

USER'S GUIDE

MRF Clean 2.0

For MapObjects

August 2000



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A message from MRF

Dear Colleague,

Thank you for choosing MRF Clean For MapObjects Version 2.0

MRF products are designed to be generic. However, they can be customized to meet user needs and to further improve productivity by as much as 15 times. Many customers have benefited from MRF's customization services.

Apart from developing off-the-shelf software products, MRF also provides professional services. MRF has been providing consulting services, custom programming services, and data conversion and migration services to our customers all over the world since 1992. MRF's experienced and highly qualified mapping and GIS experts have helped our customers to complete many challenging projects on time and within budget.

Your support and feedback are always important to us. Please feel free to contact us so that we can help you better.

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1. Overview

MRF Clean for MapObjects is a standalone map cleaning software package running in Windows platform. It cleans ESRI Shapefile. MRF Clean for MapObjects 2.0 packed MRF Clean and MRF Flag Editor together. It provides a graphical user interface for shape file displaying, cleaning and editing. MRF's industry-leading Multi-Layer, Multi-Tolerance data clean technology make MRF Clean For MapObjects very unique and powerful. Figure 1 is a general user interface of the product.

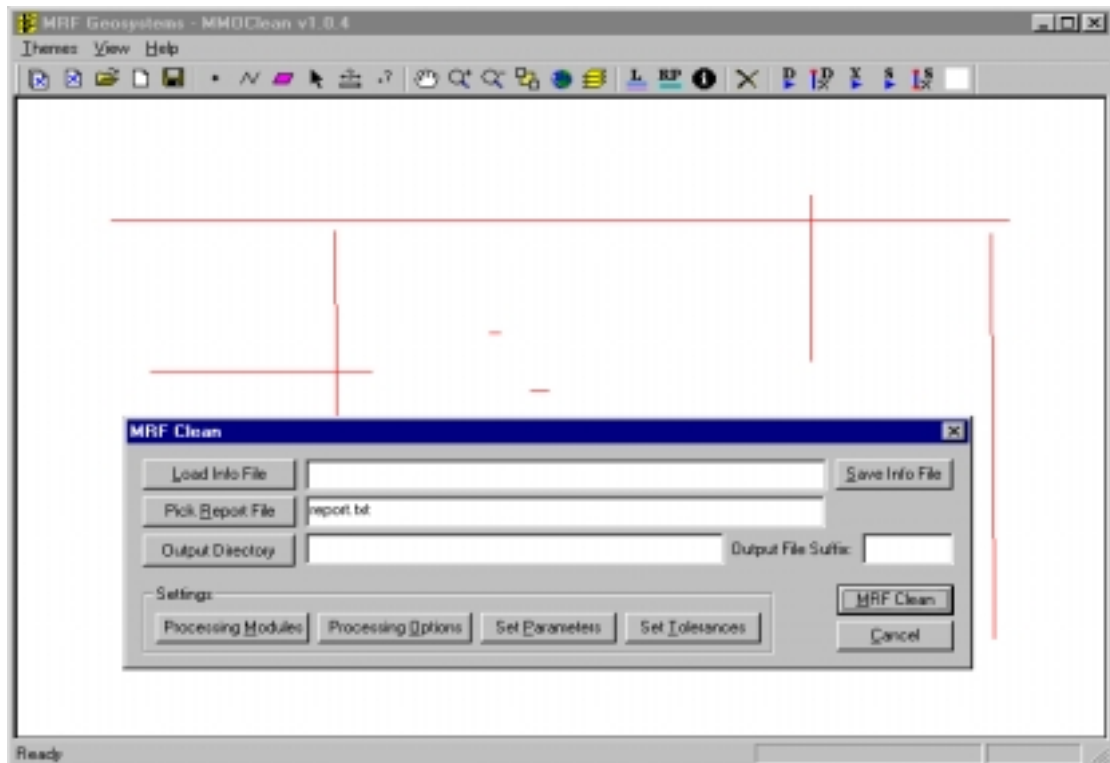


Figure 1: General Interface of MRF Clean for MapObjects

MRF Clean can:

- Correct over-shooting and under-shooting
- Perform line weeding
- Remove duplicate or near-duplicate points and lines
- Create or flag intersections in crossing line work to ease building of topology
- Flag or delete short elements and dangles
- Join singly-connected polylines with identical attributes to form longer ones
- Merge line work which has approximately the same geometry (conflation)
- Identify free end points for manual review and editing
- Reduce shape file size to save disk space and increase display speed

Multi-Layer, Multi-Tolerance capability is one of the key features offered by MRF Clean. To the best of our knowledge, **MRF Clean is the only multi-level, multi-tolerance data cleaning package on the market.** With multi-tolerance data cleaning technique, points with a larger tolerance will be moved to points with a smaller tolerance. In this way, inconsistencies such as the overlap or gap between different boundaries can be corrected by moving the less accurate boundary to the more accurate boundary. When input points have identical tolerances, the movement of points are performed in such a way that straight lines are kept straight - a very desirable behaviour for many GIS/LIS applications.

MRF Clean is the result of many years of research and development. The state of the art technology pioneered by MRF Systems Corp. makes MRF Clean extremely efficient and robust. Extensive testing and user feedbacks indicate that MRF Clean can improve the quality of data conversion and data editing for mapping, GIS, and AM/FM applications, and, at the same time, **increase productivity by two to ten times.**

MRF Flag Editor

MRF Flag Editor is designed for use in conjunction with MRF Clean. It assists the user in identifying and editing the flags, such as flag free end points “D”, intersections “X”, and short elements “S”. See Figure 2. MRF Flag Editor is designed to guide the user directly to these flags so the user may review the line work and make editing changes to the linework.

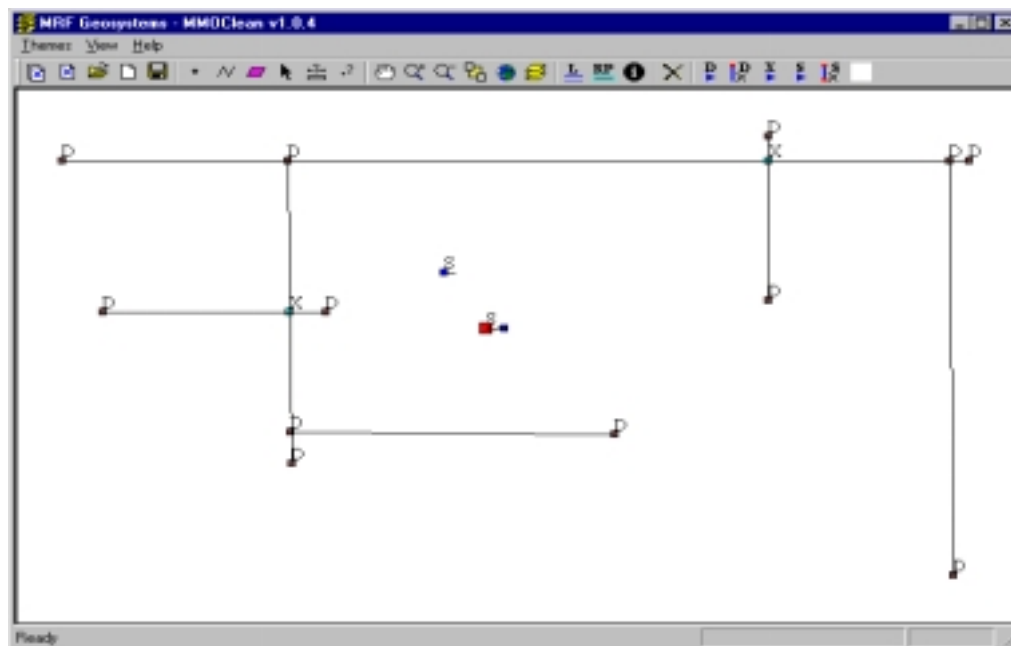


Figure 2: MRF Flag Editor for MapObjects

MRF Flag Editor allows the user to visit each flag efficiently. It makes the current flag the window center, and highlights the flag with the current highlight color. The user can zoom in and zoom out while keeping the current flag highlighted. The user can edit (delete or modify) the flagged elements using editing tools provided in the product.

2. Installation

To install MRF Clean for MapObjects, run the program **setup.exe** from the supplied CD or diskette #1. The on-screen instructions will guide you to the end of installation.

MRF recommends that you simply click the **Next** button on all the setup panels to accept the preset options to install MRF Map Object Clean.

- To manually start MRF Map Object Clean setup from a CD, insert the CD in your CD-ROM drive, double-click the My Computer icon on the Windows desktop, double-click your CD-ROM drive, then locate and double-click Setup.
- To install from floppy disks, insert MRF Map Object Clean Disk 1 in the A: drive, click Start on the Windows taskbar, click Run, type `A:\setup` in the text box, then click OK.

2.1 Uninstall MRF Clean

Click Start on the Windows taskbar, point to Settings, point to Control Panel, and click on Add/Remove Programs in the Control Panel Dialog Box. Highlight MRF Clean for Map Objects and click on Add/Remove button.

2.2 System Requirements

Your minimum system requirements are:

- Pentium personal computer
- Microsoft® Windows NT® 4.0, or Windows® 95/98 operating system
- 32MB RAM (64 MB is recommended)
- 10MB hard disk space (100MB recommended)

3. Features of MRF Clean for MapObjects

MRF Clean for MapObjects is a two-dimensional cleaning software. It is a data cleaner designed to clean Point, Line and Area features stored in shape files. MRF Clean can:

- Correct over-shooting
- Correct under-shooting
- Perform line weeding
- Remove duplicate or near-duplicate points and lines
- Create or flag intersections in crossing linework to ease building of topology
- Flag or delete short elements and dangles
- Join singly-connected polylines with identical attributes to form longer ones
- Merge linework which has approximately the same geometry (conflation)
- Identify free end points for manual review and editing
- Reduce shape file size to save disk space and increase display speed

3.1 A Better Alternative to Single-Tolerance Data Cleaning

Most GIS applications require the use of many data sets, which are collected by public agencies and private organizations, frequently using different levels of positional accuracy. Also, in a map, data sets are commonly stored on different layers. Since many spatial features share common boundaries, such as a forest stand and a lake, these common boundaries must match even when they are stored on different layers.

3.1.1 Case Study - Resource Management

As an example of the problems inherent in single-tolerance data cleaning, consider the following. A forest company uses two types of maps: maps containing lakes, rivers and roads from the state or provincial government, and forest stand maps collected by the company. Assume that the topographic and forest stand maps have positional accuracy's of two and four meters respectively. Let us also assume that the two types of maps are stored in different files. In cleaning these two types of maps, the Forest Company faces several challenges:

- If the two layers are cleaned separately, lakes and forest stands may overlap after cleaning even though they should share a common boundary.
- If the two layers are merged into one layer and cleaned using a single tolerance of two meters, then digitizing errors such as over-shooting and under-shooting in the line-work of the forest stand map may not be corrected.

Or

- If the merged layer is cleaned using a single tolerance of four meters, then the line-work from the topographic map will be generalized, reducing its accuracy for future operations.

