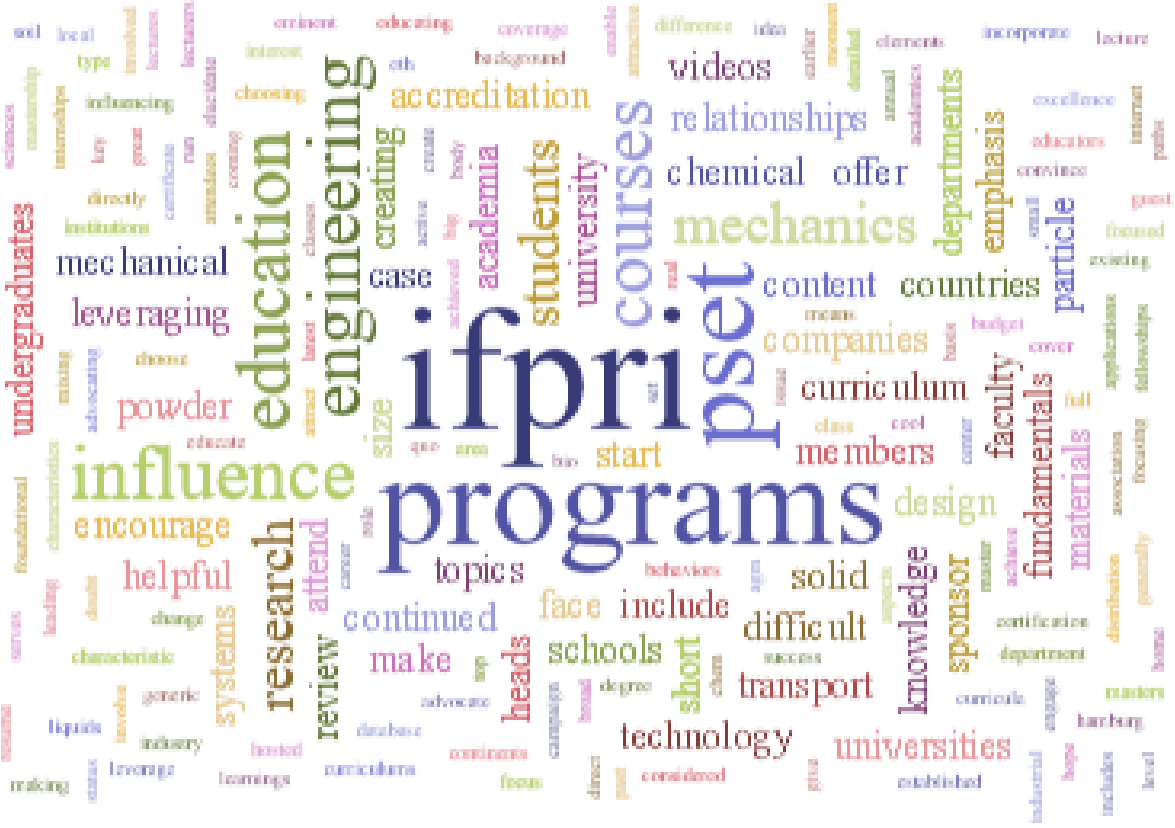
IFPRI Education Update, 2023 AGM

Paul Mort, Purdue University Materials Engineering, Center for Particulate Products and Processes



Agenda

- ~~Powder Technology IFPRI Collection~~
- IFPRI Education context
- Round Table Review
- Native Content
- Feedback!

Industrial & academic collaboration

IFPRI Education Context

- Education Workshop (2017, Litster et al)
- Ad-hoc discussions
  - Michaels, Murtagh, Louge, Bell, Pasha, Jacob, Mort…
- AGM 2019 presentation (Murtagh et al):
  - Where does PS&E belong?
  - Baseline for PS&E in industrial practice
  - What can IFPRI do to promote PS&E education?
  - ✓ Reco: Renew/revise Merrow report
- Education Round Table (2021)
  - Advocacy (Ninna Jokil, IFPRI Leadership)
  - Survey and analysis (Bell, Jacob, Mort)
- Native CONTENT:
  - UD MEPT notes (Michaels, Diemer et al)
  - Edinburgh courses:
    - Practical rheology (Royer)
    - Particle technology (Sun, Murtagh)
  - Purdue MSE512 modules (Mort)

IFPRI Education (and Advocacy) Discussion

June 23, 2019 (Burlington AGM)

Marty Murtagh, Massih Pasha, Michel Louge, Willie Hendrickson, Jim Michaels, Paul Mort, Tim Bell

Curriculum

Offer small "inducement grants" to prepare and teach particle technology subjects.

