



Current State of Particle Technology Education

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Universities of Surrey & Birmingham

and

Institution of Chemical Engineers



UK landscape

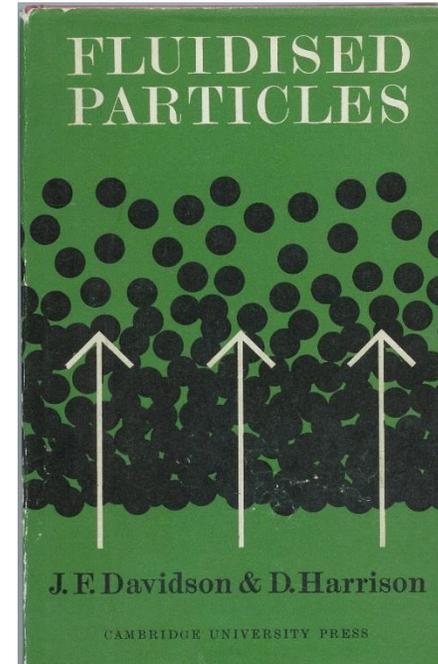


- All UK Chemical Engineering departments (~30) accredited by IChemE at BEng/MEng level – meaning students obtain academic part of Chartered Engineer (CEng) professional qualification
- Accreditation is “outcomes based”, i.e. does not prescribe X hours of subject Y, and is assessed by a mixed academic/industrial panel; includes a major Design Project
- Most departments also offer several stand-alone Masters degrees, but none (?) dedicated to Particle Technology
- Particle Technology also taught in Civil Engineering, Mechanical Engineering (e.g. food), Physics (e.g. “soft solids”)....

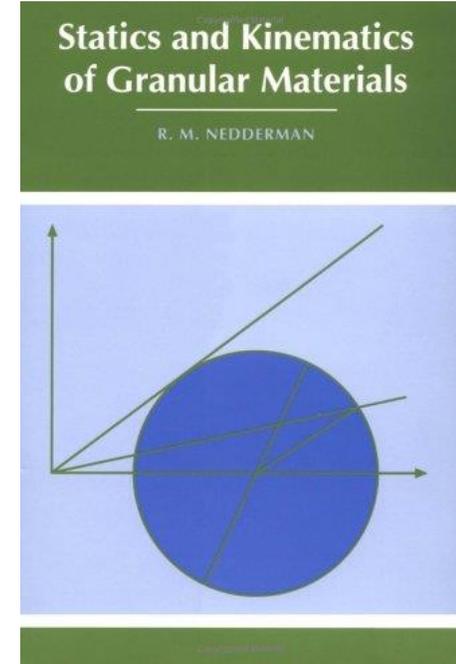
UK accredited universities

- Aberdeen, University of
- Aston University
- Bath, University of
- Belfast, Queens University
- Birmingham, University of
- Bradford, University of
- Cambridge, University of
- Edinburgh, The University of
- Heriot-Watt University
- Lancaster, University
- Leeds, University of
- London, Imperial College
- London, South Bank University
- London, University College (biochemical engineering)
- London, University College (chemical engineering)
- Loughborough University
- Manchester, The University of
- Newcastle upon Tyne, University of
- Nottingham, The University of
- Oxford, University of
- Paisley, University of the West of Scotland
- Sheffield, The University of
- Strathclyde, University of
- Surrey, University of
- Swansea University
- Teesside, University of
- + provisionally....
- Chester, University of
- Huddersfield, University of
- Hull, University of
- Wolverhampton, University of

Influence on content: the “Cambridge School”



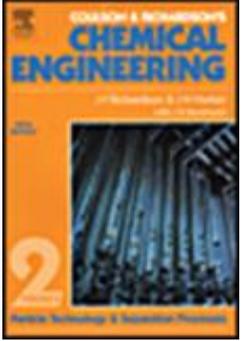
Big industrial
interest, e.g.
Shell & BP



