



## TP B.26

### **BHE/FHE Pivot Percentage Relation to Cue Natural Pivot Length**

supporting:

“The Illustrated Principles of Pool and Billiards”

<http://billiards.colostate.edu>

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For background information, see the back-hand-english (BHE) / front-hand-english (FHE) resources page:

<https://billiards.colostate.edu/faq/sidespin/bhe-fhe/>

If the bridge is at the natural pivot length (N) of the shaft, with a total tip offset of x and cue pivot of  $\theta$ , for small angles (where  $\tan \theta = \sin \theta = \theta$ ),

$$\theta = \frac{x}{N}$$

This total pivot angle and tip offset can instead be created by an appropriate combination of BHE and FHE with a given grip length G and bridge length B, both measured from the tip. The percentage of the total tip offset and pivot angle resulting from the BHE portion of the pivot is P. The remaining percentage (1-P) applies to the FHE portion of the pivot.

The BHE pivot with tip offset  $x_B$  and cue pivot angle  $\theta_B$  is defined by:

$$\theta_B = \frac{x_B}{B} = \frac{P \cdot x}{B}$$

The FHE pivot with tip offset  $x_F$  and cue pivot angle  $\theta_F$  is defined by:

$$\theta_F = \frac{x_F}{G} = \frac{(1 - P) \cdot x}{G}$$

The total tip offset and total cue pivot angle must match the natural pivot length values, so:

$$x = x_B + x_F \qquad \text{and} \qquad \theta = \theta_B + \theta_F$$

Using the second equation and the definitions above:

$$\frac{x}{N} = \frac{P \cdot x}{B} + \frac{(1 - P) \cdot x}{G}$$

Rearranging and solving for the required percentage of BHE gives:

$$P = \frac{B \cdot \left( \frac{G}{N} - 1 \right)}{(G - B)}$$

**With the bridge length at the natural pivot length of the shaft (B=N), the percentage of BHE is 100% (P=1), with no FHE pivot.**

**With a bridge length shorter than the natural pivot length (B<N), the percentage of BHE is less than 100% (P<1), and the FHE percentage completes the total pivot to 100%.**

**With a bridge length longer than the natural pivot length (B>N), and the percentage of BHE is greater than 100% (P>1), with the FHE percentage being the negative of the excess beyond 100%.**