- Recipients would report to IFPRI on results
- IFPRI would critique and endorse favored outcomes

Discuss forward-looking vs. current industrial needs in education

- Faculty and some/most students would be most motivated by future needs (additive mfg, drug development, etc)
- Industry may favor training in existing technologies and problems, which is where the money is most obvious.

Short Courses

Identify gaps amongst existing short course offerings:

- Content
- Instruction technique (lecture vs. demo vs. lab)
- Venue – hotel, university, industrial (Aveka, etc)
- Instructor skills and reputation

Motivations for IFPRI

- Courses would serve as IFPRI recruiting tool and member benefit.
- Leverage/expand existing PT programs (Delaware, Purdue…)
- Program might be self-funded via tuition

Distance Learning

- Distance learning programs can be profitable for universities and lower cost for students
- Distance learning program structures are evolving rapidly and growing quickly
- Potential to reach industrialists as part-time students
- IFPRI could endorse a program structured with our input.

Advocacy and Outreach (publish?)

New Merrow report, "Problems and Progress in Particle Processing: A Fresh Look", an update of 1980's report with broader data set.

Problems with solids handling and processing persist.

No analysis of effects of PAT and/or modeling advances.

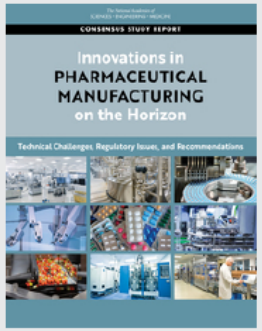
Concern regarding industrial R&D focus: short vs. long term, but little supporting data.

Advocacy and outreach

"Don't underestimate your ability to influence others"

Consider IFPRI's influence in advancing R&D and manufacturing, for example:

- Best practice guidelines;
- Standards;
- Regulatory...



Innovations in Pharmaceutical Manufacturing on the Horizon: Technical Challenges, Regulatory Issues, and Recommendations (2021)

DETAILS

120 pages | 8.5 x 11 | PAPERBACK

ISBN 978-0-309-08867-1 | DOI 10.17226/26009

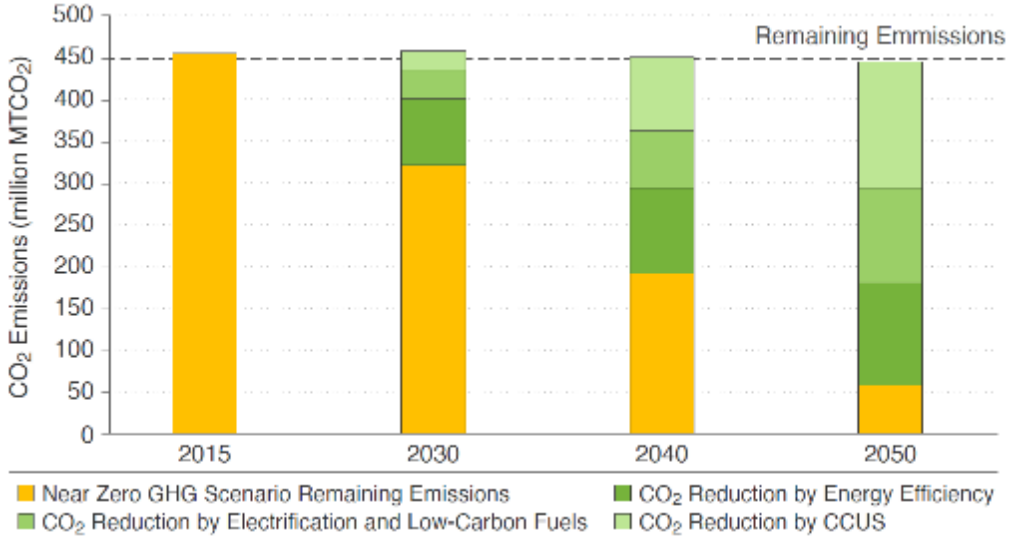
CONTRIBUTORS

Committee to Identify Innovative Technologies to Advance Pharmaceutical Manufacturing; Board on Chemical Sciences and Technology; Division on Earth and Life Studies; National Academies of Sciences, Engineering, and Medicine

SUGGESTED CITATION

National Academies of Sciences, Engineering, and Medicine 2021. *Innovations in Pharmaceutical Manufacturing on the Horizon: Technical Challenges, Regulatory Issues, and Recommendations*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26009.

