Federal Users Conference
PLTS MPS Atlas Custom Grids

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management
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PLTS MPS Atlas Custom Grids

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ABSTRACT

Maps, and more importantly Atlases, are assisting our user community in managing a large land area with complex issues, the most complex of which is the management of nuclear waste. The techniques and experiences discussed herein were gained while developing several atlases for use at the U.S. Department of Energy’s Hanford Site.

Our user community requires the ability to locate not only waste sites, but other features as well. Finding a specific waste site on a map and in the field is a difficult task at a site the size of Hanford. To find a specific waste site, the user begins by locating the item or object in an index, then locating the feature on the corresponding map within an atlas. Locating features requires a method for indexing them. The location index and how to place it on a map or atlas is the central theme presented in this article.

The user requirements for atlases forced our design team to develop new and innovative solutions for requirements that Product Line Tool Set (PLTS) Map Production System (MPS)-Atlas was not designed to handle. The layout of our most complex atlases includes custom reference grids, multiple data frames, multiple map series, and up to 250 maps. All of these functional requirements are at the extreme edge of the capabilities of PLTS MPS-Atlas. This document outlines the setup of an atlas using PLTS MPS-Atlas to meet these requirements.

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1 PLTS and ArcMap are extensions for ArcGIS Desktop, a collection of software products that create, edit, import, map, query, analyze, and publish geographic information. MPS-Atlas is a component of PLTS. ArcGIS, ArcMap, ArcToolbox, PLTS, and MPS-Atlas are all trademarks, registered trademarks, or service marks of Environmental Systems Research Institute, Inc.
HNF-32039-FP REV 1

CONTENTS

BACKGROUND ................................................................. 1

SOLUTION ........................................................................... 3
  PLTS MPS-ATLAS – OUTSIDE THE DESIGN ........................................ 3
  CUSTOM REFERENCE GRID ..................................................... 4
  ATLAS DESIGN AND DEVELOPMENT .............................................. 4
  MAP SERIES CREATION ............................................................. 4
  CUSTOM REFERENCE GRID DATA FRAME SETUP ................................ 7
  SURROUND DATA FRAME MANAGER SETUP .................................. 8
  INSET MAPS – SETUP .............................................................. 9
  FEATURE INDEX ...................................................................... 11
  USER HELP ........................................................................... 12

FIGURES

Figure 1. Index Map .................................................................. 2
Figure 2. ArcMap Grids ............................................................. 2
Figure 3. Map Layout Elements .................................................. 3
Figure 4. MPS-Atlas Menu Options ........................................... 5
Figure 5. Area of Interest Data Source Dialog Box ....................... 5
Figure 6. Area of Interest Data Source – Selection Data ................ 6
Figure 7. Scale and Extent ......................................................... 7
Figure 8. Add Data Frame Manager Menu Option ....................... 8
Figure 9. Data Frame Manager Properties ................................... 8
Figure 10. Data Frame Manager Scale and Extent Dialog Box ........ 9
Figure 11. Inset Maps - Detail ..................................................... 9
Figure 12. Area of Interest Tab .................................................. 10
Figure 13. Feature Layer Definition Query ................................. 11
Figure 14. Detail of the Index .................................................... 11
**TERMS**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOI</td>
<td>Area of Interest</td>
</tr>
<tr>
<td>ESRI</td>
<td>Environmental Systems Research Institute, Inc.</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>MPS</td>
<td>Map Production System</td>
</tr>
<tr>
<td>PLTS</td>
<td>Product Line Tool Set</td>
</tr>
<tr>
<td>TOC</td>
<td>ArcMap Table of Contents Screen Element</td>
</tr>
</tbody>
</table>
BACKGROUND

A perspective of the land and the issues being managed at the Hanford Site by the U.S. Department of Energy will help illustrate the need to create a set of atlases. The 586 square mile Site is now a large environmental cleanup project. The nature of the issues at Hanford stem primarily from the Cold War need to produce nuclear weapons components, which resulted in vast amounts of toxic wastes stored in various locations across the Site. Tracking the status of the waste sites relies heavily on maps and a geographic information system (GIS).

