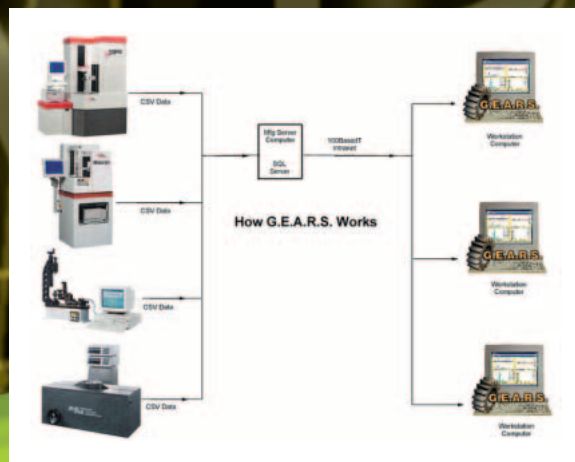


The electronic revolution of recent years has brought the world to our fingertips, and new software provides that same immediate information access to the manufacturing process.

# SOPHISTICATED SOFTWARE FOR REAL-TIME DATA RETRIEVAL

by Marvin Nicholson



In an age of information systems, we have immediate access to everything from our e-mail to the Internet. Gear manufacturers now have a system that will provide them with immediate access to their manufacturing data in real time. Gear metrology systems now are being networked and data linked so that they share files and programs. This enables process engineers to have access to these programs and files from their desk workstations. But in order to understand your process, you must have access to your data in real time. The two methods of extracting this information are Data Review and Data Collection Systems.

**Data Review:** This method requires the user to collect all printed data from the metrology equipment and record the calculated result values. The result values are then input into a format to compare to other inspected data. This process takes many hours to complete, and when that data is finalized, the actual response time window is not realized.

**Data Collection System:** This method is a real-time system that permits all process engineers to review various part numbers at the same time. Because the data importation is automatic, this method is actually real-time data. This enables the

engineer to respond in a timely manner that best fits the manufacturing environment.

When we conduct SPC (statistical process charts) on gears, what exactly do we evaluate? How can we apply SPC to gear manufacturing? In order to conduct these

studies, we must examine what SPC gear data actually consists of.

Gear geometry has many characteristics for each of the main attributes (i.e. lead, involute, index). In some cases there are up to 32 characteristics for a lead or involute attribute. In addition to the AGMA Analysis and the major OEM Analysis—such as the Ford Motor Company, General Motors, and Daimler Chrysler—the international shift of manufacturing is requiring many U.S. companies to analyze their gears in DIN and ISO formats. This creates additional types of characteristics. To manage the variables of all the different types of analysis and individual characteristics is time consuming and almost impossible by hand. With these different analysis formats, this changes the criteria on SPC studies.

Gear Engineering Analysis Engineering Retrieval System (G.E.A.R.S.) software is a gear data collection system that includes the SPC software for generating the statistical process charts. In order to make this software a useful tool for process and manufacturing engineers, it must be very intuitive toward prompting the engineer through the query process. The chart below outlines the basics of how G.E.A.R.S. works:

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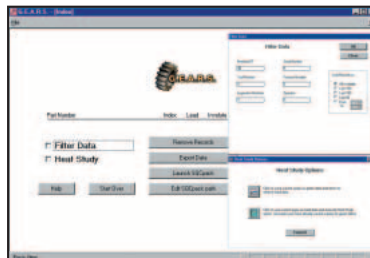
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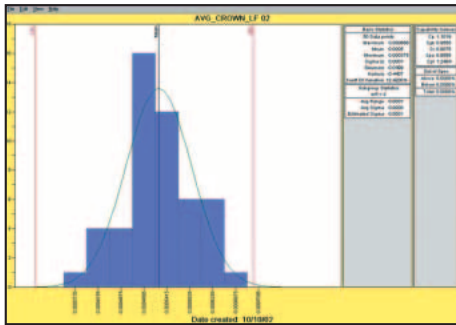
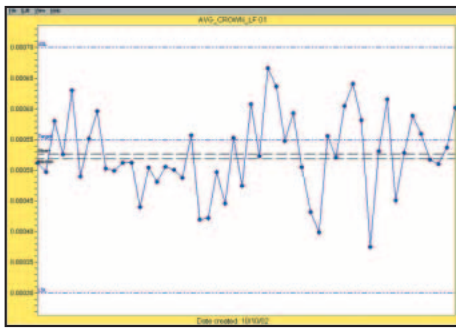
G.E.A.R.S. is based on a simple principal; the analyzed data is exported from the metrology machine, double-flank machine, or DOP gage into a database table. This data is exported in a CSV (comma separated variable) format. This type of file is generic in format and can be easily imported into many different applications without translation errors. The G.E.A.R.S. software has preset programs that import this data into pre-assigned tables in a SQL database running on a network server computer. Once the data is verified and imported into the SQL database, it is ready to be queried by the G.E.A.R.S. client software that resides on the respective engineer's workstation computer. Using ODBC (open database connectivity), the client-based software will then query the SQL database for the requested gear geometry data. The G.E.A.R.S. software then prompts the engineer to select the part number and process of the gear or the record set.