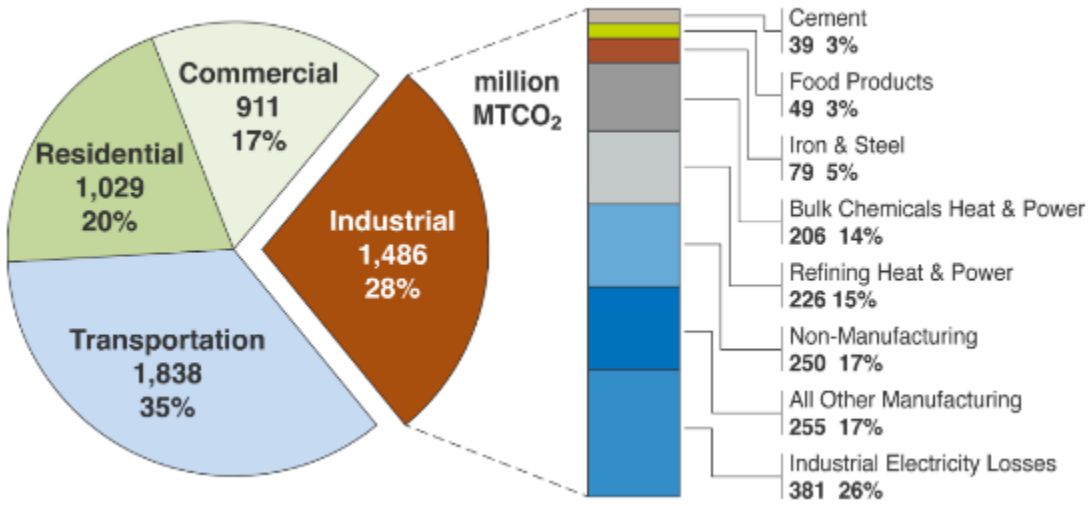
US DOE call: Clean Energy Manufacturing Institute



CO_2 emissions (million MT/year) reduction across decarbonization pillars:

- Efficiency,
- Electrification & Low Carbon Fuels & Feedstock,
- Carbon Capture, Utilization & Storage

AMO Industrial Decarbonization Roadmap, under review.



U.S. energy-related CO_2 emissions (million MT) by economic sector and a breakout by industrial subsector in 2015.

Particle Science, Engineering & Technology

Workforce of the Future:

- Anticipates shift away from carbon-based economy.
- What new skills are needed in the workforce of the future?
  1. Undergraduate, community & technical school students,
  2. Continuing education to help workers earn and retain professional certifications,
  3. Define career pathways and resources for education-to-work (entry-level pipeline), currently employed (upskilling), and dislocated (unemployed).

DE-FOA-0002564: Request for Information on Establishing a New Manufacturing Institute, July 2021