Mathematical
continuum
approaches

Influences on content: Coulson & Richardson

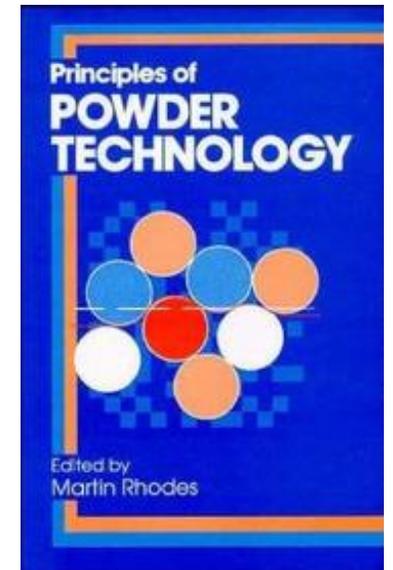
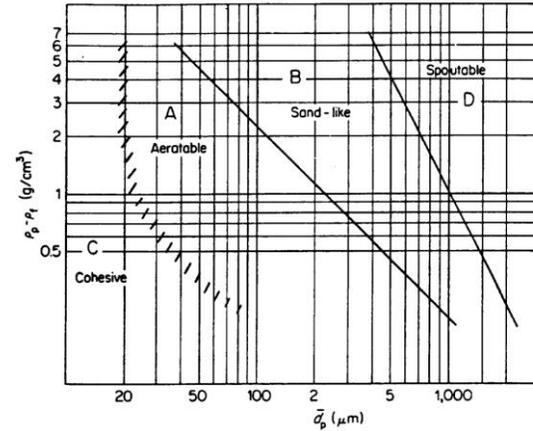
– empirical approach, oriented towards design – wide coverage of particle technology. Vol 2 (of 4): Particle Technology and Separation Processes (5th edn. 2002)



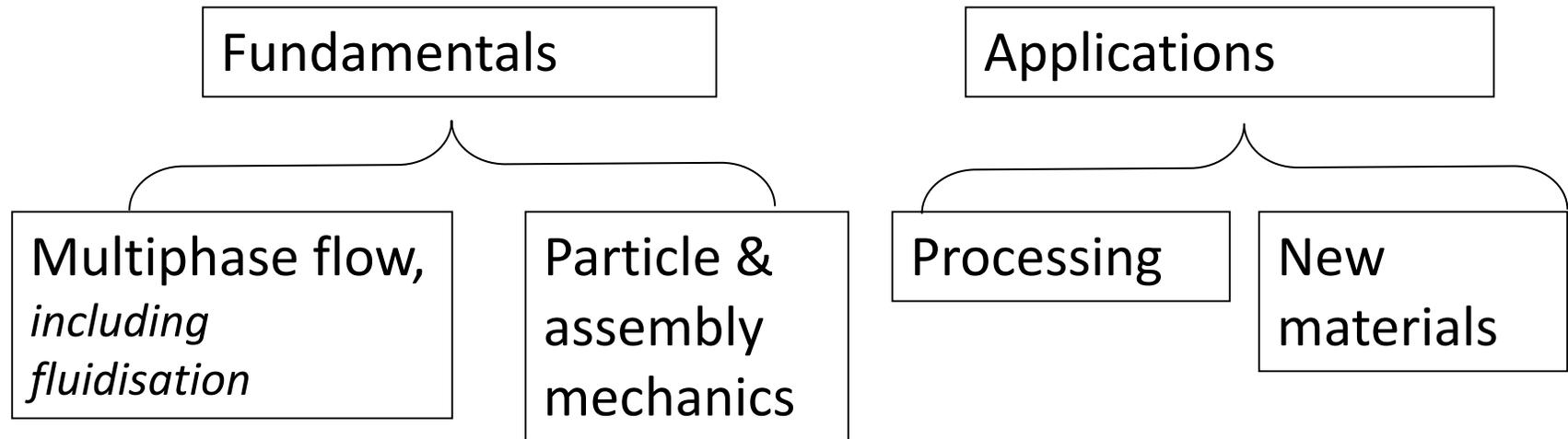
- Particulate Solids
- Particle Size Reduction and Enlargement
- Motion of Particles in a Fluid
- Flow of Fluids through Granular Beds and Packed Columns
- Sedimentation
- Fluidisation
- Liquid Filtration
- Membrane Separation Processes
- Centrifugal Separations
- Leaching
- Distillation
- Absorption of Gases
- Liquid - Liquid Extraction
- Evaporation
- Crystallisation
- Drying
- Adsorption
- Ion Exchange
- Chromatographic Separations
- Product Design and Process Intensification

Influences on content: the Bradford School/ Geldart/Rhodes

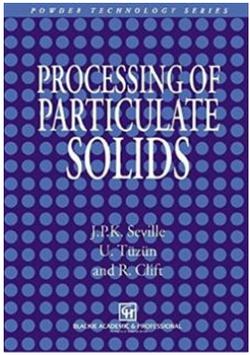
- Rooted in empirical observation (see also Loughborough, Scarlett, etc.)
- Influence on industrial practice through CPD courses: Svarovsky, Bailes
- Again, fluidisation is a strong interest, led by industrial practice



The scope of Particle Technology (personal view)

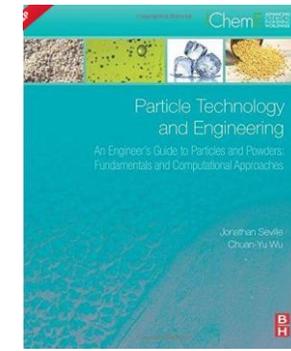


UK chemical engineering depts.:	Strong	Patchy	Empirical/ Design focus	Weak
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Seville, Tüzün & Clift, *Processing of Particulate Solids* 1997

What do we teach? Choices! Balance!



Seville & Wu, *Particle Technology and Engineering* 2016

- Particle characterisation
- Particles in fluids Big!
- Particle mechanics New!
- Characterisation of bulk mechanical properties
- Assembly mechanics Early attempt at DEM.
- Fluid-particle systems
- Gas/solid separation
- Storage and discharge of bulk solids

Includes hydraulic conveying.
“Puts fluidisation in its place.”

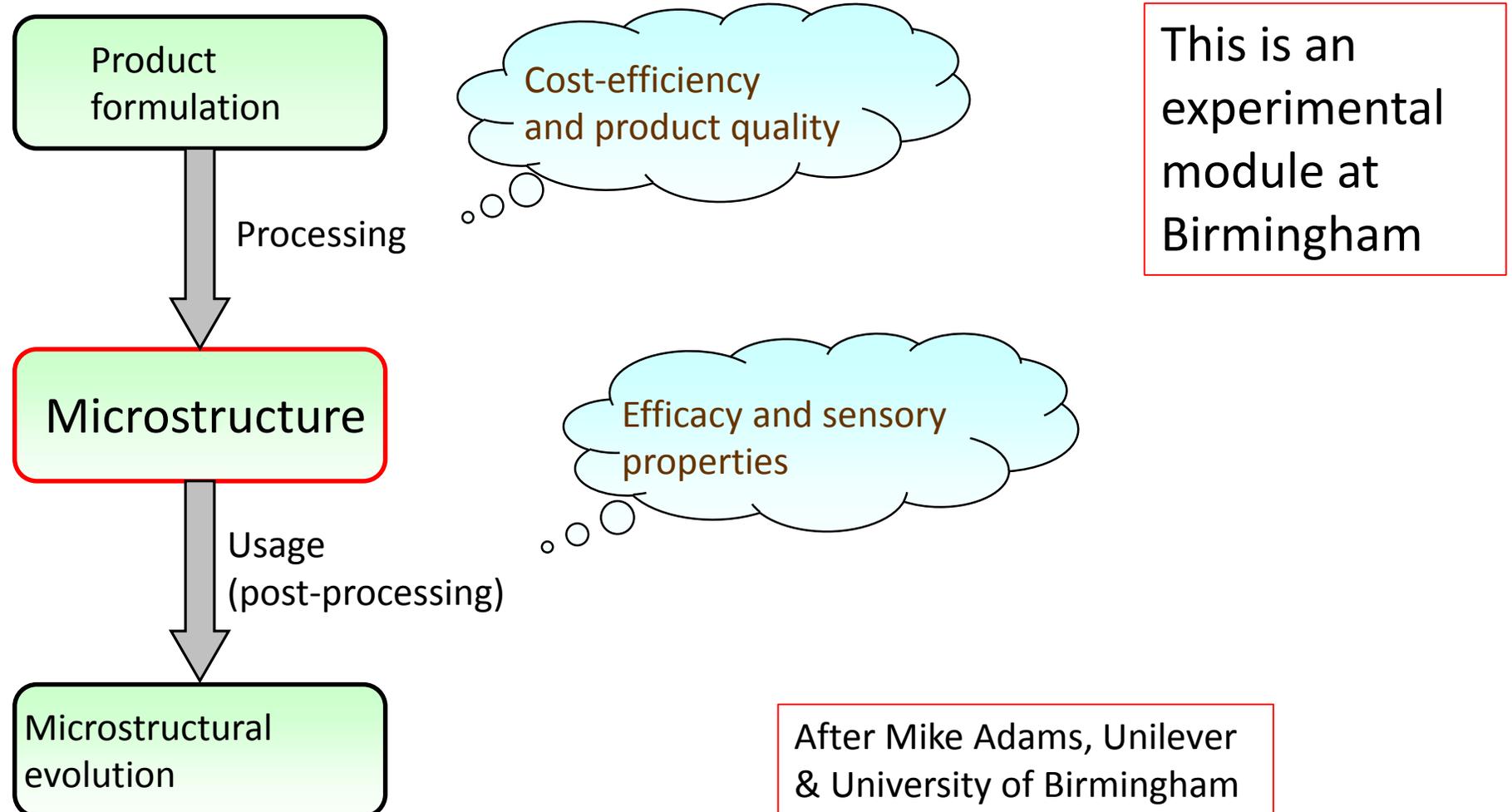
- Bulk solid characterisation Experimental stuff
- Particle characterisation
- Particles in fluids Simplified
- Gas-solid systems Splits “systems” into two. Introduces rheology. Omits hydraulic conveying.
- Liquid-solid systems hydraulic conveying.
- Mechanics of bulk solids Simplified
- Particle-particle interaction
- Discrete element methods
- Finite element modelling

New!
Computational modelling!

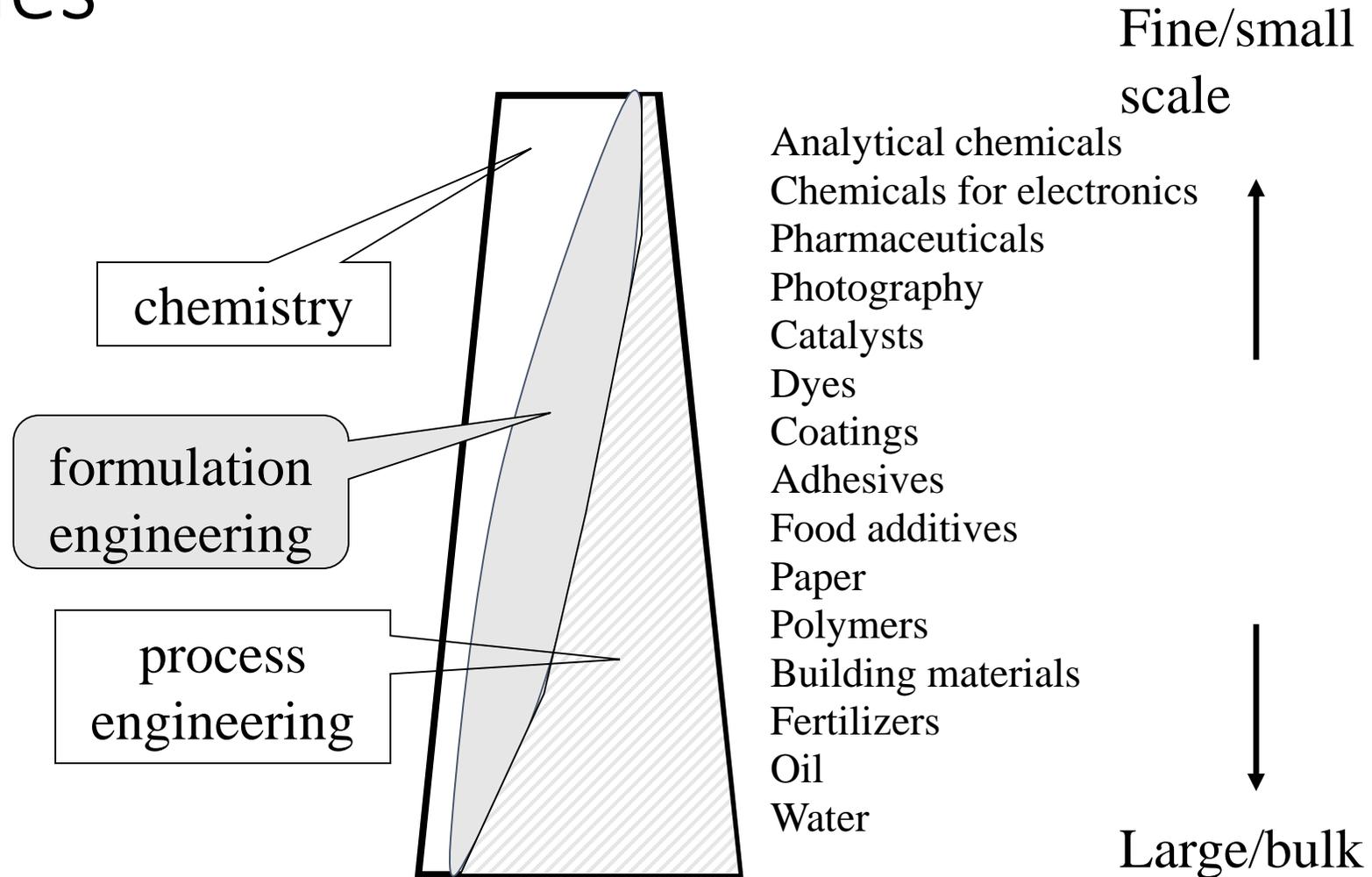
Problems

- Balance between fundamentals and practice
- Industrially-relevant example problems (see Litster's book)
- Depth of fundamental solid mechanics (see Adams, Thornton...)
- Teaching computational techniques effectively/appropriately
- Pneumatic (& hydraulic?) conveying without empirical fixes
- Colloid & interface science – how much?
- Non-Newtonian rheology – how much?
- Aerosol science – how much?
- The nanoscale
- Relationship to product engineering....

Relationship to product engineering/ "formulation"



Formulation Engineering in the process industries



After Wesselingh