Q-Type Forbes Aspheres for Diamond-Turning

EEO is now accepting drawings for diamond-turning using the Q-type Forbes bases

- EEO has developed capabilities to create diamond-turning sag tables directly from Forbes coefficients.
- Profilometer scans can be analyzed directly using Forbes coefficients.
- Surfaces can contain QCON and QBFS forms with any number of coefficients.

- Forbes Aspheres provide optical designers with control that is difficult and time-consuming to replicate using standard even aspheres
  - More easily screen undesired design forms
  - Reduce final system sensitivity
  - Forbes bases are orthogonal, so the designer can change the number of terms without affecting the surface sag
  - Drawings require 1/3 the number of significant digits
  - Coefficients can be meaningfully toleranced
Bases now accepted by EEO

\[ Q^{\text{BFS}} \text{ (mild):} \]
\[
sag(\rho) = \frac{\rho^2 \text{Curv}}{1 + \sqrt{1 - \rho^2 \text{Curv}^2}} + \frac{\rho}{\rho_{\text{max}}} \left( 1 - \frac{\rho}{\rho_{\text{max}}} \right)^2 \sum_{m=1}^{M} a_j Q_{m}^{\text{BFS}} \left( \frac{\rho}{\rho_{\text{max}}} \right)^2
\]

\[ Q^{\text{CON}} \text{ (strong):} \]
\[
sag(\rho) = \frac{\rho^2 \text{Curv}}{1 + \sqrt{1 - (1 + K) \rho^2 \text{Curv}^2}} + \left( \frac{\rho}{\rho_{\text{max}}} \right)^4 \sum_{m=1}^{M} a_j Q_{m}^{\text{CON}} \left( \frac{\rho}{\rho_{\text{max}}} \right)^2
\]

Traditional polynomial (e.g. even asphere):
\[
sag(\rho) = \frac{\rho^2 \text{Curv}}{1 + \sqrt{1 - (1 + K) \rho^2 \text{Curv}^2}} + \sum_{j=1}^{A_{\text{max}}} A_j \rho^j
\]

Diffractive (can be added to any aspheric form):
\[
sag(\rho) = \frac{\rho^2 \text{Curv}}{1 + \sqrt{1 - (1 + K) \rho^2 \text{Curv}^2}} + \frac{\text{DiffrOrder}}{n_1 - n_2} \left( \sum_{j=1}^{C_{\text{max}}} C_j \rho^{(2s+j)} \right) + \lambda \times \text{floor} \left( \frac{1}{\lambda} \sum_{j=1}^{C_{\text{max}}} C_j \rho^{(2s+j)} \right)
\]

References: