

# Using LabVIEW and DAQ to Ensure Consistently-Fitting Undergarments

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**The Challenge:** Measuring thousands of bras for cup and band size rapidly and accurately.

**The Solution:** Using NI software and hardware to control and monitor an artificial adjustable torso.

## Using LabVIEW to Determine the Right Fit

A bra-sizing rig has been developed. It takes the form of an artificial adjustable torso controlled and monitored using National Instruments software and hardware. LabVIEW software reads two joysticks and uses their positions to adjust the torso by the use of three motors. Size information and the readings from several sensors store in Excel.

## Introduction

It is a commonly held view that 70 percent of women are wearing incorrectly sized bras, although research carried out by Figleaves,

***We combined a number of NI products – motion control, data acquisition, and powerful LabVIEW software – to perform efficient and accurate bra sizing.***

the internet lingerie supplier, showed an even higher figure. In addition, manufacturers size lingerie differently, so one brand's 34DD might be another brand's 34E. Bras manufactured outside the UK often use different sizing schemes. In-store fitting can be costly, time consuming, and for some women, embarrassing.

Daniel Nabarro, Figleaves' managing director, thought of a way for women to find their correct comfortable bra size in a chosen style, quickly, easily, and with no embarrassment. A customer would order from

Figleaves using a special tape measure, which works at constant tension and avoids the inaccuracies of a normal tape measure. The system also includes four specially-shaped volumetric cups and a set of instructions. In private, a woman measures her underbust with the T-tape and measures her breast

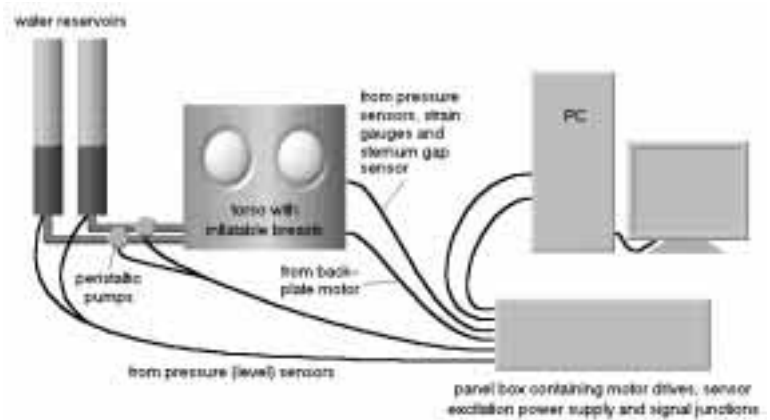
volume using the cups. Via the Figleaves Web site or the telephone order line, she can then state her size – for example: "I am a 48 band and a 5 1/2 cup" The customer is then given a list of fitting bras.

## Development of a Bra Sizing Rig

We needed a large amount of accurate sizing information gathered from thousands of bras to determine the mean size and the variation of sizes for each of the many types of bras sold by Figleaves. Figleaves commissioned Pankhurst Design and Development Ltd (PDD) of Hammersmith, London, to design and build a bra-sizing rig. PDD in turn selected Automation Interfaces to handle the PC-based software, data acquisition,

and motor control. Our concept required experienced bra fitters to fit many bras in quick succession onto an adjustable artificial torso. A PC records the precise bra information automatically. By automating much of this process, we prevented it from becoming extremely time consuming and error prone.

PDD developed a torso with two inflatable latex breasts, so that a good fit for the cup size of each bra could be achieved. We determined the band size of each bra with the torso's motorized back plate that alters its



System Schematic – Bra Sizing Rig

circumference. A National Instruments PCI-7344 motor control card controls three motors in the system – one for the back plate adjustment and two for the peristaltic pumps associated with each breast.

Determining the breast volume accurately and quickly after a good fit was a significant challenge. Each breast connects via a latex tube to a cylindrical reservoir of water. We measured the volume in the reservoirs using pressure sensors in their base, and used this to infer the breast volumes.

