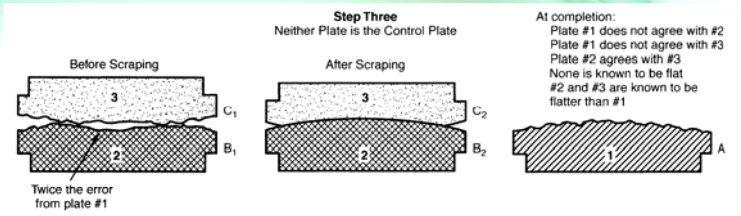


FIGURE 14–6 By scraping some of #1's error off of #2 and some off of #3, we get closer to flatness for these two plates.

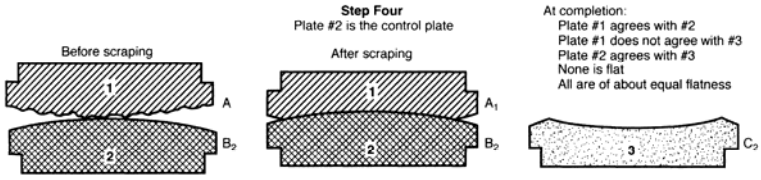


FIGURE 14–7 At the completion of this step, the plates may be of approximately the same flatness, but one is convex and two are concave.

The Three Plate Method

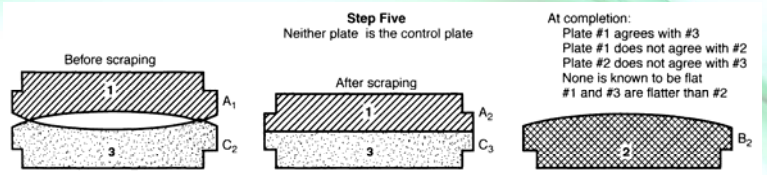


FIGURE 14–8 The first time plates #1 and #3 were brought together, only #3 was scraped. This time both were.

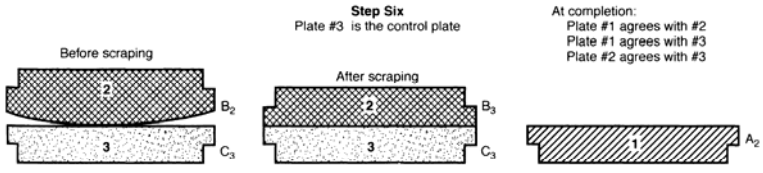


FIGURE 14–9 Although this step brings the three plates into approximate agreement, it does not mean that they are flat. The entire procedure is repeated until the desired flatness is obtained.

Perpendicularity

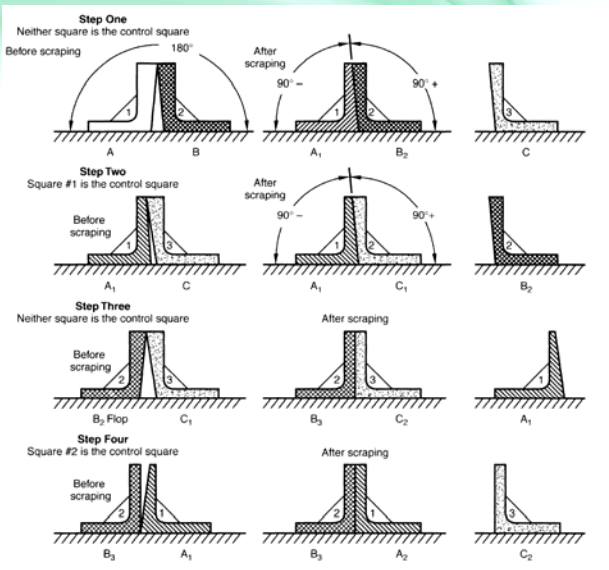


FIGURE 14–11 Master squares can be generated by much the same technique as was used for generating plane surfaces. However, the accuracy of the resulting squares is dependent on the accuracy of the reference surface on which the generation took place.

Perpendicularity

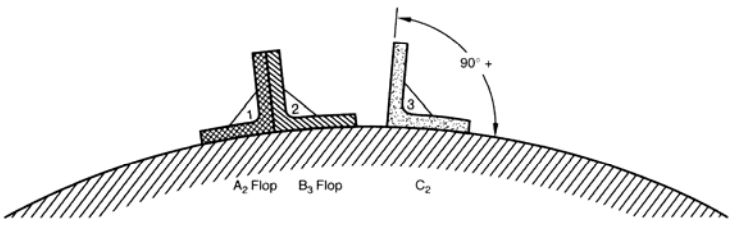


FIGURE 14–12 The generation of squares picks up the error of the reference surface as this example shows.

