Information and Power in your Hands

Data Collectors meet Mobile Computers

The DLI WATCHMAN®*DCX*™

DIAGNOSTIC DATA COLLECTOR / REAL TIME ANALYZER

With the advent of high volume, low cost mobile computers and the adoption of digital audio technology, we are now seeing the introduction of the "third generation" data collector. Where we started with bulky spectrum analyzers, we have spent the last 15 years using purpose built "portable data collectors" for the acquisition of vibration measurements. Over those years we have seen many improvements. We've gone from 8 bit A/D converters up to 16 bit for improved accuracy and dynamic range. The memory capacity has increased, the weight has come down, the tests are completed far more quickly, and the diagnostic capabilities have certainly improved. But the new generation has taken a giant leap forward, leaving the proprietary, route based data collectors behind.

Imagine carrying your desktop computer in the palm of your hand. The memory capacity is practically unlimited. Communications are substantially faster and more flexible. The software is more powerful, and is the same as you run on your desktop. And, oh yeah, you can run other software programs on the same device.

This paper will discuss the development of such a device, called the *DCX*, at DLI Engineering. It will describe the mobile computer platform, the new measurement technology, the communication improvements, the test point identification options, and the new way that the field operator can work. This really is a revolution in the way vibration data (and other field data) can be collected.

The computer in your hand

Let's start by looking at the computer itself. After years of development, manufacturers all over the world are delivering robust handheld computers that feature Pentium processors, multi-gigabyte hard drives, color or grayscale displays, IrDA (and in some cases RF) communication options, and of course, the Windows 95/98/NT operating systems. They come in all shapes, sizes and colors. The majority support touch-screens or special pens to control the user interface.

All of these devices also support the new standard in PC interfaces; known as PCMCIA. This interface allows advanced electronics in a package slightly larger than your credit card to be inserted into the mobile computer. In our case, the PCMCIA card performs all of the data acquisition – but more on this later.

Using an off-the-shelf computer means that you can find the product that best suits your needs. Would you like a larger display? What about color? Want one with snap-out batteries that can be replaced inexpensively? And what else could you do with a handheld computer? Are there other tests you would like to perform in the field? Could you take notes, access CMMS information, look up manufacturers specifications, review company proprietary information; or even check training material for added help. The options are endless.

The measurement electronics

It is hard to believe that such a small package can do so much. At DLI Engineering we have developed a PCMCIA card (type-III) that has the following main features:

- 16-bit delta-sigma analog to digital conversion (we no longer need anti-aliasing filters).
- A digital signal processor (DSP) for very high speed measurement calculations (e.g. FFT).
- Four channels of simultaneous sampling.
- A dedicated input for the tachometer (phase, speed and TSA measurements).
- ICP power supply for the transducer.

With this advanced package of electronics, which has superior performance and measurement specifications than "conventional" data collectors, we can perform a wide range of sophisticated tests. In addition to the collection of standard spectral and time waveform data, we can perform cross-channel measurements (frequency response functions, etc.), high speed "burst" acquisition for runup/coast down tests, demodulation for bearing analysis, and amplitude and phase for balancing and operating deflection shape analysis (ODS).

So, in addition to having a powerful mobile computer, you have a data collector for routine machinery monitoring, and an advanced spectrum analyzer for your machine-side investigations and balancing. In fact, the same electronics are employed in our latest on-line monitoring system.

Communication (look Mom, no wires!)

When one talks about field data collection devices, the thought of loading and unloading "routes" via the serial port would normally follow. Well, think again! With modern computer technology and Windows based software we can do much better.

First we have to cast off the idea that the data collector is some kind of slave to the desktop computer. In this new world, the data collector and desktop computer are *equal*. Anything you can do on the desktop computer can be done on the mobile device, and visa-versa.

