Developing Custom 3D Visualization Applications for Defense Using ArcGIS

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Abstract: *3D Visualization is increasingly important in a wide range of defense domains such as terrain visualization, sensor and weapons modeling, mission familiarization and rehearsal, and many others. ArcGIS enables both end-users and application developers to leverage numerous 3D Visualization capabilities which are available in many ArcGIS products including ArcGlobe, ArcScene, Military Analyst, and others. This paper demonstrates the numerous 3D Visualization capabilities that are available to the ArcGIS defense developer. It shows how to develop applications that perform common 3D Visualization tasks including the display of draped and extruded 3D graphics, 3D models, and 3D Military Symbology. For developers interested in highly complex and custom 3D graphics solutions, the presentation also discusses developing custom rendering solutions using OpenGL extensions. This presentation presents samples, tips, and lessons-learned for developing custom 3D visualization applications using ArcGIS. It should be of interest to developers and anyone interested in implementing 3D capabilities using ArcGIS.*

Introduction

With the release of ArcGIS 9, ESRI has greatly increased the 3D visualization capabilities of ArcGIS. These increased 3D capabilities include the ArcGlobe whole-earth 3D viewer, increased Military Analyst 3D capabilities, and numerous other features. The defense developer can now leverage these new capabilities to develop powerful 3D visualization applications for military domains.

This paper explores key concepts of using 3D visualization for defense domains, presents some of the benefits of 3D visualization, and demonstrates several 3D visualization applications in action. These innovative and representative 3D applications include Military Overlay Editor (MOLE), Tactical Operations Center 3D (TOC 3D), and Maneuver Control System (MCS). Finally, the paper presents several methods developers can use to easily add 3D support to their own custom 3D defense applications.

3D Visualization Concepts and Considerations

In order to create effective tools for performing the complex missions of today's military personnel, numerous important capabilities for 3D visualization systems should be considered. Therefore, for the reader who may not have extensive experience with 3D visualization, this section presents some of the major 3D visualization concepts.

3D Visualization Concepts

There are a number of important basic capabilities needed for an effective 3D visualization system. First, the 3D system needs to provide sufficient performance and throughput to support the management and display of very large sets of GIS and live-feed data. Second, the system should also have the ability to load standard GIS products and datasets directly into the 3D environment without having to first convert into a native or proprietary 3D format. Third, when displaying GIS data, the system should be able to show data using a number of different 3D techniques, such as draping imagery on the terrain, extruding structures from the surface (such as buildings) using the structures' elevation, or "floating" datasets (such as air routes or cloud layers) that are intended to be shown at a defined altitude. Finally, in addition to loading and displaying GIS data, the system must allow the user to intuitively navigate throughout the 3D scene.

Furthermore, when depicting symbolic data, the system should be able to display either notional symbology using standard 2D symbol sets or realistic 3D models. Notional 2D symbology should also be capable of being displayed draped on the surface or billboarded so that it is always oriented toward the viewer. The user should also be able to select a 3D object and obtain the object's detailed properties or even a Web hyperlink for much more detailed information.

Figure 1 illustrates many of these concepts and uses TOC 3D and the ArcGlobe control to display the same data with several different techniques. Satellite imagery is displayed draped on the surface while the buildings are shown as extruded 3D models. The hospital symbology is depicted using notional 2D symbology both draped on the surface and as raised, billboarded symbology.

