Design Toolbox for Energy Efficiency in the Process Industry

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CPSE

Who we are

- **Multi-institutional research centre**
  - Imperial - Chemical Engineering, Computing, Earth Science & Engineering, Electrical Engineering
  - UCL - Chemical Engineering

- **World-class departments at Imperial & UCL**
  - Multi-disciplinary academic staff from a wide range of disciplines with international reputation
  - Excellence in research; cf. UK Govt. Research Assessment (RAE)
What we do
– Managing Complexity

- We perform research and develop integrated models, methodologies and tools to enable scientists, engineers and managers understand, capture, operate and manage complex, multi-scaled natural, engineering and industrial systems through
  - Requirements and functional analysis
  - Modelling and design
  - Control
  - Simulation
  - Optimisation
  - Experiment Design
  - Visualisation
Multi scale systems modelling and engineering

Recognition of length and time scales
CPSE Research across multiple size and time scales

- From nano-scale (molecular) to micro-scale (particles, crystals) to meso-scale (materials, equipment, products) to mega-scale (supply chain networks, environment)

- Integrated modelling, design and optimisation where possible
Core competencies
- Managing Complexity

- Modelling and simulation
- Optimisation
  - Optimal design and operation
  - Optimisation under uncertainty
  - Risk management
- Control
Generic Research Programme

- Product and process design
- Process operations and supply chain management
- Control and measurement
- Modelling and numerical methods
Complex Interactions

Natural Resources

Process Industry

Heat and Power Generation

Utilities

Energy

Products

Emissions

Waste

Society

Waste

Environment

Emissions
Systems Engineering Approaches

- **Improve** Energy Efficiency and Reduce Environmental Impact

- **Design** Innovative Process and Energy Systems
Multi-objective Optimization

- Cost
- Energy Consumption
- Environmental Impact

Move the Pareto Curve

Not Noninferior

Traditional Process

Improved Process

Utopia
Process Synthesis and Design

- The arrangement of unit operations is not unique
  - Process intensification, e.g., hybridisation
  - Heat Integration
    - Controllability
Process and Energy Systems Integration

- Location and quantification of streams of low, medium and high grade energy demand
- Modelling discrete decisions
- CHP
  - Sequential design strategy with process
  - Operability
  - Assess various sources for energy
Process Operability

- Interactions of design and control
  - Process Synthesis + Energy Integration
- Dynamics + Disturbances
- Model-based control
  - Stability
  - Multi-parametric programming
- Flexibility
Trade-off Analysis

- Energy – Cost – Environmental Impact
- Process Synthesis and Design
  - Life Cycle Analysis
  - Sustainability
Design Toolbox

Process Synthesis & Retrofit/Design

Process and Energy Systems Integration

Energy-Environmental Impact-Cost Trade-off Analysis

Process Operability Analysis
CPSE Industrial Research Consortium