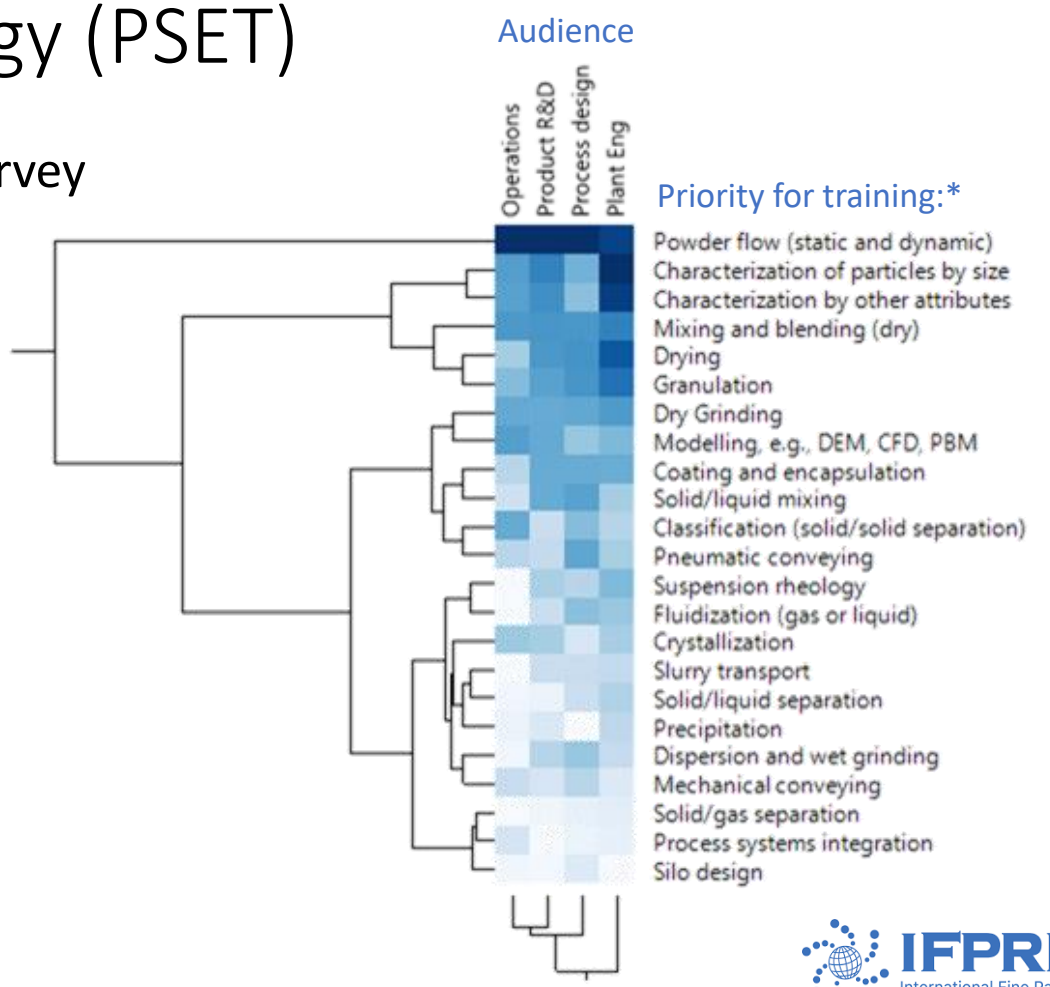
Industry Priorities for Education in Particle Science, Engineering & Technology (PSET)

2021 IFPRI Round Table; 2-way cluster analysis of survey responses (N=24) from IFPRI industrial members:

- Powder Flow cited as the top priority
- Characterization, Mixing, Granulation, Drying and Milling are high priorities.

Preferred mode of delivery:

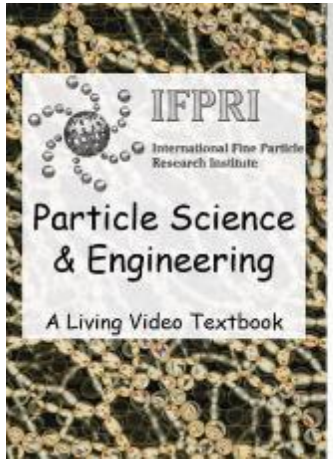
- Pre-recorded modules:
  - < 30 min
  - < 1 hour
- Distance learning (zoom, webex, etc)



IFPRI
International Fine Particle Research Institute

*Focus on continuing education, i.e., training within industry

Native content



PURDUE UNIVERSITY

Particulate	MSE512 Powder Processing	
	Making particles	Making products

• Particulate = finely-divided solid
  ○ Colloid
  ○ Powder
  ○ Granule
• Dry flow (powder, granules)
• Suspension rheology (colloid, fine particles)
	• Production from raw material (ore, gas, oil…)
	  ○ Extraction
	  ○ Refining
	  ○ Synthesis
	• Crystallization/ precipitation:
	  ○ Growth
	  ○ Aggregation
	• Comminution, size reduction
	• Granulation:
	  ○ Roll-compaction
	  ○ Mixer
	  ○ Fluid bed
	  ○ Spray drying
		• A mixture of particles
		  ○ Dry granular mixture
		  ○ Fine powder or colloidal dispersion
		• Making a useful shape with controlled composition & structure (micro, meso)
		  ○ Shape, composition (macro)
		  ○ Properties (micro, meso)
		  ▪ Particle
		  ▪ Local ensemble, “fabric”
		• Particles used in processing:
		  ○ Catalysis (packed or fluid bed)
		  ○ Peening (surface treatment)

