## The Engineering Design Process Applied to Engineering a Model of Fluid Flow

**Problem**: The *Hopewell Institute of Cardiovascular Surgery* has hired your engineering consultant team to design a model that demonstrates the effect(s) of disease on the normal functioning of the Cardiovascular System (CVS). The model will be used to demonstrate to patients the consequences of obesity and atherosclerosis on the circulatory system.

Your team: Physicist, chemist, engineer, biologist/physiologist

**Background Research**: Understanding fluid flow is central to learning about the flow of blood in the circulatory system and how to design the model. Before beginning work on the CVS model, your team will need to work collaboratively to learn more about fluid flow and its effect on the circulatory system.

Physicist: Fluid flow as defined in physics: the effects of viscosity on fluid flow, effects of length of tube and diameter of tube on fluid flow. How does pressure change as the size of the tube changes?

Chemistry: Fluid flow as defined in chemistry: Viscosity of fluids, composition of blood, fluid flow of blood, diseases common to affect circulatory system

Biology/physiology: Composition of the circulatory system, including vessels and diameter of vessels, effect of increased adipose tissue on circulatory system, define and explain causes of atherosclerosis and its effect on blood flow, what other factors affect

Engineer/ mathematician: Defining a model; how is scale used in developing engineering models; find 2-D and/or 3-D examples of circulatory system models and the amount models are scaled up or down, how to maintain issues of scale such as in capillaries and other vessels

**Develop**: Use the research and your team’s ingenuity to brainstorm CVS model design ideas that can illustrate the harmful effects of disease on the system

**Choose**: Select what you believe to be the best of the CVS model ideas that you will and design and test

**Create**: A model of the CVS based on your plan

**Test and Evaluate**: Test and evaluate the performance of the CVS model to illustrate differences in the healthy functioning of the system vs. the system in the disease state. Criteria for model evaluation should include the following components.

* Model works consistently
* Limitations of model are noted
* Model accurately represents the structure and the functioning of the CVS
* Relative scale of components where appropriate
  + Example: arteries, veins, capillaries
* Accurately represents the distinction between the healthy vs. the diseased state

**Communicate**: Develop a presentation for the Board at *Hopewell Institute of Cardiovascular Surgery* to present your new model design. The presentation should address why you expect the scaled up version to work, to benefits of this model design, and what occurred in the testing.

**Redesign**: Based on the board’s comments and your findings from tests on the CVS model, make modifications to the model, or redesign the model if necessary to more effectively meet the criteria, based on research and multiple first-round model designs.