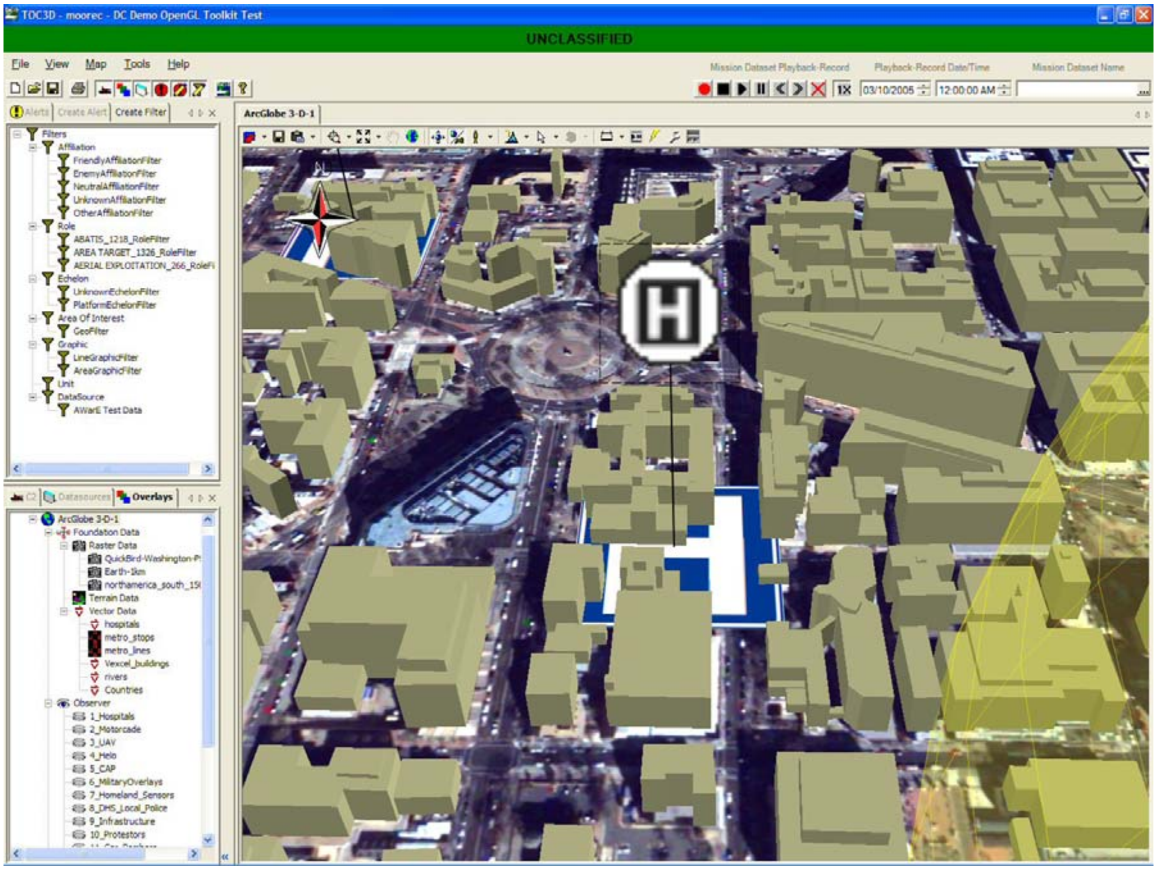

Figure 1. Techniques for 3D Data Display in the TOC 3D Application

Summary of 3D Visualization Capabilities

To summarize, a 3D visualization system should support the following:

General 3D Capabilities

- **GIS Dataset Display –** several different approaches are provided to present GIS data in the scene. These approaches should include
  - Draped—2D feature data is draped/overlaid onto the 3D surface. This is normally the desired behavior for surface features, such as roads and rivers.
  - Floating—feature data is displayed floating above ground at the requested altitude. This is normally the desired behavior for mid-air features, such as clouds and air sectors.
  - Extruded—features data is pushed up from the surface to create lines, walls, and solids. This is normally the desired behavior for features that require both elevation and surface information to be represented.
- **3D Navigation –** the viewer should allow the user to navigate anywhere within the 3D scene and to change X, Y, Z, pitch, roll, and yaw simultaneously

- **Visualization of large datasets –** the system should be able to manage and display a large number of GIS features and symbology simultaneously.
- **Details on Demand –** the system should be able to provided detailed textual information about any selected feature in the 3D scene.

