# Reduced-order modeling techniques for understanding printing and coating processes

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Computational modeling approaches for fluid flow have long been used to understand fluid mechanical phenomena underpinning printing and coating processes; in fact, many computational tools are now available to design and optimize such processes. These tools and approaches can be broadly categorized as those which solve the generalized two-dimensional and three-dimensional continuum flow equations (Navier-Stokes) and those which deploy reduced-order techniques such as lubrication and thin-film models. The chief drawback to full continuum approaches is often excessive computational expense and complexity, and the drawback to reduced-order approaches is the availability of specialized codes for a certain application. Over the past few years, we have developed a general implementation of reduced-order lubrication and thin-film flow models into a continuum finite element method code using shell elements. This implementation allows flexibility in using these reduced-order models for a variety of geometries and applications, while allowing them to couple with continuum simulations.

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In this talk, we show examples of how reduced-order models have been used to study printing and coating processes, including nano-imprint lithography and discrete patterned coatings. We will also discuss our thoughts on best practices for when and how these modeling techniques can be applied to various coating flow and related processes, including contact printing, structurally flexible coating systems, and pre-metered coating.