Upgrading a Digital Breathing Machine for Respirator Testing

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NI Product(s) Used:
NI USB-6341
LabVIEW 2013

Category:
Advanced Research
Machine Control

The Challenge
Convert an older piece of equipment using outdated hardware to a modern piece of test equipment. Make it more versatile and adaptable allowing it to simulate different types of breathing conditions.

The Solution
Use National Instruments USB-6341 and LabVIEW 2013 to create an application that would allow the user to select the correct breathing pattern to effectively test developmental respirators.

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 respirator testing, working with the government organizations that define and administer the certification tests and the manufacturers who develop and produce respirators for a variety of uses.

Background
The system was in need of being upgraded from the old hardware (Figure 1) to a new piece of equipment that would be easily maintainable. It was also required that a more current version of software be installed as well as an upgraded operating system. The enterprise where the test apparatus was to be deployed required that the all software and operating systems needed to be updated to fully supported versions.

Approach
The application and hardware that was used for this testing was needed to test breathing masks (Figure 2) that are used in firefighting and all forms of safety related fields to protect the workers from smoke and toxic gases. These tests are necessary to ensure that the masks are functioning properly under different circumstances including but not limited to different breathing patterns by different people in different scenarios. Some of the things that are tested using this equipment are the fit of a mask and how the seal may react with shallow or deeper breaths. For example, a deep inhale breath may also pull in gas from weak fitting areas around the seal of the users face. Another condition could be a weak inhale breath that may not activate the on-regulator to admit fresh air from a supply tank into the mask, instead pulling it from the seal edges creating a lack of positive pressure inside the mask. The testing can also help determine the amount of flow the on-demand regulators can provide based on the amount of lung capacity the simulated breathing machine is programmed for. The information provided by these tests help the mask designer validate and improve their product making it safer and reducing the risk of the end user having issues that could result in their inability to perform their job or to safely evacuate an area in a timely manner.

The older system that was used for this type of testing was based on a cam that would rotate and drive a piston to simulate the breathing of the subject using the mask. Based on the shape of the cam's groove the old machine would cause the piston to move in and out at different speeds during the breathing cycle of the cam. To make a new breathing profile it would require a machinist to machine a new cam and the groove in it. This system worked but it would require multiple cams to create the simulation of different types of breathing and would also require the operator to dismantle the machine to replace the different cams for each set of testing that needed to be performed. The operator would manually adjust the speed of the drive motor to achieve the desired breathing simulation for the test.

Knowing the ability of the National Instruments products, we chose to an NI USB-6321 to control the test equipment as well as read the sensor signals that would characterize the results of the test being performed. Using LabVIEW software and NI hardware gave the match for making things work together seamlessly.

The NI USB-6321 had the correct inputs to measure the necessary channels of data. It also provided the outputs needed to control the motor being used for the simulation of the breath.

One of the added features to the application was that the system could now be used to record a person's breathing pattern and use that as the basis of the control signals used in testing at a later time without the need for a machinist to make a new cam. This feature alone made it possible to quickly change the breathing pattern when a new set of tests were being run. This was something that saved both money and time to expand the coverage of test conditions.

Working with in a team of professionals that are all NI certified including myself gave me the understanding and ability to ensure that the application would be a success. The NI field sales staff assisted with the selection of the correct components for the application. This avoided potential pitfalls that might be associated with this type of application.

The biggest benefit of the application was the reduced time to change operating conditions. It would only take seconds to build a new breathing pattern or even record one from a live person that could be run during a test without having the person sitting at the test station for the entire length of the test. This would be very useful if the test needed to be conducted using specific types of gasses or chemicals that could put a person in harm if there were a leak within the mask or connected system.

Summary
The upgraded respirator test system had greater functionality and flexibility. It provided better data and was significantly more productive leading to reduced product design cycles.

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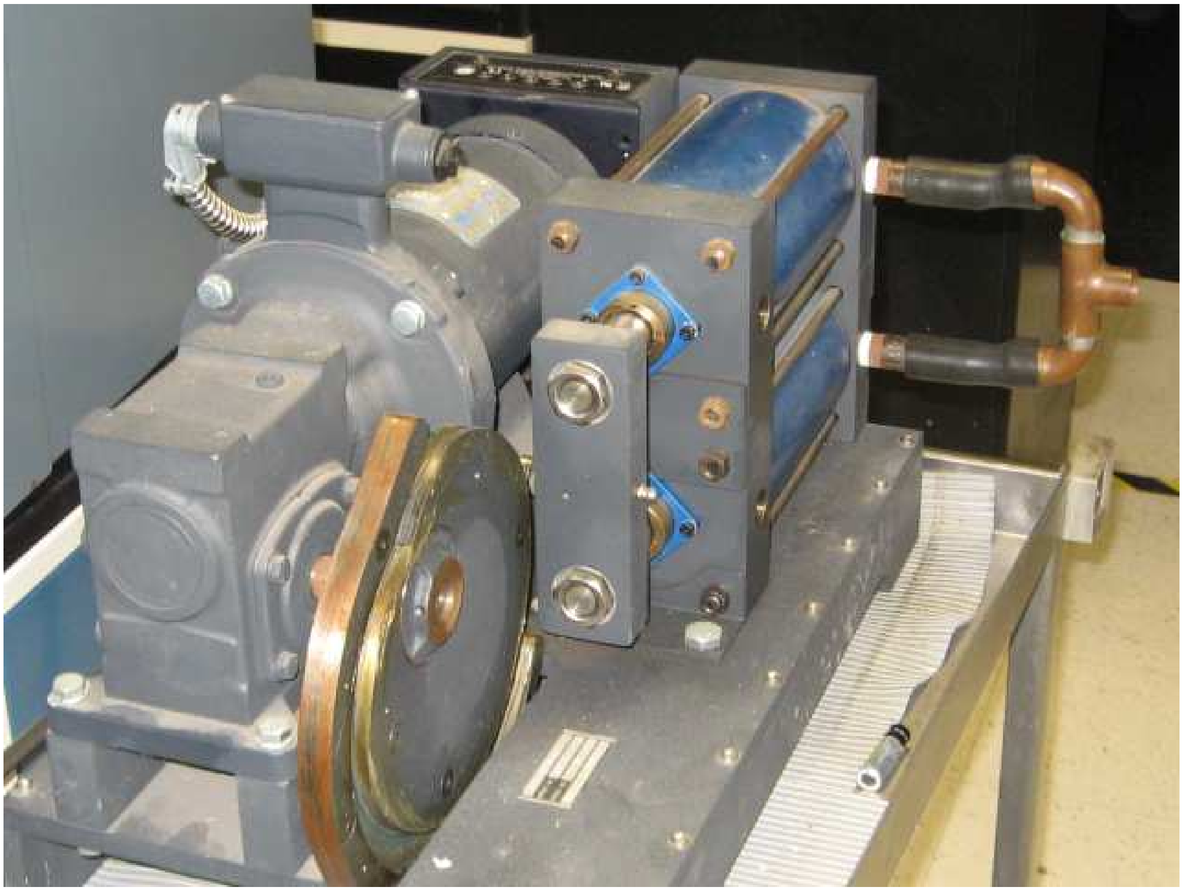

Figure 1. Old Breathing Machine

Figure 2. Typical Mask