1030-65-424 **Matthew G. Knepley*** (knepley@mcs.anl.gov), Argonne National Laboratory, Mathematics and Computer Science Division, 9700 S. Cass Avenue, Argonne, IL 60439, and **Dmitry Karpeev** (karpeev@mcs.anl.gov), Argonne National Laboratory, Mathematics and Computer Science Division, 9700 South Cass Avenue, Argonne, IL 60439. *Algebraic Structures in Finite Element Computation.*

The finite element paradigm relies on a decomposition of space into small pieces on which function spaces can be explicitly constructed, followed by an assembly on the overlap of the pieces to produce a global interpolant. This process is also familiar from the theory of manifolds, as well as, sheaves. We have abstracted this relation, in analogy with algebraic topology, to produce a flexible software framework for arbitrary element methods which is parallel, scalable, dimension independent, and quite easy to manipulate.

This framework allows easy implementation of novel multilevel solver algorithms. As an example, we will discuss the Full Approximation Scheme, a nonlinear multigrid variant. It overcomes the well-known bandwidth bottleneck experiences by global Newton-based solvers. Finally, we will discuss how techniques from algebraic geometry might be used to improve both the performance and robustness of FAS applied to the Navier-Stokes equations. (Received August 08, 2007)