Additional 3D Symbology Considerations

- **Multiple System Sets**
  - Both non-military and military - MIL-STD-2525B, Navy Tactical Data Set (NTDS), Homeland Security, etc. - symbol sets should be supported.
- **Billboarding of 2D Symbol Sets**
  - 2D symbols should always rotate to face the camera (the user), even when the global scene is being rotated, zoomed, or otherwise animated.
- **3D Models**
  - Perhaps one of the greatest benefits of 3D visualization is the ability to depict realistic models. The system should support popular 3D model file formats such as OpenFlight (.flt) and 3D Studio Max (.3ds).
- **Graphic Extrusion**
  - To prevent occlusion by terrain of vital mission symbols, the system should support the ability to raise symbols above the surface of the earth.
- **Callout Lines**
  - Symbols are raised above the surface to a user-determined "eye level" on posts, while the bottom of the posts are still anchored to the symbols' true locations.
- **Additional/Custom 3D Symbology Modifiers**
  - Custom 3D modifiers such as domes and ellipsoids can be used to depict additional information in 3D such as effective sensor and weapons ranges.

ESRI's ArcGlobe and MOLE products support all of these capabilities.

Additional Considerations for 3D Visualization Systems in Defense

When all of this multidimensional data is combined into a single whole-earth 3D scene, there is a considerable risk of information overload, so the system should also support mechanisms for effectively displaying, managing, and filtering data. Thus, the system should support mechanisms for organizing (such as MOLE's leadering and stacking) or deconflicting data. Ideally, the system should also support some means of alerting the operator when an important or exceptional event occurs. For instance, an air control system might alert its operator if an unauthorized aircraft enters a restricted area.

For mission planning, especially when dealing with dynamic or temporal data, the system should also support the ability to define routes for objects and move objects along their defined routes (sometimes called "animating"). Users can then animate these objects along their assigned routes in order to observe object interactions and behaviors in this dynamic environment. In addition to data animation, users should also be able to animate the viewpoint in order to perform virtual fly-throughs of an area for mission planning and rehearsal.

Benefits of 3D Visualization

3D Visualization provides many benefits, including the ability to provide better models and views of a real-world situation, faster data exploration and understanding, and the ability to convey additional information that is simply not possible with a 2D representation.

Continuing a trend toward using computers to model reality as accurately as possible, 3D allows users to build better models of real-world situations. Just as paper maps and printed photographs have given way to 2D Geospatial Information System (GIS) tools for modeling and analyzing geospatial data, 3D Visualization is yet another, more effective tool for defense practitioners to represent reality as accurately as possible.

With this ability to better model reality, 3D Visualization offers faster data exploration and can often lead to better results. For instance, a user no longer needs to infer 3D data from 2D cues, such as elevation labels or contour lines, but can actually see elevation differences between mountains and valleys. Real-world objects, such as aircraft and buildings are visible at their actual locations and elevations. Realistic 3D models can even be used to depict these objects with a high degree of accuracy and realism.

3D Visualization enables users to obtain faster and more accurate results from their analysis. The ability to view significantly more realistic information, analyze the spatial relationships, and make more informed decisions is a major advantage of 3D. The ability to interactively navigate through an area and intuitively understand terrain differences is extremely helpful in any domain where elevation is important, such as aviation, communications, and asset placement. For instance, emergency planners can quickly determine the best placement of a command post by visualizing a number of important criteria in 3D.

Most importantly, 3D allows users to communicate additional information that is very difficult to accurately depict in 2D. Terrain is the most obvious example, but there are many other types of additional information that can be effectively displayed in 3D. This includes sensor and threat domes, air operations areas and corridors, lines of sight and viewsheds, and many other types of inherently 3D data. 3D can even be used to show more sophisticated relationships by employing techniques, such as 3D hierarchy networks, histograms, or graphs to convey such information as command structures, sensor density per square mile, and communications connectivity.

Specific Benefits of Using 3D Visualization to the Warfighter

In modern military operations, commanders and their staff must maintain a strong Situational Awareness (SA) and perspective of the battlespace. Enormous amounts of data are available to achieve this including imagery, vector, planning, and live feed data. 3D Visualization can provide intuitive and unique perspectives of the battlespace that can aid commanders in decision-making. This additional third dimension of data can also help clarify a Warfighter's perception of the battlespace and can mean the difference between making the right or wrong decision. The following examples illustrate using 3D visualization to help the Warfighter.

