GeoStat

Interactive SPC Software

Version 6.65

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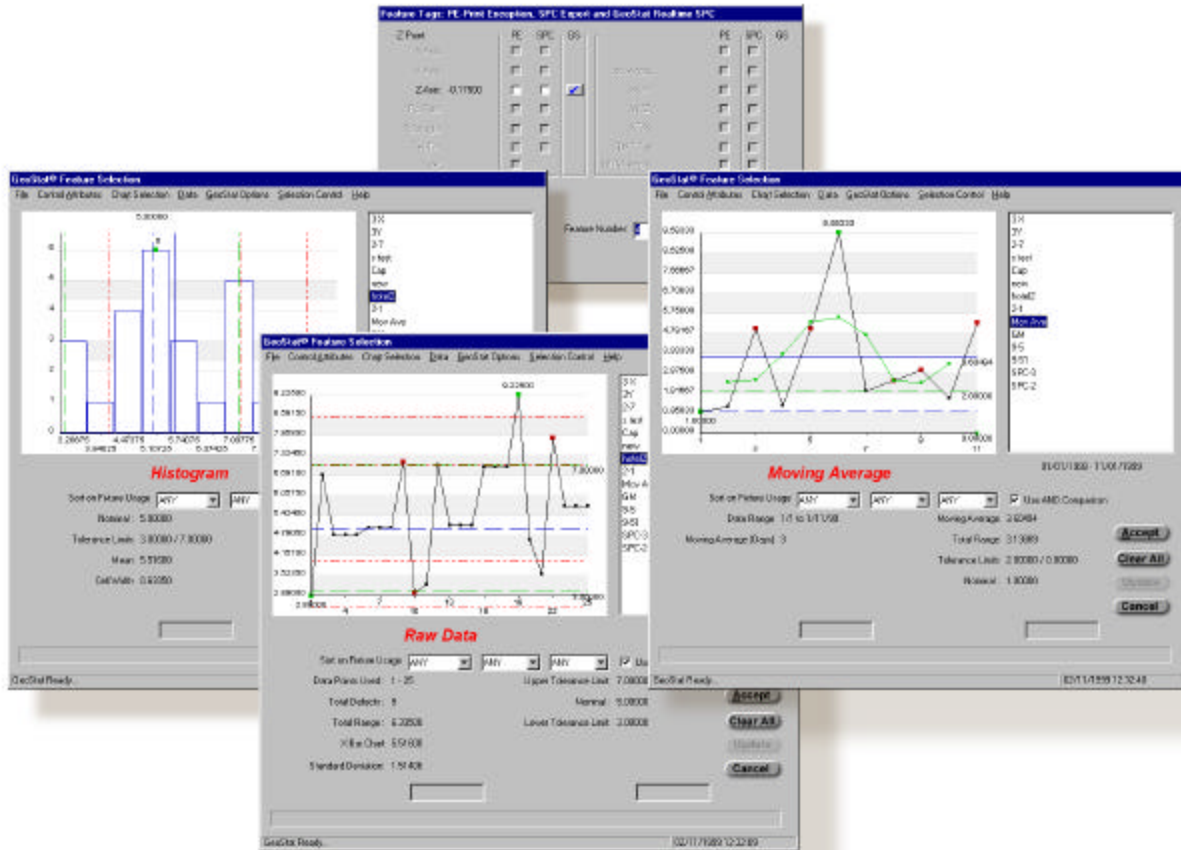
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When you bought this software, we believe you made a good decision. Why? Because you now have unleashed the power of integrated Geomet Universal CMM Software to perform the drudgery of data accumulation and performing calculations. More importantly, it means that you are now involved in Statistical Process Control (SPC).

Statistical Process Control (SPC) has become very important in and necessary in industry today as it can enable manufacturers to tune their processes and improve their quality adding a competitive edge over those without SPC.

The first goal of SPC is to determine the nominal, controlled behavior of a manufacturing process as only then can you possibly know when it changes and is "out-of-control". Once you find a point where the behavior does change, you can look to designate or assign cause of that change. Removing the cause should put the process back in control. Remember that the key to improving quality is to control the process that makes the product.

You should have a sound understanding in SPC before you start using this software. The manual, by its very nature, can only be a reference for usage of the software. It cannot be an acceptable replacement for an instructional course on the theory and application of SPC. One book on the subject that we recommend is AT&T's Statistical Quality Control Handbook, available through the American Society of Quality Control. Another example is Basic Business Statistics - Concepts and Application, 7th Edition available through bookstores at most colleges and universities.

How to Use This Manual

Please refer the chapter in this manual that contains the information you require.

Chapter 1, "Introducing GeoStat"
> Reviews the basic concepts of GeoStat. The standard user interface is described taking you through the menu hierarchy and icons. How to select features names or individual data points for processing. Applying filters through the use of fixtures and dates.

Chapter 2, "Working with GeoStat"
> Describes how to work with GeoStat Header and Measurement Data Records. Perform database maintenance. Use Limits Tests to provide first warnings when out-of-control conditions exist. Apply Chart Controls for Standard Deviation Control Levels, Histogram Cell Groups and Moving Averages.

Chapter 3, "Interaction with Geomet"
> Describes how GeoStat processes data directly from Geomet part inspections. The use of Feature Tagging is demonstrated allowing you to gather only the data required for study.

Chapter 4, "Charting Capabilities"
> Lists the charts available in GeoStat, techniques used to enhance and filter the data for more precise control and the use of Fixtures, date filtering and sorting.

Chapter 5, "Data - Import/Export"
> Describes how you can import data from other applications such as Excel or text documents. Exporting data in ASCII format can be done from a single record or the entire GeoStat database. Applying export filters to configure the data to be read by most other applications.

Appendix A, "Tables"
> Provides the common tables used in GeoStat and SPC in general.

Appendix B, "Glossary of Symbols"
> This appendix provides descriptions for the most commonly used symbols used in this Users Guide and SPC in general.

Appendix C, "Glossary of Terms"
> This appendix provides descriptions for the most commonly used terms used in this Users Guide.

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Conventions used in this manual

The following conventional terms, text formatting, and symbols are used throughout this GeoStat Users Guide.

Convention	Meaning
[File->Print]	From the File pull-down menu, the Print command is selected.
<F12>	The symbols < > represent a selected keystroke from the keyboard or a left-click button within GeoStat. Example: <F12> indicates that you should press the F12 (function key). <Accept> indicates you should left-click on the Accept button on the dialog shown.

Introducing GeoStat

Taking a Tour of GeoStat
 Activating GeoStat
 Accessing GeoStat from within Geomet

The GeoStat Menu Structure
 Pull-down Menus
 File Pull-down Commands
 Control Attributes Pull-down Commands
 Chart Selection Pull-down Commands
 Data Pull-down Commands
 GeoStat Options Pull-down Commands
 Selection Control Pull-down Commands

Using the GeoStat Data Tree

Applying Filters
 Filtering through Date Ranges
 Filtering with Fixtures

GeoStat Options
 Activate Fixture Filters
 Activate the Status Bar
 Setting Report Precision
 Setting 6 Sigma σ
 Taking a Tour of GeoStat
 File Locations

Taking a Tour of GeoStat

GeoStat is an interactive member of the Geomet Universal CMM Software family. The term interactive implies that GeoStat performs SPC data processing and reporting as Geomet performs a part inspection. This allows monitoring of the control process within Geomet immediately after the completion of a part inspection. GeoStat also performs as a stand alone program.

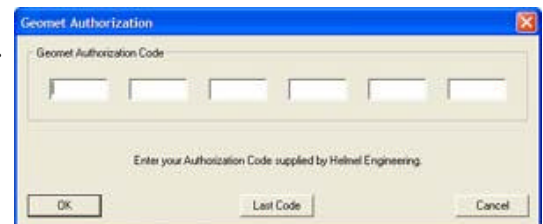This chapter will describe the structure and commands available within GeoStat.

Authorizing GeoStat

All Geomet System versions 1.05 or greater offer GeoStat as a released option. If you have not acquired an Authorization Code to activate GeoStat, please contact Helmel Engineering Products to purchase one.

When you launch GeoStat from the Windows Start menu, or from within Geomet, the security module is tested to determine if your copy of GeoStat has been authorized. Should the test show it has not, a warning is displayed and the program will shut down.

When you receive your Authorization Code, launch GeoClean and locate [Authorize->Enter Authorization Code] from the pull-down menus. Enter the authorization code and GeoStat will now be ready for use.

Accessing GeoStat from within Geomet

Accessing GeoStat requires that you first save your current inspection. If this has been done, press the <F12> function key or from the pull-down menu [Analysis->GeoStat] within Geomet. To launch from Windows use:

[Start->All Programs->Helmel Engineering->GeoStat]

GeoStat uses the current part inspection file name as the basis for creating the matching GeoStat file. For example: if your part inspection is called "Widget.GMT" your GeoStat file will be called "Widget.GST" and is stored in a separate folder, *see File Locations for default locations.*

It should be noted that Geomet and GeoStat <u>will not</u> verify that the file name has been recycled or renamed and that the GeoStat results no longer correlate with a new part inspection. For example if you run a part program called "Widget.GMT" collecting feature attributes in "Widget.GST" you can not rename the main file to "Widget2.GMT". By doing so you will not collect any further data into Widget.GST for GeoStat on subsequent inspection runs. GeoStat maintains all feature pointers inside the original GeoStat "Widget.GST" file.
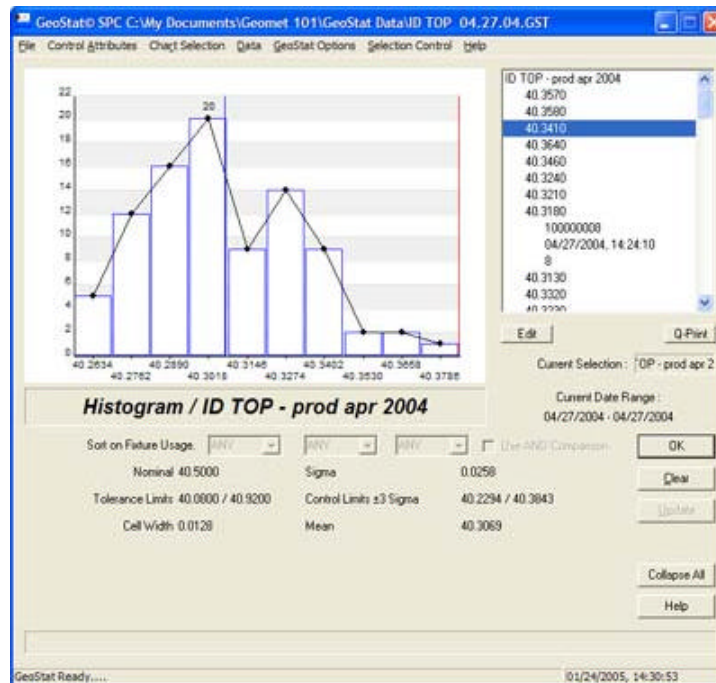
The GeoStat Display

GeoStat provides access to all features and commands directly from the main GeoStat display. Selecting a feature to view requires that you left-click on the feature name. In the example above **ID TOP - prod apr 2004** has been selected.

The GeoStat Pull-Down Menu Structure

File Pull-Down Commands

New

Start a new GeoStat Project

Open

Open an existing GeoStat Project

Close

Close the current GeoStat Project

Append

Append a GeoStat Project to the current open Project

Auto Update - Setup

Provides setup tools to link GeoStat Projects together.

Auto Update - Execute

Executes the links associated with the current GeoStat Project. This will build a common data set from all GeoStat projects.

Save

Save the current GeoStat Project.

Save As

Save the current GeoStat Project and assign a new name.

Page Setup

Accesses the underlying printer controls such as orientation, size, margins, or printer specific capabilities.

Print

Prints the current Chart.
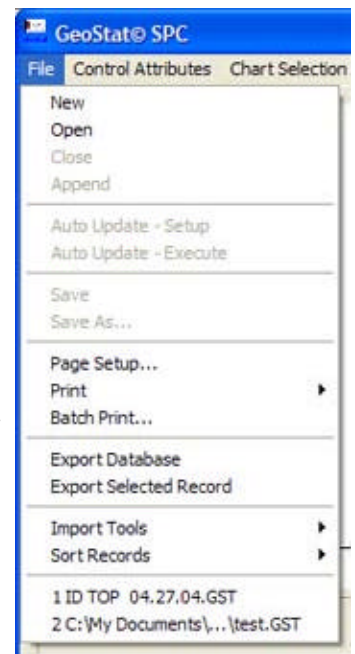
File Pull-Down Commands - *continued*

Export Database
Creates or appends an ASCII data file with the entire contents of the filtered data for all features. The ASCII format is configurable under [GeoStat Options].

Export Selected Record
Creates or appends an ASCII data file with all filtered data of the currently selected feature. The ASCII format is configurable under [GeoStat Options].

Import Data
Allows the importing of ASCII data into the currently selected feature.

Sort Records
Performs one of two sort techniques of all data matching the filter criteria. You can sort on Operator or Date.

Control Attributes Pull-Down Commands

Digital Readout Precision
allows you to choose 2-5 decimal precision on all values.

Use 6 Sigma
You can choose to apply 3 or 6 sigma.

Draw 3 Control Levels
Draws additional Control levels at ±1-2-3 or ±2-4-6 sigma levels.

Use Limits Tests
When activated, provides auto-prompts when reviewing charts when control limits have been exceeded.

Print Heavy Lines
Used when printing to high-resolution printers to enhance visibility of lines being drawn.

Show Graph Bars
Adds shaded bars along the horizontal axis in the graph area.

Batch Printing
Configures the printing tool to print all assigned graphs in one operation.
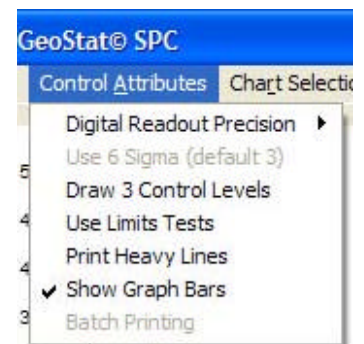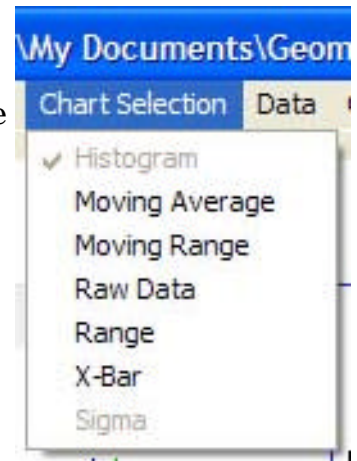
Chart Selection Pull-Down Commands

Provides pull-down menu chart selection for the currently
selected feature. The availability of these selections will be
validated against such criteria as number of subgroups, date
ranges, etc.

Data Pull-Down Commands

Enter New GeoStat Header
Manually enters a new Header Record against which
Measurement Data will be entered or imported.

Edit Header Record
Edit all fields in an existing feature header.

Enter New Data Points
Manually enter feature data points into the currently
selected Header Record.

Edit Data Point:
Not available at this time.

Remove Record
Removes the currently selected Header Record and all associated
measurement data.

Remove All Measurements
Removes all measurements from the GeoStat Project.

Database Delete Tools
Activates the database maintenance and delete tools.
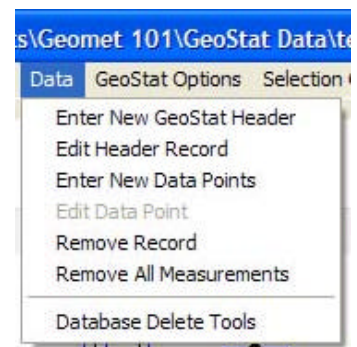
GeoStat Options Pull-Down Commands

Activate Fixture

Activate filtering through the use of fixtures for all data being evaluated.

Activate Status Bar

Activates the status bar located on the bottom of GeoStat providing the fly-by help notes and active clock.
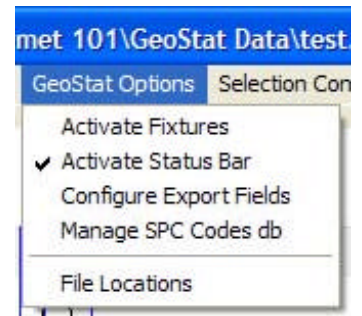
Configure Export Fields

Allows the selection of data used in the exporting of ASCII data files.

Manage SPC Codes db

Builds and maintains the database of Cause and Effect Codes.

File Locations

Used to assign path locations for project storage and Geomet program locations.

Selection Control Pull-Down Commands

Set Date Ranges

Use this command to establish a range of dates for processing the data.

Set Moving Average

Sets the number of days that GeoStat will use in the calculation of Moving Average and Moving Range.

Histogram Cell Count

Sets the cell count the Histogram graph will use when processing the frequency and grouping of GeoStat data.
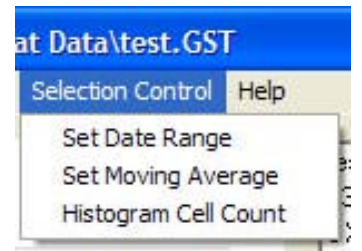
Using the GeoStat Data Tree

The GeoStat Data Tree provides you direct access to all data by selecting, or highlighting the feature. To highlight a feature, left-click with your mouse on the name located in the Data Tree located right of the chart. In the example shown here, the feature named "hotel2" is highlighted and the corresponding Histogram Chart is displayed. To change the current chart assignment, use the pull-down menus:

[Chart Selection->......]

By double clicking on a feature name you can expand it to show the measurement data that is stored. In the example, feature ID "Mov Ave" is shown in its expanded form. To obtain additional information any data point can be expanded to show the attributes. These include a Cause and Effect Codes, data/time stamp, operator, and fixtures in use. When a data field has no data stored, the the expanded information tool will be disabled.
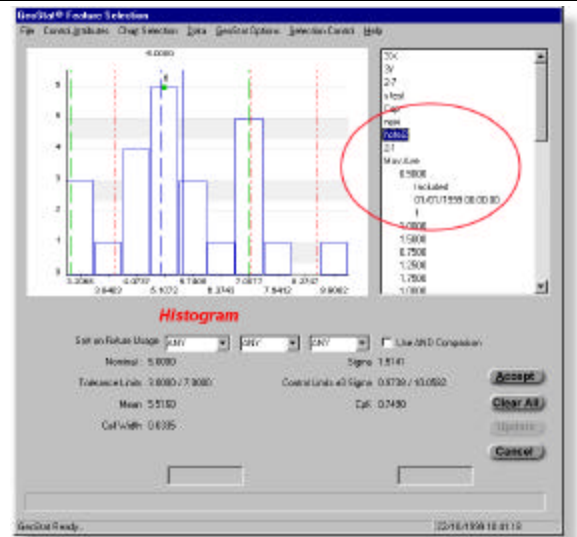
Applying Filters
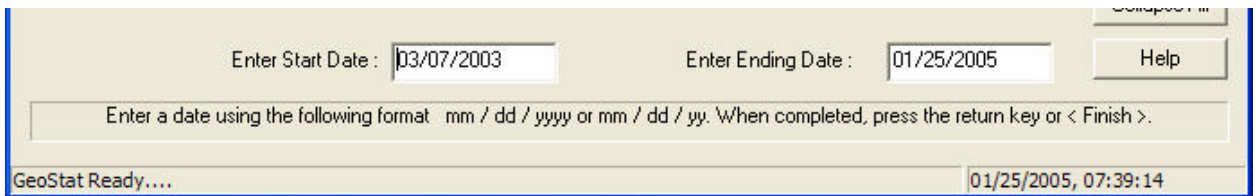
GeoStat data can be filtered using two different methods. One method is the use of dates the second method is through the use of fixtures. These methods can work together for greater control.

Filtering through Date Ranges

Once you have a Header Record selected you can apply a date range filter. This can be activated through the Pull-down menu [Selection Control->Set Date Ranges].
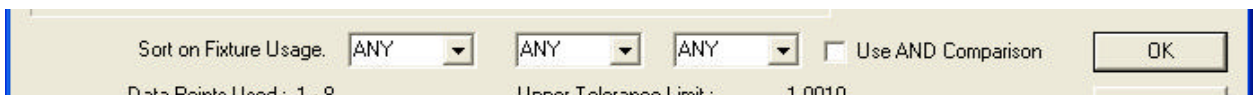

When you activate this command, GeoStat will scan the selected record and obtain the current date range. Enter into the data fields the start and stop dates of the new range and press the <Enter> key.

GeoStat will then recalculate the entire database and filter only those data points that fall within the date range. Note that the date range includes the start and stop dates.

Filtering with Fixtures

The use of fixtures allows you to group together production that has been manufactured from the same fixture. We use fixtures as a category that covers such criteria as machining center ID's, individual fixtures, shift identifiers or any other usage that may work with your manufacturing environment. The fixture data is alphanumeric and is case sensitive.


As shown above, up to three fixtures can be used with GeoStat. These fixtures correspond to what was placed in the inspection header when Geomet performed the part inspection. You can add or change the fixtures directly inside GeoStat using the Measurement Data edit tools.

Filtering with Fixtures - continued

When you elect to use the fixture sorting tool, the fixture names used are extracted from the database and placed into the corresponding fixture fields. These are pull-down selection boxes that you access by left clicking on the down arrow next to the fixture field as shown in the example. The listing shown in the pull-down will represent all unique fixture names used in the feature along with "ANY" and "NONE". To select one of the entries, highlight the choice with a mouse left-click.
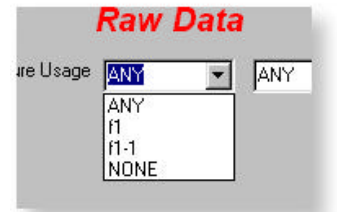
You can set the comparison between the three fixtures with the use of the "Use AND Comparison" check box. This will apply the following rules when filtering:

When using AND the comparison must match so that Fixture1 AND Fixture2 AND Fixture3 all match before it is added to the process.

When using OR Comparison the following test is applied where if Fixture1 OR fixture2 OR fixture3 is true then the record is added to the process.

After you have selected the fixtures and the search comparison, the <Update> button becomes available. Press the <Update> button and the Data Tree will update to reflect the new filters.

File Locations

GeoStat provides a tool to establish links to various folders. To access this tool use the pull-down menu:

[GeoStat Options->File Locations]

When GeoStat is installed, default path designations are provided and only under specific user needs, they require changing.
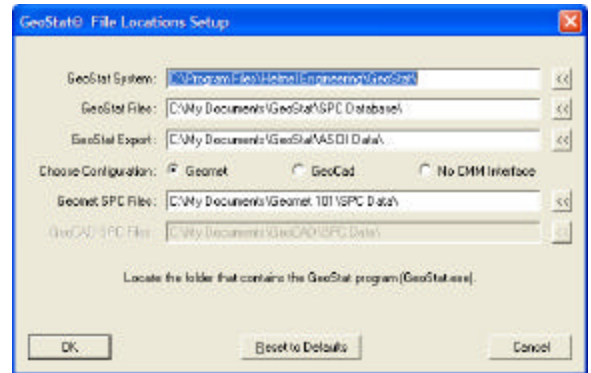
GeoStat System
This is the path to the GeoStat.exe program.

Default Path: c:\Program Files\Helmel Engineering\GeoStat\

GeoStat Files
This is the path to the folder that contains the GeoStat database files.

Default Path: c:\My Documents\GeoStat\SPC Database\

GeoStat Export
This path is used when performing an export of GeoStat data in ASCII form.