3.1.2 The MRF Solution: Multi-Tolerance Data Cleaning

Using multi-tolerance data cleaning, points with a larger tolerance can be moved a greater distance to coincide with points which have a smaller tolerance. In this way, inconsistencies such as the overlap or gap between a lake boundary and a forest stand boundary can be corrected by moving the less accurate boundary-the forest stand in the example-to the more accurate boundary of the lake. Also, when input points have identical tolerances, the movement of points is performed in such a way that straight lines are kept straight-a desirable behavior for many GIS/LIS applications. Using tolerances based on known quality limits of the input data, users can be confident that the data is being corrected automatically, without compromising the integrity of mission-critical information.

To the best of our knowledge, MRF Clean is the ONLY multi-layer, multi-tolerance 2D data-cleaning package on the market.

3.1.3 Other MRF Clean Features

MRF Clean allows you to maintain inter-layer geometric consistency. The following is an application where inter-layer geometric consistency is desirable.

In property mapping, parcel boundaries on one layer may not be geometrically consistent with corner markers on another layer. For example, a lot boundary on layer 40 may not end at the center of a Point Object on layer 20 (i.e., Figure 3).

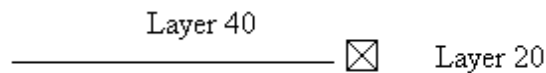


Figure 3. Example of geometric inconsistency

A user might assign the following tolerances to the listed features:

FEATURE	TOLERANCE (m)
Survey pins	1

Plan boundaries	3
Block boundaries	5
Lot boundaries	10

When cleaning up the property map, MRF Clean will move a feature with a larger tolerance to align with a feature with a smaller one:

- plan boundaries will end at accurately placed survey pins
- block boundaries will coincide exactly with plan boundaries
- lot boundaries will coincide exactly with block boundaries

In addition to the geometric advantages of multi-layer, multi-tolerance cleaning, it is also important to note that by utilizing line-work on a number of layers, data redundancy can be substantially reduced. As an example, if an administrative boundary follows the bank of a river, the river's geometry can be used in data processing. This will eliminate the need to replicate that information to another layer. This reduction in data duplication decreases the number of edits to be made when map updates are done and also reduces the size and complexity of the working Shapefiles.

MRF Clean is the result of many years of research and development. Extensive testing and user feedback indicate that MRF Clean can improve the quality of data conversion and data editing for mapping, GIS, and AM/FM applications. At the same time, MRF Clean can increase productivity by two to ten times.

3.2 Features Processed by MRF Clean

Since Map Objects do not support Arcs, curves are represented either by polylines.

MapObjects Feature	MRF Clean Processing
POINT	Cleaned as a point
POLYLINE	Cleaned as a polyline
POLYGON	Cleaned as a polygon

3.3 Definitions

The following terms are frequently used in this manual.

Shapefile: An ArcView GIS data set used to represent a set of geographic features such as streets, hospital locations, trade areas, or ZIP Code boundaries. Shapefiles can represent point, line, or area features. Each feature in a shapefile consists of a single geographical element (in .shp) and its attributes (in .dbf).

Layer: A group of features in a map, which has the same feature type (Point, Line or Area) and classification (Control Pins, Roads, Lake, etc.). Each Shapefile represents one layer.

Point Object: A single dot on a map that represents the location of a feature. It consists of a single set of coordinates: x, y . A Point Object may be represented by a Symbol.

Polyline Object: A linear object on a map that represents the location of a linear feature. It may have two or more points. Each point has a pair of x, y coordinates.

Polygon Object: An area feature such as a parcel, a lake, etc. The Polygon Object is a collection of points that comprise a closed shape.

Flag: A flag is a Point feature that MRF Clean creates and places at the location of potential topological errors. MRF Clean creates character "S" to represent short linear features (shorter than its tolerance), "D" to represent dangle linear feature, and "X" to present the intersection locations.



Flag Hints:

MRF Clean adds each flag type into a new layer superimposed over the cleaned data. Before removing dangles, short elements or creating intersections, it is a good idea to first run clean with the flags in order to check that the intended result will be carried out. The flag layers can be removed, flag settings turned off and clean can be run again. It is important to note that in any case where a flag setting is selected, the underlying feature is not activated. So running the option to flag true intersections, the intersection will not be created but rather, a flag will be placed on a new layer indicating where an intersection would be created.

4. Understanding MRF Clean

MRF Clean has eight processing modules. They are:

1. Line Simplification
2. Short Element Processing
3. Linear Extension
4. Intersection Creation
5. Duplicate Removal
6. Element Joining
7. Conflation
8. Dangle Processing

The following sections describe each module in detail.

4.1 MRF Line Simplification

Line simplification (sometimes referred to as line weeding or line generalization) involves the removal of certain vertices of linear or area geometries. The specified tolerance governs the number of vertices to be removed.

This module processes area and linear features. The example below demonstrates the simplification process.

The degree of simplification depends on the specified layer tolerances and filter factor. The maximum distance between the resulting feature and the original one will be: $(tolerance\ for\ feature) \times (filter\ factor)$. See *Clean Parameters Dialog* (section 8.3) for details on setting tolerances and factors. Figure 4 shows the result of this processing.

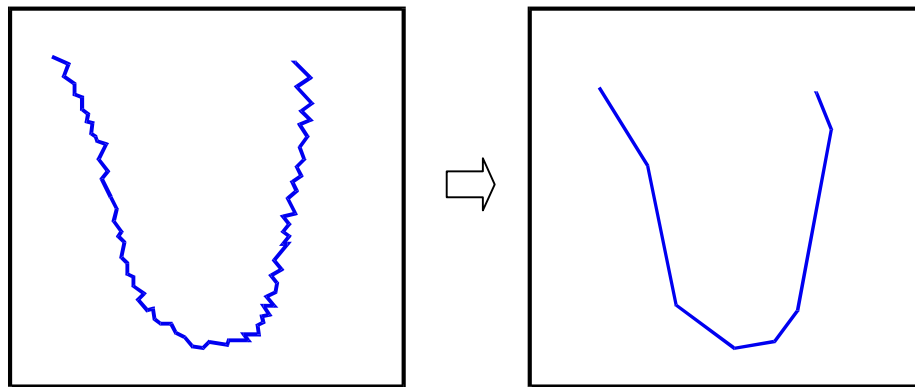


Figure 4: Line Simplification in MRF Clean

4.2 MRF Short Element Processing

This module will flag linear features that are shorter than the tolerance specified for that layer. You can select to automatically delete short linear features, or have them flagged for later editing. If they are to be flagged, for each sub-tolerance feature, a flag "S" marking its location will be created.

This module processes linear features.

4.3 MRF Linear Extension

This module extends linear geometries. It corrects undershoots, while maintaining linework direction. If a feature has a free end, the program will attempt to extend it until it meets other line-work within its tolerance. If no such line-work exists, the geometry will remain unchanged. This capability is critical to applications such as parcel mapping.

4.3.1 Examples of Linear Extension

In Figure 5, lines AB and CD will be extended to point E, if E is within tolerance of both AB and CD, and both B and D are free ends.

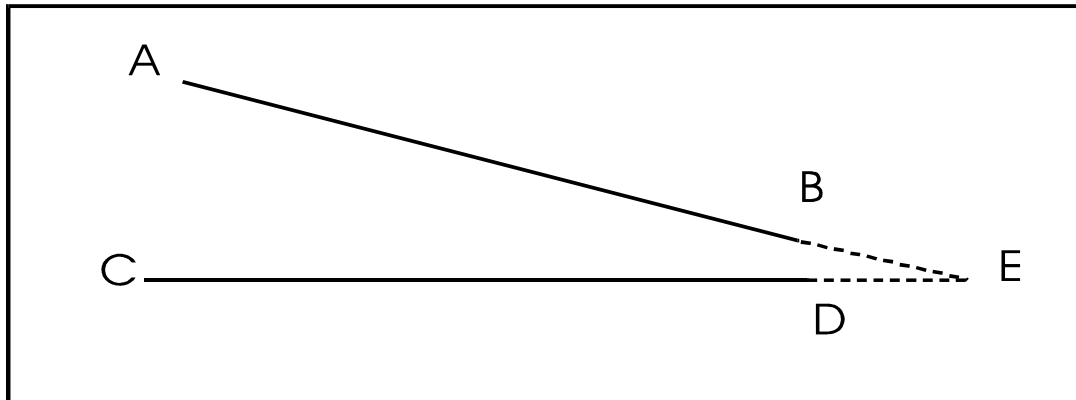


Figure 5: Linear extension example 1

In Figure 6, lines AB and DE cannot be extended to point F, even though the distance BF is less than the tolerance for AB and EF is less than the tolerance for DE. This is because B is not a free-end.

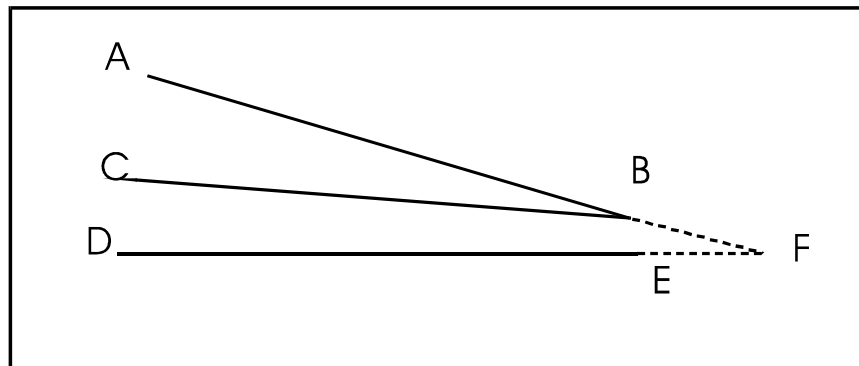


Figure 6: Linear extension example 2

In Figure 7, CD has a tolerance larger than both the distances DE and CE. In this case, point D (as opposed to point C) will be extended to point E, since it has the smaller extension distance.

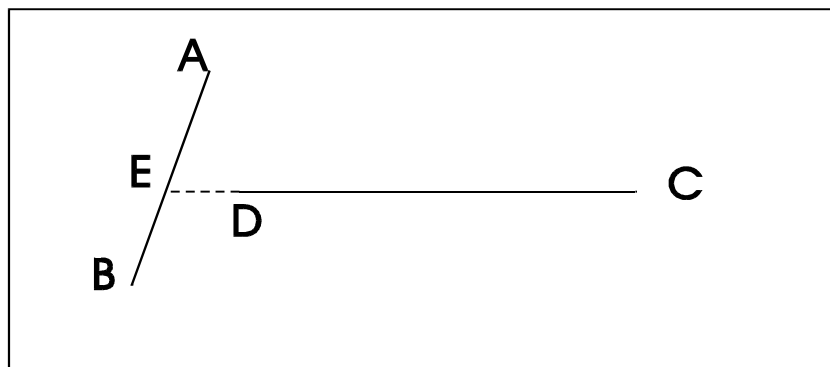


Figure 7: Linear extension example 3

If a line can be extended to more than one feature, it will be extended only as far as the closest one. In Figure 8, line AB will be extended to point C (not D or E).