Characterization	Systems integration: flowsheet modeling, control, optimization	

UNIVERSITY OF DELAWARE

2018-2019 Graduate Catalog [ARCHIVED CATALOG]

[ARCHIVED CATALOG]

PARTICLE TECHNOLOGY (MEPT)

Requirements:

The program is designed to be completed in one year. It requires completion of 30 credits, of which 24 are in courses taught on the UD campus in Newark, DE. The MEPT program can also be completed as a part-time student, and all MEPT coursework can be completed remotely via distance learning.

Eighteen credits are encompassed by core courses that cover the key concepts of particle technology:

- CHEG 670 - Particle Rate Processes (3cr.)
- CHEG 671 - Particle Transport (3cr.)
- CHEG 672 - Mathematics of Particle Systems (3cr.)
- CHEG 673 - Particle Properties and Characterization (3cr.)
- CHEG 674 - Particle Processing Operations (3cr.)
- CHEG 675 - Particle Product Engineering (3cr.)

Relevant Approved Electives

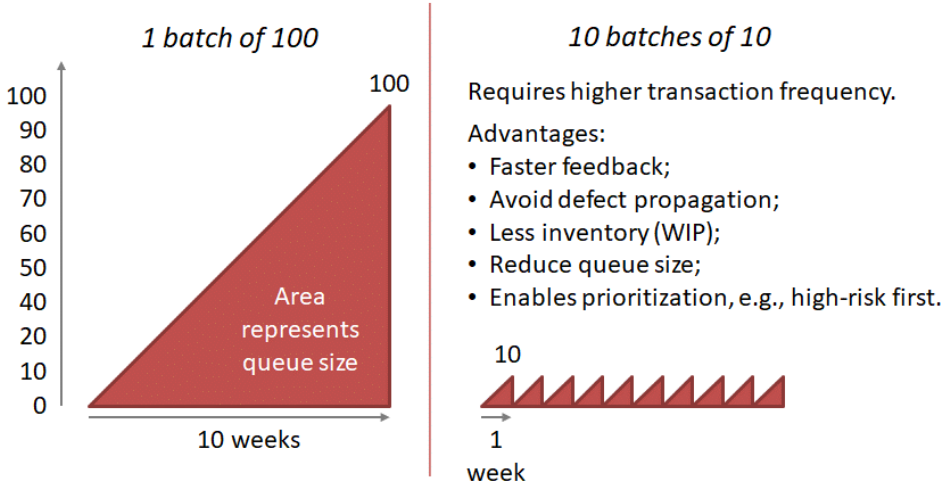
Four of these courses are taught in the fall semester and two in the spring semester. In addition, students take six credits in the form of relevant approved electives. The capstone is the industrial internship (6 credits), which is performed at one of a number of participating companies:

- CHEG 684 - Particle Technology Internship (6cr.)

Last Revised 2014-2015 Academic Year

Feedback!