Default Path: c:\My Documents\GeoStat\ASCII Data\

Choose Configuration
Select the appropriate system configuration. This selection directs the import tools of GeoStat which path to follow when looking for Geomet or GeoCad generated ASCII data files. When **No CMM Interface** is selected, GeoStat acts as a stand alone application.

Geomet SPC Files
Default Path: c:\My Documents\Geomet 101\SPC Data\

GeoCad SPC Files
Default Path: c:\My Documents\GeoCAD\SPC Data\

Working with GeoStat

## The GeoStat Database - General Description

GeoStat maintains one database for each part program. This database is identified by the part program name followed by the extension "GST". For example, if your part program is called "Widget.GMT" your GeoStat database will be called "Widget.GST".

The default location for these databases can be found at:

 C:\My Documents\Geomet 101\GeoStat Data\

You can change the default location from the System Options inside Geomet, refer to help located inside Geomet.

The GeoStat Database consists of two record types, the Header Record and Measurement Data Record. The Header Record maintains the feature identification and the attributes that are being recorded. The Measurement Data Records contain all measured data collected.
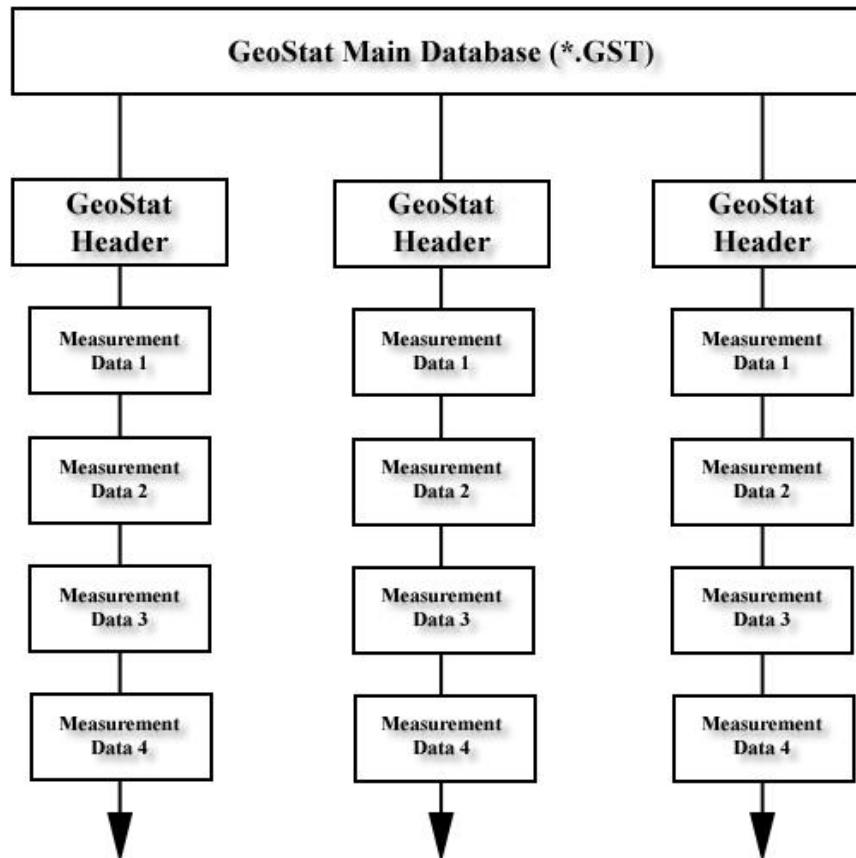
GeoStat Header Record

The GeoStat Header Record is automatically created when you tag a attribute of a feature inside Geomet or manually when selecting from the GeoStat menu [Data->Enter New GeoStat Header].

The Header Reord contains the following data:

Characteristic Name

A Unique name to identify the attribute. For example a feature such as an XY ID Circle with a number of 4 might have a name "4 X" indicating the X component of feature number 4.

Nominal Value

This is a basic value for the data to apply upper and lower tolerance against. The nominal should be the same value as reported in the inspection process.
(+) Plus: This is the Upper Specification Limit (USL).
(-) Minus: This is the Lower Specification Limit (LSL).

Subgroup Size

This value represents the number of measurements of a given group used in all SPC calculations. In GeoStat the minimum subgroup is 2.

Subgroup Lookback

This is a moving subgroup value that will "lookback" x number of subgroups when updating charts. For example if the lookback was set at 10, then GeoStat will only read in from the database 10 subgroups for displaying, reporting and charting.

Upper Tolerance Limit

This value defaults to the USL.

Lower Tolerance Limit

This value defaults to the LSL.

Note: You can override the Upper and Lower Tolerance Limits if you want to control a tighter process.

When a Header has been accepted by pressing the <OK> button or the <Enter> key, GeoStat will add it to the database and initialize the attached Measurement Data list.

Editing GeoStat Header Records

You can edit an existing GeoStat Header Record at any time. To edit, select the Feature ID in the Data Tree on the right side of GeoStat and from the pull-down menus select [Data->Edit Header Record]. A second method to start the edit control is to highlight the Feature ID and press the <Edit> button located below the Data Tree.

This example shows the current data associated with "hotel2" which will be displayed allowing you access to edit any field. After accepting your changes, GeoStat will recalculate the Data Tree, reported values and selected charts.

Editing allows you the ability to perform "what-if" calculations such as increasing the subgroup size or the look back value on subgroups and instantly see the change to the reported values.

Note: While you are in GeoStat, any changes you make by editing the Header Records will not become permanent until you press the <Accept> button. If you elect not to make a permanent change to the database, press <Cancel>.

Control Limit Override

GeoStat allows you to elect an override when recalculating the standard deviation, USL and LSL for the Xbar chart only.

On the GeoStat Header dialog, you can elect this option by placing a check next to the label; "Use Manual Control Limits (Xbar)". When selecting this feature the two entry controls for USL and LSL become active.

You can now enter a fixed value for use on the Xbar chart. One condition that this may be desirable is when you want to monitor your production against a set of values derived from a pilot (or test) run. On the report and chart, the control limits and standard deviation is marked with "Manual" indicating the calculations were compared against a entered value.
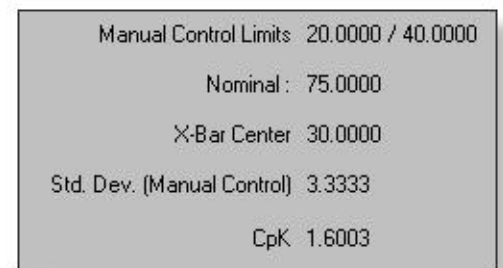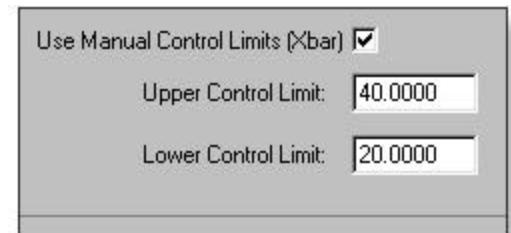
Removing Header Records

You can remove an existing GeoStat Header Record at any time. To remove a Header, select the Feature ID from the Data Tree on the right side of GeoStat then from the pull-down menus select [Data->Remove Record]. When this command takes place, the header record and all associated measurement data will be removed.

GeoStat will update the Data Tree showing the deletion of the record. Note that this will not take effect on the database until you press <OK> or the <Enter> key. If you press <Cancel> then the changes will not become part of the database.
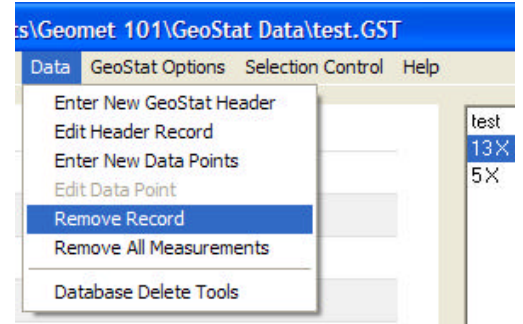
Cause and Effect Codes

Cause and Effect Codes can be assigned to individual measured data to assign a standardized message. These messages are designed by your Quality Control Department who should be responsible for building the Cause and Effect Code lookup database.

Cause and Effect Codes are helpful for the inspector to assign standard messages to a measurement data point. This help to explain conditions of the inspection that may cause undesirable chart behavior.

Maintaining the Cause and Effect db

To build the Cause and Effect db, from the pull-down menu choose:

[GeoStat Options->Manage SPC Code db]

Add a New Entry

To create a new record, enter a Alpha-numeric code in "Edit the SPC Database". In our example, we show a "B" is entered. The code is case sensitive allowing for upper and lower case designation.

To complete the operation, enter a brief description as to the meaning of the code and press <Append>.

Delete an Entry

To delete an entry, highlight the entry in the list and press <Delete>.

When all changes have been completed, press the <Ok> button to save the data to the Cause and Effect database.
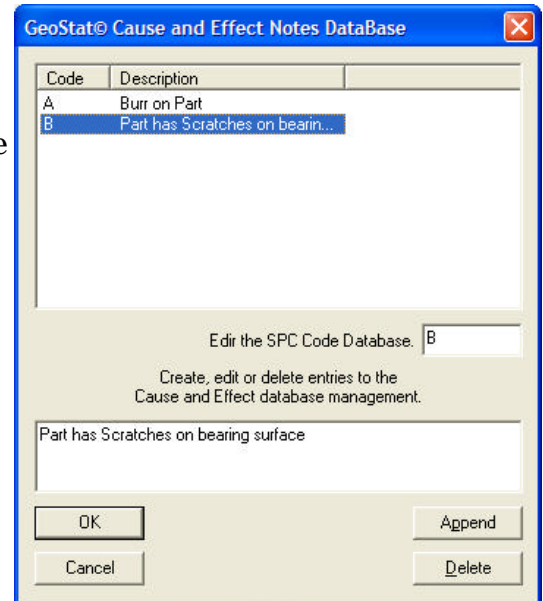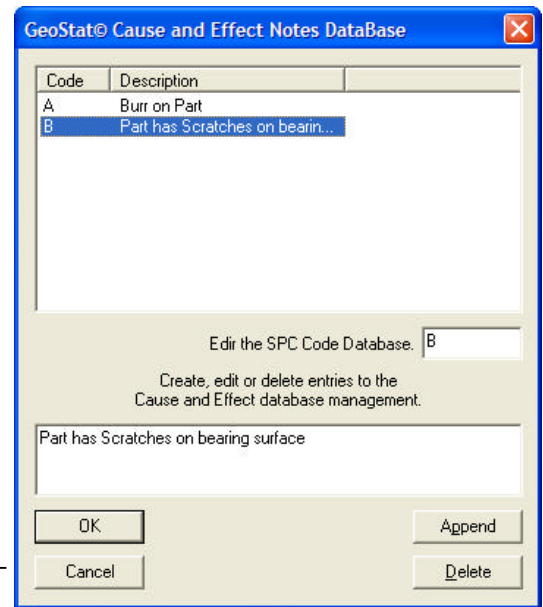
Interpreting the Graph and Data Tree

When a Cause and Effect Code has been assigned to a Measurement Data Record, it will appear in the Data Tree highlighted in Bold letters and the subgroup or data point will be circled in the graphic area. As shown in this example, 40.3440 has been expanded to show that codes A and B are assigned to it. The 40.3440 is shown in Bold letters and the subgroup it belongs to is circled. When a measurement data point is highlighted in the data tree, the graph displays a box with the associated value shown. When printing this chart, the added information from the Cause and Effect codes will be printed.
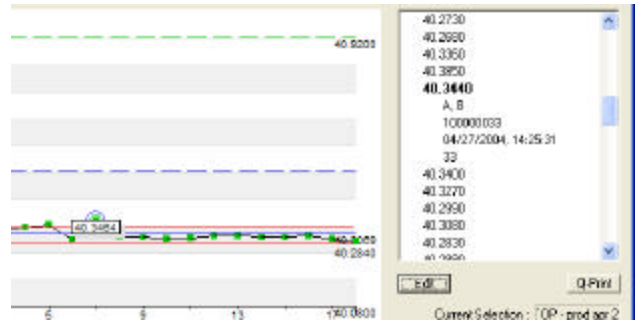
Raw Data Chart

There are special display tools offered when the selected chart is Raw Data. When you highlight a measurement data point in the data tree, the corresponding node in the graph displays the associated measurement value and any attached Cause and Effect Codes.
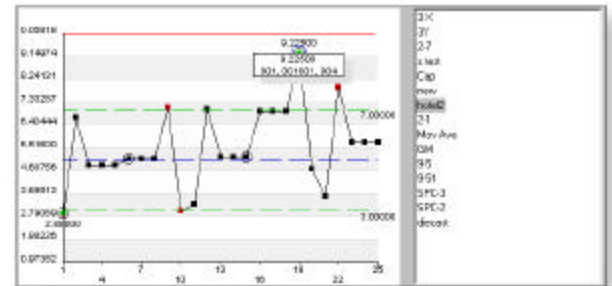
If you left-click on a node in the graph area, the corresponding measurement data point will scroll into view and highlighted.

