The Work of a Breath

Authors
Zachary J. Reed, Automation Systems Engineer, Data Science Automation, Inc.
Ronald J. Cochran, Senior Automation Systems Engineer, Data Science Automation, Inc.

NI Product(s) Used
LabVIEW2015
USB-6341

Category
Advanced Research

The Challenge
Determining the amount of work it takes for the human body to breathe through a respiratory protective device (RPD).

The Solution
Developing the new algorithm in LabVIEW using the built in signal processing VI made it fast and easy to get the data needed to reveal the work of breath on an existing NI-based system.

Introduction
Data Science Automation (DSA) is a premier National Instruments (NI) Alliance Partner that specializes in automating and educating the world leading companies. Clients choose DSA because of DSA's deep knowledge of National Instruments products, disciplined project development process, its staff of skilled Certified LabVIEW Architects and Certified Professional Instructors, and its unique focus on empowerment through education and co-development. DSA has long been the leader in mechanical life testing, working with manufacturers of critical structural components for complex engineered systems.

A RPD is a types of mask designed to offer protection from the inhalation of hazardous substances. There are many different types of RPDs available on the market today. When a person uses a RPD it requires extra work by the respiratory muscles as they need to generate slightly higher pressures to overcome the associated respiratory loads. This related labor is referred to as Work of Breath (WOB).

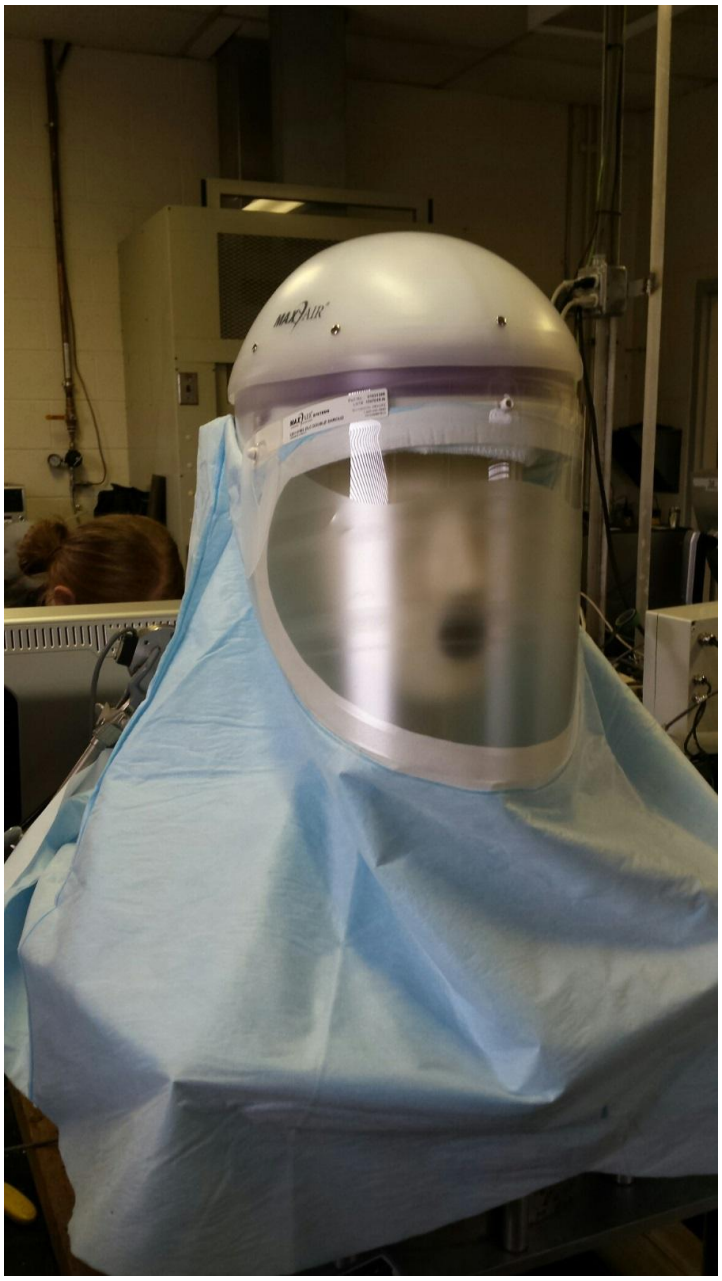

Figure 1 RPD Mask

The data was currently being copied from files created by a digital breathing machine controlled by a LabVIEW application. The breathing machine collected a series of waveforms through a RPD at different breathing rates. The information was used to determine the total WOB over the full range of breathing rated. These tests would also need to be run with different RPDs and using different head forms that represent the different contours of different human heads.