During the Cold War years, the Government purposely disguised references to locations at the Site. For example, nine different coordinate systems were used at the Hanford Site. During the Site’s first 60 operational years, site locations were referenced only by building number. The building numbers contained no information on physical location. Locating a building or almost any other feature was therefore a matter of “tribal knowledge.” The retirement of the long time employees and their “tribal knowledge” had an adverse impact on essential site services. The greatest risk was to emergency response.

Most commercial software applications recognize block numbers and street names. The migration from a building-centric location reference system to a block number and street name system would be difficult given all of the existing references in policy and procedures. The compromise selected was an interim step; locations would be based on a one tenth mile by one tenth mile custom grid. This custom grid provided a method that can be used to generate an index.

The one-tenth mile by one-tenth mile custom grid follows local county government standards for block numbering. Block numbers based on that standard would result in a six- or seven-digit numbering convention, and therefore an increased chance of transposing digits. A five character alphanumeric cell naming convention was selected as a compromise to the seven-digit block number and street name standard.

Block numbers are used most effectively with buildings. The county addressing standard had one other complexity that made the custom grid approach appealing. Each block number was based on the egress point to the street. Most of the buildings that were part of the map did not relate to an egress point. Instead, they were sited in small clusters, making it difficult to determine what the actual road or egress point was. Block numbers and street names did not prove to be useful when locating other features like waste sites or wells.

The problem with the custom grid approach was how to display the value scale on the map. PLTS MPS-Atlas does not offer the option to create this type of data frame custom grid. The custom grid value scale is dependent on the map location. Figure 1 shows the Sheet Index Map. Figure 2 is a detail map showing the main data frame and the reference grid data frames.

The methods described in the following section have been successful in creating three of the proposed five atlases. The largest Site atlas contains about 250 pages with a left and right layout to create a book style atlas.
Figure 1. Index Map.

Figure 2. ArcMap Grids.

Measured Grid

Reference Grid
HNF-32039-FF REV 1

SOLUTION

The use of PLTS MPS-Atlas to develop atlases is not particularly unique or innovative; however, the atlases developed were at the extreme edge of the PLTS MPS-Atlas capabilities. Placement of the custom grid on the maps required creative solutions. This document will discuss those solutions, as well as general work within PLTS MPS-Atlas.

The MPS-Atlas as an extension to ArcGIS manages the creation of a map series or Atlas; however, functional requirements fall short in their capability to create a custom reference grid. The work around is to construct a set of four data frames that surround the main data frame (Figure 3). They are linked to the main data frame using a Data Frame Manager. The key to understanding how they work is the Data Frame Manager setup.

Figure 3. Map Layout Elements.

PLTS MPS-ATLAS – OUTSIDE THE DESIGN

The following discussion is written assuming that the audience is already familiar with PLTS MPS-Atlas, and will therefore skip over the basic operation of the MPS-Atlas component and focus on building an Atlas with the set of four data frames. The following example contains two other data frames, Regional and Neighbor inset maps. They are discussed to present some setup parameters not needed for the set of four surround data frames.

ArcMap Core (core function integral to ArcMap, not PLTS MPS-Atlas) provides the tools to develop a map layout. The ArcMap Data Frame Properties dialog box allows the user to assign a reference or measured grid to a data frame (not shown – See ArcMap Help – Data Frame/General/Grids). The reference or measured grids are displayed along the data frame boundary. The available reference grids all reset the numbering sequence for each map in the series. User
requirements for Site atlases require a custom reference grid that is consistent, regardless of the location of the map extents. It is also beneficial to reuse the dynamic reference grid on other atlases.

