MRI Compatible Gustometer for Childhood Obesity Research

Overview
About 1/3 of American children suffer from the weight related disorders overweight or obesity. A need exists to better understand the neurological perception of taste in order to create better tasting nutritional beverages. To do so, Dr. Keller, an assistant professor in the departments of food and nutritional sciences at Penn State, has proposed an experiment that monitors brain activity of children resulting from different taste stimuli. This experiment requires a device, called a gustometer, to deliver beverages to a child within an MRI scanner.

Objectives
The team set out to create a completely computer operated gustometer that would feed a biologically relevant amount of up to six different types of beverages to a child within an MRI scanner.

Approach
- Customer needs were gathered through conversations with Dr. Keller, the expected operator of the gustometer
- Existing adult gustometers created by groups at Yale, Vanderbilt and the Penn State Hershey Medical Center were reviewed to generate concepts for the child specific gustometer
- Gustometer mouthpiece designs were modelled using SolidWorks in order to communicate these ideas
- Syringe pumps were chosen based on availability, cost, compatibility with easy to use programming software, and their ability to deliver one beverage at a time
- Bernoulli’s equation was used to determine beverage tubing size restraints based on head loss stemming from height differences between the operator room and the scanner bore
- Qualitative testing proved 3.0mL/min will provide a meaningful volume of beverage without posing risk to the child in the required three seconds of dispensing beverage
- Quantitative testing showed an average flow rate of 2.8 mL/min, requiring a correction factor to ensure a 3.0mL/min flow rate during the experiment

Outcomes
- The gustometer summarized here costs $4000 to produce, saving Dr. Keller $21,000, based on Dr. Keller’s statement that she would be willing to pay $25,000 for a high end gustometer
- Materials used in mouthpiece production were reduced based on the Yale mouthpiece design, which required all tubes to converge into a larger component
- The SyringePumpPro software controlling this gustometer is much easier to use than the standard MATLAB for those without programming background, such as the nutrition scientists in Dr. Keller’s lab