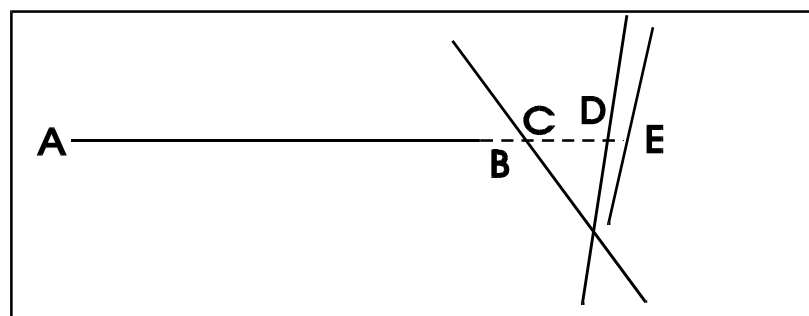


Figure 8: Linear extension example 4

4.4 MRF Intersection Creation

This module flags and/or creates true and fuzzy intersections. It consists of geometry intersection, clustering, and splitting sub-functions. This module processes all features that are listed in Section 4.3.

4.4.1 True Intersections

True intersections are created where two lines cross each other, as in the example shown in Figure 9. The location marked with an X is a true intersection.

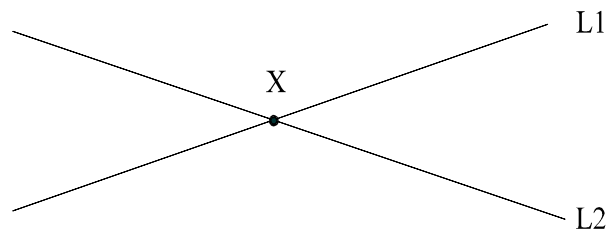


Figure 9: True intersection example

4.4.2 Fuzzy Intersections

Fuzzy intersections can be created between a pair of features that are within one of their tolerances, but do not actually touch or cross. In other words, the two lines nearly intersect, and the minimum distance from the end of one line to the other line is shorter than one of the lines' tolerances.

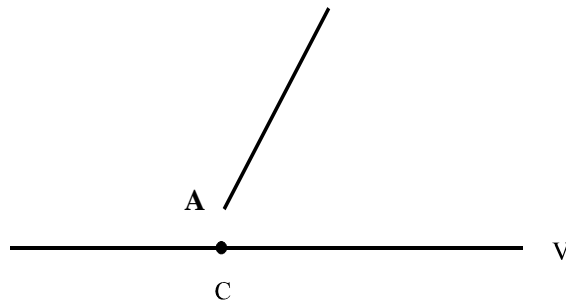


Figure 10: Fuzzy intersection example

In the example shown in Figure 10, if the distance from end point A to line V is shorter than one of the two lines' tolerances, then node A is projected the shortest distance to line V, to determine where the intersection is located. This projected point, point C, is called a critical intersection while A is called an end intersection.

Each intersection point inherits its tolerance from its input feature. The End Intersection, point A, will have the same tolerance as the line that contains A, and Critical Intersection C will have the same tolerance as that of line V.

4.5 MRF Duplicate Removal

After the intersection creation process, two near-duplicate features may become exact duplicates. The duplicate removal function removes these exact duplicates to reduce file size and aid in topology building. In Figure 11, two input lines are within tolerance. As a result, end points A and D would create critical intersections at C and B. Assuming that line AB has a smaller tolerance, C will be clustered to A, and D will be clustered to B.

After splitting, CD and AB would have identical geometry, so AB and CD would be candidates for duplicate removal. If you choose to use By Geometry option for duplicate removal, then all but one of the features with the same geometry after clustering will be deleted. Only the entity with the smallest tolerance will be kept. If both features have the same tolerance, one feature will be retained and the other deleted as a duplicate. In Figure 11, CD will be removed because it has a larger tolerance.

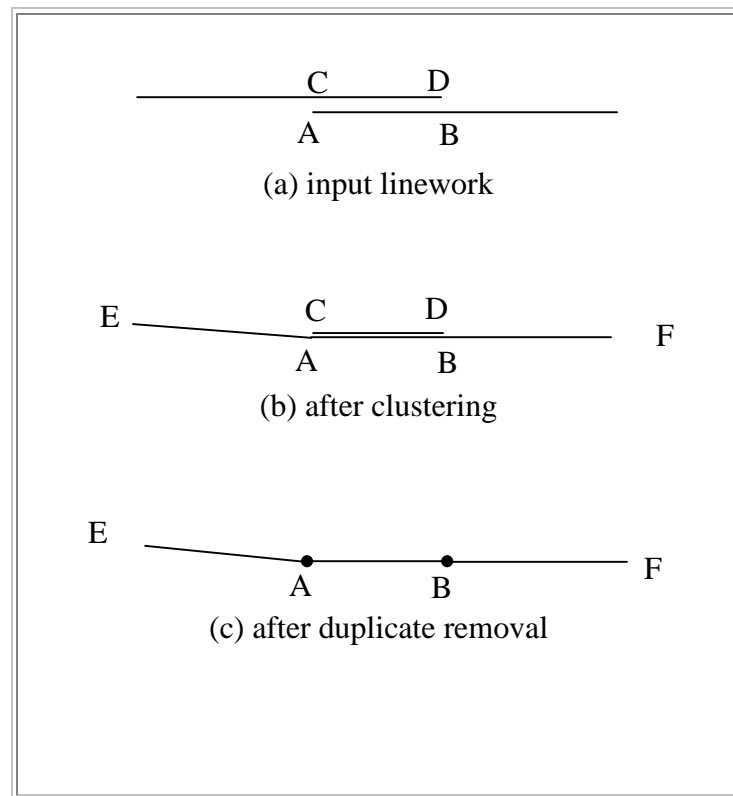


Figure 11: Duplicate removal

If you choose the By Geometry option on the parameter form, then AB and CD will be considered as duplicates if they have identical geometry, after clustering, and the following Map Objects properties in common:

- Layer
- Symbology

Caution: When in doubt choose the "By Criteria" option to preserve duplicate lines which should not be treated as duplicates, such as street centerlines and district boundaries.

4.6 MRF Element Joining

This module joins singly-connected linear features to create longer ones. The benefit of this is that the number of geographic features is reduced, making many mapping/GIS operations more efficient.

Where only two polylines are singly connected at a node or end point, MRF Clean will join them to form one longer polyline, if they have the following attributes in common:

- Layer
- Symbology

In Figure 12, assume the input polylines have identical attributes. After duplicate removal, there will be three polylines: EC, CB, and BF. In contrast, after polyline joining, only one polyline will exist containing four points: E, C, B, and F.

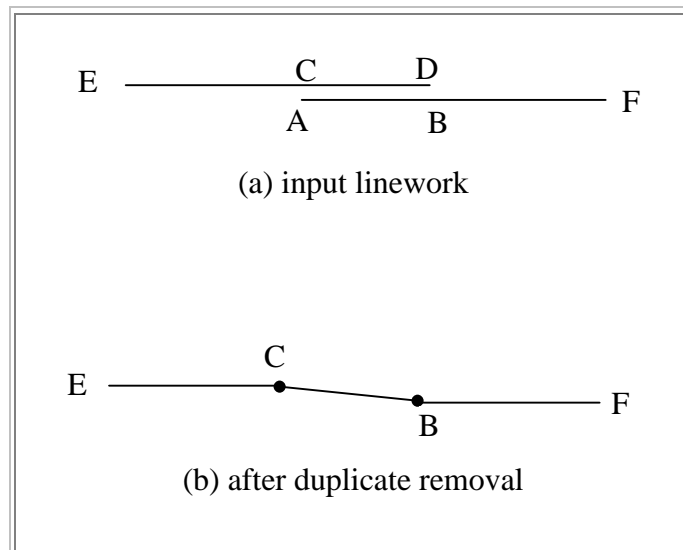


Figure 12: polyline joining

If there are multiple polylines with identical geometry but different attributes, polyline joining is still carried out as long as network topology is maintained. For example, if there are features on three different layers as shown in Figure 13, we will have three polylines with the points E, C, and B after entity joining, assuming that the entities on each layer can be joined.

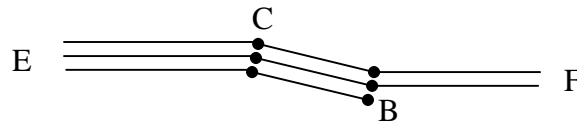


Figure 13: Multi-polyline joining

4.7 MRF Conflate

Conflation is the merging of linework which has the same or similar geometry. This removes slivers and gaps and allows for alignment of linear features which should have the same geometry, such as national, state and city political boundaries.



Note: Two polyline entities are conflated together if they share the same start and end nodes, and are within tolerance.

After conflation, the polyline with a larger tolerance will have the same geometry as the polyline with the smaller tolerance. In Figure 14, polyline AB and ACB share the same nodes, A and B. If AB has a smaller tolerance, and ACB can be conflated to AB, then ACB will have the same geometry as AB after conflation. After conflation, exact duplicates will be removed, as explained in sub-section "Duplicate Removal".

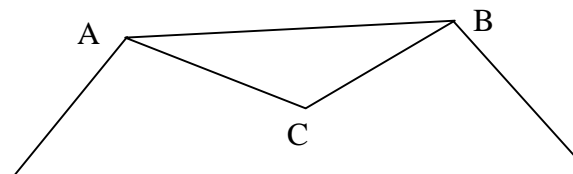


Figure 14: Conflation

4.8 MRF Dangle Processing Module

A dangle is a linear entity which has at least one end not attached to another linear entity or point. Dangles with a length less than (dangle factor times tolerance) will be removed. Dangles that are longer than (dangle factor times tolerance) will be flagged with the letter "D" placed on the Dangle Flag Layer. If Fuzzy Intersection is not selected then all dangles will be flagged and undershoots will not be corrected.

A dangle is a line end that does not meet up with any other line-work (a dead-end). If you specify the Use Bloaks in MRF Clean Processing options, line-work ending at a point feature will not be considered a dangle.

You can select to have some or all features with dangle geometries removed automatically. Use the Dangle Factor (on the Parameters Page) to indicate how short a dangle feature must be to be automatically removed.

5. Sample Results of MRF Clean

MRF Clean uses generic algorithms to perform data cleaning and does not follow a set of pre-defined cases. The best way to discover the behavior of MRF Clean is to construct test cases and run MRF Clean on them. The following diagrams demonstrate the cleaning principles of MRF Clean. Each feature is assumed to be on a unique layer unless otherwise stated. Tolerances are shown at the top of each figure.

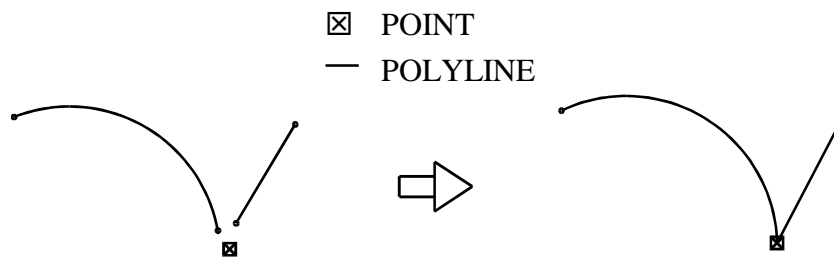


Figure 15: Polyline nodes moved to Point object

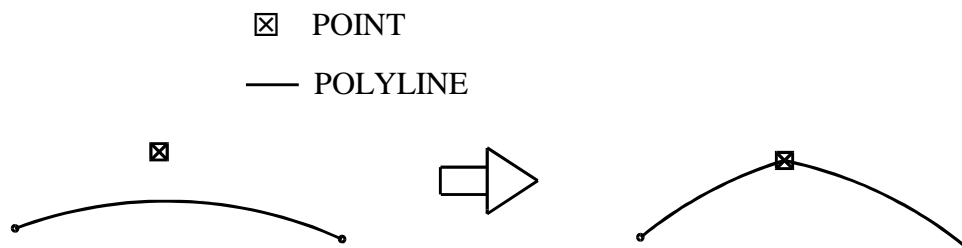


Figure 16: Polyline broken and ends collocated to point object.

