# Increasing Your Test Department Productivity Through Proper Data Management

# Introduction – Data-Rich but Information-Poor

Technical product data is generated throughout the entire development process – whether by simulating a process or actually testing a real prototype. With the cost of simulation systems, data acquisition hardware, automation systems, and the associated personnel, collecting this data represents a significant investment. The increasing trends in microprocessor speed and storage capacity have resulted in an explosion of data stored in files and databases. While on one hand technology is enabling fastest and richer data retention, managing and making good use of this data is still a challenge. In today's fiercely competitive business environment, companies need to rapidly turn test and simulation data into usable information to efficiently drive product development.

Several roadblocks can get in the way of optimal exchange of information, the most notorious of which is the improper capture of information at the time of test. All too often data is stored without descriptive properties, in inconsistent formats, and scattered about on arrays of computers, creating a graveyard of information that makes it extremely difficult to locate a particular data set and derive decisions from it. As a result many companies are seeing a loss in efficiency and increasing development costs.

Presuming you capture the data with sufficient descriptive attributes, the next hurdle is making the data available for others to easily access and use. Solutions to this challenge range from primitive file and folder naming conventions to complex database solutions that are costly to set up and maintain. The ability to turn raw data into interpretable results instantaneously and to easily share these results with cooperative project partners is critical for the efficiency of the overall development process.

Take for example commercial flight testing, which is known for generating an overwhelming amount of data. Because of the criticality involved, cutting corners is not an option; however, the competition for contracts is high and there is a lot at stake for those companies competing for new business. To obtain the official approval for commercial use for a regional passenger jet (50 to 100 passengers) more than 1,800 flight hours are required to conduct all necessary tests. Each flight hour requires approximately 70 engineering hours to evaluate the test data. Assuming that the engineering hour is worth $140 the cost for evaluating the data amounts to $17.64M. Decreasing the analysis time by 10% would amount to a cost savings $1.76M. Such optimization reduces overall development, and is required for companies to remain competitive. To realize these savings, proper choices regarding file storage, data management and analysis, and reporting all need to be primary considerations.

# Overall Design Goals Require Seamless Exchange of Information

The situation described above scales from single subtasks to global design goals. The product development process is generally broken down into a certain number of manageable subtasks similar to products being broken down by components. For instance, an automobile is comprised of a body, engine, transmission, chassis, tires, and so on. However, the successful accomplishment of overall design goals such as "improving the fuel consumption of a vehicle" or "maximizing the MTBF (mean time between failures) of a product" requires optimized "interplay" of multiple or even all components of a product.

Therefore designers need to have access to measured and simulated characteristics of all components that are relevant for their design task. Being able to easily access test and simulation results for verification, comparison drives down development costs and increases productivity significantly.

Another example is optimizing automobiles for fuel efficiency. In a challenging economical environment with a volatile oil price, the reduction of the fuel consumption of a car is a key factor for bringing competitive vehicles to the market. The reduction of the fuel consumption is a classical example where multiple components (aerodynamics of the car body, drivetrain, power train, as well as tires) of the car have a significant impact on the achievement of the design goal. The number of optimization variables is overwhelming and requires proper data management systems to effectively aid in decisions that effect fuel efficiency.

# Today's Situation

Statements such as *"70% of our time is spent finding data, only 30% of the time is spent creatively extracting information"* and *"At least 1 out of every 10 tests has to be redone because we can no longer find the data"* are representative of today's data management situation.

Sharing test results and knowing what others in the organization are working on still remains a challenge, even in an age where so many advancements have been made in information exchange. Search engines such as Google and Yahoo have dramatically impacted how people work, making information on every subject instantly available. Our engineering bookshelves are no longer populated with rows of product specification guides because this information is now online, up to date, and easy to access. Yet when it comes to managing test and measurement data, we are largely living in the Stone Age. Data files are routinely lost, thus requiring duplicate test runs; and excessive amounts of time are spent locating files. Moreover, searching for trends across multiple data sets and locating data based on key identifiers, which is functionality useful for all technical professionals, unfortunately has been reserved for only those who have made significant investments in building customized data management systems.

Viewing this situation in the context of today's business trends – faster time to market, large companies building distributed R&D centers, and the outsourcing of tests – it is obvious that we face a "data problem." A traditional method to solve the data problem can be summarized in the following steps.

