

Next Generation Reaction Platforms				
Challenge	State-of-the-art	Short term	Medium term	Long term
<a href="#">Reactor Platforms</a>	Lab batch reactors are pervasive as easy to use and reliable, but not scalable and limited access to range of synthetic parameters. Flow reactors, e.g. Oscillatory Baffled Reactors, emerging, but not widely used due to perceived complexity	Well characterised, easy to use 'plug and play' meso-scale flow reactors	Self-reconfigurable reactors covering 90% or more of chemical applications	Universal Synthesiser: Modular, reconfigurable reactor platform that is reliable, scalable, adaptable, automated, pervasive, covers nearly all chemical applications, allowing access to a wide parameter space for a range of materials, e.g. metastable states
		Laboratory flow reactors and ancillary components that can handle slurries and solids	Low cost lab-on-a-chip devices combining a range of unit operations exploiting innovative fabrication techniques such as 3D printing	
<a href="#">Intelligent Feedback Control</a>	Emerging area that currently involves application of existing control technology in the laboratory and in particular in discovery that is routinely used in industry today	Intuitive software and open, multivariable control and acquisition platform for synthesis automation. Pervasive data logging	Small scale supercritical fluid reactors. Address engineering challenges in supercritical CO2	Intelligent feedback controllers with on the fly reaction analysis driving self-building reaction models automating discovery, process optimisation and work up
		Standardised, easy to use and low cost probes and flow cells. Employ innovative fabrication techniques	Smart, 'universal' molecular probes integrating new analytical techniques and time resolved measurements	
<a href="#">Microfluidics, Lab-on-a-chip</a>	Microfluidic devices for reactions commercially available, but can be costly to redesign. Barrier to entry to the uninitiated, in easy only for single-phase systems	Capturing kinetic information out of the box to support scale up	Development of smart probes and algorithms for near real time molecular structure elucidation. Use this as feedback to control direction of reaction by manipulating synthetic parameters	Microfluidic systems with integrated reactors, separators, analytics, optimisation
		Miniaturisation of key analytical techniques, e.g. low cost mass spec on a chip or low cost in-line NMR	Alternative energy vectors introduction (light, micro-wave, ultrasound). Topology, surface heterogeneity effects. Confined geometries thermo-dynamics	
<a href="#">Networks of reactors</a>	Certain commercial lab-scale reactors can be linked together for solution transfer from one reactor to the next	Well characterised, easy to use 'plug and play' microfluidic flow reactors with integrated ancillary components such as pumps, flow cells, etc.	Fully characterised, multiphase hydrodynamics	Reconfigurable multi-unit operation reactor networks for complex multi-step synthesis incl. reactors, analytics and purification
		Innovative fabrication techniques such as 3D printing for microfluidic and lab-on-a-chip devices	Handling and transferring of metastable solutions	
<a href="#">Purification</a>	Purification almost an afterthought as existing approaches are not considered together with the reaction at hand. Solvent switching, reuse and recycling not fully addressed currently	Integrated, low cost liquid/solids handling and preparation system. Handling and transfer of reactants	Integrated synthesis-purification/separation and pre-formulation at early stages	Adaptable, sustainable and in-line separation/purification module with data logging. The goal includes modelling tools and controller development for high throughput work-up design
		Novel methods for reaction-separation including counter current chromatography, micro distillation, micro extraction, flow crystallisation. Challenge also tracks development of modular reactor platforms above	Low cost sustainable techniques and tools with new media incl. small scale supercritical fluid separators, ionic liquids, scavengers	
		Scale down tools used in process development and engineering for use at early stages of development		