

## Workshop (Monday, 05 August, optional event)

01aug19

**10:30 Forum and workshop registration at Purdue's Center for Particulate Products and Processes (CP3)**  
**FLEX Lab, 205 Gates Road; Discovery Park West Lafayette; (D9 on Campus map). Use the Discovery Parking Lot.**

### 11:00 Lab-related short presentations

<b>Carl Wassgren</b>	Purdue University	Research at Purdue's CP3
<b>Sudarshan Ganesh</b>	Purdue University	PAT and systems integration for continuous manufacturing
<b>Paul Mort</b>	Purdue University	Multimodal particle size analysis
<b>Tom Weinhart</b>	MercuryLab	Effect of particle size and cohesion on powder yielding and flow
<b>Sharon Nowak</b>	Coperion K-Tron	Loss-in-weight feeding; importance of feeder accuracy in continuous processes
<b>Matthew Walczel</b>	Alexanderwerk	The power of roller compaction; presentation and demo

### 2:00 Laboratory tours and demonstrations

- **Purdue University's Particle, Powder, and Compact Characterization Laboratory (FLEX Lab) :**
  - high-bay equipment (batch process)
  - introduction to Particle, Powder & Compaction Characterization Laboratory
  - flow properties testing: FT4, shear cell
  - microstructure characterisation: microtomography (Brucker)
  - segregation testing: the SPECTester (demo by Kerry Johanson, Material Flow Solutions)
- **Purdue University's Pilot Plant discussion (Room B36 at POTR):**
  - introduction to the equipment and laboratory
  - PAT: mass flow sensing and composition sensing
  - advanced control and operations management
  - Coperion K-Tron

### 5:00 Conclusion and lessons learned from Purdue

6:00 Welcome Reception at Purdue's FLEX Lab, **Sponsored by Rocky DEM**

# Scientific Conference (Tuesday/Wednesday, 06-07 August)

Neil Armstrong Hall of Engineering, 701 W. Stadium Avenue, Purdue Campus; G5 on the Campus map (West Lafayette)

## Theoretical and numerical aspects:

<b>Jennifer Sinclair Curtis</b> University of California, Davis		Using DEM to develop constitutive models for CFD simulations of particulate flows
<b>Richard Lueptow</b> Northwestern University		Predicting particle segregation in industrial granular flows
<b>Carl Wassgren</b> Purdue University		Contact spreading of liquid between particles in mixed granular systems
<b>Anthony Thornton</b> University of Twente, Netherlands		Multiscale modelling of industrial granular materials
<b>Yu Liu</b>	Dow Chemicals, TX	Modeling granular material segregation using a finite element method and advection-diffusion-segregation equation multi-scale model
<b>Thomas Weinhart</b>	MercuryLab, NL	MercuryCG - from discrete particles to continuum fields
<b>William Ketterhagen</b>	AbbVie, IL	Application of DEM to understand, predict, and de-risk segregation in the manufacturing of pharmaceutical drug products
<b>Daniel Mateo-Ortiz</b>	AbbVie, IL	Continuous powder blending inside a twin screw extruder
<b>Paul Mort</b>	Purdue University	Cohesion as a strategy to control segregation and implications for flowability
<b>Siyang Liu</b>	Vertex	Connecting segregation to rheology for inherently scalable model development
<b>Ben Freireich</b>	PSRI	A review of mixing and segregation in fluidized beds
<b>Zhekai Deng</b>	Northwestern University	Continuum modeling of segregation for polydisperse granular materials in hopper discharge flow
<b>Ivan Christov</b>	Purdue University	Fundamental aspects of continuum modeling of granular diffusion and dispersion in tumbler flow

