Interfaces – The Next Generation

Here we look at three of the latest interfacing solutions for school science, the Pasco Xplorer GLX, Vernier Labquest and the Asus EEE PC equipped with Go! Sensors.

Xplorer GLX

Figure 1 - The Pasco Xplorer GLX (front). Can it replace the other equipment in the picture?

The Pasco Xplorer GLX can be used either as a computer interface or a stand-alone data logging instrument. It has a greyscale 320 x 240 pixel LCD screen, which is backlit, and a keypad with alphanumeric and cursor keys. Like those on a mobile phone, three or four letters are allocated to each key - it does not have a full QWERTY keyboard. 12 MB of memory comes as standard. As well as a port for connection to a computer, the GLX has its own USB port to allow it to be used with a memory stick or peripherals such as a mouse or printer. It has a built-in loudspeaker and sound sensor which also serves as a microphone, and comes with a voltage probe and two temperature probes. At the rear are four sockets for Pasport sensors (*Figure 2*). Many schools will have the older Pasco ScienceWorkshop sensors. These can be used via the optional analogue or digital adapters (*Figure 3*). Full specifications can be found on the Pasco website [1].

Figure 3 - Xplorer and digital adapter

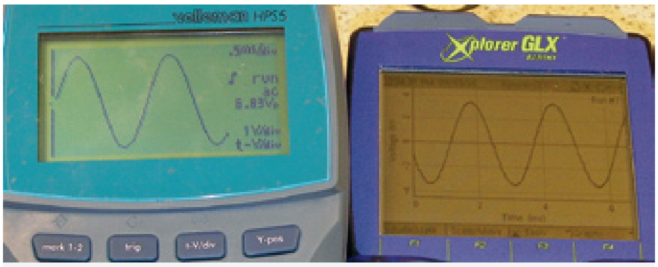

Figure 4 - Velleman and Xplorer at 400 Hz

Figure 2 - Sockets for Pasport sensors

Two function generators are included on board. These can be set independently to allow beats to be heard. The Xplorer can run from a built-in rechargeable battery, replenished via its mains adaptor.

The inclusion of sensors means that the Xplorer can be used straight from the box. When one of the supplied sensors or a Pasport sensor is plugged into the unit, it is recognised and the display changes accordingly. For example, when we attached an ultrasonic motion sensor, a graph of position versus time appeared on the screen. Using the cursor keys, we were quickly able to replace position with velocity or acceleration. Our trial investigation used a light gate and voltage probe to find out whether the voltage output of a model wind turbine was proportional to its angular velocity. Getting the display to graph one quantity with respect to the other was very straightforward. One criticism we had of Pasco's Data Studio ScienceWorkshop [2] software was that getting a graph with anything other than time on the X-axis was far from an intuitive process. The Xplorer presents no such difficulty, though scaling or zooming parts of the graph can be fiddly using the cursor keys. The answer here is to buy a USB mouse. These cost less than £4 from independent suppliers and make operating the Xplorer much easier. A USB keyboard may also be used.