1. **Identify the descriptive information you want to use to relocate your data for postprocessing after it is stored –** You need to store information such as UUT (unit under test) name, serial number, test date, configuration, min/max values, and so on – information the data consumers want to use to identify the data they want to work with.
2. **Create a database structure that includes columns to store your descriptive information –** Databases offer the possibility to define so-called database queries in order to search data records based upon certain conditions. By storing descriptive information in a database, we provide the data consumer a way to search for specific data records, as opposed to browsing manually through directories or relaying on phone calls or e-mails to locate data.

3. **Implement searching and data mining tools with which you or the data consumer can find exactly the data set required –** As a last step, the tools that are used by the data consumers to access data need to offer a user-friendly interface so they can interactively search for the data in which they are interested.

However, this approach involves a significant one-time investment in software commodities (e.g. database server and client licenses) as well as in development efforts for data model conception, implementation, and integration of client software. The remainder of this paper will explain how National Instruments latest products and technologies can help you increase your productivity at fraction of the cost of traditional systems.

# National Instruments Data Management Solution

National Instruments, recognizing that dealing with the deluge of data is a high-priority problem in need of a solution, has developed a technology that brings the power of Internet search to your test data, without all the hassles of configuring and maintaining a dedicated database data management solution. By following the three-step approach of storing, managing, and mining, National Instruments customers can turn their data into information instantaneously by using off-the-shelf products and technology such as LabVIEW, DIAdem, and the TDM (technical data management) storage format. The following sections outline National Instruments total system approach to data management. This includes proper data storage using the LabVIEW data storage VIs that write TDM files, the DIAdem DataFinder to manage test data, and DIAdem for further posttest analysis and reporting.

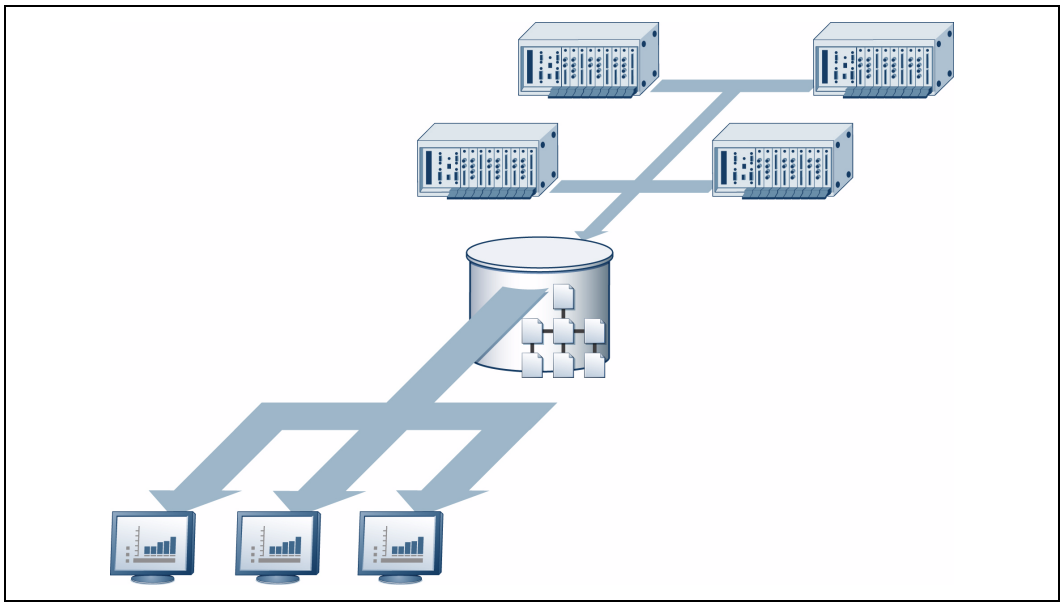

**Figure 1.** National Instruments has developed a total systems approach to aid in managing the deluge of data generated in today's testing environments.

