# Modeling, simulation and optimization of process with particle size change

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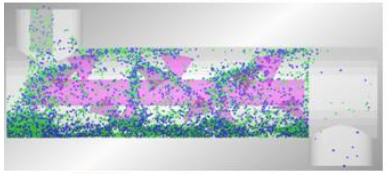
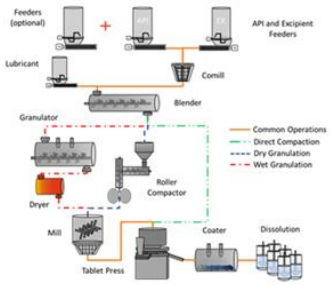
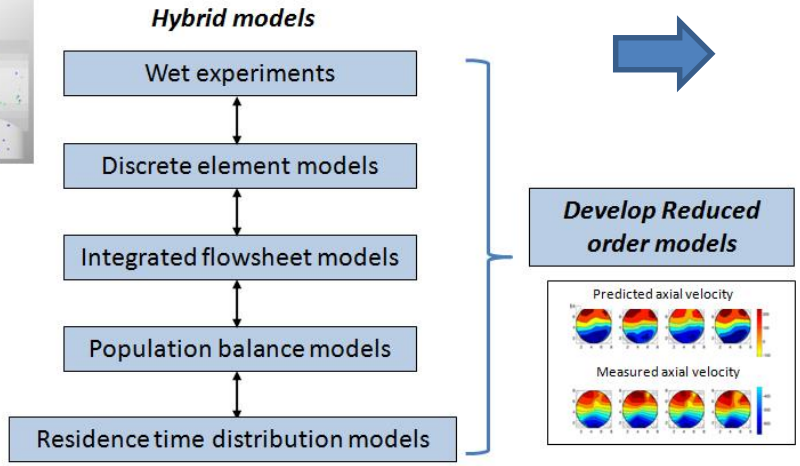
- Develop hybrid/reduced order models for understanding and evaluating pharmaceutical unit operations performance
- **Motivation:**
  - Reduce computational expense from using high dimensional models such as Discrete element model, Population balance model, Integrated flowsheet models etc.
  - Utilize capabilities of different modeling techniques and explore hybrid approach for increased efficiency and accuracy



*DEM for continuous mixer*




*Integrated flowsheet model*




- *Principal component analysis*

If $X_{NxK}$ is data matrix then

$$T_{NxA}^{NEW} = X_{NXK} P_{KXA}^{NEW}$$

**A :** Reduced dimension (<K)

- *Partial least squares regression*

**X = TP' + E ; T = XW***

**Y = TC' + F = XB + F**

Scores: **T, U**

Weights: **W*, C**

- *Kriging, Radial basis functions, Artificial neural networks, HDMR are some other Reduced order modeling techniques*

**Projects:**

- Prediction of flow and friability properties in a continuous conical mill operation
- DEM of comill to develop a mechanistic breakage kernel