After selecting the part number, the engineer is then prompted to select a date range for the query. This date range is pre-selected based on the newest and oldest record in the database for this part number. The engineer can also select individual time-based studies such as first shift, second shift, third shift, all shifts, and 24-hour time increments.

After selecting the date and time range for the query, the data is queried and received from the SQL database. The engineer now has the ability to filter the data using additional criteria such as machine brass tag number, tool number, serial number, inspection machine, furnace number, and operator. From this point, the engineer can export this data to the SPC software program or conduct a "heat study" query. A heat study query is done by retrieving two separate queries on a given part number that has prior and post heat-treat inspections stored. The engineer can then save these two queries as Excel files and then into the Heat Study Analysis Sheet (usually a Microsoft Excel worksheet).

Being able to manipulate the data easily is important in extracting the required gear data. When the required filtering is finished, the data is then exported into a SPC software package. G.E.A.R.S. typically uses SQCPack written by PQ Systems,





which is located in Miamisburg, Ohio. However, G.E.A.R.S. can export to many other common SPC software such as Visual SPC. A run chart and histogram automatically created by G.E.A.R.S. is found below:

SQCpack offers many advanced features. All calculations are compared against NIST data and popular statistical process control texts, including AIAG, in order to ensure the integrity of the statistics. Homegrown packages or formulas created in Excel cannot begin to stand up to the rigorous testing that SQCpack has undergone over the last 20 years. One of the key features of SQCpack is that, as the engineer is reviewing a typical run chart, by right clicking with the mouse on the data point, the actual data information is displayed, including the inspection test number, part number, date and time of inspection, inspection machine, and serial number, as well as the actual numerical value. This information makes it very simple to track back through the metrology software to review an inspection that might be in question.

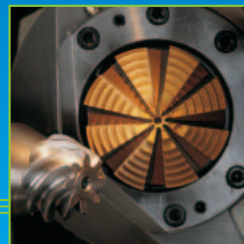
G.E.A.R.S. is designed as a multi-user license program where many users access the information from their individual workstations. For the gear manufacturer that only has one or two process engineers, they now have the option of a single-station user license. This software is packaged as G.E.A.R.S. Lite, which runs on the engineer's workstation and retrieves the data from the metrology machines over the intranet. The SPC software package used on G.E.A.R.S. Lite is Chartrunner, written by PQ Systems of Miamisburg, Ohio.

A company's intranet network now plays a vital role in manufacturing, with new innovations such as the eDRO (ethernet digital readout) electronics that permits the process engineers to assign a tolerance to DOP (dimension over pins) gages as well as collect data. In the past, these gages had dial indicators and at best a digital readout that would only display the number.

The eDRO offers a new dimension of control for the floor gages. This gage is configured using a typical IP (Internet protocol) address. The process or

## Custom Manufacturing of High Performance Gears

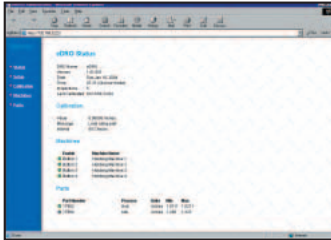
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quality engineer uses their standard Internet browser to configure and program the embedded processor inside the gage. This offers the following features:

- 1) **Part Number Labeling**  
This creates a list of part numbers stored inside the eDRO.
- 2) **Date/time Stamping**  
After each captured inspection the data is date/time stamped.
- 3) **Tolerance Fields: Min. ~ Max.**  
Min. and Max. tolerances give the operator a "pass" or "fail" message.
- 4) **Assignment of Function Buttons**  
There are five programmable function buttons that could be labeled, for example, to reflect the hobbing machines cutting the gears.
- 5) **Programmed Calibration Interval**  
The calibration interval is determined based on either number of checks or number of minutes, hours, and days.

This routine will require the operator to recalibrate the gage prior to inspecting the next part.

#### 6) Data Collection

Data is stored on the unit for SPC reporting. This can be done either on an individual basis or through the G.E.A.R.S. software.

Currently, this eDRO is setup for a DOP gage, but only the user's imagination is the limit. The embedded processor has the ability to accept various types of digital and analog I/O, including two-channel quadrature decoder input and four-channel pulse width modulated output.

The ability to program, control, and retrieve data from an in-process control gage is very important. Using the Web-based html interface, the gage can be programmed for the part numbers and processes required. Below is an example of the html interface.



### About the author:

Marvin Nicholson is president of Nicholson Gear Technology, Inc., which is an Ohio-based company specializing in gear manufacturing software databases, gear tooling, and machines. For more information, please contact Nicholson at (330) 722-5807, or send e-mail to [gearsrus@ix.netcom.com](mailto:gearsrus@ix.netcom.com).

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