# NI TDM Format

The NI TDM format is designed to capture and manage all of the important information surrounding a measurement or simulation. It assures that the data is self-explanatory, reusable, and requires no additional explanation to recreate the conditions under which it was captured. It is a structured, search-ready format. For example, it provides for storing descriptive information about the UUT, test type, configuration, and environmental conditions. This information will not only help you or your coworkers understand the context in which the data was acquired but also help locate exactly the data one wants to work with.

TDM Files written natively using DIAdem, LabVIEW data storage VIs, or LabWindows™/CVI™ storage functions provide three levels of hierarchy to structure your test data – file, group, and channel levels. Each level comes with a rich set of standard attributes as well as the ability to add descriptive attributes specific to a certain application.

A TDM storage file consists of two components – an XML component that contains the data structure and the descriptive attributes, and a binary component for the actual test data. This architecture ensures high performance and manageability at the same time.

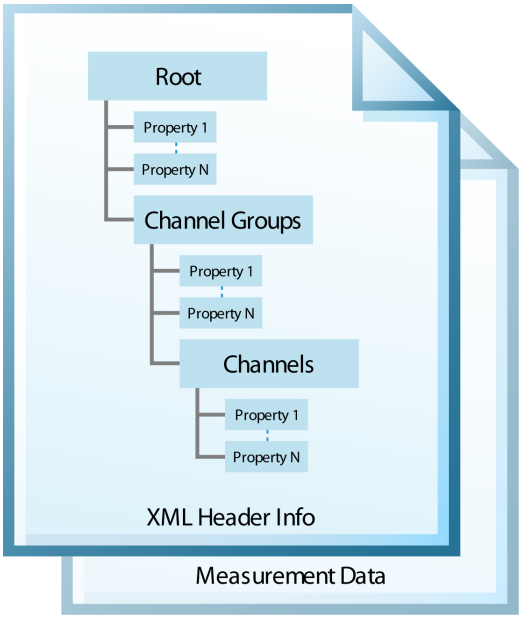


**Figure 2.** The TDM format is flexible to accommodate the most demanding data storage applications.

Having a rich set of attributes increases the range of possible search conditions. The LabVIEW data storage VIs provide the easiest way to document your test data in LabVIEW, making it search ready. NI also provides add-ins for reading TDM files into Excel, along with full format specification and programming libraries if you wish to incorporate TDM in applications not based on NI products.