Perpendicularity

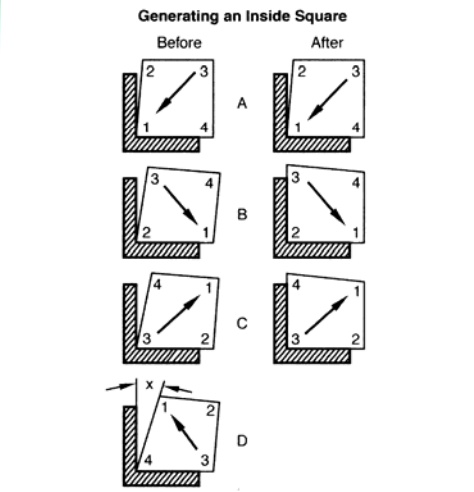


FIGURE 14–13 The same general technique can be used to simultaneously generate an inside square and a master square. X is the error magnified 4X.

Modem Reference Planes

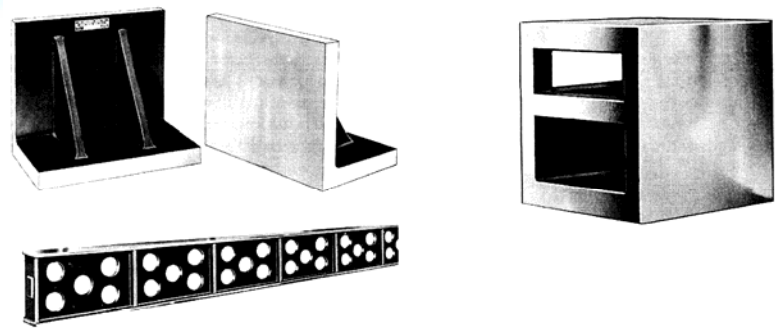


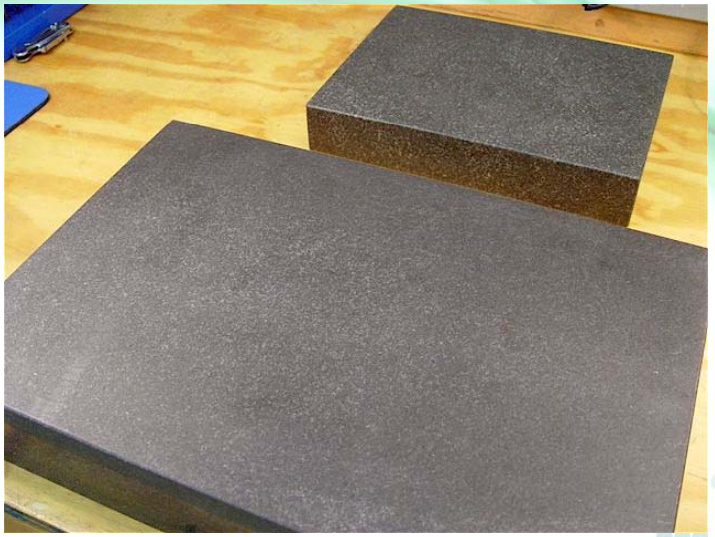
FIGURE 14–14 These are typical references made of hand-scraped cast iron. They function as supports as much as reference surfaces and therefore, are heavy and rugged. *(Courtesy of Challenge Machinery Co.)*

Modem Reference Planes

SEDIMENTARY	IGNEOUS	
Limestone	Gabbro	Diabase
Marble		Hypersthene Gabbro
Slate	Granite	Biotite Granite #1
Shale		Muscovite-biotite granite gneiss
Sandstone		Biotite Granite #2
Miscellaneous others		

Modem Reference Planes

Modem Reference Planes



Modem Reference Planes

BASIC RULES FOR SURFACE PLATE USE

- Set parts carefully on the surface plate. Dropping parts onto the granite surface can chip the surface.
- Rotate the areas of the surface plate used for inspection. Using the same area year after year can wear a "hole" in the plate.
- When using threaded inserts, use the minimum torque required to hold the part in place.
- Don't place a heavier load on the table than the load rating indicates. If the load is higher than the rating, the plate can be permanently bent.
- Clean the surface plate daily, using a cleaner recommended by the vendor.
- If not in use, cover the plate with a surface plate cover to protect it from dirt and dust.