The custom reference grid works similar to the way the Microsoft Excel® references cells are named: by rows and columns. The intersection of the columns and rows defines a cell. The cell name (column-row) associated with a feature provides a location component. A five-digit alphanumeric cell name becomes the index value for that feature. The Cell Name contains enough information for the experienced user to generally locate a feature.

CUSTOM REFERENCE GRID

Construction of the custom reference grid begins with developing a series of row and column polygons that are one tenth mile wide by 35 miles long. Each grid polygon is uniquely named; rows are numeric and columns are alpha. The grids are added as a feature class to a personal geodatabase used to manage the map series. Next, the map sheet extents, or areas of interest (AOI), polygons are drafted and added to the geodatabase as a feature class. The AOI is a set of polygons that define the boundaries of each map in the series.

ATLAS DESIGN AND DEVELOPMENT

The primary focus is the custom reference grid; however, there are design considerations for the development of the atlas that will make the process easier. The overall atlas design should be established before any map series is constructed.

Atlas Design Considerations

1. The AOI for each page, map extents, zoom scale factor
2. The atlas map or page sequence, book or stand-alone plotting
3. Map layouts, graphic or dynamic surround elements
4. Main data frame content, base data, labeling, raster.

The sequence of development can affect re-work and duplication of the atlas. Some of the design details will be covered later in subsequent sections. The atlas design considerations were gained from the experience of developing an atlas that had four different map types: Site Index, Area Index, Area Overview, and Detail. Each type included an odd page and an even page map layout, expanding the total number of map series in the atlas to eight. This level of complexity was constrained by the software, hardware, and network speed. The example here follows an atlas with one map series. The process is repeated for each additional map series in the atlas.

MAP SERIES CREATION

The map series creation starts with the main data frame. It can be part of the current ArcMap .mxd or it can be referenced from a stand-alone .mxd file. The development of atlases with multiple map series is simplified when the main data frame is developed to a point that it contains features and map surround elements that are common to all of the map series. After the
map series is created, any changes made to the main data frame in a map series are not replicated in the others. The main data frame only requires an AOI feature class. The AOI should be the last feature class in the TOC so that any definition queries will function properly.

The previous paragraphs have focused on design and concepts. The discussion now shifts to PLTS MPS Atlas menus and Dialog Boxes. The discussion will not detail how to initiate a menu or dialog box.

There are two menu options to generate a map series, *Add Map Series* and *Add Simple Map Series* (Figure 4). The *Add Simple Map Series* offers fewer setup options. The following discussion is based on the *Add Map Series* option.

**Figure 4. MPS-Atlas Menu Options.**

The *Add Map Series* menu will initiate the Map Series Setup Wizard, which will guide you through all the properties necessary to set up a new map series. The first dialog box, *Area of Interest Data Source*, identifies what feature class is used to define the map sheet extents (Figures 5 and 6). MPS Atlas will generate a map for each polygon in the AOI feature class and set the extents to those of the polygon.

**Figure 5. Area of Interest Data Source Dialog Box.**
Figure 6. Area of Interest Data Source – Selection Data.

From the Data dialog box, the Select Features dialog box is accessible, which contains several tools with which to select data. The SQL icon offers the user a method to create queries that select specific features from the AOI feature class. For example, the AOI Data Source Selection feature would be useful in an odd/even page layout for a map book atlas.

The Map Sheet Properties dialog box is the next one in line. There are two types of storage methods available in MPS-Atlas. Maps can be stored as individual Map Document files (.mxd), or as a collection of maps stored in the current, single .mxd file. The Map Sheet Properties dialog box sets the AOI feature class table column that will be used to create the name of each map sheet.

The Rotation, Spatial Reference, and Buffer dialog boxes require little in the way of additional explanation.
The Scale and Extent dialog box needs some further discussion (Figure 7). The AOI polygons, described earlier, define the extent of each map in the series if the Do Not Calculate Scale or Extent radio button is selected. The other radio buttons modify the relationship of those AOI polygons and their associated map sheet. In most cases, the map sheet is centered on the centroid of the polygon and modified according to the option selected. The example atlas relies on a zoom scale factor in a column in the AOI polygon feature class to set the extent of each map.

