ABSTRACT

ArcGIS 9 is professional Geographic Information Systems (GIS) software, produced by Environmental Systems Research Institute (ESRI), Inc. of the United States of America. ArcMap is the principal application of ArcGIS, providing a mapping, editing, and analysis graphic user interface. While most of the cartographic processes are done interactively in ArcMap, some cartographic operations involve associated applications such as ArcCatalog, loadable components such as ArcToolbox, or extensions such as the Maplex label placement engine.

This paper discusses the tools that facilitate the long-standing and time-consuming problems of labeling and text placement. It explores the different tools in the ArcGIS applications and extensions for the purpose of professional labeling of the map.

Labeling tools are available in core ArcGIS as well as in the Maplex extension. Both the Standard and Maplex Label Engines are discussed together with the creation of annotation at specific map scales. Dynamic labeling is compared with creation of static annotation. The concept of feature-linked annotation is explored. A detailed discussion is included on different workflows and on when to use which method and tool.

LABELING OR ANNOTATION?

In ArcMap there are two labeling engines: the Standard Label Engine and the Maplex Label Engine. The latter requires the ArcGIS Maplex extension and has more rules that one can set to create and facilitate better name placement on maps. Figure 1 shows a decision making roadmap to assist the user when using the ArcGIS software as to what path to use in labeling or annotating the map.

ArcMap uses default settings for dynamic labeling when one first starts labeling. Although the software has some good fixed labeling defaults, some labels might not be positioned correctly where they should. Both the Standard Label Engine and the Maplex Label Engine can help the cartographer by offering stricter rules that he/she can set to enhance the quality of the labels and dramatically reduce the label placement problems.
Regardless of the Label Engine used, the labels will remain dynamic until one converts them into annotation. This freezes them for the scale of map publication and for a chosen viewing distance. At this time the cartographer can manually finalize the placement of the annotation features. The ArcMap user has a choice to save the annotation in a map annotation group where the annotations are stored in the map document, or store the annotation as an annotation feature class in a geodatabase. Thus, the ArcMap user has a lot of flexibility in creating useful and faster reading maps using text sizes that are legible at the scale of map publication and satisfying the required viewing distance for the map use.

THE LABELING TOOLBAR

The labeling toolbar, Figure 2, offers many labeling tools and can be used for both the Standard Label Engine and the Maplex Label Engine. More tools are available for the latter engine. The cartographer can switch the Maplex Label Engine on and off from this toolbar.

The Label Manager in ArcMap:

On the Labeling toolbar are five useful buttons. Figure 3 shows an example of the Label Manager which helps the cartographer in managing the labels of all the data layers in the map document in a common dialog. Layer labels are placed in label classes. Each data layer has a Default label class, e.g. the Default label class of the City Boundaries layer is shown in Figure 3; the Default label class of the Restaurants layer was renamed to FastFood. You can add more label classes per layer in order to accommodate labeling different features of the same layer differently, e.g. FastFood and NotFastFood are two label classes for the Restaurants layer. The SQL Query button can be used to select which features will be labeled by which label class. The Expression button allows the cartographer to concatenate text values from several fields in the feature attribute table as well as inducing formatting tags in the expression. When one converts the labels of one layer to annotation these label classes will turn into annotation classes.

Figure 1: A decision making roadmap to assist the user of ArcMap as to what path to use in labeling or annotating the map. GDB stands for the geodatabase data model of ArcGIS. FC stands for feature classes. GP stands for geoprocessing tools in ArcGIS. CAD stands for computer-aided design data formats.
Figure 3: An example of the Label Manager in ArcMap. The Default label class of the City Boundaries layer is active.

Symbolizing a label class in ArcMap

Clicking on any label class of a layer in the Label Manager will allow the cartographer to set the different properties of the text of the labels in addition to controlling the label placement rules. Activating the Maplex extension will give the cartographer more rules that he/she can set to better control the name placement on the map. Whether using the Standard or the Maplex Label Engines, the properties that were set by any of the two labeling engines will be captured when converting the labels to annotation.

Unplaced labels in ArcMap

With all the rules set, regardless of which labeling engine used, a conflict detection operation takes place while the software places the labels per the cartographer’s set rules. Depending on the map scale and the size of the map sheet, this may result in preventing some labels from showing up on the map. A button is available on either the Labeling or the Annotation toolbars that will help the cartographer to view the unplaced labels or annotation respectively. The cartographer can make a decision then on what to do with these unplaced labels or annotation.

The Label Priority Ranking and the Label Weight Ranking

Two buttons on the Labeling toolbar are responsible for setting ranks for labels. The Label Priority Ranking will assist the cartographer in setting which labels from which layer/label class will have priority over the other when being placed. An example: the city names from the Cities layer might be more important than the country names from the Countries layer, so the country names might move a bit further from the placed city names, or perhaps kicked out to the unplaced labels if there was insufficient room.

The Label Weight Ranking is an additional tool the cartographer can use to set the relative importance of the label with respect to the feature. An example of this, in certain map specifications, is that a coast line should never be crossed by a city name. This way the coast line feature weight can be set larger than the city label weight, so the city name can be pushed away from the coast line to either the land or the water body.