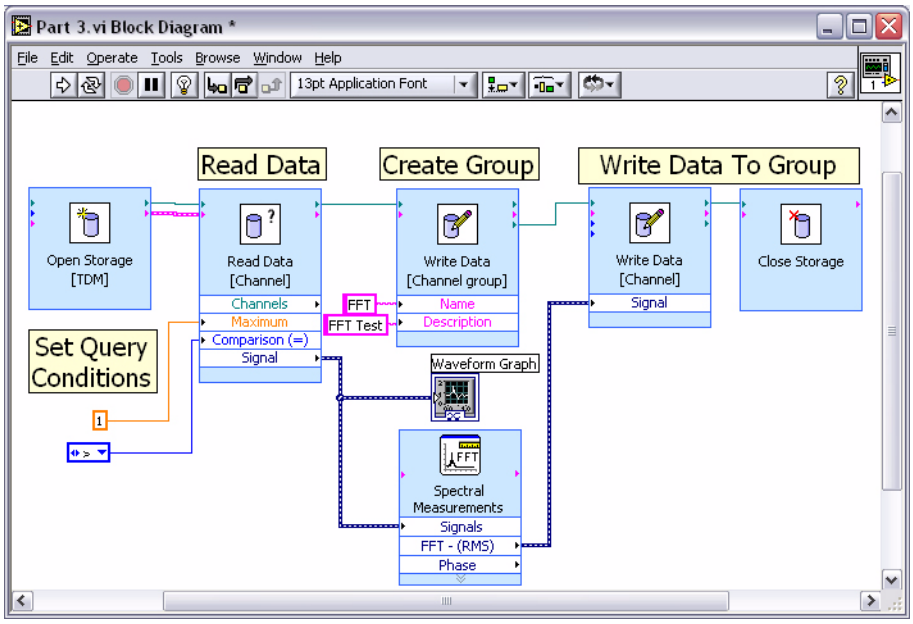


**Figure 3.** The LabVIEW data storage VIs provide a flexible, easy-to-use interface to read and write TDM files.

# Test Data Management and Mining with NI DIAdem

Over the last 15 years, National Instruments DIAdem has been a workhorse data analysis and report generation tool with a solid reputation for helping scientists and engineers streamline data processing. With features for loading extremely large datasets and creating professional reports in a WYSIWYG environment, NI DIAdem has helped many companies save valuable time while also improving how engineers communicate with one another. For version 10.0 of DIAdem, National Instruments has developed a revolutionary DataFinder technology. With the DIAdem DataFinder you can perform Internet-like searches across all your data files, regardless of format and location within your company intranet. Simply install DIAdem, point DIAdem to the location of your data files, and seconds later, you can search for your files just as you would search for information on the Internet.

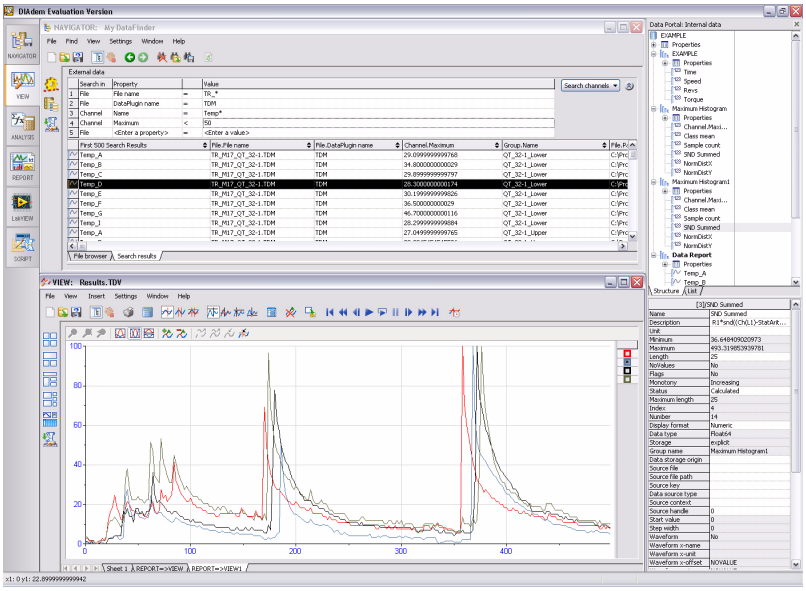

**Figure 4.** DIAdem combines off-the-shelf data management and data mining tools with flexible data analysis and report generation.

Comparable to Google desktop, DIAdem DataFinder crawls through defined search areas that may be located anywhere on your local machine or on any computer connected to your local intranet accessible to you, and indexes your test data. This means all descriptive attributes as well as the relationships between files, channel groups, and channels will be transferred into the internal DataFinder database together with the information about the physical storage location of the file itself. DIAdem 10.0 itself provides a user interface for keyword searches as well as an advanced search interface to mine for data based on specific attribute conditions.

> For example, you can mine for all tests where Serial Number = ABC, Test Status = Failure, and Test Type = Shock Test.

After locating these files with DataFinder, you can use DIAdem for further analysis and reporting. Using DIAdem DataFinder not only makes finding your test data easier, but also enables you to establish relationships and uncover anomalies you previously did not have the visibility to do.

> For example, you can now mine for certain channels stored in the data files you have identified where the max value is greater then XYZ.

This functionality, useful for all technical professionals, unfortunately has previously been reserved for only those who have made significant investments in building customized data management systems. Knowing what tests other engineers have run has been a challenge that often leads to unnecessary duplication of tests. Using the DIAdem DataFinder you now have an easy and intuitive way to locate data others have collected.

# Inspecting Analyzing and Reporting Technical Data with NI DIAdem

Once data has been loaded into DIAdem, it can be inspected interactively so you can gain valuable insight and understanding of the characteristic of your data instantaneously. In DIAdem you visually inspect your data and draw conclusions by interacting in tabular, graphical, and multimedia forms. Here you find functions for scrolling, zooming, measuring, and synchronization of videos and data, as well as for data manipulation.

To convert technical data into usable results, DIAdem provides libraries of the most commonly used analysis functions, such as basic mathematics, curve fitting, signal analysis, statistics, matrix operations and 3D analysis.