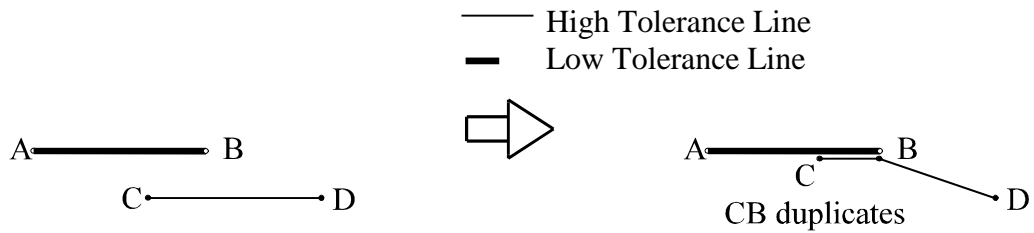


Figure 17: Line with larger tolerance moved to line with smaller tolerance

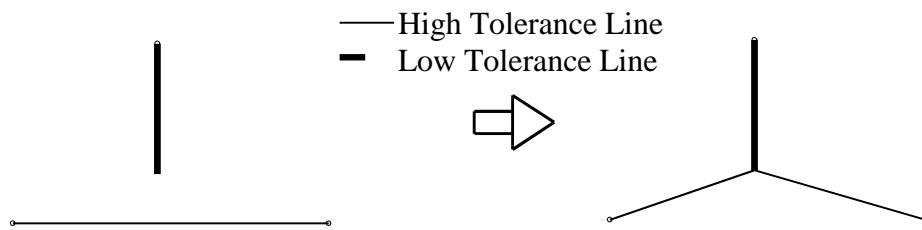


Figure 18: Fuzzy intersection created in linear feature with smaller tolerance



Figure 19: Fuzzy intersection created in linear feature with smaller tolerance

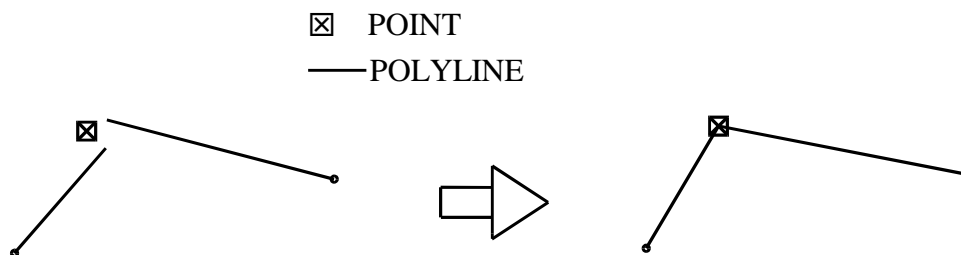


Figure 20: Linear features with large tolerance moved to collocate with point object with smaller tolerance

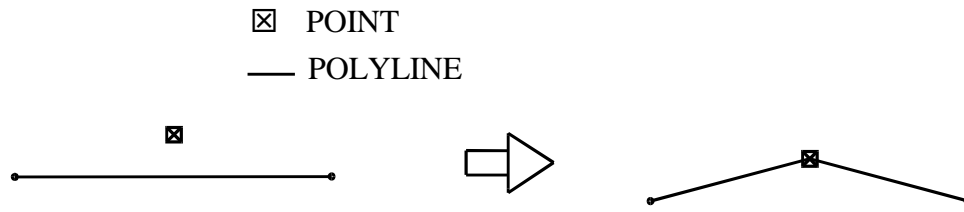


Figure 21: Fuzzy intersection created in linear feature with smaller tolerance

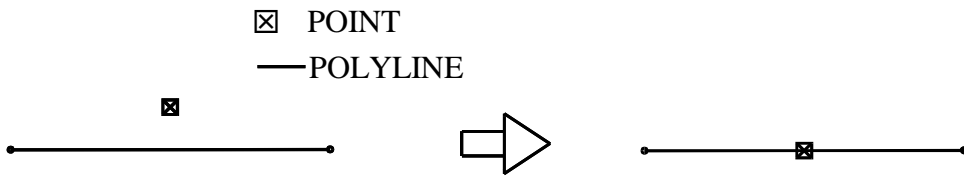


Figure 22: Insert with large tolerance moved to fuzzy intersection in linear feature

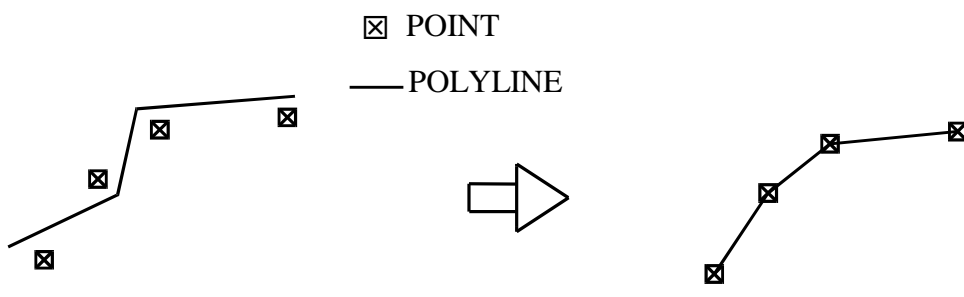


Figure 23: Nodes and vertices on linear feature with large tolerance collocated at point feature with smaller tolerances

6. Running MRF Clean

6.1 Start MRF Clean for MapObjects

After you install the software successfully, you can get started with the examples provided along the product. If you use the preset installation options during the installation, the program is located in: *C:\Program files\MRF\MRFClean4MapObjects*, with the name of **MMOClean.exe**. The examples are located in *C:\Program files\MRF\MRFClean4MapObjects/Examples*.

To start the program, double click on MMOClean.exe. The user interface will display, as shown in figure 24:

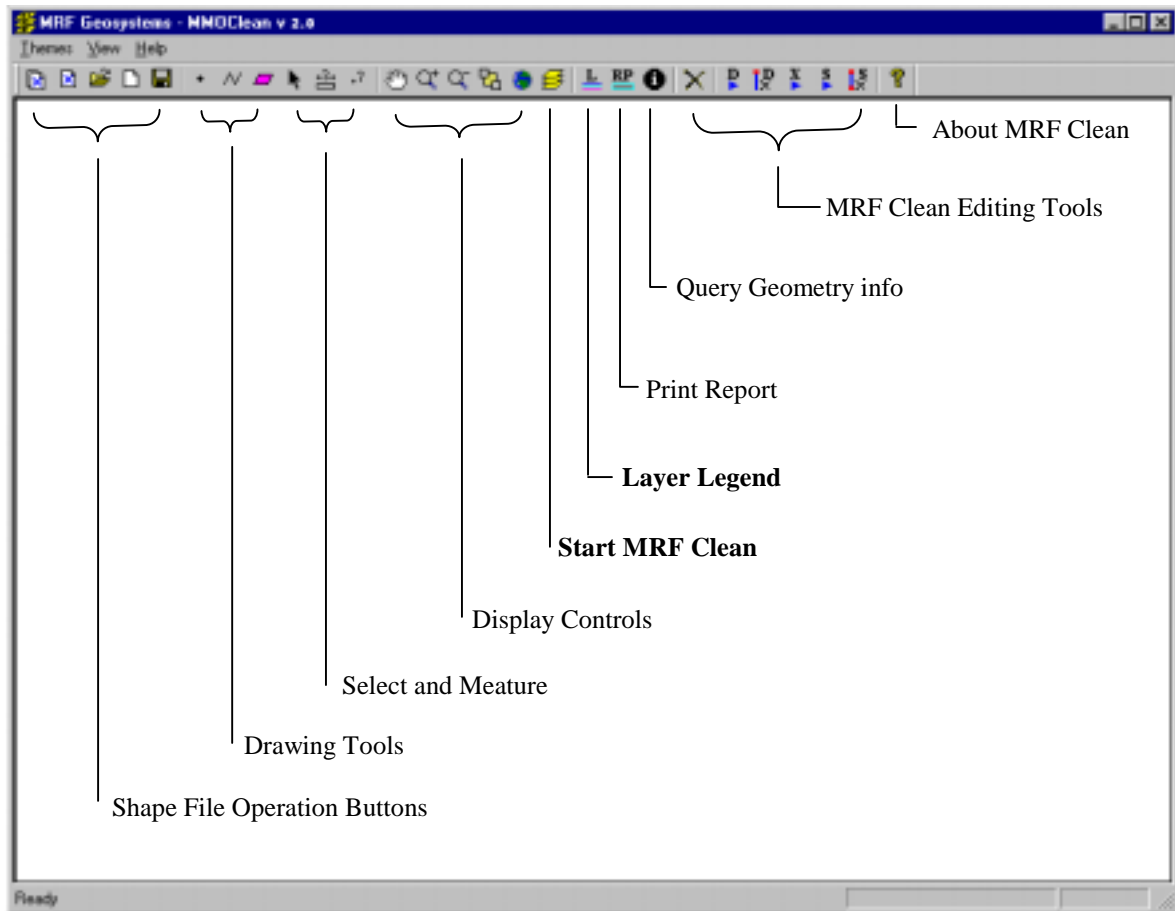


Figure 24: MRF Clean for MapObjects user interface

The following figures give the functionality of some buttons (figure 25):

