Roadmapping Quantitative Understanding of Cleaning and Decontamination

Workshop Dates   **Tuesday 20ᵗʰ-Thursday 22ⁿᵈ April 2021**

Post Workshop Day   **TBC X September 2021**

Organisers

Ian Wilson	University of Cambridge
Julien Landel	University of Manchester
Graham Christie	University of Cambridge
Peter Fryer	University of Birmingham
Ian Hall	University of Manchester
Kath Whitehead	Manchester Metropolitan University

This workshop springs from the activity of the UK Fluids Network Special Interest Group on the Fluid Mechanics of Cleaning and Decontamination (SIG10). This group successfully brought together more than 100 UK and international academics working on fluid mechanics aspects of cleaning and decontamination (mainly in applied mathematics, chemical and mechanical engineering, and chemistry) with industrial colleagues from the nuclear, pharmaceutical, defence, device and fast-moving consumer goods sectors over the three years of the UK Fluids Network programme.

Venue

The venue workshop is Jesus College, Cambridge. Cambridge has excellent public transport connections (rail, road and coach) to the rest of the UK as well as internationally through London's airports, particularly Stansted. The College opened its new West Court facility in 2018, with state-of-the-art digital presentation facilities in the Frankopan Hall, as well as good quality accommodation, breakout rooms and dining facilities. The Frankopan Hall facilities will allow live streaming and interactive presentations for delegates who are unable to attend in person or guest lecturers who chose to participate remotely rather than engage in significant travel.

Area of research

Cleaning and decontamination are ubiquitous operations in the home, healthcare and industry. The removal of unwanted residues from surfaces in order to avoid cross-contamination between products (*e.g.* in the kitchen, food or pharmaceutical manufacture), the removal of fouling layers to return surfaces to their original condition or level of performance (*e.g.* from windows, walls or heat exchangers), or the elimination of organisms and biofilms from surgical instruments (*e.g.* in healthcare) have historically been tackled by 'tried and tested' approaches which have been developed over time.

Such empirical approaches are unlikely to be suitable for the new cleaning and decontamination challenges which the UK and many other nations face, which include

(a) **New soils and surfaces.** The food industry is subject to continuous innovation as it seeks to supply nutritious food subject to evolving guidance on ingredients, allergens and consumer requirements. For example, the replacement of saturated fats by unsaturated fats leads to cooking deposits with different chemical characteristics, for which existing removal methods may not work. Elsewhere, the National Health Service (NHS) and other healthcare providers are regularly challenged by different organisms comprising the hygienic status of patient facilities. Innovative materials and equipment employed across many industrial sectors also

constitute new cleaning challenges. For instance, the miniaturisation of test devices in healthcare reduces easy access of cleaning formulation through increased pressure loss.

(b) **Dangerous soils**. The poisoning of Sergei and Yulia Skripal in 2018 was followed by many months of hazardous, costly and complex effort to decontaminate the Skripal's house and other items and locations which had come into contact with the Novichok substance. The UK nuclear industry faces a range of new cleaning and decontamination challenges associated with the decommissioning of reactors and fuel reprocessing plants. Determining how to clean these effectively without extensive testing is critical as the materials used to clean the surfaces are themselves contaminated: trials are very costly in time and resources. There is a general need to identify suitable techniques for such soils to achieve the required extent of removal while minimising the amount of waste generated.

(c) **Limited resources.** Many cleaning operations employ large volumes of clean water, often heated and often containing cleaning agents. The sustainability of many food manufacturing operations is determined by the time spent cleaning (reducing productivity) and the cost of providing, preparing and treating this water. A dairy typically consumes 3-6 litres of fresh, drinking quality water to produce one litre of milk. In areas of high water stress, where potable water is in short supply (such as military operations in arid environments, or Southern Europe), cleaning diverts water away from food production or drinking.

Experience-based knowledge has been summarised in qualitative measures such as Sinner's Cleaning Circle and the 'Cleaning Map' of Fryer and Asteriadou which appear in industry guidelines such as those provided by the European Hygienic Equipment Design Group [EHEDG] and the US equivalents.

There is a pressing need for **quantitative models** based on **mechanistic understanding** to be developed, as these will allow:

(i)   Existing cleaning operations to be optimised using evidence-based predictive models, reducing resource consumption;

(ii)   New installations to be designed, at different scales, using rigorous methods to transfer findings from one case to another;

(iii)   For new soils, identification of underlying mechanisms and models will allow cleaning strategies to be developed with a minimum number of (expensive and/or hazardous) trials, as well as results from existing trials to be evaluated for future applications;

(iv)   For challenging soils, expertise obtained in other industrial sectors can be translated.

It has become evident that cleaning and decontamination are topics with much, diverse, activity but little overall strategy. The SIG 10 networking activity has identified the following needs:

(i)   UK plc faces major challenges relating to cleaning in order to achieve existing goals in healthcare, security, industrial decommissioning and manufacturing sustainability.

(ii)   There is a wide range of activity within UK academia and industry sectors, which would benefit from being mapped. A public archive of results would be very helpful, such as an extended version of the archive on the SIG workshop at https://www.sig10-cleaning-decontamination.net/resources.html.

