The relationship between cue ball spin and cue tip offset

Linear impulse results in linear momentum:

\[ \hat{F} = mV \]  \hspace{1cm} (1)

The offset (b) of the impulse about the ball center results in angular momentum:

\[ b\hat{F} = I\omega = \frac{2}{5}mR^2\omega \]  \hspace{1cm} (2)

Solving for and equating the impulse from Equations 1 and 2 yields:

\[ \left( \frac{\omega}{v/R} \right) = \frac{5}{2} \left( \frac{b}{R} \right) \]  \hspace{1cm} (3)

The term on the left side of Equation 3 is the spin rate factor (SRF), expressed as a percentage of the natural roll rate of the ball (v/R). The b/R term is the offset factor, expressed as a percentage of the ball radius.

The typical maximum recommended offset to not risk miscues is approximately:

\[ b_{\text{max}} := \frac{9}{16} \text{ in} \quad \text{with} \quad R := 1.125 \text{ in} \]

which corresponds to an offset factor of:

\[ \frac{b_{\text{max}}}{R} = 0.5 \]
The spin rate factors for various offsets are:

\[
\text{SRF}(b) := \frac{5}{2} \cdot \frac{b}{R} \quad \text{SRF}(0\text{-in}) = 0 \quad \text{SRF}\left(\frac{b_{\text{max}}}{2}\right) = 0.625 \quad \text{SRF}\left(\frac{2}{5} \cdot R\right) = 1 \quad \text{SRF}(b_{\text{max}}) = 1.25
\]

- Stun shot: 62.5% of natural roll
- Natural roll: 25% more than natural roll

The maximum spin rate factor observed in HSV A.98-A.109 (in A.106) was:

\[
\text{SPR}_{\text{max}} := 1.37
\]

which, from Equation 3, corresponds to an offset factor (b/R) of:

\[
\frac{2}{5} \cdot \text{SPR}_{\text{max}} = 0.55
\]