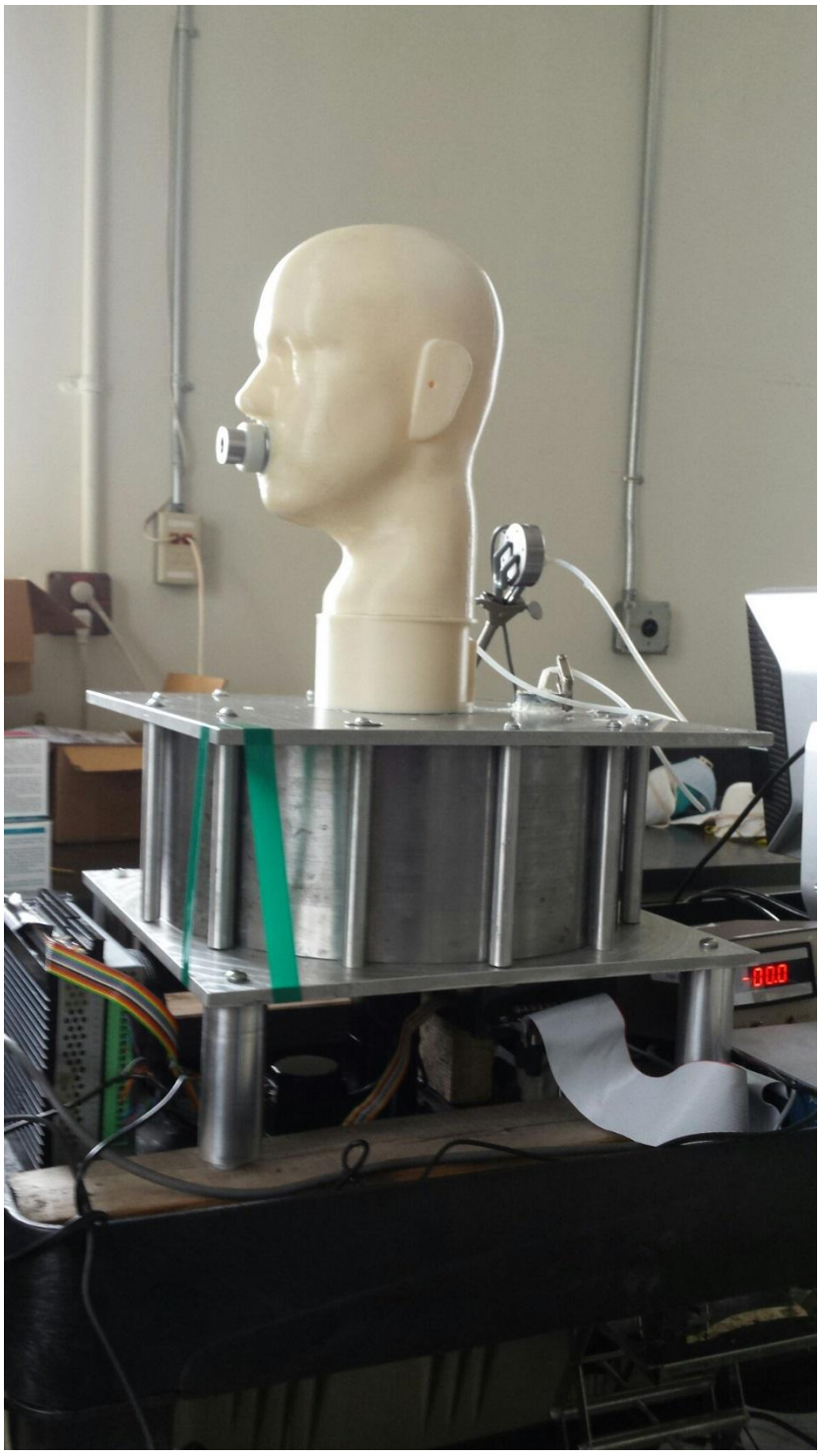

Figure 2 Digital Breathing Machine

All of the calculations and determination were being done manually in an excel spreadsheet. This was a time consuming way of sorting the data to get to the answer for the WOB. Each run of the RPD at a different breathing rate took the operator about an hour of time to analyze the run of data. This data

needed to be formatted into an average waveform using ten waveforms of a specific rate of breath. The operator needed to manually look for the beginning and end points of each waveform.

Before the new application the data needed to be configured allowing the determination of the beginning of the inhalation or exhalation starting point of the first waveform. From this point the operator would look to find the same point on the following waveform. They would take that number of points and use it to get the first ten cycles of breath to create the average waveform to run the calculations on.

Using the Peak detection VI in LabVIEW it was easy to determine the number of points in the single cycles of breath. These point were then used to separate the ten breathes from the full waveform and average them to allow the calculations to be performed. This was a big advantage over the use of the spread sheets because the operator did not need to manually look at the data to find the correct point count or place the data into the correct spreadsheet for analysis. The application would determine the correct calculations to use and fine the inhalation and exhalation portions of the wave to get the values of the WOB.

The data that is collected is the pressure or vacuum of the air in the system. The location of the piston as it travels through the breathing waveform to determine the volume of air. These parameters are used to calculate the lung volume verses the pressure that each RPD requires for breathing.

For a person breathing the muscles create a pressure that either fills the lungs with air or forces out the gases from the lungs. While wearing a RPD the inhalation and exhalation face a higher resistance and can cause a change in the total volume that the lungs take in. as it is true that the different RPD's have different work of breath totals they may also have different resistances for inhalation verses exhalation An unassisted filter type mask will normally have a stronger inhalation resistance then the exhalation resistance.

Conclusion

Because the existing LabVIEW code was to control the breathing machine and store the data it was easy to add the new code modifications. The code was also made to be a standalone application that would allow the operator to select a data file that had already been created in the past and generate the result without needed to total rerun the tests. The standalone application also eliminated the needed to use the spread sheet and manual manipulation of the data.

The end result of the new code added to the existing application was to help speed up the process of determining the WOB. It also reduced the time lag to see the results of each set of tests on the different types of RPDs as well as the different number of breathing rates that were selected for each test. The end user was happy to have the quicker turnaround of viewing the results and the ability to compare the old test results to the new values.

Contact Information

Zachary J. Reed, info@DSAutomation.com
Data Science Automation Inc., 375 Valley Brook Road, Suite 106, McMurray, PA 15317-3370
www.DSAutomation.com