Engineering Project 8: Hierarchical Overlay → DPM Predictor (Units / Dies / Bumps)

Problem statement

- Build a hierarchical, data-driven model to predict Defects Per Million (DPM) at the bump, die, and unit levels using overlay and process variation modeled with Gaussian and Rician distributions.

The problem this project solves

- Overlay variation propagates nonlinearly across packaging hierarchies, making DPM estimation difficult with flat, single-level metrics.
- Traditional yield models fail to capture how x/y overlay distributions translate into radial misalignment risk at finer structural levels.
- This project links physical overlay statistics to hierarchical defect outcomes in a scalable, quantitative framework.

Applications

- Package architecture comparison (Fan-Out, Flip-Chip, 2.5D) based on predicted DPM.
- Risk assessment for pitch scaling, bump density increases, and die stacking decisions.
- What-if analysis to quantify DPM sensitivity to overlay control, warpage, and geometry changes.
- Uncertainty-aware DPM forecasting using Monte Carlo propagation of overlay distributions.

Why it's important

- Enables physically meaningful, hierarchy-aware yield prediction instead of single-point metrics.
- Supports informed design and process trade-offs early in package development.

- Scales naturally to real inline metrology data for advanced manufacturing analytics and reliability planning.