SETTING LABEL PROPERTIES

There are many rules pertaining to the label properties that can be set for the map labels. The following paragraphs will touch on the more elaborate and unique rules that are available in ArcMap and which will immensely assist the cartographer in speeding up the map production process.

Formatting tags

ArcGIS text formatting tags allow the cartographer to modify the formatting for a portion of a piece of text. This allows the creation of mixed-format text where, for example, one word in a multi-word label is underlined or bolded.
Text formatting tags can be used almost anywhere text is placed on or around the map in ArcMap. For example, the cartographer can use these tags in dynamic label expressions, annotation, legend text, map titles, and in the values of fields used to label features. See Figure 4 for an example of using formatting tags when labeling with Visual Basic. Other text properties can be set directly on ArcMap’s interface using the General tab in the symbol Editor dialog.

Enhanced text effects

The cartographer can change the text symbol to show a text fill pattern inside the character components, a halo of a certain thickness and color around the characters, or add a drop shadow to the characters. These properties can be manipulated in the Advanced Text and Mask tabs in the symbol Editor dialog. These can be set to comply with certain map specifications. Figure 5 shows examples of enhanced text effects.

Text backgrounds for enhancing text legibility

The cartographer can change the text symbol to show a text background for each label. The text background can be in the form of a balloon, simple line, or line callout; or it can be a marker background behind the text. Each of these background types has its own properties that can be set in compliance with pre-set map specifications. Line callouts can have a leader line of several styles. These properties can be manipulated in the Advanced Text tab in the symbol Editor dialog. Figure 6 shows examples of text background.
Label placement for points

There are thirty six different combinations in ArcMap’s Standard Label Engine of how one can set rules of name placement relative to point features. Figure 7 shows only six examples. This flexibility in the software lends itself to different map specifications including support for languages that read from right to left such as Chaldean, Assyrian, Hebrew, and Arabic. The Maplex extension extends these combinations to much stricter rules that are more user defined. See the Zones option in Figure 8. Additionally, Maplex allows the point feature labels to be aligned with graticule lines especially for small scale maps.

![Figure 7: Six examples of different rules that can be set for name placement priorities for point features. The Standard Label Engine allows thirty six different combinations. Priorities are marked by numbers; “one” being “try this place first.”](image)

Other rules deal with labeling at a specified angle, or a set of angle trials. These angles can be set using measurement from north (Geographic) or from east (Arithmetic).

Label placement for lines

There are several rules that can be set in the Standard Label Engine for labeling linear features. Figure 9 shows examples of such rules. Several combinations of such rules are possible.

![Figure 9: Placement properties for labeling relative to linear features in ArcMap.](image)

There are additional rules in the Maplex extension for labeling streets as a special case of linear features. Figure 10 shows three examples of such rules: one for curving the label with the street curvature, and the other for solving the problem of short streets with multiple-word names. The Overrun rule is coupled in this example with another rule for stacking multi-word names.
**Label placement for polygons**

Names for polygonal features have their own properties in ArcMap too. Figure 11 shows examples of the rules that the cartographer can set for polygon labeling. Additionally, Maplex has a special rule that will control how the label will fit inside parcels without overlapping with the building footprints.

**Duplicate labels and repeated labels**

There are occasions where long roads might consist of several segments. Defaults in ArcMap might try to repeatedly and unnecessarily label all segments. However, the cartographer can control whether or not labels are to be duplicated. Figure 12 shows the rules that one can use for controlling this. Maplex has an additional rule for controlling the distance within which no label is to be duplicated.
Font size reduction and font width compression

When labels must entirely fit within the length of a line or within the area of a polygon, Maplex offers additional rules that one can use to vary the height and/or the width of the characters. These rules must be used with caution so as not to end up with too much variation of text sizes which result in an ugly map. One must remember that text size should be varied to create a label hierarchy. The abuse of these rules can ruin this objective. Figure 13 shows an example of these rules.

![Figure 13: Maplex adds more rules for controlling the height and width of each character in the name.](image)

Stacking labels

Stacking multi-word names from a single field in a feature attribute table can be done in ArcMap using the Maplex extension. A character can be defined, e.g. a space, or a “/”, at which the name will split and stack. Figure 14 shows an example of how this is done.

![Figure 14: The Maplex extension allows for additional stacking rules for labels.](image)

Automatic abbreviations

One of the advantages of the Maplex extension is the use of abbreviation dictionaries. This feature in the software should be set before labeling. Then the software will use this dictionary, and based on the user’s three pre-set rules, will apply the abbreviations. This saves the cartographer a lot of time and effort; minimizing the post-processing or editing of the map labels.

Resolving ambiguity in name placement

Figure 15 shows an example of two choices available with the Maplex extension to automatically resolve ambiguous labeling on linear features. Maplex will either place the name across the junction or repeats the name on either side of the junction.

