6.837 Final Project Proposal
Group Members: Arjun Veer Narayanan and Lucas Smyk

Introduction:
Our project will be to develop a particle-based fluid simulation. We will implement a technique known as Smoothed-Particle Hydrodynamics (SPH) (http://en.wikipedia.org/wiki/Smoothed_particle_hydrodynamics). The previous link provides a good general description. However, we will base our implementation on a research paper entitled "Particle-Based Fluid Simulations for Interactive Applications." We have included a copy of this paper in the Assignment 5 directory. It is the file “sphPaper.pdf.”

The Physics:
SPH involves the actual physics behind the fluid simulation. It gives models for various forces including pressure, viscosity, surface tension, and external forces such as gravity. The forces are given in terms of a kernel function. We will have to simplify the mathematics and get a closed form expression for each force that we can then implement. We will also need a grid data structure that allows us to quickly find the neighbors of a given particle. It would be extremely inefficient and infeasible to evaluate the forces on a particle by all the other particles. We need to find the relevant ones.

Rendering:
While SPH details all the necessary physics, it does not actually specify how to render the final fluid. We will support two rendering modes. One will simplydisplay all the particles as small spheres. The other will actually render a surface representing the fluid. To do this, we will implement the technique of "Marching Cubes" (http://en.wikipedia.org/wiki/Marching_cubes).

Plan of Action:
The following is a list of steps we will take to complete this project:

1. Implement and test the grid data structure
2. Simplify all the mathematical expressions for the forces (this will involve a fair bit of multivariable calculus). Check over the results thoroughly to ensure that our math is correct.
3. Implement and test the pressure force and gravity.
4. Implement and test the viscosity force.
5. Implement and test the surface tension force.
6. Implement marching cubes to render the final surface.

Final Notes:
We realize that this is a complex project. However, we are very interested in physics simulations because of how realistic and mathematically involved they are. We also think fluids in general are really cool. We are very determined to complete this project and hope to learn a lot. We have cleared the idea with Professor Matusik. He agrees that it will be challenging, but thinks it is

definitely doable.