FIGURE 14–22 Following these rules will extend the life of your surface plate.

How Flat Is Flat

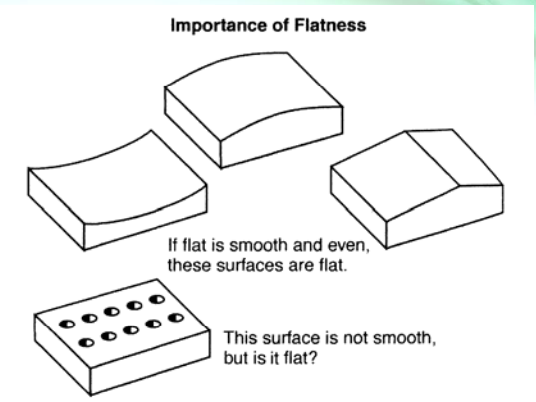
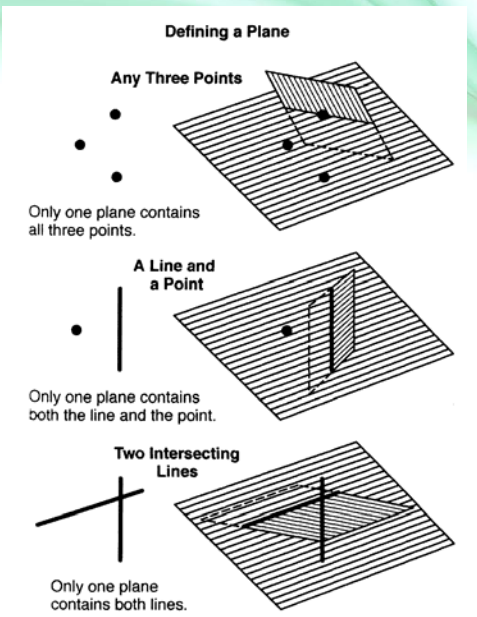


FIGURE 14–23 These exaggerated drawings show the confusion about flatness.

How Flat Is Flat



How Flat Is Flat

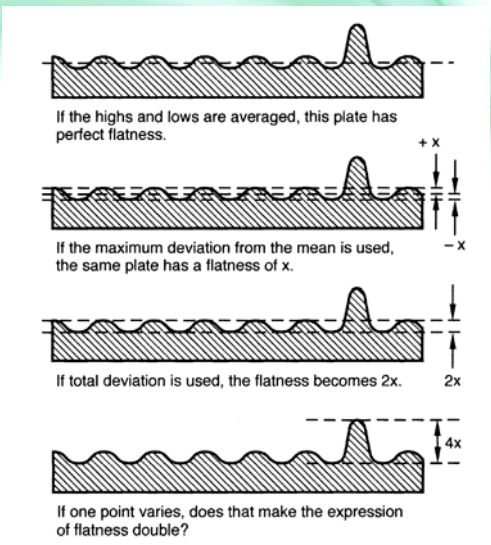


FIGURE 14–25 This illustration shows that the statement of accuracy must specify precisely how the accuracy is defined.

How Flat Is Flat

SIZE AND ACCURACY

Size				Work surface accuracy	
Work surface		Grade A thickness (minimum)	Grade B thickness (minimum)	Grade A tolerance plus or minus	Grade B tolerance plus or minus
Width	Length				
Inches	Inches	Inches	Inches	Inch	Inch
3 1/2	4	1	1	0.000025	0.0001
8	12	3	3	.000025	.0001
12	12	3	3	.000025	.0001
12	18	4	4	.000025	.0001
18	18	4	4	.000025	.0001
24	24	4	4	.000025	.0001
24	36	6	5	.000025	.0001
24	48	8	6	.000050	.00015
36	48	8	6	.000075	.00015
36	72	12	10	.00015	.0003
48	96	14	12	.0002	.0004
48	144	24	20	.0004	.001

FIGURE 14–26 This table is from Federal Specification GGG-P-463c(1). Note that the tolerance widens as the size increases.

References

http://www.loscoltrahues.com/01-00-000%20Herramientas%20Camera%20Department%20-%20Camera%20Department%20Tools/01-01-000%20Ajustes%20y%20Calibracion%20-%20Adjustments%20and%20Calibration/Granite%20Surface%20Plate%20-%20Superficie%20de%20Granito.JPG

http://www.finelinehair.com/home/surface_plate_1.jpg