## **Experimental, industrial and peripheral aspects:**

<b>John Hecht</b>	Procter & Gamble	<a href="#">What we still need to eradicate powder segregation in industrial processes</a>
<b>Michael Gentzler</b>	Merck, PA	Quantification of segregation potential for polydisperse, cohesive, multi-component powders and prediction of tablet die-filling performance. A methodology for practical testing, re-formulation and process design
<b>Parind Desai</b>	GSK, PA	Evaluation of segregation intensity of pharmaceutical blends using near infrared spectroscopy
<b>Jie Ren</b>	Merck, PA	development of a continuous blending process through mechanistic understanding of the shear effect
<b>Hongyang Cheng</b>	University of Twente Netherlands	Bayesian calibration/validation and uncertainty propagation for discrete particle models of granular materials
<b>Tom Baxter</b>	Jenike & Johanson	Separation anxiety (part 1): experimental segregation test methods and their use from development to commercial scale Separation anxiety (part 2): troubleshooting & solving blend and segregation issues in industrial applications
<b>Rohit Kumar</b>	Alkermes, MA	Effect of different powder charging techniques and blender angle on the powder blending efficiency in an IBC blender
<b>Manogna Adepu</b>	Arizona State University	Particle and wall friction in discharging cylindrical hoppers
<b>Kerry Johanson</b>	Material Flow Solutions	What type of mass flow will prevent or limit segregation of powders? Calculation of custom design curves for a particular powder in preselected process geometry
<b>Wyatt Roth</b>	Eli Lilly and Company	industrial perspectives on mixing in a continuous direct compression manufacturing process
<b>Chen Mao</b>	Genentech/Roche	Assessment of powder flow obstruction using principles of continuum mechanics implications in drug product manufacturing
<b>Rohit Ramachandran</b>	Rutgers University	The genesis of content non-uniformity in high-shear wet granulation

**notes:** 1-keynote presentations are highlighted in blue; keynote presentations are 45 minutes in duration and podium presentations are 30 minutes  
2-abstracts and biosketches are posted on the website under the SPEAKERS tab

## Symposium (Thursday, 08 August, optional event)

Neil Armstrong Hall of Engineering, 701 W. Stadium Avenue, Purdue Campus; G5 on the Campus map (West Lafayette)

### motivation

Rotary tablet presses have existed for about a century and evolved into an ubiquitous, sophisticated pharmaceutical processor. Yet, insufficient scientific basis exists to support their design/behaviour and much remains to be known about the attendant challenge of high-speed die compaction. Similarly, the punches and dies which form the tablets are critical, as they control the production performance of a press.

With the advent of pharmaceutical continuous processing at the end of the last century, operational issues such as punch sticking, lamination and capping have come to the forefront and are to be addressed scientifically if the modern rotary tablet press is to become a truly-continuous processor.

In parallel, material-sparing requirements and rational design approaches have increased the profile of press simulators; significant work is now being dedicated to the development of die compaction models which will lead us to the next level of the material-sparing paradigm.

*This 6-hour intense symposium is limited to a small group and gathers presses/compaction experts who attended the Conference and are willing to update the group on their recent findings and research. Critical topics such as punch sticking, compaction models, feeders and PAT aspects will be explored.*

**8:45 introduction: [scientific aspects of rotary tablet presses: design/operation, PAT and die compaction](#)**

**9:00 short, casual presentations/discussions focused on rotary tablet presses, including M&S of die compaction (limited to a small group)**

- Elisabeth Peeters  
Pfizer, CT
- Marcial Gonzalez & Carl Wassgren  
Purdue University
- Anton Kulchitsky & Jerome B. Johnson  
Coupi, Inc
- Anthony Thornton & Thomas Weinhart  
MercuryLab
- Martin Bennett  
Huxley Bertram
- Leo Francis Manley  
Eli Lilly and Company
- Robert Sedlock  
Natoli Scientific
- Jeffery Larson  
AbbVie

**11:00 presentation and discussion of three die compaction numerical models:**

- the modelling challenges of die compaction
- Purdue University
- MercuryLab
- Coupi

**1:30 short presentations (continued)**

the following topics will be presented during the morning & afternoon short presentations:

- using PAT in a tablet press feed frame to support process understanding
- tablet press compression force as a process analytical technology (PAT)
- the effects of production press stiffness on tablet compaction strain rate
- simulation of load-limiting presses using a compaction simulator
- the discrete nature of punch sticking and how to characterise it
- powder handling/feeding and mechanical aspects of rotary tablet presses

**3:00 conclusion of the Symposium and end of Forum**