Show All Codes

To show all assigned Cause and Effect Codes in the graph area, double left-click in any open location within the graph area, and all Cause and Effect Codes will appear, *see example shown here*.
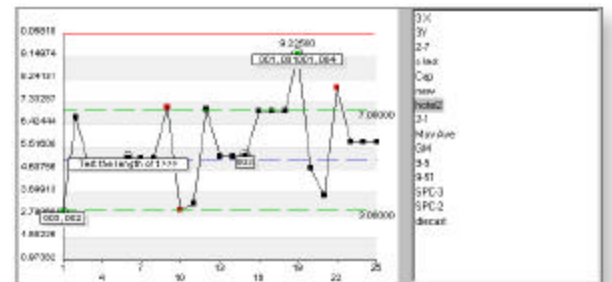
GeoStat Measurement Data Record

A GeoStat Measurement Data Record consist of actual data gathered directly from Geomet, entered manually or imported from applications such as Excel generated ASCII text file. Data Records are attached to a GeoStat Header Record and can be viewed in the Data Tree by double clicking on the feature ID.

In this example we have a GeoStat Feature ID of "3 X" with the expanded listing of attached data. The first measurement has been expanded to show the date and time and fixture usage assigned to the measurement.
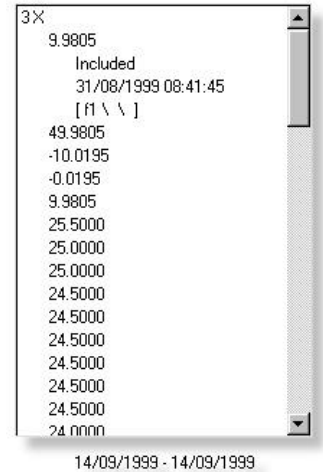
Measurements can also have an operator, serial number and Cause and Effect codes attached to it. GeoStat only displays fields that have data in the Data Tree.

GeoStat only displays the measurement data that fall within the date range filter and subgroup look back value. For example if the subgroup size is five and the look back is set to ten, then only the last fifty measurements are displayed.

Manually Entering a Measurement Data Record

You can enter GeoStat Measurement Data Records against an existing Header. To enter, select the Feature ID in the data tree and from the pull-down menus select [Data->Enter New Data Points]. If the command in the menu is grayed-out, you have not selected a Feature ID from the existing data tree.
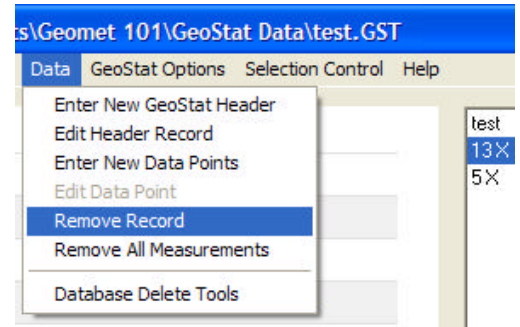
The Date field will default to the current date upon opening. The serial number field increments by one with every press of the <OK> button or <Enter> key.
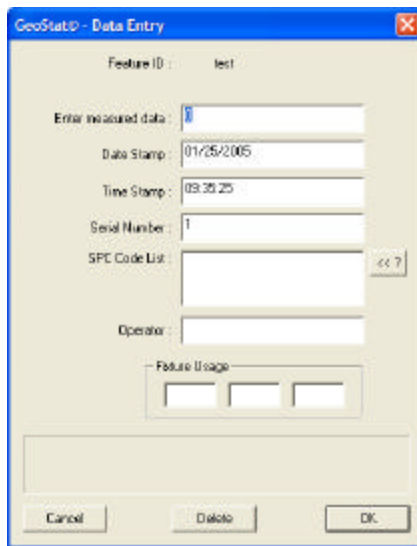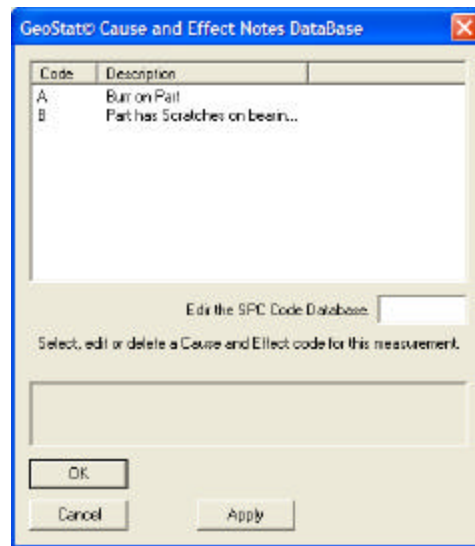
Manual Data Entry   *Cause and Effect Code List*

The **SPC Code List** offers a lookup function designated by the button, **<<?**. When you select this function, the Cause and Effect Code List appears from which you can choose and existing code, and insert it into the data record. Should you be required to enter more than one SPC Code, repeat the procedure.

The operator, notes and fixture fields are optional.

Edit Measurement Data Records

Editing an existing measurement data point can be accomplished by highlighting the measurement in the data tree and calling the command through the pull-down menu [Data->Edit Data Point] or by selecting the <Edit> button located below the data tree.

Deleting Measurement Data Records

For data integrity, GeoStat password protects the deletion of individual data records. To delete a measurement point, highlight the point in the data tree. Activate the Edit Data Point Tool through the pull-down menu [Data->Edit Data Point] or by selecting the <Edit> button located below the data tree.

The measurement point data will be displayed in the Edit Control. Locate the <Delete> button on the Edit Control. When you are using the delete data point command for the first time, GeoStat will prompt you for a password. This is to

Delete Button　　　　　　*Password Entry*　　　　　　*Delete Message*

protect your data from data manipulation or accidental deletions to the measurement data. Enter the password which has previously been defined. If you have not previously defined a password, the password you enter here will be saved for future use. Please record this password and store in a secure place. Additional Delete commands during this GeoSta session will not prompt for the password.

Delete all Measurement Data Records

All Measurement Data Records can be removed from the Header Record by highlighting the Header Record, or any Measurement Data associated with the Header Record and select from the pull-down menus [Data->Remove All Measurements].
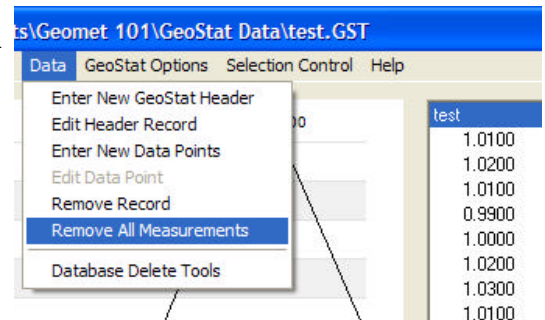
GeoStat Database Delete Record Tools

GeoStat Database files can become very large over time. When measurement data is volatile, not required for future use, there are two tools which will permanently delete measurement data from the database.

If the data is not volatile, we suggest using the export tools first to build a historical file of your measurement data.

To delete measurement data from the database, there are two options. The first option deletes all measurement data based on a specified date. This will remove all measurement data before and including the specified date. The second option removes all measurement data by limiting the size of the database to a specified allowed number of records.

The Database Delete Tools can be found in the pull-down menus [Data->Database Delete Tools].

Delete by Date

Enter a date in mm/dd/yyyy format that will represent the newest measurement data to delete permanently from the database. When accepted <Ok>, all measurement data prior to the entered date up to and including the entered date will be deleted.

Delete by Count

With this option, you specify how many measurement data records to keep in the database per Header Record.
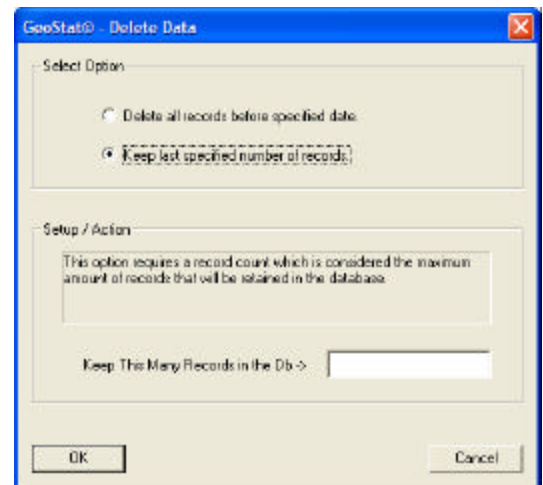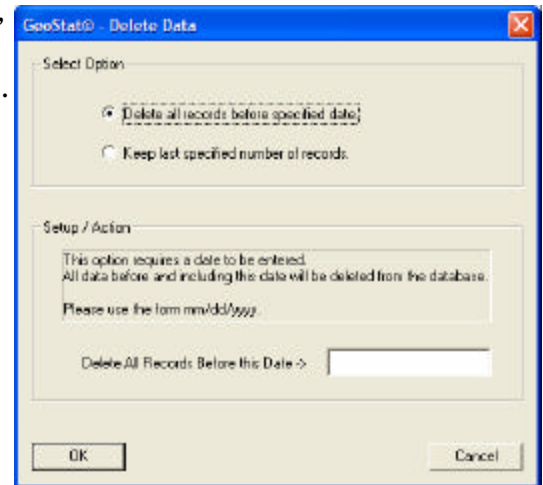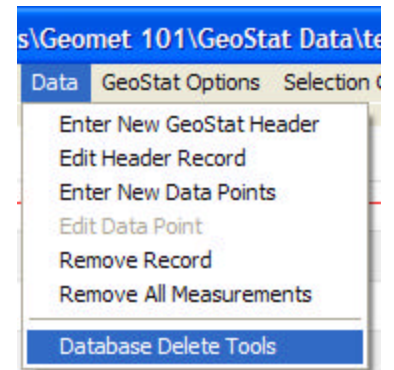
GeoStat Sorting Controls

GeoStat offers controls to sort the measurement data of the selected Header Record by one of three categories:

> Date
> Operator
> Locator Index

The sort command can be found in the pull-down menu [File->Sort Records->....].

Sort on Ascending Date

Sorting by the date reorders the measurement data based on the date field in ascending order. Measurement Data that has been captured directly from Geomet is automatically entered into the GeoStat database using the time and date stamp in ascending order. However, data that is manually entered or imported does not sort on the date field, but enters the data in sequential order from the ASCII file. Apply the sort by date to correct the sequence of entry for the database. To initiate the Date sort, select the Feature ID from the data tree and then choose from the pull-down menu [File->Sort Records->Sort on Date Ascending].

Sort on Operator

To group all operators together, select the Feature ID from the data tree and then choose from the pull-down menu [File->Sort Records->Sort on Operator]. The resulting action will sort the Header Record by the operator field. This is helpful when exporting data for further analysis.

