There are many industrial and biological processes, such as beer brewing, nano-separation of colloids and bird flocking, which can be described by integro-PDEs. These PDEs describe the dynamics of a ‘particle’ density within a fluid bath, under the influence of diffusion, external forces, and particle interactions. They often include nonlinear, nonlocal boundary conditions.

A key challenge is to optimize these types of processes, which requires tools from PDE-constrained optimization. In this talk I will introduce a numerical method to solve this class of optimal control problems, which combines pseudospectral methods and spectral elements with a sweeping algorithm. This provides a tool for the fast and accurate solution of the resulting optimality systems. Finally, some examples of current work and future industrial applications will be given. This is joint work with Ben Goddard and John Pearson.