Abstract
Imagine if sales and marketing representatives carried a portable lab that they could use to demonstrate the true performance of their products. It would serve as a powerful marketing tool that could potentially increase revenue for the company. For this project, Medtronic tasked the team with conceptualizing and constructing a portable demonstration kit to showcase the hydrodynamic performance of various hydrocephalus shunt valves in their product line. An existing demonstration set-up and standard shunt testing procedures were used to create a simple, portable system that would allow users to easily demonstrate the performance of shunts in just a few steps.

Performance Requirements
The demonstration kit must meet the following performance goals as defined by Medtronic and the team:
• Maximum dimensions: 56 x 36 x 23cm
• Maximum demonstration area: 0.205 m²
• Maximum weight: 7.7kg
• Set-up and demonstration time: <20min
• Number of shunts: 5
• Flow rates: 0, 20, 50 ml/hr
• Easy to use by 3 non-technical people
• Data acquisition and display of shunt pressures
• Instructions for use and demonstration video
• Capable of demonstrating siphoning

Engineering Challenges
The technical challenges for this project included:
• Pump and pressure transducer selection to meet performance requirements
• Modeling ventricles of the brain using a silicone reservoir
• Data acquisition and display of pressure readings
• Calibration of pump and pressure transducer
• Proper isolation, organization, and accessibility of electrical connections
• Demonstration of siphoning conditions

Testing
To ensure system functionality and ease-of-use the following tests were conducted:
• Repeatability of pressure readings for individual shunts
• Reliability study that compared shunts’ actual pressure readings to shunt manufacturer performance charts
• Syringe pump calibration to ensure proper flow rates
• Siphon test to ensure that the system properly modeled siphoning upon introduction of a negative siphon head
• Ease-of-use test proctored to three non-technical users, whom were provided with a user manual and demo video, to quantify the simplicity and ease of use of the kit
• Reservoir quality test to ensure the reservoir was not inducing any significant pressure changes on the system

Overall, the demonstration kit is functioning as expected. No major concerns were observed in the results of the tests.

Keys to Meeting Engineering Challenges
To meet the engineering challenges, the following solutions were introduced:
• Modified syringe pump with two flow rates modeling average CSF production and maximum flow rate shunts are designed to withstand
• USB powered pressure transducer from Omega Engineering with data acquisition and display software
• Silicone intravenous (IV) bag used to model the elastic properties of brain ventricles
• Junction box added to the side of the kit for easy access to and protection of electrical connections

Results & Conclusions
The final prototype of the shunt demonstration kit meets carry-on sizing constraints, accommodates 5 shunts, and includes the following: a modified syringe pump, a silicone reservoir with a small mechanical jack to adjust height, a pressure transducer with data acquisition and display software, a manometer, a manifold, and a junction box. The kit also features a user manual and instructional video. Although the weight goal was slightly exceeded 1.3 kg, the kit still meets FAA carry-on weight limits and all other performance requirements were either achieved or improved upon. The demonstration kit has the potential to be fully developed and integrated into the Medtronic sales and marketing department.

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