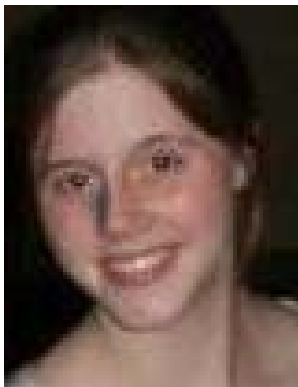




MASSACHUSETTS CLEAN TECHNOLOGY AWARDS

A Program from The Foresight Project Inc; www.theforesightproject.org



Region V: Southeastern MA, Recognition:

Lauren R. McGough, North Quincy High School

“ Fluid Dynamics: Computational and Experimental Methods for a Variety of Flows ”

Lauren is a future mathematician with an interest in fluid dynamics. She has received recognition at science fairs and research conferences for her work in applying mathematics to counterterrorism, fluid dynamics, and most recently in comparing the efficiencies of different ways of modeling fluid flows, a topic highly relevant to the field of climate study, where fluid models can be useful for climate prediction and interpretation. She is the founder of her school's math team, where she organizes participation in local, regional and national competitions; she received the highest score on the AMC 12 both her junior and senior years. When she is not doing math, Lauren may be found studying chamber music, composition, and solo studies at the Longy School of Music. She performs often in the Boston area, and at New York City's Merkin Hall. Lauren also enjoys speaking French, baking, and helping to run a local middle school math team.

MY PROJECT:

The Navier-Stokes equations often cause analyzing fluid motion to be a formidable endeavor. [The Navier Stokes equations use complex mathematical techniques to evaluate the net effect of the stresses including viscosity and pressure in a system, resulting in a description of the flow throughout the system. They can be used in Newtonian or non-Newton cases, and can become extremely complicated due to the many variables and their interactions that need to be included.] Recently, computational methods of analyzing fluid flow have proven useful as a simpler approach. This project involves the implementation of several computational simulations of fluid motion. Specifically examined is the question of whether the finite-volume or finite-mass approach to fluid simulation is preferable in terms of efficiency and accuracy.

Several use cases, simplifications for studying fluid motion, are implemented. These include a simulation of a single particle moving in one-dimensional space; a single particle moving in three-dimensional space; and a specific situation involving many fluid particles which implements a simplification of the Navier-Stokes equations for incompressible, Newtonian fluids. Each of these simplifications is implemented in both a Eulerian mind-set and a Lagrangian mind-set, where one tracks the properties of motion according to points in space, and the other assigns them to moving particles. These simplifications are then analyzed in terms of time and memory-efficiency in order to make conclusions about more general cases of fluid modeling. It is found that while the Lagrangian view of fluid motion is preferable for modeling situations with extensive, changing boundary conditions; the Eulerian model is preferable for conditions where the boundary of the fluid remains constant.