(iii)   Translation of learnings and methods has been promoted by activities such as the SIG10 network. Nevertheless, there is scope for more, which would be best served by the generation of a strategic roadmap which would provide the basis for a national programme along the lines of a Grand Challenge or multi-site Doctoral Training Programme application.

The aims of the workshop are:

(i) To map expertise and current activities in the area of cleaning and decontamination in the UK and beyond, in all relevant disciplines, and particularly those where quantitative methods are employed as this supports the transfer of solutions or approaches from one field to another.

(ii) To provide a forum where industrial and governmental stakeholders can share aspects of future needs, both immediate and long term (without committing to resources).

(iii) To identify strategic needs for research, which could take the form of modelling methods, measurement techniques, socio-economic trends, or metrics for assessing and quantifying the impact of cleaning and decontamination operations and challenges.

(iv) To ensure that the workshop materials will be available as an archive for workers in the field.

Workshop programme

The workshop will take the form of a 2.5-day physical meeting in Cambridge (Tuesday 20th -Thursday 22nd April 2021 followed by a 1-day web-conference of the organisers in X September 2021 where the summaries will be finalised. The Workshop Schedule is appended.

Day 1 will focus on establishing the state of the art (or science) in related disciplines, with a series of keynote presentations by invited speakers on topics ranging from mathematical methods to experimental techniques and data methods. These will be interspersed by sessions with short oral presentations by active researchers in order to highlight ongoing work, and ferment networking. The emphasis will be on current work. Whereas the keynote presenters will be invited, there will be an open call for the short oral presentations, particularly from young researchers active in the area(s).

Day 2 will focus on challenges, with invited presentations from industry (including food, pharma and nuclear), government (e.g. DSTL, DEFRA) and services (e.g. water, hospitals). Each presentation will be followed by a discussion of the quantitative elements involved, focusing on gaps in existing science and issues arising in testing, modelling and resources.

Day 3 will start with a structured expansion of the material presented on Days 1 and 2. The delegates will be split into smaller groups, each led by a facilitator with a notetaker.

Task 1 will be to glean additional input related to the presentations, to build a comprehensive overview of the topics. This will be added to the summaries which will be posted on the archive site.

Task 2 will be to identify priorities in research and future work for the roadmap, and noting where the following apply:

- Science limitation – the mechanisms are not understood
- Theoretical limitation – the methods for quantifying or predicting cleaning are not understood
- Resource limitation – resources are not available, or the demand needs to be reduced
- Organisational limitation – an acceptable framework (political, social, economic) is needed

The schedule contains the speakers who are being approached to deliver keynote presentations and industry/government challenges.

The maximum l number of delegates (subject to COVID-19 guidelines) has been set at 55, with targets of 20 from industry and government, 20-25 established researchers, and 10-15 early career researchers.

Workshop Schedule - Provisional

Day 1 – 20th April 2021 (full day) – State of the Art

Time			Prospective speakers	Topic
10 am	Welcome and introductions			
	Workshop Aims and Overview		Ian Wilson (PI)	
10:40	Tea/Coffee			-
11:00	Keynote presentation 1 + discussion		Julien Landel (Manchester)	Fluid mechanics in cleaning
12:00	Keynote presentation 2 + discussion		Stuart Clarke (Cambridge)	Surfaces and chemistry
13:00	Lunch			
14:00	Keynote presentation 3 + discussion		Worth Calfee (US EPA)	Decontamination
15:00	Short oral presentations			
16:00	Extended tea break and posters			
17:00	Keynote presentation 4 + discussion		Luis Melo (Porto)	Microbiology and biofilms
18:00	Keynote presentation 5 + discussion		Peter Fryer (Birmingham)	Scale up and taking lab results to practice
19:30	Evening meal + networking			

Day 2 – 21st April 2021 (full day) – Challenges and Needs

Time			Prospective speakers	Topic
9:00	Keynote presentation A + discussion		Denis Heldman (Ohio State Univ)	Food
10:15 am	Keynote presentation B + discussion		Conor Collins (GSK, Cork)	Pharma
11:30	Tea/Coffee			
11:45	Keynote presentation C + discussion		Alex Jenkins (Sellafield Limited)	Nuclear
13:00	Lunch			
14:00	Keynote presentation D + discussion		Richard Amlôt (Public Health England)	Decontaminating people: physical science and social science
15:15	Short oral presentations			
15:45	Extended tea break and posters			
16:30	Keynote presentation E + discussion		Tim Felton (Wythenshawe Hospital)	Health and Hospitals
17:45	Keynote presentation F + discussion		Jim Taylor (Holchem)	The business angle: what suppliers and cleaners need
19:30	Workshop Dinner			

Day 3 – 22nd April 2021 (half-day) – Roadmapping

Time		Activity
9:00	Group Work task 1	Additional Input followed by reporting
10:15	Tea/Coffee	
10:45	Group Work task 2	Strategy developing followed by discussion
12:30	Summary session	
13:00	Bag lunch	
14:30	Steering group meeting	Organisers and delegates who will participate in November web meeting plan activities for November web meeting