Sharing information with collaborating project partners requires you to communicate results clearly and concisely. With a drag-and-drop environment tailored for creating engineering and scientific reports, DIAdem offers an interface to graphically create reusable report templates. A report may contain as many 2D and 3D graphs, tables and images as you need to report your findings. Each report also can have an unlimited number of pages and can include additional texts, pictures, and variables. A template can be reused easily with similar data sets (e.g. create a report from 10 data sets that belong to one test series). The content of your report will be populated automatically depending on the data set(s) loaded into DIAdem. Reports may be printed or exported in various formats such as HTML, JPEG, and BMP.

# Working with Legacy and Third-Party Data

DIAdem DataFinder works natively with TDM files. However, many companies have developed test file formats that capture essential test information in header files. NI DataPlugin technology makes your custom file formats and legacy data available for searching by reading in the attributes from any arbitrary, binary, or ASCII file into the DIAdem data index. You also can use the DataPlugin wizard in DIAdem 10.0 to automatically generate DataPlugins for ASCII files or use the programmer's API to create your own DataPlugin using the DIAdem VBScript interface.

Today NI has already created more than 40 DataPlugins for third-party software and hardware and industry-standard formats (e.g. Yokogawa and Nicolet instruments, ISOMME, UFF58 and others). These are available for download on `ni.com/diadem/dataplugins.htm`. DIAdem DataPlugins ensure a smooth transition when introducing a new data management system; they also provide a migration path when the requirements of your organization expand beyond today's status quo.

# ROI Considerations

Business trends such as extremely high time-to-market pressure and distributed R&D centers significantly drive up the importance of having a streamlined development process. This means 1) to have the ability to easily collaborate across groups through using platforms and 2) having access to test and design information throughout the development process. Studies have shown that companies that focus on these points.

1. Have 12 percent greater success in bringing new products to market.
2. Experience 9 percent higher success rate in meeting budgets.
3. Are 14 percent faster than the competition in releasing new products.

   Source: *Electronic Business, Business Trends by Beth Stackpole, September 2005, Results conducted by PTC (*`www.ptc/go/report`*)*

To achieve these results, companies have previously been forced into significant investment in databases, client application, and custom software development. These investments have easily exceeded 6-digit numbers; not to forget the reoccurring costs for further development and maintenance. And yet such custom systems are typically not transferable to other applications within an organization because they are designed to meet the need for a particular application. They are also difficult to scale down for smaller user groups because of the frequently encountered very high administrative overhead (support, maintenance, IT).

National Instruments DIAdem DataFinder technology significantly reduces the investment necessary to streamline the development process and to be able to turn your test data into information instantaneously. DIAdem 10.0, a commercial off-the-shelf product, brings Test Data Management to every engineer desktop for a fraction of the cost of traditional data management systems.

Companies such as Raytheon, Airbus, Cummins, and Daimler Chrysler benefit from large time reductions in their postprocessing of technical data by using the data management and automation capabilities of DIAdem.

“By using DIAdem, we can turn our data into usable results in minutes rather than days. We have documented an overall time reduction of 95 percent since we integrated DIAdem into our system.”

*—Jim Knuff, Principal Systems Engineer Raytheon Missile Systems.*

# Conclusion

Your test and simulation data represents an investment in time and money. How fast you convert your raw data into information is a measure of your organization's efficiency. If it routinely takes hours or even days to receive the results from a recent test you might be suffering from the "data problem."

NI DIAdem DataFinder is revolutionizing how engineers and scientists work with their data. Not only can you locate the data you need faster, but also you now have the ability to search for patterns and trends that were not previously possible when your data was saved in flat files scattered across a variety of computers. Adopting the TDM file format and the DIAdem DataFinder increases the value of your collected data and has a dramatic impact on shortening the product development cycle.

For more information about DIAdem, visit `ni.com/diadem`. To learn more about LabVIEW data storage VIs and the TDM file format, visit `ni.com/tdm` or `ni.com/labview`. Finally, to explore the various DIAdem DataPlugins, visit `ni.com/dataplugins`.

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NATIONAL INSTRUMENTS™

11500 North Mopac Expressway • Austin, TX 78759-3504 USA
Tel: (512) 683-0100 • Fax: (512) 794-8411 • Email: `info@ni.com`