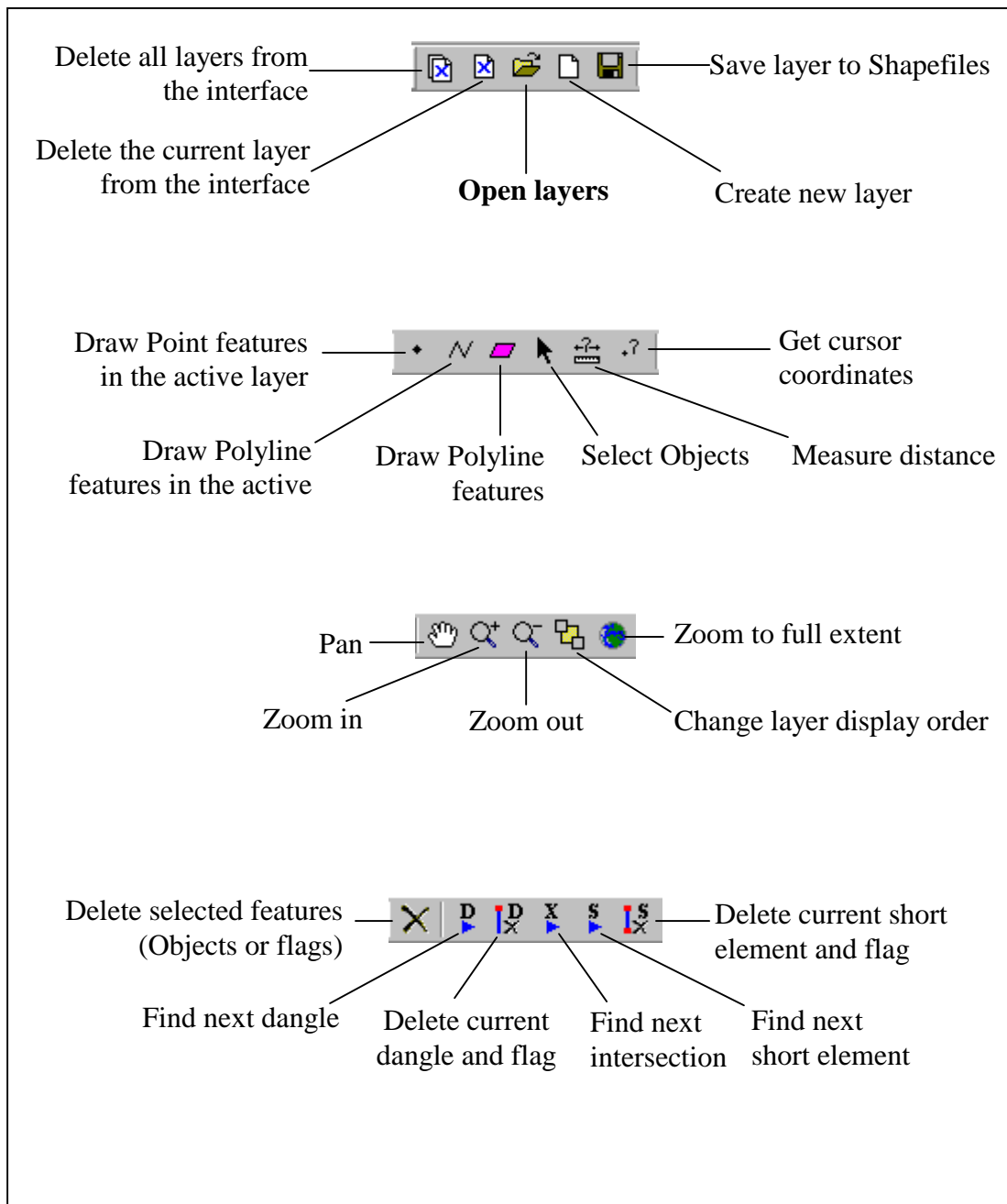


Figure 25: Functionality of buttons

You can also use menu to access some of MRF Clean functions, such as Edit Colors for opened layers, use MRF Clean Help, etc. Figure 26 shows the user interface for set layer colors:

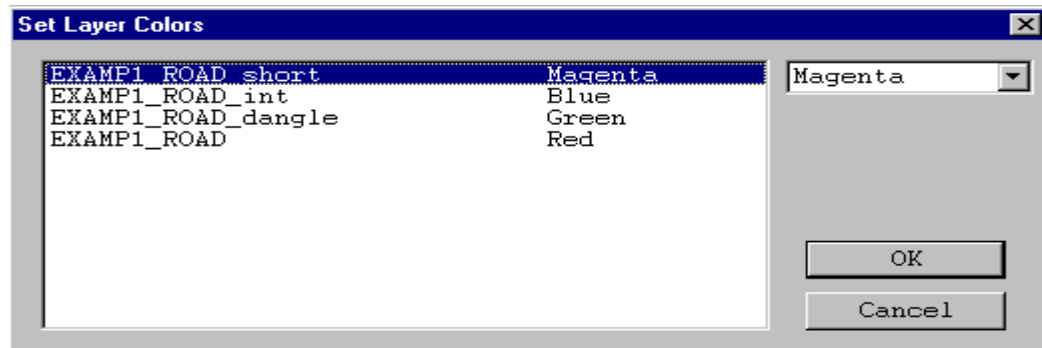



Figure 26: Set layer Colors

To set color for a layer, first select the layer in the layer list in the left, then select a color in the color drop down list. Click OK when finished setting colors for all layers. You can **turn off** polygon fillings using **Polygon Transparent** option in **View** menu. The default setting for polygon filling is on.

In Add Shape File dialog (**Add Theme** item in **Themes** menu, or Open Button ), you can open multiple shape files by holding Shift or Ctrl key while selecting files.

6.2 Start MRF Clean Process

Click on MRF Clean button  to start data clean process.

A number of input parameters are required to successfully clean vector data. This section discusses how each parameter affects processing. Figure 27 is the main console for MRF Clean, and all clean settings are controlled through this window.

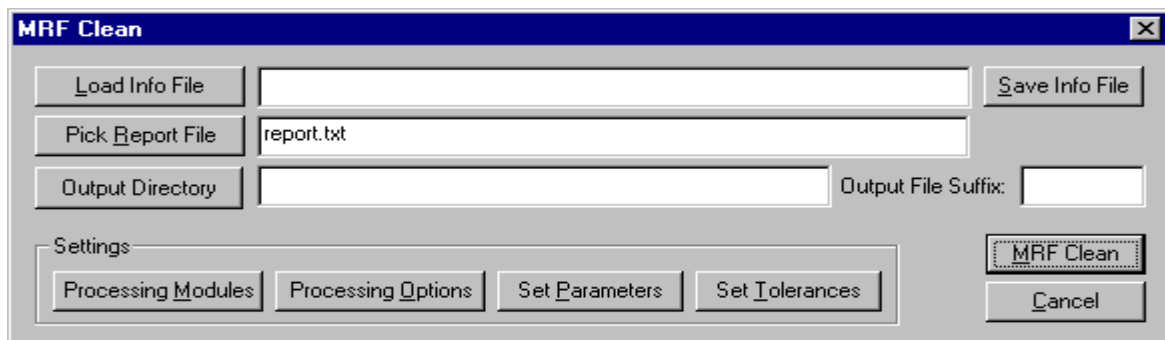


Figure 27: MRF Clean main window

6.2.1 Output Directory and Suffix:

If left blank, by default the output file name will be the original layer file name concatenated with "_out" in the same directory as the last opened file. A different output directory can be specified by selecting the *Output Directory* button which will allow the user to search and select a new directory location. The *Output File Suffix* is an optional feature that will insert 10 characters or numbers between the output name and the "_out.shp" ending.

For example, if the layer name is *ROAD_WEST* the default output file name is *ROAD_WEST_out.shp*. If a value of "**Jim001**" was entered in the *Output File Suffix* box, Then the layers will have the following format:

ROAD_WEST_Jim001_out.shp

The dangle flag layer will have the same naming convention except "_dangle" will be concatenated at the end instead of "_out". Same format applies to intersection flag "_int" and short element flag "_short".

6.2.2 Info File: (Optional)

The Info File contains the parameters for running MRF Clean. Using an Info File allows you to ensure that the same parameters are applied to a set of files. Toggle button values are represented by 0 for OFF or 1 for ON. in the Info File. An option button can have as many values as the number of options: the first option is 1, the second 2, etc. The ordering of the options is the same as displayed in the dialog box.



Note: You can activate the file picker push-button beside the Info File field to select an Info File.



Recommendation: It is recommended that you create your info File by opening an existing Info File and manually editing the parameters through the MRF Clean module. Then saving the info file to a new name.

6.2.3 Report File: (Optional, ASCII text file).

MRF Clean uses this file to log details of the cleaning. The default file name is "report.txt". If no Report File is specified, MRF Clean uses "report.txt" in the current directory as the default. If the report file does not exist, MRF Clean will create it.



Note: This is a prime source of information if you ever have a problem cleaning a shape file.

6.2.4 Set Parameters:

Click this push-button to open a sub-dialog box for entering or modifying parameters. The "MRF Clean Parameters" form will appear.

6.2.5 Set Tolerances:

Click this push-button to open a sub-dialog box for entering or modifying the tolerance for each layer.

6.2.6 MRF Clean:

This is the button to start MRF Clean process. Do not push this button until you have set all of the parameters you wanted for the processing.

6.2.7 Cancel:

Click this push-button to exit this dialog box without cleaning.

6.2.8 Save Info file:

When you click on this push-button, MRF Clean will save the parameters and tolerances to the specified Info File.

7. Setting Tolerances for MRF Clean

Tolerances for each layer can be entered by pressing the "Set Tolerances" push-button in the MRF Clean Main User Interface. Figure 25 shows the sub-dialog box of MRF Clean. In this sub-dialog box you can select a layer and enter a tolerance for that layer. If the default tolerance value for a layer is -1.000000 (nothing displayed in the layer list), which means that the layer will be skipped and no output for it. Tolerances are listed in the current coordinate system units. You must enter a non-negative tolerance for each layer you want to clean. Each layer can have a different tolerance.

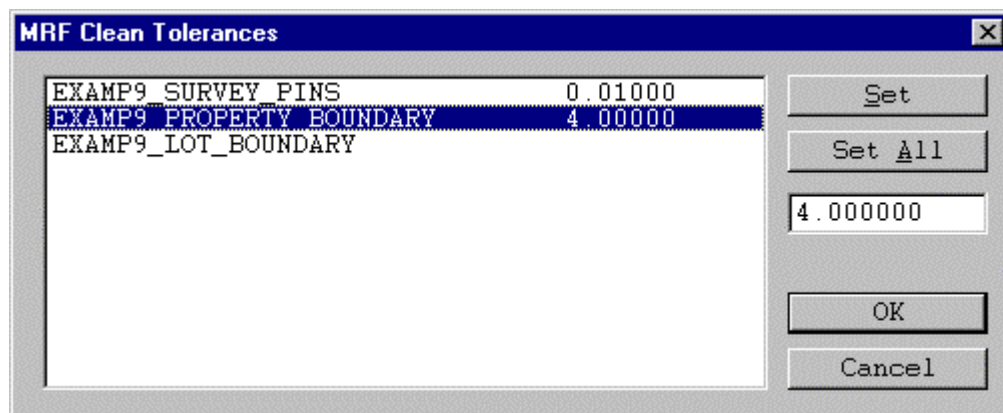


Figure 28: Set Tolerances

7.1 Edit Tolerance:

When you click a line inside the list box, the tolerance for that layer will be displayed in the "Edit Tolerance" text field box. You can then enter a valid tolerance for that layer. If you enter a negative value or leave the tolerance blank, MRF Clean will use the default value of -1.0. The SET button will set the value for that layer in the list box, and will set the value when you leave the control of the "Tolerance" text field.

7.2 Set:

Click this push-button to set the tolerance of the selected layer to the tolerance in the "Tolerance" box.

7.3 Set All:

Click this push-button to set the tolerances of all the layers to the tolerance in the "Tolerance" box.

8. MRF Clean Processing Modules

This section deals with MRF Clean processing modules, options and parameters. Understanding these concepts is paramount as they can radically change the outcome of the clean function.

8.1 Modules

To set the processing modules, click on the "Processing Modules" button on the main MRF Clean dialog. Figure 29 shows these models. MRF Clean parameters can be entered through a parameter file. Parameters may also be entered interactively by pressing the Parameter button. This section will discuss how each parameter affects MRF Clean processing.