Sort on Locator Index

This sort command reorders the Measurement Data within the selected Header Record in its original order on entry.
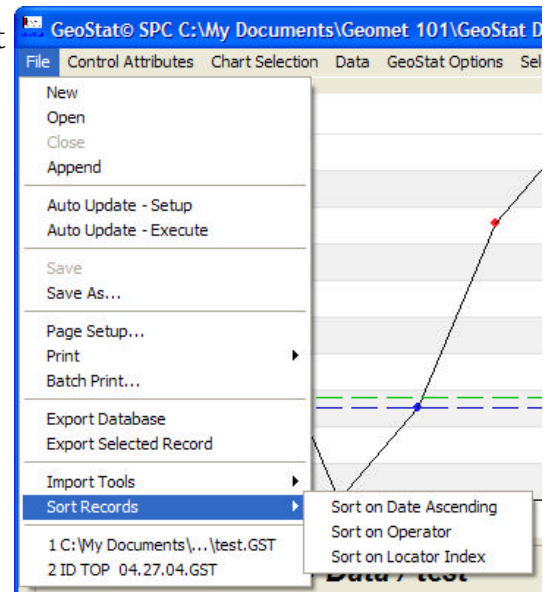
GeoStat Database Appending and Merging

Combining similar GeoStat databases can be helpful when the capturing of Measurement data has been completed in several CMM or manual entry station locations. This procedure is known as AutoLink.

AutoLink provides two tools to combine GeoStat database. These are: Setup and Execute. An example would be the use of two CMMs that capture the same measurement data from production parts. Each CMM maintains its own GeoStat database on its own or a shared network drive.

One CMM, or SPC workstation would be designated as the "Master" GeoStat station. This station would establish the necessary AutoLinks to all associated GeoStat databases.

AutoLink Setup

The AutoLink Setup Tool assigns the necessary path designations and Merge characteristics. The links that are created can be defined to the entire range of Header Records or to a single, selected Header Record. To launch the AutoLink Setup tool, locate in the pull-down menus [File->Auto Update Setup].

The AutoLink Setup tools appears showing all Header Record names in a tree structure.

<Add File>

This function allows you to assign one AutoLink path to an external GeoStat database. Assigning this link will allow the AutoLink feature to merge data from the external GeoStat database.

To start, press <Add File> and you will prompted you to navigate with the "**Browse for Folder**" dialog. Locate the GeoStat database you want to automatically merge measurement values from. After you have located the file, press <Ok> and the link will be assigned to ALL GeoStat Header IDs in the current open database.

NOTE: If you have designated mapped drive letters to a remote workstation, it is important to not change those mapping IDs.

<Next File>
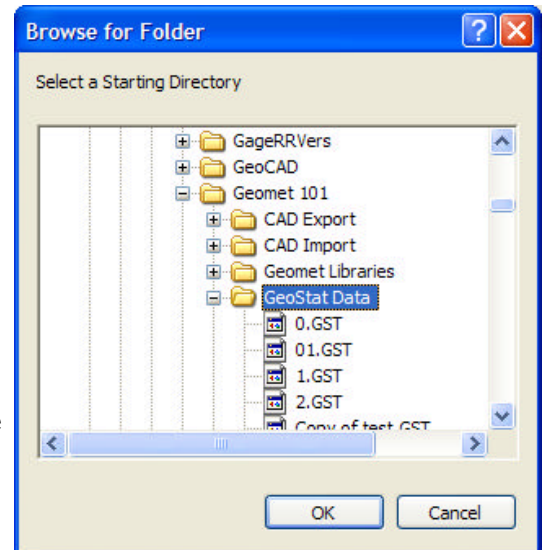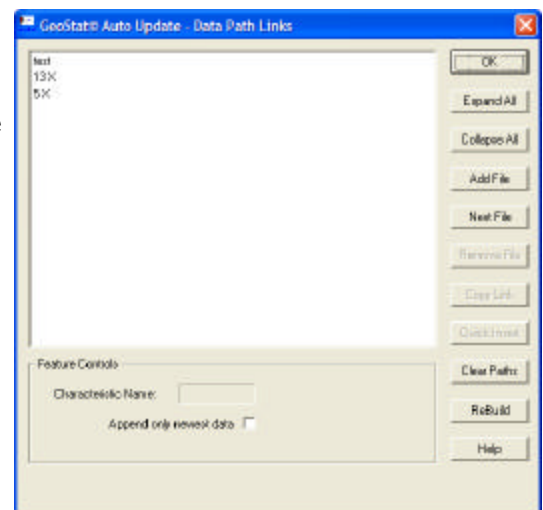
This function allows you to locate and assign AutoLinks to other GeoStat databases for automatic measurement data merging. This function changes behavior depending on the current selected item in the display tree.

- No items are selected
- A single GeoStat Header is selected
- One AutoLink path is highlighted

No Items are selected

In this condition, the Next File functions will update all GeoStat Headers similar to the **Add File** function. To start press the <Next File> button and you will prompted you to navigate with the "**Browse for Folder**" dialog. Locate the GeoStat database you want to automatically merge measurement values from. After you have located the file, press <Ok> and the link will be assigned to ALL GeoStat Header IDs in the current open database. Next File will add the link to all GeoStat Headers in the first available open link location. For example: if a link is already assigned to position number 1, the new link will be recorded in position 2. The same holds true if position 2 is already assigned then position 3 will be tested.

A single GeoStat Header is selected

In this condition, the Next File functions will update only the selected GeoStat Header. To start press the <Next File> button and you will prompted you to navigate with the "**Browse for Folder**" dialog. Locate the GeoStat database you want to automatically merge measurement values from. After you have located the file, press <Ok> and the link will be assigned to the selected GeoStat Header in the current open database.

One AutoLink path is highlighted

When the display tree is expanded you will see the assigned locations for the AutoLinks plus the option for merging flag. If a single AutoLink is highlighted, then Next File performs an update only to that selected AutoLink.

An optional method to start the "**Browse for Folder**" navigation tool begins with highlighting the AutoLink path and right-click your mouse.
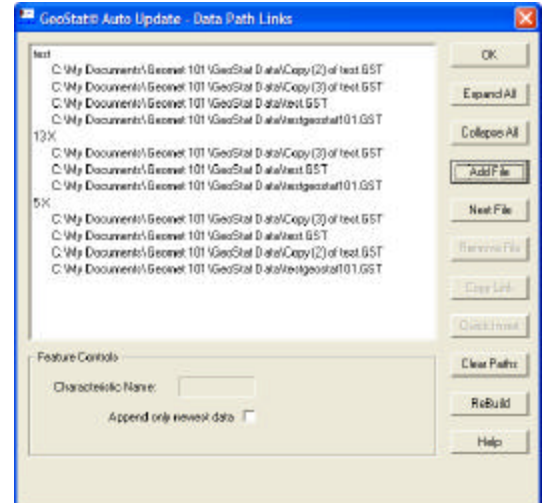
\<Remove File\>
This function allows you to remove 1 or all assigned AutoLinks within a selected GeoStat Header. If the current selection in the display tree is the GeoStat Header ID, the pressing \<Remove File\> will delete all assigned AutoLink paths.

If the selected item in the display tree is an AutoLink path, then pressing the \<Remove File\> will only remove the selected item.

\<Expand All\>
Expands all Header Records in the display tree to show the current AutoLinks.

\<Collapse All\>
Reduces the display tree to show only the Header Records.

\<Copy Link\> / \<Quick Insert\>
Not implemented in GeoStat 6.65.

\<Clear Paths\>
This command will remove all AutoLink assignments in the database.

Append only newest data
When checked, the merge operation will only extract all new data since the last merge.

\<Help\>
The Help command provides instant help on all topics within the AutoLink Setup tool. To use, press the \<Help\> button and your mouse will change into a Question mark cursor. Press any other button or even the display tree and the help topic for that selection appears.
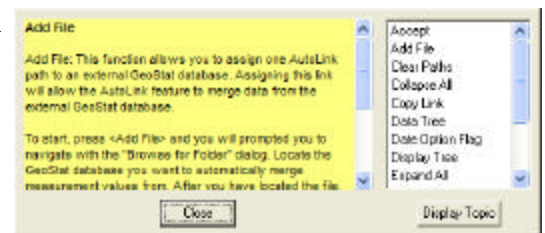
Within the help tool, there is a topic tree from which you can select additional help topics. When you close the Help tool, the mouse will continue to show the Question Mark cursor until the \<Help\> button is pressed again.

Auto Update - Execute

This commands executes the merge.

Append a Database

GeoStat provides a Database Append tool for combining the Header Records and measurement data into the current open database.

To launch the Append tool, choose from the pull-down menus [File->Append]. The Database Append Options tool will appear which provides configuration settings on how to handle Header Records and Measurement Data.
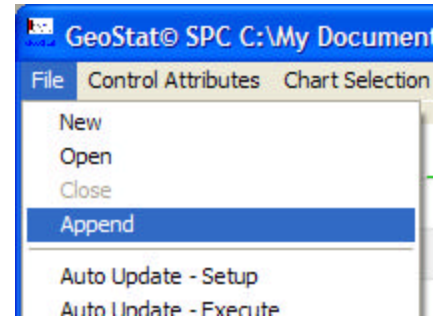
Header Control

Append all data and combine GeoStat Headers
During the Append operation, Header Records from the remote database that share a common Header Record name in the current database will have the measurement data combined. This is the preferred choice when combining similar databases from which one SPC solution will be calculated.
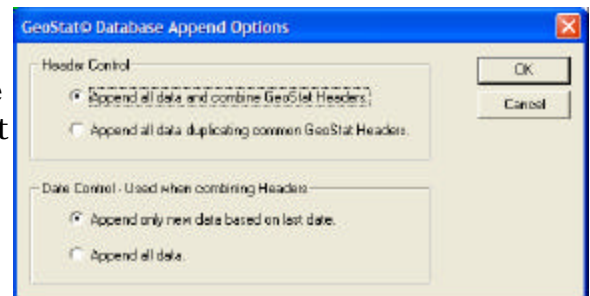
Append all data duplicating common GeoStat Headers
During the Append operation, Header Records from the remote database will not combine with similar Header Records, but are added to the database as a new Header Record.

Date Control - Used when combining Headers
When Appending data from a remote database, this section controls how the measurement data is controlled. Used only when **Append all data and combine GeoStat Headers** is selected.

Append only new data based on last date
This option looks at the date measurement records were previously appended at adds only new measurement data into the current database.

Append all Data
This option appends all measurement data regardless if previously appended.

Proceed with the Append Operation
To proceed, select the options and press the <Ok> button. The file navigation tool will appear to select the remote database. Once the remote database has been selected, the append operation will continue automatically.

Interaction with Geomet

Geomet and GeoStat
>Creating a New GeoStat Database
>Activating Feature Tagging
>Selecting Single Attributes

Creating a New GeoStat Database

As described earlier, GeoStat uses the name of the part program as the base name for the database. Before you start assigning tags to features to be used in GeoStat you must save your part program.

Once this has been accomplished, activating Feature Tags inside Geomet will automatically create the GeoStat database.

