Lessons to learn from Roadmapping in Cleaning and Decontamination

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Chemical Engineering & Biotechnology
Cleaning and decontamination

- Purge
- Clean
- Decontaminate
How clean is clean?

Measurement  ‘Clean’  Reliability

Impact  Acceptability  RISK
Cleaning and decontamination are universal activities
Major UK sectors with intensive cleaning activity

Agriculture
Energy
Environment
Food & Drink
Healthcare/Public Health
Hospitality
Nuclear
Personal Care Products
Pharmaceuticals
Shipping
Water

Recent incidents
Sinner’s Circle and Sustainability

- Thermal energy: hot
- Chemical energy: pH, reagents
- Flow rate: large volumes, cold water, small volumes

Components:
- Time
- Chemistry
- Mechanical action, e.g. flow
- Temperature
Sinner’s Circle and Sustainability

- Flow rate
  - small volumes, cold water
  - large volumes
- Chemical energy
  - pH, reagents

Thermal energy
- hot

\[ = f(Re, T, Q, x, y, z) \]
A 21\textsuperscript{st} Century Sinner’s Circle

\[ = f(Re, T, Q, x, y, z, A, B, C) \]
Roadmapping of Quantitative Modelling of Cleaning and Decontamination

20-22 April 2021
Aims of the workshop

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.

**What has been done?**

To provide a forum where industrial and governmental stakeholders can **share** aspects of future needs, both immediate and long term.

**What is the need?**

To identify strategic needs for **research**.

**What needs to be done?**

To ensure that the workshop materials will be freely available as an **archive** for all workers in the area.

**How and what to communicate?**
Attendees

April 2021  80 delegates on-line

September 2021  hybrid follow up meeting
Keynote presentations - applications

Worth Calfee *US Environmental Protection Agency*

Development of capabilities to support large-scale biological incident response operations

Conor Collins *GSK*

Cleaning of manufacturing equipment in Pharma – current approaches and challenges

Sam Collins *Public Health England*

Decontaminating people

Alex Jenkins *Sellafield Ltd*

Decontamination for the nuclear industry
Keynote presentations – physical sciences

Julien Landel  *University of Manchester*
Fluid mechanics of cleaning and decontamination

Omar Matar  *Imperial College London*
Numerical simulations of multiphase flows in the presence of surfactants

Peter Fryer  *University of Birmingham*
Scaling up (and scaling down) cleaning

Dennis Heldman  *Ohio State University*
Current research on cleaning and sanitation in food manufacturing facilities
Keynote presentations – life science and business angles

Luis Melo *University of Porto*

Biofilms disinfection and cleaning – an overview

Martin Seed *NHS Manchester*

Respiratory hazards in healthcare cleaning

Jim Taylour *Taylour Consulting*

What suppliers and cleaners need. How do we get cleaning right?

Allister Theobald *Warwick Chemicals – Lubrizol Corporation*

The business angle
Sectors and challenges

**Common Issues Relevant to Most Cleaning and Decontamination Processes**
- Chemicals used for cleaning and disinfection
- Mode of disinfection (wipe, spray, fog)
- Mode of cleaning (wipe, spray, fog)
- Mobile/permanent
- Location
- Facilities
- Staff training
- Sustainability
- Environmental Concerns
- Cost
- Consequential losses
- Regulations
- Use/number of rinses
- Removal of foulant/contaminants
- Safe disposal of contaminated material
- Safe disposal of cleaning agents
- Process and cleaning validation standards
- Process and cleaning validation implementation and training
- Link between illness of cleaning staff and chemical ingredients used

**Food**
- Fouling
- Filtration
- Cross-contamination
- Allergens
- Pathogens
- Surfaces

**Energy**
- Oil
- Solar panels
- Turbines
- Transport fuels
- Nuclear
- Wave energy

**Marine & Aviation**
- Ship hull fouling
- Energy usage
- Gross biofilms
- Fuel lines
- Storage tanks

**Water**
- Cooling Towers
- Wastewater treatment
- Biological reactors
- Pathogens

**Environmental contamination**
- Soil & Sediments
- Urban areas
- Building fabric
- Groundwater
- Air
- Land
- Water

**Homes**
- Ovens
- Dishwashers
- Washing machines
- Windows
- Surfaces

**Terrorism**
- Chemical agents
- Biological agents
- Decontaminating people
- Nuclear and explosive
- Radiological

**Contamination by natural disasters**
- Air
- Volcanoes
- Mudslides
- Tsunamis
- Water
- Soil

**Dentals Services**
- Chairs
- Surfaces
- Denture production
- Dental Lines
- Pathogens

**Buildings**
- Stone/brick work
- Facades
- Statues
- Concrete
- Biodeterioration

**Pharma**
- Batch integrity
- Transfer between products
- Cleaning production lines
- Surfaces
Quantitative models - QMs

QMs are needed for

• Selection and design of cleaning operations
• Optimising and adjusting existing processes
• Transferring results between applications
• Quantifying resource consumption, waste generation and costs
• Supporting management decisions involving resources and risk
• Meeting and developing standards, regulations, legislation
• LCA and sustainability studies
These are messy problems

Answer = f(Re, T, Q, x, y, z, A, B, C)

What do we want to know?

Soil history
Process timescales
Reaction timescales
Resource availability
Response times

Do we know the input parameters?

Soil length scales
Device size(s)
Distribution of soil
Delivery of cleaner(s)
Cleaning action length scales
QM types

Core science insight

The soil is rarely well understood

Rarely simple calculations

Robust numerical methods are needed

Defining ‘clean’ can be difficult: evaluation of Risk
Needs and Challenges

- Sustainability
- Sensors
- Existing knowledge
- Diversity
- Language
- Training
- Talent
- "C&D is viciously interdisciplinary"

RISK
Calculation
Communication
Roadmap

- Community
- Training
- Communication [www.modcad.org](http://www.modcad.org)
- Science base

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A Roadmap for Quantitative Modelling of Cleaning and Decontamination

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The important bit..