The database on the mobile collector *is exactly the same* as the database on the desktop computer. You no longer have to follow "routes". You no longer have to wait until you get back to the office before performing analysis, report generation, and other tasks. All of the data is available in the DCX mobile collector, and all of the software used on the desktop computer can also be used on the DCX mobile collector. You can even set up the database while you are standing next to the machine.

But this means that we need a way to keep the desktop, server, and mobile databases in synch. A change to one database must be reflected on all other databases. This is all achieved transparently via *replication*.

Sharing data via replication

When you have two or more sites (including the DCX units) that need to share the data, you have to consider what data needs to be moved between the sites when changes are made to any one database.

For example, if John modifies his desktop database at the same time as Betty is collecting data in the field (and perhaps updating the machine nameplate information), then somehow Betty's changes have to get back to John's database, and John's updates need to get to Betty's database. If at the same time Joe has another DCX at a remote site, he may need the changes John made, and he may also like to know the results of Betty's tests. Sound complicated? It's not!

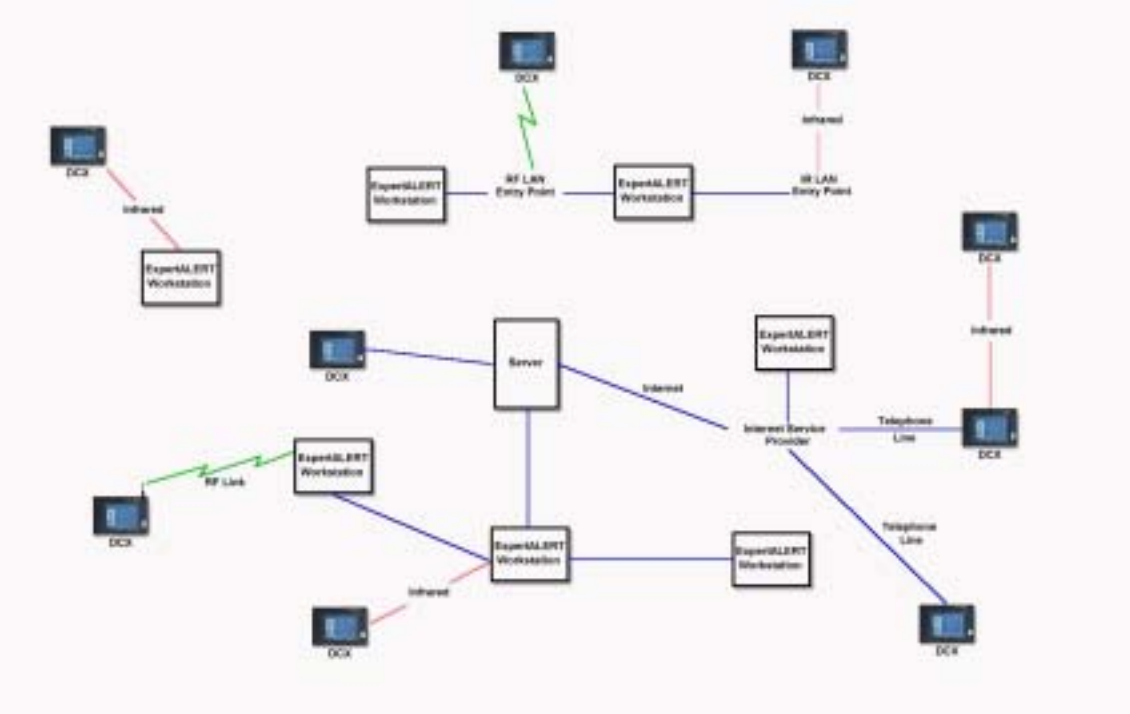
Whenever any of the desktop or mobile computers are connected to the network, a background software program checks each of the databases to see what changes have been made. So when Betty connects to the network, the replication software can see the new test data, the diagnostic results, Betty's observations, and the changes made while Betty was in the field. When John is connected to the network (which is probably permanent), his database will be updated, and any changes he made will be packaged ready for Betty and Joe's databases. When Joe connects, his database gets the changes made to Betty's and John's database.