Activate Feature Tagging

Within your Geomet Part Program you can activate the Feature Tagging tool by selecting the feature and right-click with your mouse to activate the feature sub-menu *see example*. Select the menu command [Feature Tags], which will pass the measured data from the feature into the Feature Tag Tool. You can then select the GeoStat button to create a record.
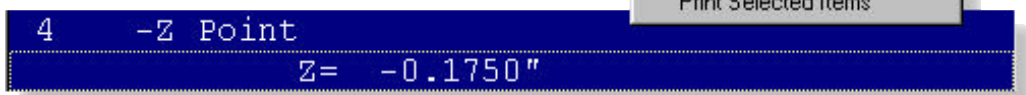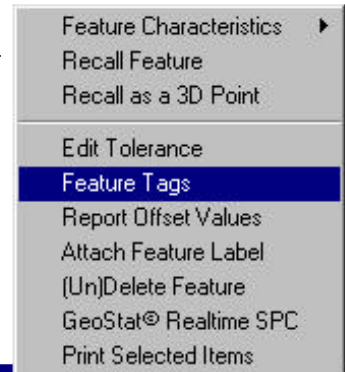
Selecting Single Attributes

The Feature Tagging dialog configures itself for the current feature. The example here we have a +Z Point with a actual value of 0.9611. We circled the GS column showing the GeoStat button, which has a checkmark placed in the button. This check indicates that GeoStat already has an assigned record for this feature.
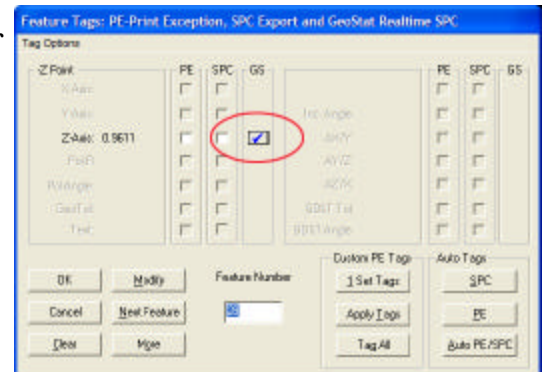
When you left-click on the button either the create a new GeoStat Header or edit an existing GeoStat Header dialog will appear, *please review GeoStat Header Records in chapter 2 for further explanation.*

When you have finished editing the GeoStat Header, press <Ok> to save the data to the GeoStat database.

For complete help on other tagging features inside Geomet, please refer to the on-line help located inside Geomet.

Charting Capabilities

Selecting a Chart for Viewing
Using 3 or 6 Sigma σ
Draw Standard Deviation Levels
Using Limit Tests

Histogram Chart
Definition
Setting Cell Count

Moving Average Chart
Definition
Setting Moving Period

Moving Range Chart

Range Chart
Definition

Raw Data Chart
Definition

Xbar Chart

Sigma Chart

Test for Instability

Printing Charts
Printing Single Charts
Printing XBar and Range Combination Chart
Batch Printing of Charts

Configuring the Charts

Using 3 or 6 Sigma

GeoStat offers you the choice of working with a Standard Deviation of 3 or 6 for all reporting and charting. The setting of this value is located using the menu [Control Attributes->Use 6 Sigma (default 3)]. This setting is global to GeoStat in that it affects all data files.

Draw Standard Deviation Levels

GeoStat provides you with the option to show each Standard Deviation Level directly on the charts.
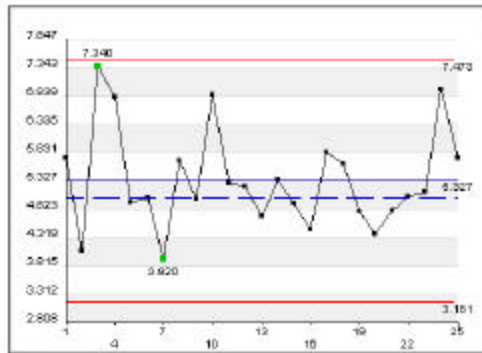
Hide Control Levels   *Draw Control Levels*
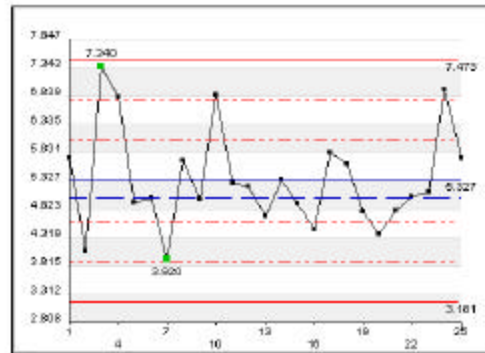
In the examples above, the chart on the right shows the three standard deviation levels. The setting is global to GeoStat and all available charts and can be found in the menus under [Control Attributes->Draw 3 Control Levels].

Using Limit Tests

The use of Limit Tests provides a warning when you first view a chart that has an out-of-control value in it. When GeoStat updates the viewing of a chart it monitors all calculated data and compares it against the UCL/LCL limits for all charts accept Raw Data. The Raw Data chart compares the measurements against USL and LSL.

Limit tests are helpful as an early warning indicator in production environments
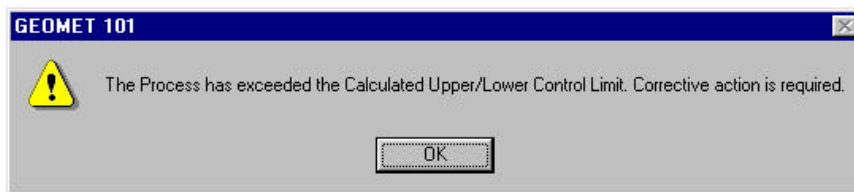
where several operators may be asked to review and print charts. To activate this option choose from the menu [Control Attributes->Use Limit Tests].

Histogram Chart

The Histogram capability offered by GeoStat is best described as frequency histogram. The graph borders extend to include all measurement data points and are proportional to the frequencies within the cells. Each bar is centered on the midpoint of the cells with a height proportional to the frequencies in their respective cells.

The chart also draws lines representing the Nominal, Upper/Lower Specification Limits, Xbar and Control Limits.
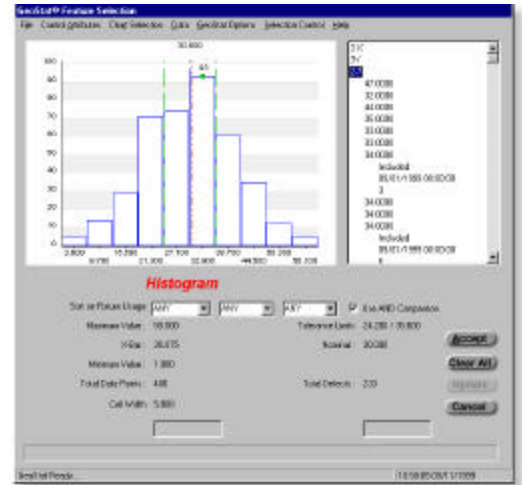
Setting Cell Count

Changing the Histogram Cell Count can be accomplished by selecting from the menus [Selection Control->Histogram Cell Count]. A dialog will appear that defaults to the current setting. The valid ranges for Histogram are a minimum of 4 and a maximum of 200.

The cell count is a global setting that effects all Histogram being displayed and is not configurable between different GeoStat Projects.
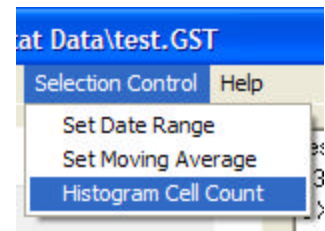
Moving Average Chart

A Moving Average Chart is designed for smoothing a time series and is highly subjective and dependent of the length of the period used in constructing the averages.

Understanding the process of moving average will help you in deciding how to set the period value, which in Geomet is always considered days.

To eliminate cyclical fluctuations, the period should be a value that corresponds to the estimated length of a cycle. This period can also be set as a multiple, example; if the cyclical period is 3 days, an acceptable setting for the period is 3, 6, 9, etc.

To understand how Moving Average is calculated, refer to table shown at right.

We have recorded the average production value of Widgets for consecutive days starting 1/1/99. The first step is to apply the following formula to obtain the moving total over the period of 3 days.

$$X_1 + X_2 + X_3 = MT_2 = 6.6+7.2+8.1 = 21.9$$
$$X_2 + X_3 + X_4 = MT_3 = 7.2+8.1+7.7 = 23.0$$
$$X_3 + X_4 + X_5 = MT_4 = 8.1+7.7+6.5 = 22.30$$

Then we compute MA(x) by dividing MT(x) by the period length L.

$$21.9 / 3 = 7.30 = MA_2$$
$$23.0 / 3 = 7.67 = MA_3$$
$$22.30 / 3 = 7.43 = MA_4$$

The resulting moving average is plotted centered on the middle value of the period. For example the moving average for 1/1/99 to 1/3/99 is 7.30 and is plotted against 1/2/99.
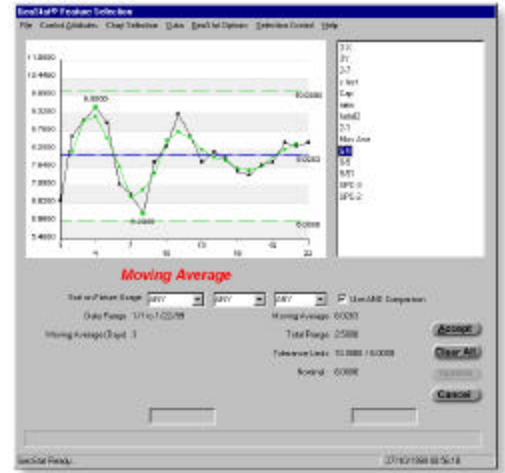
Moving Average

Date	Value	Moving Total	Moving Average
1/1/1999	6.6		
1/2/1999	7.2	21.90	7.30
1/3/1999	8.1	23.00	7.67
1/4/1999	7.7	22.30	7.43
1/5/1999	6.5	19.40	6.47
1/6/1999	5.2	18.80	6.27
1/7/1999	7.1	19.80	6.60
1/8/1999	7.5	22.30	7.43
1/9/1999	7.7	21.70	7.23
1/10/1999	6.5	21.00	7.00
1/11/1999	6.8	21.40	7.13
1/12/1999	8.1	23.10	7.70
1/13/1999	8.2	24.20	8.07
1/14/1999	7.9	22.00	7.33
1/15/1999	5.9	20.00	6.67
1/16/1999	6.2	18.60	6.20
1/17/1999	6.5	20.00	6.67
1/18/1999	7.3	21.20	7.07
1/19/1999	7.4	21.50	7.17
1/20/1999	6.8	21.20	7.07
1/21/1999	7.0	19.80	6.60
1/22/1999	6.0	18.90	6.30
1/23/1999	5.9	19.40	6.47
1/24/1999	7.5	21.00	7.00
1/25/1999	7.6	22.20	7.40
1/26/1999	7.1		

Therefore we can not obtain moving averages for the first and last day of our date range for a 3-day period (L). The number of days that we do not plot moving averages for are the first (L-1)/2 and the last (L-1)/2 days.

When displaying the Moving Average Chart, there are two X-Y lines being drawn. The black line represents the daily average and the moving average is represented in green.

This chart does not employ exponential smoothing commonly referred as *exponential weighted* moving average.
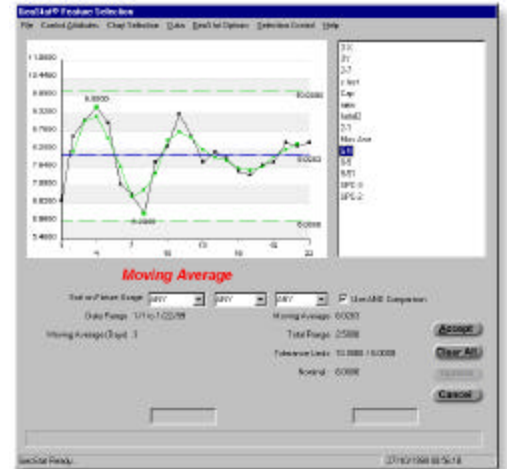
Setting the Moving Period

Changing the Moving Average Period can be accomplished by selecting from the menus [Selection Control->Set Moving Average]. A dialog will appear that defaults to the current setting. The valid ranges for Moving Period are a minimum of 3 and a maximum of 1056 or 3 years.

Besides the minimum and maximum range, GeoStat also validates that the entered period length is an odd number.

The period length is a global setting that effects all Moving Average Charts being displayed and is not configurable between different GeoStat Projects.
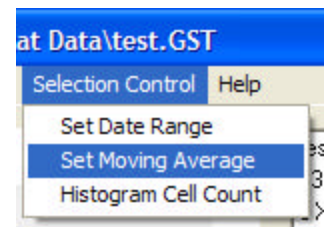
Moving Range Chart

The Moving Range chart contains the same date restraints as the Moving Average. Each node in the chart, represents the range within the subgroup.