The Feature Class Query dialog box is not used to set any of the parameters for the main data frame. Its function will be described as part of the inset map setup.

The Paper dialog box is the last one in the sequence and requires little additional comment.

The Finish option on the Paper dialog box completes the development of the map series. This process could take some time depending on the complexity and number of map sheets in the series. Map series beyond 250 sheets basically are unworkable.

CUSTOM REFERENCE GRID DATA FRAME SETUP

The map series outlined thus far is not unique or innovative; however, it is presented in order to provide a general understanding of MPS Atlas map series creation. The unique aspect of this atlas is the four surround data frames: Above, Below, Left and Right (Figure 3). These data frames provide scale values for the custom grid. The grid used is consistent across all of the maps in the atlas and can be used in other atlases.

The four surround grid frames Above, Below, Left and Right are added to the atlas. They only required two data sets, AOI feature class and Grid Polygon feature class. The AOI feature class in each of the four surround data frames is linked to the Main Data Frame by a Data Frame Manager.
SURROUND DATA FRAME MANAGER SETUP

Figure 8. Add Data Frame Manager Menu Option.

Each of the four surround data frames Above, Below, Left, and Right are linked to the main data frame by a Data Frame Manager (Figure 8). This menu is available from the MPS-Atlas tab, options, menu (right mouse button). The Map Series Setup Wizard will sequence through the setup tabs (Figure 9). The setup of the four surround data frames Data Frame Managers differs only slightly from the setup of the Main Data Frame Data Frame Manager as referenced in Add Map Series section.

Figure 9. Data Frame Manager Properties.

The Area of Interest Data Source tab points to the same feature class used for the AOI polygons in the main data frame. The default values for the other tabs should be accepted.
Figure 10. Data Frame Manager Scale and Extent Dialog Box.

The Scale and Extent tab selects the data field used to control the area viewed in the surround data frames (Figure 10). The main data frame uses a data filed in the AOI to control scale. The surround data frames should use the same field. The scale and extent of the data frames will follow the AOI feature class if left to the default values.

INSET MAPS – SETUP

Two additional data frames, a neighboring page inset map and a regional inset map, are found in the lower corners of each map in the series (Figure 11).
The Regional Map (inset) stays focused on the entire extent of the atlas as the Main Data Frame is shifted to a different map in the series. Both inset maps show the Main Data Frame extent highlighted as a red polygon. The Neighboring Map (inset) data frame changes its extent as well, but at a larger scale.

The inset maps are first placed on the map layout using the Insert Data Frame command. Both data frames only require the AOI feature class. The AOI feature class is used to link data frames to the main data frame. The remaining data sets and symbolization are added to give context to the maps.

There is one AOI polygon in the Regional Map data frame. The Neighboring Map inset data frame uses the same AOI data source as the main data frame. The scale and extent are zoomed out to give a broader perspective and show the neighboring maps.

Both inset map data frames are linked to the main data frame using a Data Frame Manager. The Data Frame Manager is added in the same manner as the previous data frame managers.

The Data Frame Manager setup differs from the setup for the Main Data Frame and the Surround Data Frames in a couple of key areas. The Data Frame Manager Properties dialog box shows all of the property tabs. Detailed below are only those tabs that are required to link the inset maps to the Main Data Frame.

The Area of Interest tab in the Data Frame Manager Properties dialog box allows the user to decide what will be considered the area of interest for the map sheet. Centroid or Whole Shape can be selected(Figure 12). Centroid returns the feature that intersects the center of the current map sheet AOI feature. The Whole Shape intersects where the whole shape of the map sheet AOI intersects any part of the current data frames AOI feature class. The Regional inset map requires the Centroid and Union of All selections in order to remain focused on the entire region. The Neighbor inset map needs the Map Sheet Area of Interest selected to function correctly.