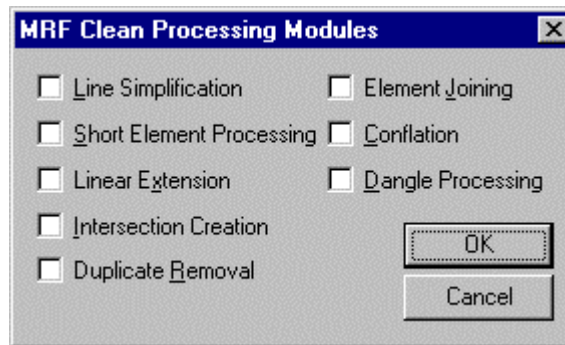


Figure 29: Processing Modules To Run MRF Clean

8.1.1 Line Simplification: (Default is unchecked.)

When this button is checked, line weeding, as shown in figure 4, is performed.

8.1.2 Short Element Processing: (Default is unchecked.)

If this button is Checked, MRF Clean will calculate the length of all features and compare it to its tolerance. If the length is smaller than the tolerance, the feature is either flagged or removed, depending on whether or not the Flag Short Element option is selected. When this button is OFF, the Flag Short Element option and the Short Element flag layer are disabled, and the lengths of entities are not compared to its tolerance.

8.1.3 Linear Extension: (Default is unchecked.)

When this button is checked, the line features are extended until it reaches other features (within the specified tolerances). To use this feature, Intersection Processing must be ON.

8.1.4 Intersection Creation: (Default is unchecked.)

When this button is checked, intersections are flagged and/or created, as described in section 4.4 MRF Intersection Creation.

8.1.5 Duplicate Removal: (Default is unchecked.)

When this button is checked, duplicates, those that were in the originally and those created by other MRF Clean processes, are removed, as described in section 4.5 MRF Duplicate Removal.

8.1.6 Element Joining: (Default is unchecked.)

When this button is checked, polylines that are singly connected at a node or end point are joined to form one larger polyline, as described in section 4.6 MRF Elements Joining. In order to be joined, the polylines must have the same layer and symbology.

8.1.7 Conflation: (Default is unchecked.)

When this button is checked, linework that has similar geometry will be merged, as described in section 4.7 Conflation.

8.1.8 Dangle Processing: (Default is unchecked.)

When this button is checked, free end features are either flagged or removed if its length is shorter than (tolerance times dangle factor), as described in section 4.8 Dangle Processing Module. When this button is unchecked, the Dangle Factor, Dangle Flag Layer and the Flag Dangle options will not be used.

8.2 MRF Clean Processing Options

Along with the processing modules there are also processing options that can be set. See Figure 30. The following is a description of them.

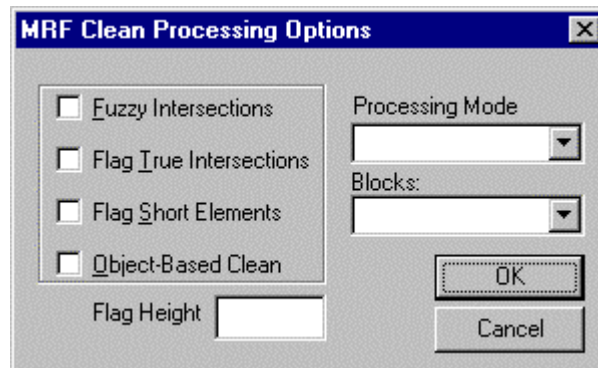


Figure 30: Processing Options

8.2.1 Fuzzy Intersections: (Default is checked.)

When this button is checked, MRF Clean will create intersections where linework is very close to intersecting, but not actually touching. Fuzzy intersection creation generally fixes undershoots and overshoots. When this button is unchecked, no fuzzy intersections are created. To use this feature, Intersection Processing must be checked.

8.2.2 Flag True Intersections: (Default is unchecked.)

When this button is checked, all true intersections will be flagged on the layer specified by the user in the Intersection Flag Layer box. To use this feature, Intersection Processing must be checked. Either fuzzy intersection OR flag true intersection can be activated at once. If both are selected, only the flag option will be set.

8.2.3 Flag Short Elements: (Default is unchecked.)

When this button is checked, any feature that has a total length less than or equal to its tolerance will not be deleted. If you want to flag all linework which is shorter than the tolerance, check Flag Short Elements on, and enter a valid layer number in the Short

Element Flag Layer box. When this button is unchecked, the Short Element Flag Layer box will be disabled, and any entity that has a total length less than or equal to its tolerance will be deleted. To use this feature, Short Element Processing must be checked.

8.2.4 Object-Based Clean: (Default is unchecked.)

When this button is checked, the objects are preserved. When this button is unchecked, objects can be deleted, joined and created by MRF Clean.

8.2.5 Flag Height:

Sets the height of the flags to be drawn above the point in question. The flags will have a "D", "X" or "S" character.

8.2.6 Processing Mode: (Default is By Geometry.)

Duplicate and near duplicate features from the input may become exact duplicates after splitting or conflation. Two options are available to remove these duplicates, to join features or to conflate the features:

1. By Criteria

When this option is activated, MRF Clean will only remove duplicate, join and/or conflate features that have identical geometry and Map Objects entity characteristics. The criteria are considered when deleting or joining entities can include layer and color.

2. By Geometry

With this option activated, MRF Clean will remove duplicate, join and/or conflate entities if they have the same geometry, regardless of their attributes. Only the entity with the smallest tolerance will be kept. If a number of features have the same tolerance, only one of them will be kept.

8.2.7 Use Blocks

Either "Use blocks" or "No blocks" can be selected from the drop down list. If "Use Blocks" is selected, the Point feature will be treated as a node in feature joining, dangle removal, conflation, and free end flagging. In some utility workflows, a line starting and ending at Blocks is not considered as a dangle. For this situation, the Block should be treated as a node.



Note: A Block is a Point feature, such as control point.

For example, in Figure 31, if the Point C is treated as a node, line AC will not be considered as a dangle. However, if the Point C is not treated as a node, line AC will be treated as a dangle.

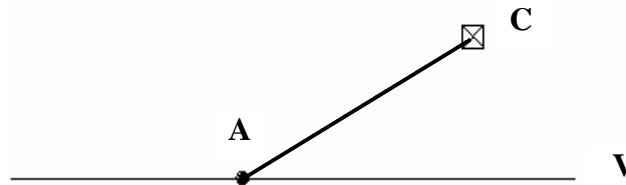


Figure 31: Insert option

8.3 Clean Parameters

Snap tolerance, filter factor and dangle factor are set in a dialog, as shown in Figure 32.

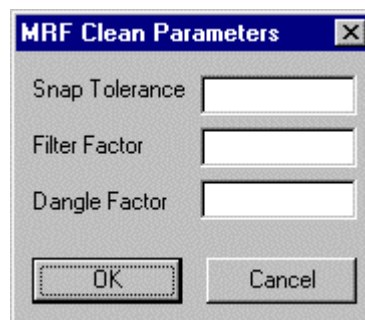


Figure 32: Parameters

8.3.1 Snap Tolerance: (Default is 1e-006)

When the difference between two points is smaller than the Snap Tolerance they are considered to be the same point.

8.3.2 Filter Factor: (Default is 1.0)

MRF Clean allows the user to weed the input linear features, or simplify linework by removing unnecessary vertices. MRF Clean uses a modified version of the Douglas-Peucker algorithm for this process. The modification produces better results for some special cases. This process uses a weeding tolerance of (Filter Factor times tolerance). The minimum value for Filter Factor is 0.0. The larger the value of (Filter Factor times tolerance), the more vertices will be removed. Here again, experimentation with the data may be required to develop the best set of parameters. To use this feature, Line Simplification must be ON.

8.3.3 Dangle Factor: (Default is 1.0)

A dangle is an entity that has at least one free endpoint. MRF Clean removes a dangle if its length is less than (Dangle Factor times tolerance). The minimum value for Dangle Factor is 0.0. This principally affects removal of overshoots. Some dangles, such as street centerlines ending at a cul-de-sac, may be appropriate to keep. To use this feature, Dangle Processing must be ON.

9. Flag Layers

9.1 Short Element Flag

MRF Clean will place a point labeled "S" at each short entity to help you identify them. The flags will be put on a new layer that will have the text "_short" appended at the end. To use this feature, Short Element Processing and Flag short elements must be checked.

9.2 Intersection Flag Layer

MRF Clean will place a point labeled "X" at the spots where each intersection would occur. The flags will be put on a new layer that will have the text "_int" appended at the end. To use this feature, Intersection Processing and Flag True Intersections must be checked.



Tip: The best set of parameters for flagging true intersections is:

Intersection Processing set to ON

Flag True Intersections set to ON

Intersection Flag Layer set to a valid layer

9.3 Dangle Flag Layer

MRF Clean will place a text entity "D" at each free end on that layer, which could not be resolved as an overshoot or undershoot. The "D" flag will be placed on a new layer that will have "_dangle" appended at the end. To use this feature, Dangle Processing must be ON.



Tip: The best set of parameters for flagging, and not removing dangles is:

Dangle Factor set to 0.0

Dangle Flag Layer set to a valid layer

10. MRF Flag Editor

MRF Flag Editor provides tools to view and edit flags after clean. As shown in figure 33, you can easily navigate to each flag, modify or delete flag and the relevant feature.

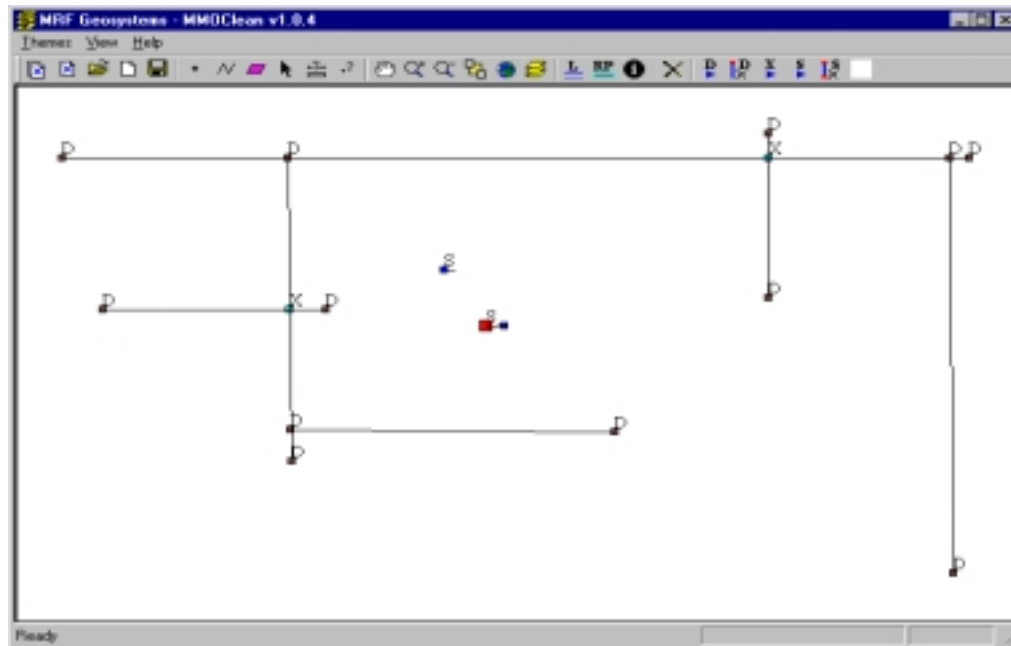






Figure 33: MRF Flag Editor

Tools can be used in editing include:

 : Select an object. The selected object and its node will be highlighted. Users can simply click on a node, move the mouse and click again to modify the location of the node. The default mouse mode of MRF Clean is Select.