![Figure 15: Example of two choices available with the Maplex extension to automatically resolve ambiguous labeling on linear features.](image)
ANNOTATION

The cartographer turns labels in ArcMap to annotation so that he/she can manipulate individual text annotation to create a more legible map and easier to find labels. ArcMap will honor the moved annotation and will keep them static as it tries to label the remainder of the labels that were not turned into annotation. Annotation can be saved as an annotation feature class in a geodatabase or as a map annotation group as part of the map document. The latter can be linked to a layer.

An annotation feature class can be feature-linked or standard. When annotation is feature-linked, then when the feature is moved its annotation will move as well. Any edits in the feature attribute table values that are linked to the annotation update the annotation as well; making life easier for the cartographer by saving him/her a lot of time. Annotation can also be feature based or non-feature based. Feature based annotation means that the names are derived from a field in the feature attribute table of the layer. An example of a non-feature based annotation is when one delineates an area on the map for a specific reason (e.g. pointing to a water seepage zone) and labeling it with text that is not in the database (e.g. “Zone of recent seepage”).

When creating new annotation or editing an existing annotation feature, the cartographer will need to use the Annotation toolbar. See Figure 16.

Creating new annotation

The cartographer can create a new annotation feature by starting an editing session and using the Annotation toolbar. See Figure 17. It is required to (1) set the construction method whether Horizontal, Straight (inclined), Curved, with a Leader Line, or to Follow the Feature. The text (2) can come from an existing label field or one can simply type anything relevant. Then, one needs to (3) set the text symbol. Once all these setting are done, the cartographer, with the use of any of the three relevant labeling buttons (4) on the Annotation toolbar can add the annotation (5). The example in Figure 17 shows the use of the Leader Line button.

Editing annotation

The cartographer can use the editing tools, including the Edit Annotation Tool, see Figures 16 and 18, to change how the annotation looks or where it should be placed. The primary ways of modifying annotation appearance are with the Edit Annotation Tool and the Attributes dialog box.
The Edit Annotation Tool's context menu, which is invoked by right-clicking on the annotation feature after selection, has commands to modify the appearance of annotation. Some of the tasks include stacking or flipping annotation and modifying the annotation construction method—for example, to make horizontal annotation curved.

![Annotation Tool Context Menu](image)

Figure 17: Adding annotation using the Annotation toolbar in ArcMap.

Figure 18: Editing annotation using the Annotation toolbar in ArcMap.

Finally, any unplaced annotation can be discovered by clicking on the Unplaced Annotation button on the Annotation toolbar, see Figure 16. The cartographer can then make a decision whether or not to add those unplaced annotation.

**CONCLUSION**

The ArcMap application in ESRI’s ArcGIS 9 has reached advanced levels in the labeling and name placement functionalities that the cartographer has long been waiting for. This paper highlighted only selected features of this software for labeling and name placement that makes the cartographer’s task much simpler. However, one must always keep in mind, that no matter how sophisticated the software might be, the cartographer will be the one responsible for making the decision on where and how the final label will appear on the map. The cartographer’s task is to make sure that his/her final map product is easy to read and that names are quickly found.

**REFERENCES**


BIOGRAPHY

Mr. Murad-al-shaikh has over 30 years of experience in the educational field in a variety of disciplines ranging from civil engineering, cartography, and Geographic Information Systems (GIS). He joined Environmental Systems Research Institute (ESRI), Inc. in 1993 as a Senior Instructor and teaches both introductory and advanced courses focusing on ESRI technology. Mr. Murad-al-shaikh received his B.Sc. in Civil Engineering in 1969 from Al-Hikma University in Baghdad, Iraq, a certificate in Educational Technology from Huddersfield Polytechnic in England in 1979, and his M.S. in Cartography from the University of Wisconsin-Madison, USA in 1983.

While as a senior instructor in ESRI’s Educational Services group, Mr. Murad-al-shaikh has been involved in designing, authoring, and conducting training courses for ESRI software users. Mr. Murad-al-shaikh has trained users at universities, companies, and government agencies both in the United State of America and abroad. He is the course manager, co-author, and author of several instructor-led courses at ESRI. His recently published ESRI’s course is *Cartography with ArcGIS*. He has participated in enhancing several ESRI courses to better communicate cartographic and GIS concepts with his graphics capabilities.

Between 1970 and 1993, Mr. Murad-al-shaikh worked as an Assistant Professor at the Institute of Technology in Baghdad, Iraq. Since 1983, he was responsible for the instruction of cartography and remote sensing courses at various levels at that location. Mr. Murad-al-shaikh also taught various cartography and remote sensing courses on a part-time basis in the graduate and undergraduate programs at the Geography Department of the University of Baghdad, Iraq. He was the first cartographer to introduce GIS concepts as part of the curriculum in both institutions he was teaching at in Iraq.

Since 1996, Mr. Murad-al-shaikh has been teaching GIS cartography courses within the GIS certification programs of five local colleges and universities in Southern California, USA.

Mr. Murad-al-shaikh has written thirteen text and reference books in civil engineering, calligraphy, educational technology, cartography, GIS, and remote sensing. He also has published several papers on calligraphy, cartography, remote sensing and GIS.