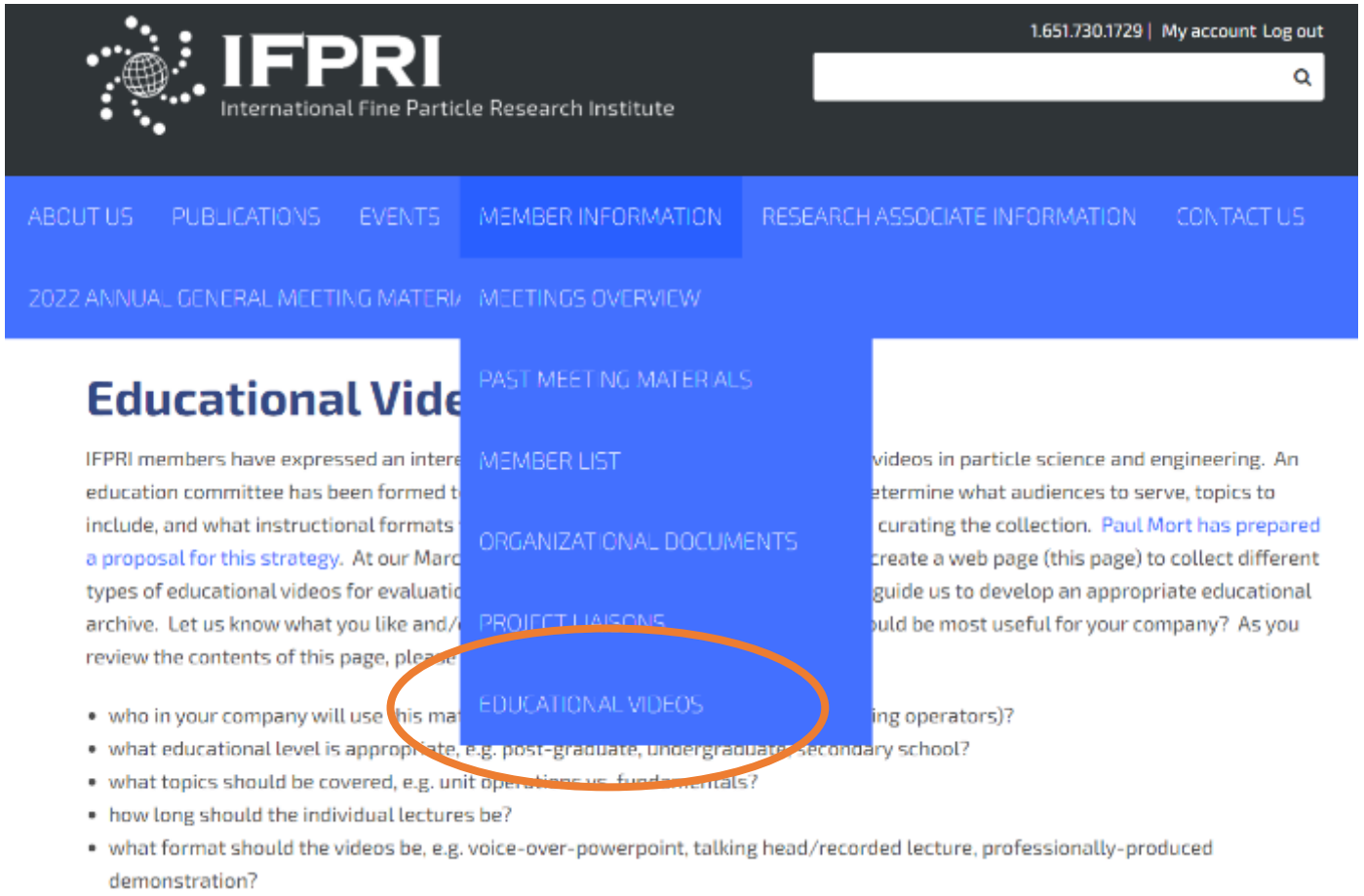
Education as Product Design?



D. Reinertsen, The Principles of Product Development Flow, Second Generation Lean Product Development, 2009.

- Opportunity to refine production of content.
- Narrated video (module priority)
- Knowledge check
- Data analysis tools
- …

What else?



Purdue MSE 512, Powder Processing, Fall ‘23

Foundation

- Interfacial phenomena: surface forces
  - … electrostatic, steric stabilization
  - … Brownian motion, suspension stability
  - … weakly-attractive systems, colloidal gels
  - … dense suspensions, pastes
- Characterization
  - … image analysis – size and shape
  - … size and shape distributions – display and analysis
  - … surface area, sorption isotherms
  - … wetting, surface tension, capillary forces
  - … porosity, permeability
  - … moisture analysis
- Powder Flow
  - … quasi-static flow, bin design
  - … dense flows
  - … gas/solid fluidization
  - … fluidized drying
- Mixing and scale of scrutiny
- Shrinking core reaction models

Unit ops / Processing

- Feeders, mixers
- Size reduction: wet and dry milling
- Precipitation and sol-gel
- Crystallization
- Separation & filtration
- Slip casting (ceramics)
- Spray Drying
- Binder granulation, high-shear
- Fluidized bed granulation
- Dry granulation, roller compaction
- Uniaxial compaction
- Extrusion, pastes
- Sintering
- Additive manufacturing
- Systems integration / Product design

Industrial & academic collaboration