 : Delete the selected object.

 : Flag navigation tools. It allows the user to locate and display the next dangle, intersection or short elements respectively. The current flag and element are automatically selected when use this navigation tools.

 : Delete the dangle and the flag character “D”.

 : Delete the short element and the flag “S”

11. Advanced Topics

11.1 Memory Requirements

To run the software properly, MRF Clean needs an amount of memory equal to 100 times the input file. For example, if your input file is 0.5 MB, then you will need about 50 MB of memory, which may consist of a combination of RAM and Virtual Memory.

You can use the following steps to reduce the memory requirement when cleaning large files:

- Only clean related layers simultaneously.
- Other layers can be cleaned in one or more separate processes.

11.2 Efficiency

The efficiency of MRF Clean depends on the total number of input points, the amount of RAM available, and the user-specified tolerances for the selected layers. If two layers are not related at all, they should be cleaned separately.

When the number of input points is high, it may be more efficient to run MRF Clean a few times using increasing tolerances. The initial cleaning may reduce the size of the file by weeding redundant vertices and reducing the number of entities by merging many shorter entities into one entity.



Note: Do not try to fix all the dangles with MRF Clean. This may not always be possible. Increasing tolerances has a point of diminishing returns where either the time to process is prohibitive or the tolerance is so large that small polygons may be removed by clustering of the boundary vertices.

Part of successful data cleaning is to know when to stop processing with MRF Clean and when to begin manual editing with MRF Flag Editor.

11.3 Trouble Shooting

If you have difficulties running MRF Clean, try the following:

- Use smaller tolerances
- Increase your virtual memory settings and/or your RAM
- Contact your authorized MRF dealer for assistance

12. Upgrade and Technical Support

If you purchased MRF Clean from an authorized MRF dealer, you can receive free technical support from your dealer for thirty (30) days from the date of purchase. MRF Geosystems Corporation has annual maintenance plan that covers technical support and upgrade. Please contact MRF for more details.

13. Learning MRF Clean with Example Shape Files

You are encouraged to use the supplied example shape files to understand the cleaning effect of MRF Clean. Unless default directory was changed, the sample files can be found in the following directory:

C:\Program Files\MRF\MRFClean4MapObjects

Info files that will need to be loaded are provided in the same directory. While learning the functionality of MRF Clean for MapObjects, it is a good idea to test different combinations of options on these files.

File name	Cleaning Goals	Layers	Tolerance
example1.shp	Correcting overshoots and undershoots	1	30.0
example2.shp	Line weeding	1	23.0
example3.shp	Moving less accurate points to more accurate points.	1 2 3	20.0 5.0 90.0
example4.shp	Removing dangles	1	15.0
example5.shp	Removing duplicate and near-duplicate lines	1	90.0
example6.shp	Moving less accurate points to more	1 2	5.0 20.0

	accurate points Joining shorter entities to create longer entities		
example7.shp	Joining shorter entities to create longer entities	1 2	20.0 5.0
example8.shp	Cleaning inserts and lines	1 2	3.0 2.0

Table 12.1 Sample Examples

14 How to Contact MRF

Thank you for choosing MRF Map Object Clean 2.0

This version of MRF Map Object Clean includes two MRF tools: MRF Clean and MRF Flag Editor. They are combined into one viewing console.

MRF Map Object Clean is designed to make your GIS data maintenance and analysis processes easier and more efficient. Your feedback is critical in making MRF Map Object Clean a better product. Please feel free to contact us by email, phone, fax, or regular mail.

Contact information

If you have suggestions that will make MRF Clean a better product, or need further information about MRF Clean and related products, please contact:

MRF Geosystems Corporation

Suite 700, 665 - 8th Street S.W.

Calgary, Alberta

CANADA T2P 3K7

Tel: (403) 216-5515

Fax: (403) 216-5518

E-mail: mrfsales@mrf.com

Internet: <http://www.mrf.com>

Would you like an on-site visit?

MRF GIS experts will make personal site visits to both our valued clients and potential customers in the United States and Canada. Our experts enjoy the opportunity this gives them to meet with those using our products and our services, to discuss in person the benefits of using MRF products, the projects our customers are working on, and to answer any questions that may arise. Customers have found that the site visits to be very helpful. Some of them were very pleased to find that MRF has very efficient products and services to solve their problems.

✦ If you would like our experts to visit your company site, and discuss how MRF can help you, please call us via our toll free number: 1-877-216-5515 or email us at mrfsales@mrf.com

Thank you for choosing MRF Clean!











15 MRF Professional Services Division

MRF Geosystems Corporation is a well-established AM/FM and GIS software provider. In addition to our leading edge software solutions, MRF has been providing consulting services, custom programming services, and data conversion and migration services to our customers all over the world since 1992. Recently, MRF has created a Professional Services Division to focus on providing complete Professional Services: everything from customized tools to complete turnkey systems.

"We have built long term relationships with many customers over the past few years. MRF's strength in technology has given it the competitive edge over other service providers. Since MRF has a complete set of GIS and Mapping tools, it can use these tools to cut cost and shorten project schedules. Our customers feel very comfortable that MRF has the ability to build software tools from scratch, and this allows us to create very efficient workflows and to complete the projects quickly at lower cost. Consequently, we provide excellent value to our customers for the entire range of projects and services."

Gary Zhang, President

The Professional Services division can provide project services including:

-  Complete GIS database design and support for Oracle, Access and other databases.
-  Customized software applications for MicroStation, GeoMedia, GeoMedia Pro, GeoMedia Web Map, MGE, AutoCad, Arc/Info, Framme, and MapInfo
-  Scanning
-  Attribute collection and/or extraction
-  Geo-referencing
-  NAD conversion
-  Map cleaning and editing
-  Warping of raster images and vector maps
-  System integration
-  Stand-alone, intranet or internet-based GIS and mapping applications

MRF has completed numerous GIS and mapping projects for municipalities, engineering companies and utilities.

Appendix A: MRF Software Products and Libraries

MRF has 10 shrink-wrapped Mapping/GIS products that are used by over 6000 customers in over 40 countries. These software products perform map clean-up, automated polygon creation, buffer generation, spatial overlay analysis, and geodata conversion. MRF's industry-leading multi-layer, multi-tolerance fuzzy intersection and clustering technology allow MRF products to offer CAD-level complexity while delivering very advanced GIS capabilities. These MRF tools can offer between 2 to 10 times productivity over similar tools from major GIS vendors such as Intergraph, ESRI, AutoDesk, and Bentley Systems Inc.

A.1. MRF Clean For MapObjects

MRF Clean For MapObjects is a standalone map cleaning package on the Windows platform for ESRI shape data cleaning. It combined MRF Clean and MRF Flag Editor and provided a graphical user interface for shape data displaying, cleaning and editing. MRF's industry-leading multi-Layer, Multi-Tolerance data clean technology make MRF Clean For MapObjects very unique and powerful.

A.2. MRF Mapping Tool Kit (MMTK) and MRF GIS Tool Kit (MGTK)

MMTK/MGTK is a software suite that contains many advanced mapping and GIS tools, including the industry-leading MRF Clean, MRF Flag Editor, MRF Polygon, MRF Buffer and MRF Overlay. These tools can run individually or together in a mapping or GIS workflow. MRF has the following software suites:

MMTK for MicroStation

MMTK for AutoCAD

MGTK for GeoMedia and GeoMedia Professional.

The following are brief descriptions of MRF mapping and GIS tools.

A.2.1 MRF Clean

(Component of MMTK for MicroStation and AutoCAD, MGTK for GeoMedia, and MRF Clean for MapObjects)

MRF Clean is a MULTI-TOLERANCE, MULTI-LEVEL graphical data cleaner. Cleaning data or correcting digitising and scanning errors is one of the major tasks in graphical data conversion, which is costly and time consuming. MRF Clean cleans two-dimensional design files with user specified tolerances. The major capabilities of MRF Clean are:

- Correct over-shooting and under-shooting
- Perform line weeding

- Remove duplicate or near-duplicate points and lines
- Create intersections to ease building of topology
- Remove or flag dangles and short spikes
- Join short, single elements with identical attributes together to form longer ones
- Merge the linework which has approximately the same geometry
- Identify dead-ends for further editing
- Reduce file size

MULTI-LEVEL, MULTI-TOLERANCE capability is one of the key features offered by MRF Clean. To the best of our knowledge, **MRF Clean is the only multi-level, multi-tolerance data cleaning package on the market.** With multi-tolerance data cleaning technique, points with a larger tolerance will be moved to points with a smaller tolerance. In this way, inconsistencies such as the overlap or gap between different boundaries can be corrected by moving the less accurate boundary to the more accurate boundary. When input points have identical tolerances, the movement of points are performed in such a way that straight lines are kept straight - a very desirable behaviour for many GIS/LIS applications.

MRF Clean is the result of many years of research and development. The state of the art technology pioneered by MRF Systems Inc. makes MRF Clean extremely efficient and robust. Extensive testing and user feedback indicate that MRF Clean can improve the quality of data conversion and data editing for mapping, GIS, and AM/FM applications, and, at the same time, **increase productivity by two to ten times.** After cleaning, the size of the data file is also reduced substantially, in some cases, to less than 20% of its original size.

A.2.2 MRF Clean 3D

(Component of MMTK for MicroStation)

MRF Clean 3D is a multi-level, multi-tolerance three-dimensional graphical data cleaning utility. It is designed to clean linear elements, unshared cells, or both in a three-dimensional space. Its functionality is very similar to MRF Clean except that it always strokes arcs to line strings.

A.2.3 MRF Flag Editor

(Component of MMTK for MicroStation and AutoCAD, MGTK for GeoMedia, and MRF Clean for MapObjects)

MRF Flag Editor is designed for use in conjunction with MRF Clean, MRF Clean 3D, and MRF Polygon. It assists the user in identifying and editing the flags, such as flag free end points “D”, intersections “X”, and short elements “S”. MRF Flag Editor is designed to guide the user directly to these flags so the user may review the line work and make editing changes to the line work.

MRF Flag Editor allows the user to visit each flag efficiently. It makes the current flag the window center, and highlights the flag with the current highlight color. The user can zoom in and zoom out while keeping the current flag highlighted. The user can edit (delete or modify) the flagged elements using editing tools provided by MRF Flag Editor or its environmental platform, such as MicroStation, GeoMedia, AutoCAD, or ESRI.

A.2.4 MRF Polygon

(Component of MMTK for MicroStation and AutoCAD, MGTK for GeoMedia)

MRF Polygon is a polygon formation package ideal for cadastral mapping, municipal, and resource management applications. It takes a cleaned two-dimensional file as input, and converts lines, line strings, and circular parametric arcs into polygons. MRF Polygon allows unlimited nesting levels of islands and holes and can transfer attributes from linework to polygons.

MRF Polygon organizes the formed polygons so that no polygon hides another when it is filled. As a result, visualization and plotting can be readily done without any further preparation. Because error polygons are flagged, users can perform queued-editing of these errors using MRF Flag Editor. Polygons with no label or with more than one label will be set to the colors specified for easier identification and editing.