Figure 12. Area of Interest Tab.
The final step is to highlight the AOI Polygon. Both inset maps need a Current map symbolized as the AOI. The Current map works with the Feature Layer Definition Query to limit the list of features to just the Current map. This layer is symbolized to highlight the AOI.

The Feature Layer Definition Query tab allows the user to highlight a polygon of interest (Figure 13). In this case, the current AOI polygon is a bold red color. When MPS Atlas creates a map sheet, it automatically adds the definition query to the layer. In Figure 13, those layers with a mark in the check box will receive a definition Query. See ArcMap Help - Layer Properties - Definition Query. Note that the Fields displayed in the Feature Layer Field Name drop down list box are taken from the last layer in the data frame’s TOC. The help documentation says the first, an error to be corrected in future releases.

**Figure 13. Feature Layer Definition Query.**

**FEATURE INDEX**

Creation of the index uses the Identity tool in the Analysis/Overlay Toolset in ArcToolbox. Each of our atlases focuses on a different theme. Our largest and most complex atlas is the waste site atlas, which contains about 5,500 objects and 200 map sheets. The Identity tool is used first to determine on which page the waste site feature resides. The Identity tool is run twice more to note which row and column the feature occupies. Some features occupy multiple pages and grid cells. The Identity tool creates an additional feature class that combines both sets of attributes, the waste site feature class, and the AOI feature class. A Microsoft Access™ query is used to combine the results of the Identify command into a useable index (Figure 14).

**Figure 14. Detail of the Index.**

<table>
<thead>
<tr>
<th>Bldg</th>
<th>Zone</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>222S-BA</td>
<td>CU189</td>
<td>110</td>
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<tr>
<td>222T</td>
<td>CV171</td>
<td>110</td>
</tr>
</tbody>
</table>
USER HELP

The map design and development process occasionally needs to be redone. The work necessary to re-do a map series can be reduced if the following sequence of events is followed. The first activity is to settle on main data frame map layout and the overall graphical elements, i.e., main data frame content, custom grids, inset maps, dynamic data elements, static graphic elements, etc. The next item in the sequence is the A01 feature class. The A01 feature class may have to be re-worked if the detail gets too dense, e.g. more pages, larger zoom scale, re-positioning A01 polygons, etc. The final task is to add the Data Frame Managers. Make sure the map series is functioning as envisioned before you move on to the next step. Any changes made after the map series is added may have to be done on several screens.

- Use True Type fonts; they print and export to other file formats more consistently.
- View the map in the Print Preview before making changes. The Layout View and Print Preview display engines do not function in the same way. The Print Preview graphic display engine is closer to the printed or exported map.
- Sequence all raster elements to be drawn last or nearly last, because any raster element that is rendered will cause the remaining layers in the draw order to be render as a raster rather than a vector image.
- Export the map sheets to PDF or EPS to do final pagination. Adobe manages this process better than ArcMap.
- Export or Printing is resource intensive. The map will consume all available memory at about 15 sheets exported/printed. It requires the user to close ArcMap and reload your map series. There is no known work around until ArcMap 9.2 is implemented.
- Set the update rules for dynamic elements so they only update on important changes in your map. The default state is to update them with any change. This can be time consuming if you have many dynamic elements.
- Positioning a number of feature class annotation objects can be time consuming, especially if you have to wait for the map to re-draw after the reposition event. A couple of steps reduce the time for the annotation update process:
  - Export the map as geo-tiff.
  - Create a new map series with just the geo-tiff in the main data frame.

Now the annotation feature class can be updated a little bit faster because the graphic renders a bit faster than the source vector data.

Using map caching may help, but not always. The map cache only stores geodatabase features, so if shape file features are being used, no features will be cached. There may be some small performance gain for personal geodatabase feature classes.