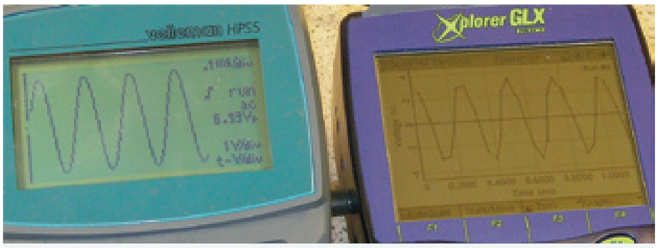

Figure 5 - Velleman and Xplorer at 4 kHz

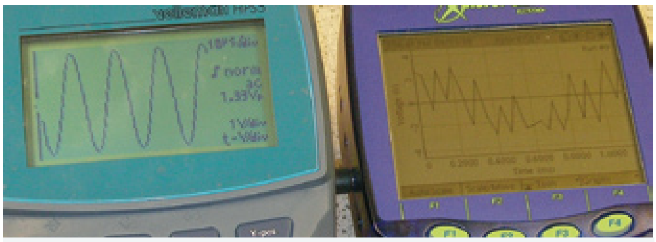

Figure 6 - Velleman and Xplorer at 40 kHz

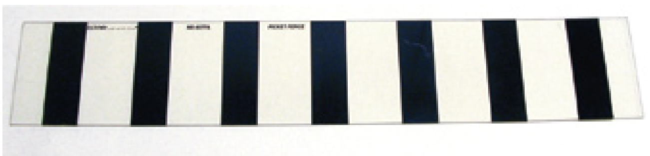

Figure 7 - Picket Fence

A comprehensive suite of analysis tools are provided for data, including statistics, linear fit and area under the graph. The instrument also has a scope mode that allows it to behave like an oscilloscope. We found this useful for examining its data capture rate. For comparison purposes, we pitched it against a Velleman HPS5 LCD 5 MHz oscilloscope, connecting both to a signal generator. The displays for approximately 400 Hz, 4 kHz and 40 kHz are shown in ***Figures 4, 5 and 6*** respectively.

Our Xplorer had a maximum capture rate of 25000 readings per second when used with the supplied voltage probe. This makes it perfectly adequate as an oscilloscope at 400 Hz. At 4 kHz, it is at the limit of its useful range and at 40 kHz the trace bears no relationship to the original signal. Its oscilloscope features are thus fine for the majority of classroom tasks up to the start of Higher Physics. Note that the data capture rate depends on the sensor used. It can be as high as 50000 readings per second.

All computer interfaces contain a piece of circuitry called an analogue to digital converter (ADC). This is because the output from temperature, sound sensors and their kind is a voltage. This analogue voltage varies infinitely between a maximum and minimum value. The ADC turns this into a binary number that the computer can use. The Xplorer has a 12 bit ADC. This means that it has 12 digits available to make binary numbers. It can therefore make 212 different binary numbers to represent voltages. 212 is equal to 4096. Taking the voltage probe as an example, it can measure between -10 V and +10 V, a range of 20 V. The voltage resolution, i.e. the smallest subdivision of voltage that it can measure, is thus 20 V ÷ 4096 which is around 5 mV. Pasco tell us that some of their sensors have a higher resolution than this because AD conversion takes place in the sensor itself.

Used with an optional Pasco light gate and digital adapter, the Xplorer can be used for timing, speed and acceleration measurements. Note, though, that there is no facility to do double mask experiments. Instead, a multiple mask called a Picket Fence is available (***Figure*** *7*).

Vernier Labquest

Figure 8 - Labquest interface

Like the Xplorer, the *Vernier Labquest* (***Figure*** *8*) can be used as a stand-alone instrument or a computer interface.

It has a 320 x 240 pixel colour screen, which is touch-sensitive, and a set of cursor keys but no alphanumeric keypad. Instead, a keyboard pops up on the screen when required. On-board memory is 40 MB, expandable through SD or MMC cards. Ports include two for Vernier digital sensors (***Figure*** *9*), four for analogue sensors, a USB port for memory sticks and compatible printers and a socket for connection to a computer (***Figure*** *10*). It is also possible to connect microphones, headphones and speakers to the unit.

The Labquest has a data capture rate of 100000 readings per second. It too has a 12-bit ADC, giving a 5 mV resolution with a voltage probe (available separately). Full specifications can be found on the Vernier website [3].

Figure 9 - Labquest digital ports

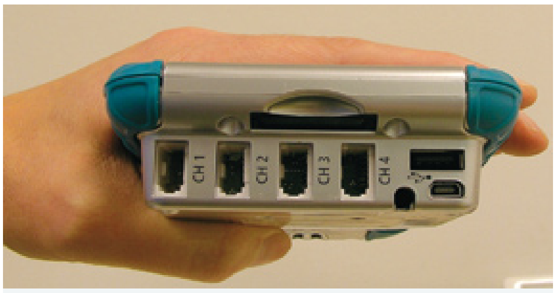

Figure 10 - Other Labquest ports

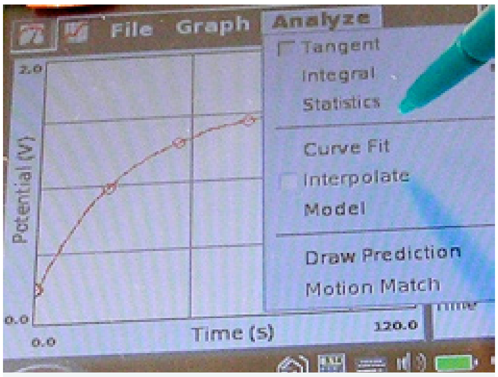

Figure 11 - Analysis tools menu

Figure 12: Small but beautifully formed (the Asus EEE, not the hand)

Analysis tools for graphical data are particularly easy to use due to the touch screen (*Figure 11*).