A.2.5 MRF Buffer

(Component of MMTK for MicroStation and AutoCAD, MGTK for GeoMedia)

MRF Buffer is a multi-level, multi-tolerance application for generating buffers based on user-selected input elements. Each level can have a different buffer distance. Rather than generating one buffer zone for each element, MRF Buffer generates buffer zones for a set of selected elements simultaneously. A buffer zone of an entity is defined as a region where every point in the region is within the user-specified buffer distance of the entity. If the buffer zones for the input elements overlap, MRF Buffer will merge these buffer zones to form larger buffer zones.

To ensure that no narrow gaps exist in the output buffer zones, MRF Buffer allows the user to specify different cleaning tolerances for the input levels. The user can also specify a different buffer distance for each input level. To the best of our knowledge, **MRF Buffer is the *only* Multi-level, Multi-tolerance, and Multi-buffer-distance Buffer Generation Package on the Market.**

A.2.6 MRF Overlay

(Component of MMTK for MicroStation, MGTK for GeoMedia)

MRF Overlay is a multi-level, multi-tolerance spatial overlay package. It allows the user to overlay many layers simultaneously. The selected layers can be nodal, linear, or

polygonal, and the user can assign each layer a different tolerance. When one layer is assigned a tolerance smaller than that of another layer, MRF Overlay will move features on the larger tolerance layer to the features on the smaller tolerance layer if they are within tolerance. In this way, MRF Overlay avoids the generation of sub-tolerance polygons (slivers).

A.3. MRF Match

(Available for MicroStation)

MRF_MATCH is useful tool to eliminate data inconsistency from different sources. It matches one map (A) with another map (B). It outputs three maps containing elements that are:

- Common to both maps;
- From map A only;
- From map B only;

The matching is done using a user-specified tolerance. If an element or part of an element from A is within the tolerance of an element or part of an element from B, they are considered being matched and output to the "Common to both maps". Otherwise they will be output to "From map A only" or "From map B only" respectively.

A.4. MRF Rubber Sheeting

(Available for MicroStation)

MRF Rubber Sheeting adjusts graphic elements in a 2D design file using the original and destination positions of control points. The adjustment process includes a regional trend correction and a local refinement. The effect of this adjustment is like rubber-sheeting a map, so that parts of the map or the whole map get stretched or shrunk to fit control points.

MRF Rubber Sheeting is useful in Mapping, GIS/LIS, and AM/FM where features in one map should geometrically fit to features in the same map or another map. It is ideal when the differences between these features are random in terms of magnitude and/or direction.

A.5. MRF Warp

(Available for MicroStation)

MRF Warp is a map warping utility in MicroStation. It warps raster images and vector DGN files accurately. The software uses Helmert Linear Affine (Affine-1) and Projection transformation algorithms. When the number of control points exceeds the minimum number required, the warping software does least squares adjustment.

MRF Warp has been used often for geo-referencing unregistered maps or images using some control points.

A.6. MRF NAD

(Available for MicroStation and AutoCAD)

MRF NAD is a transformation tool for transferring 3TM, 6TM or 10TM coordinates (easting, northing) between the NAD27 and NAD83 reference systems. The transformation algorithm is based on Geodetic Canada's NTV2 software; it utilizes grid shift coordinates derived by Geomatics Canada for precise transformation.

MRF NAD uses user-specified false easting and false northing values for the input DGN file to calculate the coordinates of elements in the output file. The output file will keep the global origin defined in the input DGN file by default. For interchange between various agencies, where their standard specifies different global origins, the output file can inherit the desired global origin.

A.7. MRF Driveway

(Available for MicroStation)

MRF Driveway is designed to process three-dimensional files in a two-dimensional fashion. This is of particular interest to those in the photogrammetry industry where the elevation of a feature (e.g. driveway) must be preserved but must be broken by other features (e.g., roof) that cross or intersect it in 2D, or top view. MRF Driveway corrects overshooting, and undershooting. It also put flags on the endpoints of dangling line strings. MRF Flag Editor can be used to edit the flags efficiently.

A.8. MRF Libraries

MRF Developed many efficient software components that offer MRF customer the flexibility to develop their own applications.

A.8.1 MRF DGN Library

The DGN LIBRARY is a DLL for Windows 95/NT and consists of reading and writing modules for direct access to MicroStation 2D DGN files. With these modules, the user can concentrate on the specific information needed and the level of detail the application requires. MRF supplies a set of data structures on top of common data structures used in MicroStation. The MRF data structures provide easy access to the DGN file format.

A.8.2 MRF CGM Library

The CGM LIBRARY is a DLL for Windows 95/NT and provides functionality for reading and writing CGM files. The CGM implementation follows the ISO standards (ISO 8682

etc.). The DLL can create a new CGM file and append information such as graphic elements, raster data, line types, line styles and etc. to it.

A.8.3 MRF GeoTIFF Library

GeoTIFF files are TIFF files with special tags added to record geo-referencing information. The MRF GeoTIFF Library is a DLL and a set of header files for Windows 95/NT.

With this library a user can easily add, update, or delete all of the standard GeoTIFF keys and tags from both C and C++ environments. An ordinary TIFF file becomes a GeoTIFF when geo-referencing information is added using this utility.

A.8.4 MRF DGN2DWG Library

MRF DGN2DWG converts two-dimensional MicroStation DGN Files to Release 12 (11 or 10) AutoCAD DWG files. It runs under Windows NT and Windows 95 and has the capability of keeping original information (Color, Symbol, etc.) and processing multiple files.

A.8.5 MRF DGN2DXF Library

MRF DGN2DXF converts two-dimensional MicroStation DGN Files to AutoCAD Release 12 DXF files and vice versa. It converts the MicroStation elements to AutoCAD entities and keeps the original geometry attributes. It has the capability of processing multiple files.

A.8.6 MRF DXF2DGN Library

MRF DXF2DGN converts two-dimensional AutoCAD DXF files (Release 12 and Release 13) to MicroStation DGN Files. It runs under WINDOWS, Windows NT, and Windows 95. It converts the AutoCAD entities into DGN types and keeps the attributes. It has the capability of processing multiple files.

Appendix B: MRF PROFESSIONAL SERVICES

Apart from developing off-the-shelf software products, MRF provides professional services to its worldwide customers. MRF's experienced and highly qualified mapping and GIS experts have helped our customers to complete many challenging projects on time and within budget. MRF professional services includes:

B.1 Data Conversion

MRF helps its customers to convert data from paper to digital and from one digital storage form to another. MRF has extensive experience in data conversion and has used many GIS systems in the past seven years including

- MicroStation
- MGE
- GeoMedia[®]
- GeoMedia[®] Professional
- GeoMedia[®] Web Map
- FRAMME
- Arc/Info
- AutoCAD
- Etc.

The conversion services MRF provides include:

- Document scanning
- Attribute collection and/or extraction
- Geo-referencing
- Cleaning and editing
- NAD (North American Datum) conversion
- Data integration
- Custom software for conversion.

MRF is currently engaged in a project that requires the scanning and geo-referencing of about 266,000 tract maps, parcel maps, record of survey maps, corner records, township plats, survey field notes, freeway plans, etc. MRF will also develop a web-based viewing system to allow end users to view the scanned images and vector GIS data sets stored in Intergraph's MGE/MGDM system using Intergraph's GeoMedia Web Map product.

B.2 Data Migration

Data migration usually involves software-based data translation, data integration and some manual editing. MRF has helped many customers migrate CAD data (DGN format) to MGE and GeoMedia® Pro.

MRF recently migrated over 800 MicroStation DGN files and attributes in Oracle into topologically structured GIS features. The major tasks in data migration include:

- Automated graphical data clean up
- Database linking
- Manual editing

MRF was also involved in the design and implementation of a Water Network Information System (“WNIS”) migration project. MRF supplied its MRF Clean tools and its PROLOG programming expertise to automatically migrate most of the water features from DGN elements into FRAMME features.

MRF has a suite of file conversion libraries that has been used worldwide. For further information regarding file-conversions please refer to Appendix A of this Manual.

B.3 Software Application Development

MRF has developed 10 shrink-wrapped Mapping/GIS products that are used by more than 5000 clients in over 40 countries. The flagship product MRF Clean is the world-leading application for cleaning map data by eliminating undershoots, overshoots and duplicate graphic elements. MRF Clean is the only data cleaning tool in the world that offers multi-layer, multi tolerance, fuzzy intersection and clustering capability. Intergraph Corporation has licensed some MRF technologies since 1995.

MRF is a member/affiliate of the following GIS industry leaders:

- Intergraph’s Team GeoMedia®
- Microsoft Developer Network
- Oracle Partner Program
- AutoDesk Developer Network
- Enterprise Developer for Bentley Systems Inc.

As the Intranet/internet has become more familiar to people, more and more MRF customers are migrating applications to the web. MRF has recently designed a web-based plotting application using IPLOT for one customer.

MRF recently developed its Spatial ANALysis (SANA) tool for GeoMedia[®] Pro. This program is used to generate spatial relationships between two different feature classes and store these relationships as a table in any write-able data warehouse supported by GeoMedia[®].

In 1995, MRF built a GIS system for one customer using parcel maps, urban maps, and topographic base maps. MRF designed the clean-up and polygonization workflows to create the parcel-based GIS. MRF also wrote a software tool to link database attributes such as ownership information with the graphical elements in the DGN file.

B.4 Software Customization

To increase process efficiency, it may be necessary to customize existing software. The following list highlights some of the processes for which MRF provides software customization services.

- Map cleaning
- Map editing
- Database design and implementation
- North American Datum transformation
- Data/information representation (through internet/Intranet)
- Vector/Raster warping
- Geo-referencing
- Expert systems (design and implementation)

MRF customized the MRF Rubber Sheeting software package to rubber-sheet a vector map to agree with a corrected photogrammetric image. The customized version processes points, lines, line strings, and complex strings. The customization efforts increased MRF customer's productivity by a factor of 4. The customized MRF Rubber Sheeting runs within the MicroStation environment.

MRF was contracted to develop a multi-map warping package within the Intergraph MGE environment to simultaneously warp multiple vector maps to agree with highly accurate GPS points. The customized software is developed in MDL and runs within MGE NT environment.

In 1998, MRF was awarded a contract to develop MRF Warp, which does simultaneous warping of a vector map and its corresponding raster map. MRF Warp runs within the MicroStation + IRAS/B environment. It supports similarity, linear affine, and projective transformations. When more control points are available, MRF Warp uses least squares adjustment to determine the transformation parameters.

MRF was awarded a contract to customize the MRF_OVERLAY, MRF_POLYGON and MRF_CLEAN software tools to create MRF_CLIP and MRF_MATCH. The client then used these tools to match city ownership parcel fabrics with its legal survey fabric based on user-specified tolerances.

B.5 Consulting Services

MRF Geosystems Corporation is well known for its quality consulting services. MRF employs a group of senior GIS consultants, many of whom have M.Sc. or Ph.D. degrees, that can help clients define GIS requirements, develop implementation strategies, and provide GIS user training. MRF has provided consulting services since 1992, covering a wide range of mapping/GIS applications. Among them are:

- Municipalities
- Forestry
- Utilities (gas, water, etc.)
- Mapping agencies
- IT providers