So, in summary, without them really knowing (it happens quickly and transparently), all of the databases are bought up-to-date. So Joe can see the measurements, diagnostic results and comments made by Betty, even though he is still off-site!

This method of sharing data can also be applied between different sites, enabling users at remote sites or sister plants to have immediate access to all of the key information and data. This concept is part of the DLI Engineering *Information Everywhere* strategy, and is discussed in a separate paper.

Moving the data between John, Betty and Joe

Replication works very well, but you may wonder how the test measurements and changes to the database on the DCX unit actually gets to the other databases. Rather than using the slower serial port and "unloading the route" as with conventional data collectors, we connect to the network so that replication can take place. The network connection can occur via the IrDA infrared port on the mobile computer, an RF network, the standard computer network that you find in your office, and even via the Internet.



IrDA infrared port

The majority of mobile computers come with the new IrDA infrared port. You simply add a communication device to a PC (supplied by DLI Engineering), and all you have to do is sit the DCX within 3-4 feet of this device and communication begins. No wires! The IrDA port is roughly 35 times faster than your fastest data collector over a serial port. And do not worry, if you accidentally block the infrared path, communication will pick up where it left off.

Radio frequency network

You can also set up a radio frequency (RF) network at your site for a lot less money than you may think. With such a network, the mobile collector could be in constant communication with all other users on the network. As data is collected, the results will be known to all other users on the network almost instantly. You can even send and receive e-mails (and browse the Web) while you work!

Standard network connection

You can also connect the DCX to your network via the standard BNC and telephone-style connectors. The communication rate would be roughly 90 times faster (or 900 times faster for 100 megabit per second networks) than your standard data collector.

The Internet

And for remote sites and consultants, you can even communicate via the Internet. Just dial-in to your ISP (Internet Service Provider) and communication will begin. You must have a computer back in the office that is also connected to the Internet.

Ease of Use

Everyone says their product is easy to use. But ours really is! Here are the two most important reasons why this is true.

Reason One: Familiar software

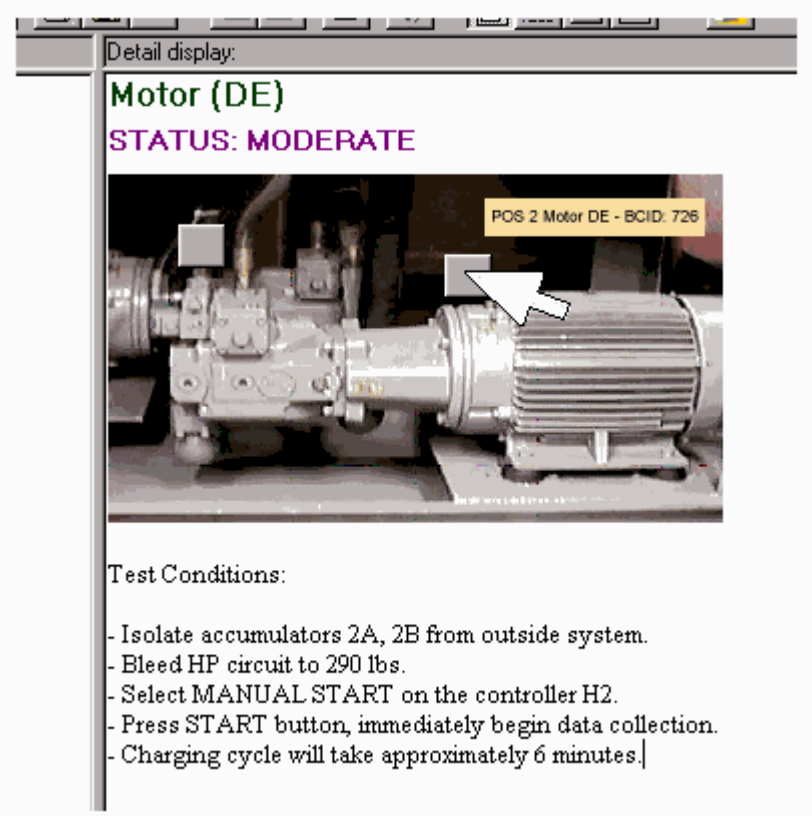
The DCX unit uses the *same* software as the desktop computer (you can even plug the PCMCIA card into your desktop and collect data!). This means that staff only needs to learn one software package. The main software looks a lot like the Microsoft Explorer software, and most people know how that works.