The Labquest can be used with Vernier light gates for kinematics measurements. An interesting feature is a comprehensive set of illustrated lab instructions, accessible via the File menu.

Asus EEE PC and Go! Sensors

SSERC bought some of these sub-£200 ultra mobile PCs (*Figure 12*) for staff who were on the road a lot as the *EEE* comes with a set of office-style applications and integrated Wifi. Rather than a conventional hard drive, it has solid-state storage making it far more resistant to shocks and jolts when compared with a conventional laptop. Its disc storage is small at 4 gigabytes, but this can be expanded through external USB devices or SD cards. Our EEE uses a version of the Linux operating system rather than Windows, though versions with *Windows XP* are now available. For day-to-day tasks, the EEE's Linux desktop was very easy to use, though, as we shall see, going beyond the mundane can be entertaining. Interaction with the Asus is via a standard keyboard and tracker pad. A mouse can be plugged in, as can an external monitor or projector.

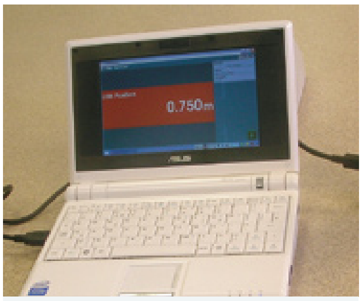

Figure 13: Asus EEE and Go! Motion sensor

We then heard from Instruments Direct Services [4] who also distribute the Vernier Labquest. IDS informed us that they had a version of their sensor software available for Linux. Having downloaded this, we followed the installation instructions whose hilarious complexity reminded us of the bad old days of MS-DOS. It should be stressed that Vernier are only beginning to work with Linux and we can anticipate this will become easier as they gain experience. Despite the rather obscure installation procedure, when we plugged a *Go!* Motion sensor (*Figure 13*) into the Asus USB port and started up the software, it was recognised immediately.

The free-to-download version of the Labquest software (*Figure 14*) was very like that built in to the Labquest interface.

With the Go! Link (*Figure 15*), a large number of Vernier sensors can talk to the Asus.

We have yet to fully evaluate the data capture rate and voltage resolution of this combination. What is of immediate interest is that there are now a number of inexpensive portable computers on the market that bring the age of "one laptop per child" tantalisingly close. A machine that does word processing, spreadsheets, presentations, internet access and interfacing is a useful beast. We found the Asus to be robust (yes, we dropped it) and easy to use.

Conclusions

We do not intend to recommend one of these interfacing solutions over the others. All have their strengths. The Xplorer was packed with features beyond those expected of an interface and came with a usable set of sensors. The Labquest had a clear, full colour touch screen that made using the on-board software very intuitive, and the Asus was a fully-fledged computer as well as a datalogger. What schools buy will be largely down to personal preferences and perhaps more pertinently what they already have in their science departments.

All three solutions allow pupils to gain direct experience of collecting and analysing data in the lab and in the field, using equipment that is as up to date as anything they will find in their business administration class. All the above interfaces cost under £300. If this still seems like a lot, here is something to consider. When we reviewed the Pasco ScienceWorkshop 500 interface in 1997 it cost £378 for a black box that was unusable without a computer. With data logging explicitly mentioned in *Curriculum for Excellence* draft outcomes (SCN 216F - *Using modern technology, for example a data logger, to gather and present information, I can analyse and compare the thermal insulating properties of materials and choose the most appropriate material for a particular purpose*), we hope that schools are given the means to carry out this activity using modern, easy to use equipment.

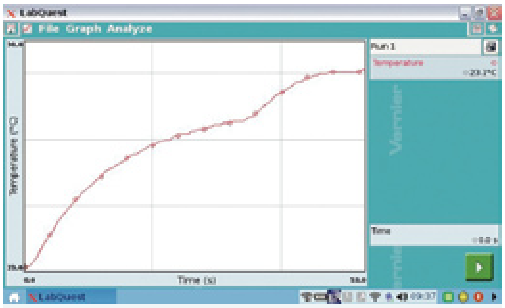

Figure 14: Asus screenshot

Figure 15: Go! Link adapter

[1] http://www.pasco.com/products/probeware/PASPORT/glx/features.cfm
[2] SSERC Bulletin 192
[3] http://www.vernier.com/labquest/techspecs.html
[4] http://www.inds.co.uk