In the displayed graph, the solid blue line represents the Moving Range Average. The Total Range is represented numerically in the report.

To set the Moving Period, please refer to *Setting the Moving Period* described in the Moving Average section on the previous page.
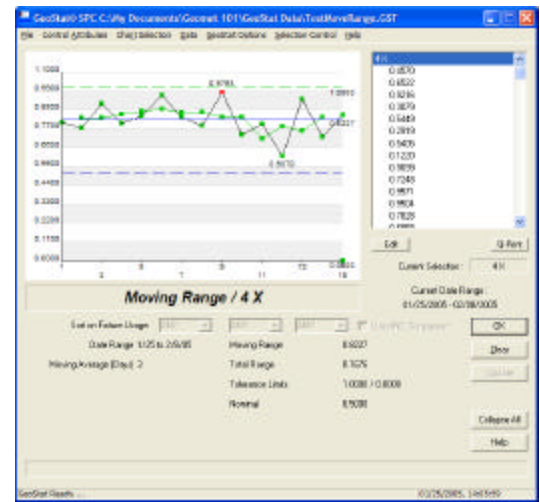
Range Chart

The Range Chart (**R**) monitors variability of the process by charting the difference of the largest and smallest within a subgroup of measurements. The range charts work together with the Xbar Chart and should be reviewed prior to developing the Xbar chart. A typical **R** chart must be set with a subgroup of 2 or more but should not be greater than 10. The sampling size or subgroup look back should be 20 or more, if possible, but not less than 10. **R** charts will enable you to determine whether the variability of a process is in control or whether shifts are occurring over time. If the process range is in control, then it can be used to develop control limits for the average.
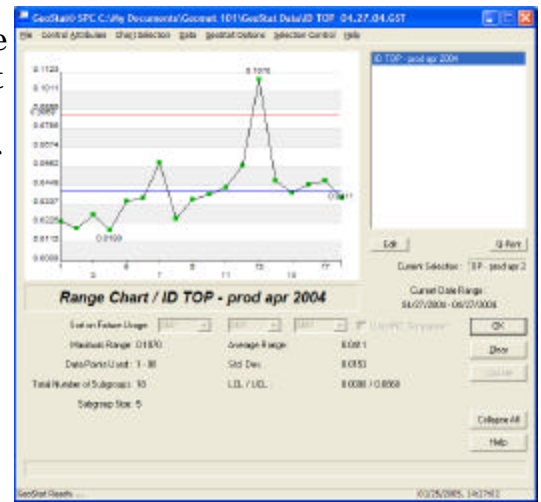
Control limit ranges for **R** charts are calculated using the following equation:

$$UCL = Rbar + SL * Rbar * (d_3 / d_2)$$
$$LCL = Rbar - SL * Rbar * (d_3 / d_2)$$

where:

Rbar = average of all the observed ranges.
SL = GeoStat Control Limit Setting 3 or 6.
d_3 = Table of factors, refer to Appendix A.
d_2 = Table of factors, refer to Appendix A.

Raw Data Chart

The Raw Data Chart charts all measurement observations exclusive of their subgroups, but limited to the subgroup look back value. For example if the subgroup size is 5 and the look back is 10 there will be 50 plotted measurements.

From these measurements GeoStat will compute the Standard Deviation, Xbar and Total Range. The chart will reflect these values and be scaled between the LSL and USL or, if required the largest extent of measurements.

This chart is useful as an aid in observing the overall pattern of your manufacturing process. Additionally it provides a visual reference when conditions such as out-of-control or out-of-specification exist.

The Raw Data Chart interacts with Cause and Effect Codes to produce a printed graph showing the location and code assignment attached to the individual measurement data nodes, see *Cause and Effect Codes.*

XBar Chart

The Xbar chart monitors variability of the process by charting the average of the measurements within a subgroup. This chart is used after the R chart in the control process.

The combination of the R and Xbar charts offer the most sensitive control in identifying and tracing causes to your process. The data plotted for each subgroup is derived from the following equation:

$$Xbar = (X_1 + X_2 + X_3 + \ldots X_n) / n$$

where:

n = subgroup size
$X_1..X_n$ = measurements within each subgroup

The Estimate of averages of the subgroup averages and Control limit ranges for Xbar charts are calculated using the following equation:

$$Xbarbar = (Xbar_1 + Xbar_2 + Xbar_3 + \ldots Xbar_k) / k$$
$$UCL = Xbarbar + SL * (Rbar / (d_2\sqrt{n}))$$
$$LCL = Xbarbar - SL * (Rbar / (d_2\sqrt{n}))$$

where:

Xbarbar = average of all subgroup averages.
$Xbar_{(n)}$ = sample mean for subgroup n.
Rbar = average of all the observed ranges.
k = number of subgroups.
SL = GeoStat Control Limit Setting 3 or 6.
d_2 = Table of factors, refer to Appendix A.

In addition, the process capability index or CpK is reported here, *see Glossary of Terms for definition.*

Sigma Chart

~~The Sigma Chart when used with the R chart provides monitoring of the variation of a process over time. Unlike the Xbar chart which works with the estimated mean of subgroup, the Sigma chart monitors the variation within the subgroup. The plotted observations are the Standard Deviation σ for each subgroup.~~

~~The average sigma is derived from the estimated mean of all calculated subgroup σ values. The standard deviation for all subgroups are then calculated from the subgroup σ values and the control limits, 3 or 6, is then reported to complete the chart.~~

NOTE: The Sigma Chart has been removed from GeoStat!
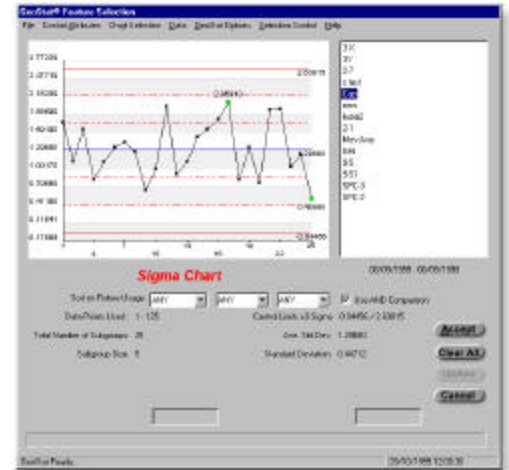
Tests for Instability

GeoStat provide 4 standard tests when viewing the control charts Xbar and Sigma. These tests are performed to provide the operator an early warning that an "unnatural" pattern is forming.

The 4 tests that are performed include:

Test 1

Any point outside of the control limits.

Test 2

Two out of three successive points fall in Zone C or beyond.

Test 3

Four out of five successive points fall in Zone B or beyond.

Test 4

any 8 consecutive data points on one side of the centerline.

GeoStat will display warning statements in the lower message area of the display. If more than one test fails, the message will indicate all warnings, as shown in the example above.

Printing Charts

Printing on demand is accomplished through the pull-down menu command [File->Print], or by using the <Q-Print> button located under the data tree.

There are three options to printing available when selecting through the pull-down menus. These options are:

Print Current Chart
Print XBar and Range
Batch Printing of Charts

Print Current Chart

This command will print the current chart.

Print XBar and Range

This command creates a dual report providing the Charts and Results for the XBar and Range Charts on a single form, *see example*.

Batch Printing of Charts

Due to the high number of chart that can be printed, GeoStat offers a Batch Print utility which is configured per Header Record, and acts upon the Batch Print command.

Before Batch Printing is available, each Header Record must be configured through the pull-down menu:

[Control Attributes->Batch Printing]

This setup tool configures the Header Record for Batch Printing by assigning one or more charts for printing. Place a check next to the chart type and press <Ok> to same the setup, or press <Apply to All> to assign the print setup to all Header Records.

To perform a Batch Print select from the pull-down menus:

[File->Batch Print...]
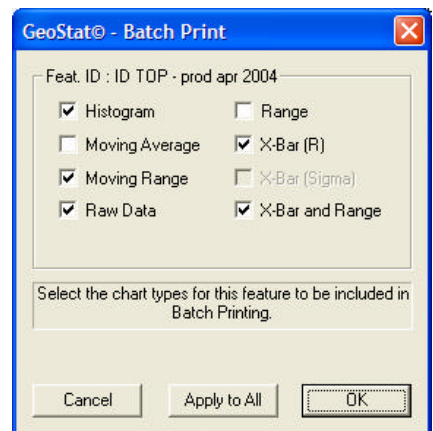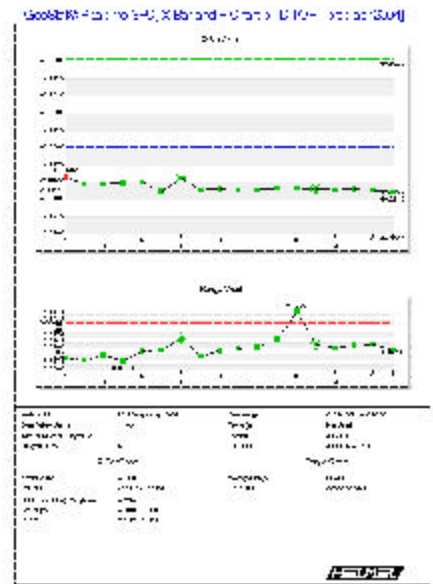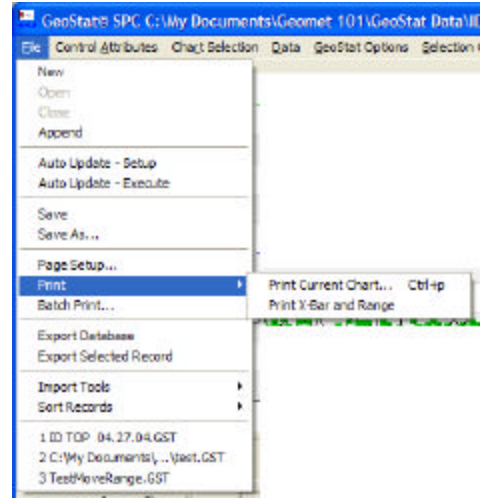
Data Import / Export

Importing Data
Data File Structure
Importing a Data File
Example from Excel
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Importing Data

In GeoStat you can attach measurement data against an established GeoStat Header through the use of the Import command [File->Import Data->…].

This command opens an ASCII data file that has columns of data that are comma or space delimited. Most applications from spreadsheets, word processors and other measurement devices can write ASCII data files.

Importing of data starts by highlighting a Header Record in the data view tree. This will be the recipient of the imported data.

Import Data File Structure (non-subgroup)

GeoStat works with several data structure formats allowing flexibility as to the data fields that are required. The structures of the data fields are:

Actual, Date, Time, Serial Number, Operator, Fixture1, Fixture2, Fixture3

where:

Actual is any valid number.

Date can be any of the following examples:

1/25/1999	01/25/1999
January 25 1999	Jan 25 1999
25 January 1999	25 Jan 1999

It should be noted that we require full year, 1999 not 99.

Time can be any of the following examples:

09:30:00   (hours:minutes:seconds)
09:30   (hours:minutes)
21:30:00

The time format should conform to the 24-hour format where 21:00 is equal to 9:00 p.m.

Serial Number is any alphanumeric string.

Operator is any alphanumeric string.

Fixtures are any alphanumeric strings.