Reason Two: Simple test point identification

The DCX system gives you four ways to identify the test point. This is naturally a very important feature, as a mistake here can cause considerable problems, from the need to go back out a re-test the machine to the misdiagnosis of a machine problem.

Touch a picture of the machine

You can save actual photos (or drawings) of the machine in the database. At set up time you specify where the transducer is to be placed on the machine. When you are collecting the data, simply touch the screen at the correct test location and the measurement will begin (with optional confirmation).



Select the machine from a list

Of course, you can also view a simple list of the machine's test locations and touch the screen to start the test. It is extremely easy to navigate through the list. And you can easily tell which machines have been tested, and which still require testing.

Automation through barcodes

DLI Engineering pioneered the use of barcodes to identify the test location. Just walk up to any machine, swipe the barcode, and the collection will begin. Just watch the screen to witness the collection progress, then move to the next machine. Very easy and very reliable.

Go one better with RFID

In harsh or dirty environments, go one better than barcodes with RFID (Radio Frequency ID) tags. RFID tags are about the size of a quarter, and are glued to the machine. The operator just walks up to the machine, waves the RF wand *near* the tag, and the test begins. Contact with the tag is not necessary. The tag can be painted, it can be covered in dirt and grim and dripping in caustic liquid (within reason), and it will still work every time.

Are there any other benefits to using a computer?

We have already seen that a mobile computer gives significantly greater performance, form-factor flexibility, communication and user interface options, and we know that having a mobile computer gives an operator numerous options for running additional application and communication software. Let's explore some other ways in which the predictive maintenance process has been improved.

Database set up

When the database is initially established, the machine is normally visited for the key information. Traditionally a notepad would be taken out, and test locations, nameplate information, and other pertinent information was recorded. Then back in the office the database was set up while referring to those notes.

Now you can replace the notepad with the DCX and perform both steps at once. Using smart "wizards", the machine is created with minimal steps (also setting up everything the expert system needs to know). You can take your digital camera and leave it connected to the DCX mobile computer; choose from a graphical list to specify the orientation of attachment pads; record all of the nameplate information and more.

Automated diagnostics

While in the field collecting data, the *Expert Automated Diagnostic System* (EADS - a powerful screening tool that is also able to assist in the diagnosis of common machine faults) will detect when all the points on the machine have been tested and automatically check to see if there are any faults to report. If the test conditions were incorrect, the operator will know instantly. If a significant fault is detected, the operator can act immediately: perform a closer audio/visual inspection; perform additional vibration tests; question local operators for observed changes; and alert another maintenance staff member if necessary.

Improved on-site analysis

When in-depth field analysis is required, not only will you have all the capabilities provided by the spectral analysis system, but you will be able to draw upon the history of test results.

DCX provides all of the standard measurement capabilities such as runup and coast down tests, bump tests, live spectral/time waveform displays and more. You will even be able to turn the unit into a mini on-line monitoring system to watch a machine over a period of time. But in addition, all of the test data taken previously will be available for review. Notes and observations entered by users; previous EADS diagnoses and recommendations; analyst comments; and more are all available while out at the machine. All of these tools, and access to this wealth of information put you in the best position to make the best decision.

Conclusion

The success of mobile computing applications has given the maintenance group an excellent new weapon in the fight against machine downtime. The combination of extraordinary power, familiar software, quality miniaturized measurement electronics, and advanced software is a definite leap forward from the previous generation of proprietary portable data collectors.

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