A joystick adjusts the sizing rig's breast size. LabVIEW reads the voltage produced from the joystick (0.5-4.5V) and uses it to set the speed of the pump motor. We can adjust the pump motor "on the fly." The user has instant and complete control of the speed. Equal pump speeds inevitably do not deliver equal volumes of water to the two breasts, so the software waits until the user releases the joystick. The software then makes a final fine adjustment to one of the pump motors to equalize the volume in the two breasts.

For calibration, engineers place a plastic cup of known volume on each breast, and inflate them with the joystick to approximately 15 pounds per square inch (PSI). This indicates that the breast completely filled the plastic cup. The user then tops up the water level in the cylindrical reservoir, so the water reading on the cylinder's inverted scale equals the known volume of the plastic

## Customer Solutions

cup. Finally, the user presses a button in the software enabling the reading of the pressure sensor in the base of the cylinder. LabVIEW then adjusts the calibration factors that link the voltage from the pressure sensor in the cylinder to breast volume.

The software continuously reads a second joystick and uses it to control the position of the torso's back plate. Again, this is a variable-speed control.

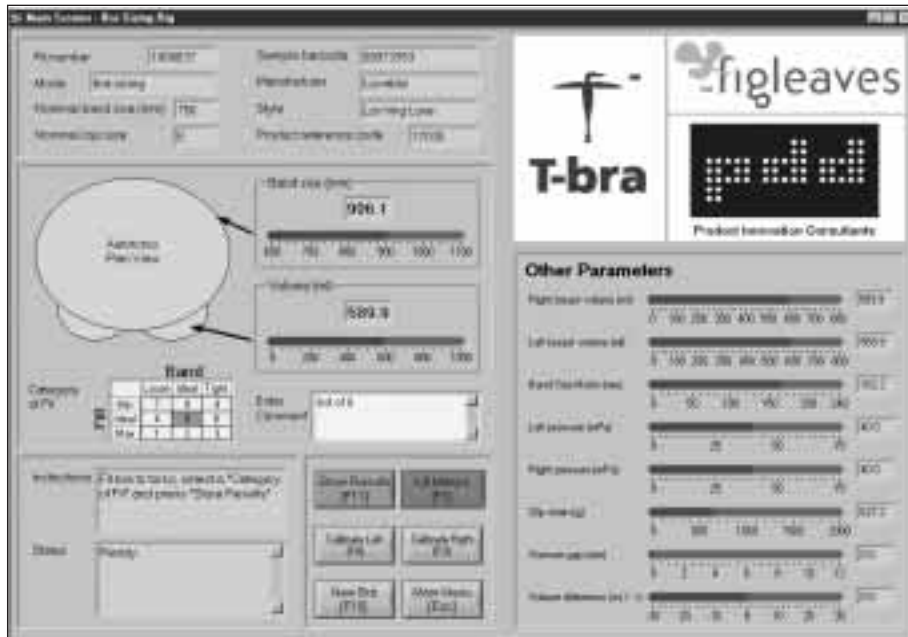
The bra clips attach to matching clips on the back plate, enabling two strain gauges to measure the tension in the band of the bra. The PC stores this information in an Excel spreadsheet.

A position sensor on the front of the torso detects whether there is a significant gap between the front of the bra and the "sternum" of the torso.

The PC acquires signals from the various sensors in the rig using National Instruments PCI-6034E multifunction data acquisition card. This produces very useful records of each fit.

### Data Collection Procedure

To measure a single bra, the experienced fitter first scans its barcode, and the LabVIEW software looks up the details of the bra (manufacturer, type, nominal size) in an Access database. Then the fitter attaches the bra to the artificial torso and achieves a good fit with the two joysticks. The fitter can feel the fit or use pressure and strain information as an aid. The fitter then presses an on-screen store button, and then the program stores the readings from the seven sensors in the system, along with the cup volume and band size. During this process, LabVIEW generates alarms if any of the sensors show values outside certain limits.



Main screen in LabVIEW software

### Conclusion

A number of National Instruments products – PCI-7344 motion, FlexMotion, data acquisition, and powerful LabVIEW software – now perform efficient and accurate bra sizing. In time, this may revolutionize bra sizing in the UK and beyond!

### The Future

Figleaves is linking the data collected from the rig to its Web site later this year and, at the same time, launching their specialized tape measures and measuring cups. The entire concept is known as T-bra. ■

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