Importing a Data File (non-subgroup)

Before you begin the import process, you should select which Feature ID, or GeoStat Header Record to attach the incoming data too. After you have your feature chosen select the data file from the Open File Dialog located at [File->Import Tool->Import Data]. Locate your ASCII text file and press <Open>. GeoStat will extract the measurements from the data structure as described above.
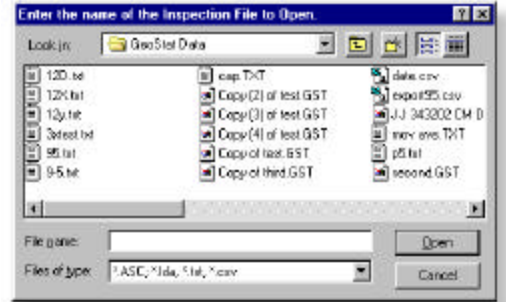
GeoStat extracts the data starting with the measurement value in the left column. It is not required to have data in all fields, as the examples below will illustrate.

GeoStat evaluates the first data line to determine if it contains column labels. If it determines that the first letter is not a number, then it will skip that line and proceed with the next. This should be noted when creating labels for columns. A label "Circle 2" will be evaluated as a label where "2 Circle" will extract the "2" as a measurement value.

Example using Excel Spreadsheet Software

One way data can be created is through the use of the Microsoft Excel spreadsheet. In the example below we created a file which we will then enter the measurement data.

Meas. Value	Date	Time	Serial Number	Operator	Fixture 1	Fixture 2	Fixture 3
10.251	10/19/2003			John			
10.2605	10/19/2003	8:00		John			H1A
10.2598	10/19/2003				H2B		
10.2594	10/19/2003	8:05:00	00102	John			

In the example above we have data in different fields allowing us the ability to skip data when it is not required.

When you have entered all your data proceed to save your work. Choose from the menu command [File->Save As] a save dialog will appear. Set the format in the pull-down "Save as type:" "CSV (Comma delimited)(*.csv)". Provide a file name and the location to store the data.
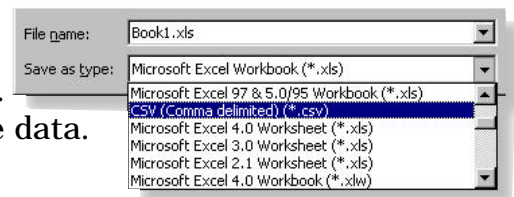
```
Meas. Value,Date,Time,Serial Number,Operator,Fixture 1,Fixture 2,Fixture 3
10.251,10/19/2003,,,John,,,
10.2605,10/19/2003,8:00,,John,,,H1A
10.2598,10/19/2003,,,,H2B,,
10.2594,10/19/2003,8:05:00,00102,John,,,
```

Actual CVS Data File

Import Data File Structure (subgroup)

GeoStat imports ASCII data files that are created in a Row / Column format where each Row is a subgroup. The structures of the data fields are:

$Actual_1$, $Actual_2$, $Actual_3$, $Actual_4$,........$Actual_n$

10.2536	10.2585	10.2542	10.2556	10.2538
10.2528	10.2535	10.2541	10.2555	10.2562
10.2542	10.2538	10.2562	10.2523	10.2511

In this example, we have a data file that contains 5 measurements per subgroup and there is a total of 3 subgroups.

Importing a Data File (subgroup)

Before you begin the import process, you should select which Feature ID, or GeoStat Header Record to attach the incoming data too. After you have your feature chosen select the data file from the Open File Dialog located at [File->Import Tool->Subgroup Import]. Locate your ASCII text file and press <Open>. GeoStat will extract the measurements from the data structure as described above.

GeoStat extracts the data starting with the first measurement value in the left column and continues looking for measurement values until the end of the line is reached.

Exporting Data

GeoStat provides an export capability to save your measurement data in the ASCII text form for use with other applications. These text files are comma delimited and the format for the data is controlled by the command Configure Export Fields.

Configure Export Fields

To configure the ASCII export characteristics for all data being exported select from the menu; [GeoStat Options->Configure Export Fields]. You can define the following fields for the export format:

1. Only Actuals
2. Feature ID
3. Date / Time
4. Operator
5. Serial Number
6. Fixtures
7. SPC Codes
8. Export by Subgroups

Export by Attributes

By selecting fields 2, 3, 4, 5, 6 or 7 or any combination of, you are configuring the ASCII export to place in comma delimited format the respective data. The columns are constructed as follows:

Feat ID, Actual, Date, Time, Serial Number, Operator, Fixture$_1$, Fixture$_2$, Fixture$_3$, Code$_1$, Code$_2$, Code$_3$

An example of a record being exported with all field tags selected will look like:

3 X, 1.1230, 25/10/1999 00:00:00, 1, John, f1, f2, f3, A, B, C

An example that has only Feature ID selected would look like:

3 X, 1.1230

An example that has only SPC Codes selected would look like:

1.1230, A, B1, D
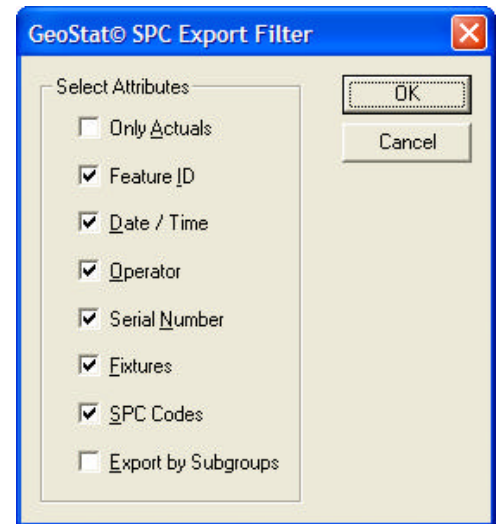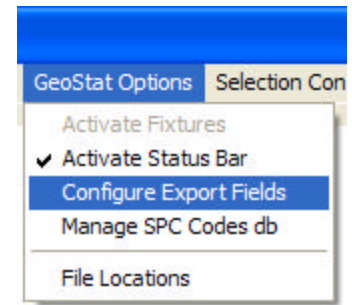
Export by Subgroups

When you select "Export By Subgroups" all other options will become grayed-out and unavailable. This method is used to allow grouping of data for use in applications such as Excel spreadsheets. When you select this option, your output will look like:

```
9.9805,     49.9805,     -10.0195,     -0.0195,     9.9805, ....
25.5000,    25.0000,     25.0000,      24.5000,     24.5000, ....
```

Each line across will contain one full subgroup as defined in the Feature Header. This will allow for better assignment of calculations where each row is a subgroup.

Export Using Only Actuals

When you select "Only Actuals" all other options will become grayed-out and unavailable. This method exports all actual in a single column. When you select this option, your output will look like:

```
9.9805
49.9805
-10.0195
-0.0195
9.9805
25.5000
25.0000
25.0000
24.5000
24.5000
....
```

Exporting the Entire Database

To Export all measurement data select from the menu [File->Export Database]. This command will export all data within the database in an ASCII text field using the format as specified in Configure Export Fields.

If you specify an existing file, GeoStat will prompt you whether to over-write or replace the file.

The data file created will contain groups of data where each group is the measurement data from a single Header Record. Each group is separated by a blank line.

Tables

Control Chart Factors

Observations in Sample	d2	d3
2	1.128	0.853
3	1.693	0.888
4	2.059	0.88
5	2.326	0.864
6	2.534	0.848
7	2.704	0.833
8	2.847	0.82
9	2.97	0.808
10	3.078	0.797
11	3.173	0.787
12	3.258	0.778
13	3.336	0.77
14	3.407	0.763
15	3.472	0.756
16	3.532	0.75
17	3.588	0.744
18	3.64	0.739
19	3.689	0.733
20	3.735	0.729
21	3.778	0.724
22	3.819	0.72
23	3.858	0.716
24	3.895	0.712
25	3.931	0.708

Glossary of Symbols

Statistics Symbols used in GeoStat

Symbol	Description	Note
σ	Sigma	Standard Deviation
LCL	Lower Control Limit	Lowest Control Point for acceptable values
LSL	Lower Specification Limit	Nominal Lower Tolerance
R	Range	Total Range example: Range Chart
Rbar	R-Bar	Average of all observed values
SL	Sigma Limit	Specifies 3 or 6 Sigma Level
UCL	Upper Control Limit	Highest Control Point for acceptable values
USL	Upper Specification Limit	Nominal + Upper Tolerance
Xbar	XBar	Average of each observed subgroups
Xbarbar	XBar Bar	Average of all Xbar values

Glossary of Terms

*.csv	a comma delimited file format used in Microsoft Excel to save data into a ASCII formatted file.
*.GST	the extension used for native file formats within GeoStat.
*.GMT	the extension used for native file formats within Geomet.
ASCII	American Standard Code for Information Interchange. The file format used by GeoStat for import and export of measurement results for use by other applications.
Attributes	a single characteristic of a measured feature. Example: the X location of a XY Circle.
Cell Count	the number of cells, or bars, GeoStat will use in the creation of a Histogram.
Centerline	either the Xbar of control and range charts or the nominal or raw data charts.
Control Levels	when activated, GeoStat draw control levels at 1-2 standard deviation on a 3 sigma control or 2-4 standard deviation levels when configured for 6 sigma. These lines represent Zones A, B and C.
CpK	Process capability index. The reported value is the lesser of (USL - Mean) / (SL * σ) and (Mean - LSL) / (SL * σ).
Date Range	a user defined range of dates that GeoStat will use when building the measurement files to be used in SPC.
Double clicking	the process of applying two fast-button presses from the mouse using the left button. Used in selection and expanding processes.
Feature ID	the visible name of a feature shown the data display of the GeoStat window.

Feature Tagging — the process of assigning a feature within Geomet to be exported to GeoStat.

Fixtures — user defined fields in Geomet and GeoStat that allow segregating of measurement results to reflect location of manufacture, fixtures assigned too, etc.

Header — the record identifier for a single attribute that GeoStat will capture all common measurements against. The Header maintains the tolerance values, subgroup sizes, and subgroup lookback and is shown in GeoStat as the Feature ID.

Histogram — shown as a bar graph whose heights of the bars represent the frequency of distribution of all measurements. The bars, or cell widths, are inclusive of the measurement range.

LCL — Lower Control Limit. The calculated limits of control based on - 3 or - 6 standard deviation.

Limit Test — provides a pop-up warning box when viewing a control charts that has point(s) outside the control limits or when exceeding the specification limits on a Raw Data chart.

LSL — Lower Specification Limit (Nominal - Lower Tolerance).

Moving Average — smoothing calculation of a set of observations over a time period.

Moving Period — the number of days used as the smoothing factor for Moving Average and Moving Range charts.

Nominal — the basic value from the print for the measured feature.

Print Heavy Lines — doubles the weight of printed lines when using high-resolution printers.

R (Range) — the difference of the largest and smallest within a subgroup of measurements.

Raw Data — provides a chart that represents all measurement values with regard to the LSL - Nominal - USL levels.

Report Precision — the number of places to the right of the decimal place for all charts and calculated results.

Subgroup Lookback — a user defined value that will represent how many subgroups GeoStat will use in calculating values for all charts.

Test 1	a test to review the current chart for any data points that exceed the control limits. Test 1 applies to the Xbar and Sigma charts only.
Test 2	a test to review the current chart for any 2 data points from 3 consecutive data points that are in Zone C or beyond. Test 2 applies to the Xbar and Sigma charts only.
Test 3	a test to review the current chart for any 4 data points from 5 consecutive data points that are in Zone B or beyond. Test 3 applies to the Xbar and Sigma charts only.
Test 4	a test to review the current chart for any 8 consecutive data points on the same side of the Xbar line. Test 4 applies to the Xbar and Sigma charts only.
UCL	Upper Control Limit. The calculated limits of control based on + 3 or + 6 standard deviation.
Unnatural	a pattern of data points that fail to balance themselves around the centerline of the control chart. GeoStat uses Test1, 2, 3 and 4 for identify these.
USL	Upper Specification Limit (Nominal + Upper Tolerance).
Zone A,B,C	these zones represent three equally spaced levels between the centerline to either ± 3 or 6 standard deviations. They are also referred as "one sigma zone" or "two sigma zone", etc. Zone A is equal to Xbar ± 1 standard deviation when configured for 3 sigma.

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