3D Benefits on Land

There are many key physical geographic factors to successful military operations. 3D visualization can aid the Warfighter when these geographic factors become critical success factors. For instance, high ground, steep terrain, and dense vegetation affect mobility and line of sight which can in turn greatly impact the outcome of a battle.

For instance, Figure 2 depicts a typical military scenario. Within a 2D view, one might say that the red force has the advantage because a brigade is much larger than a battalion. However, when one looks at the scene from a 3-D perspective, one sees immediately that the blue force is positioned at a higher elevation.

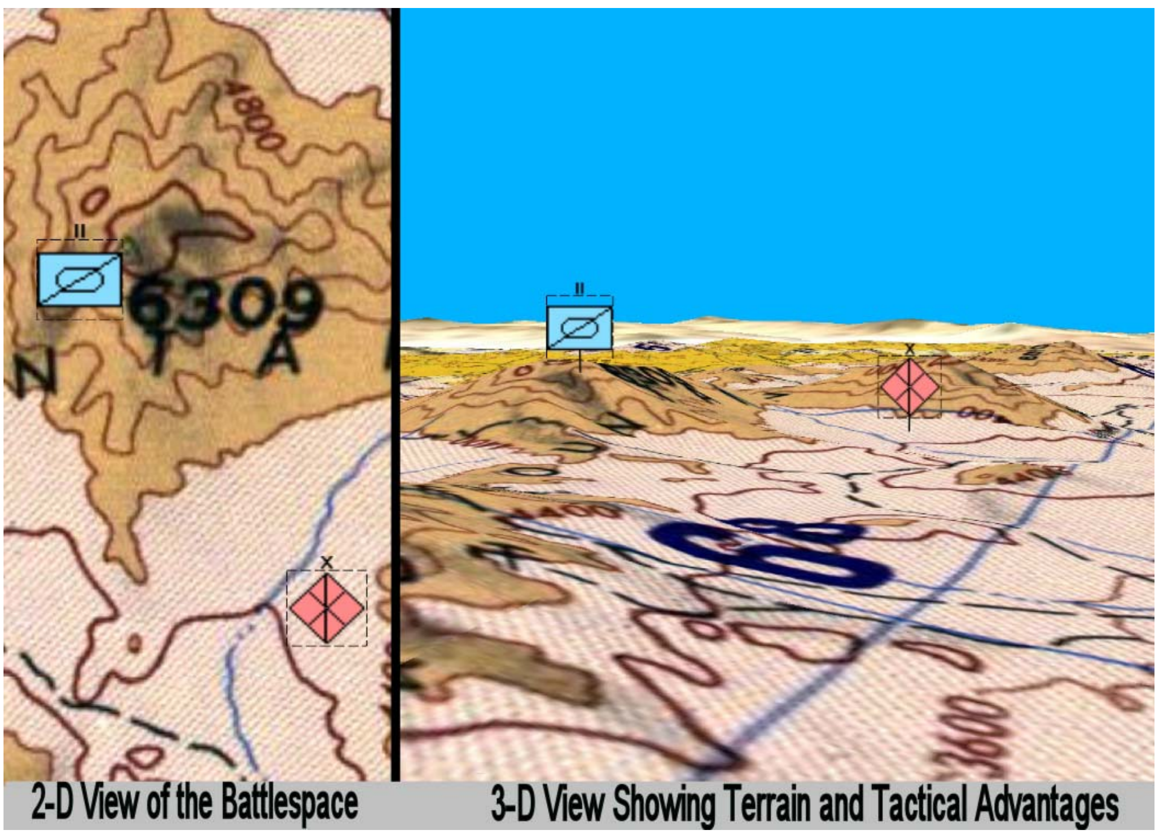

Figure 2. 2D versus 3D Scene Display in the TOC 3D Application

3D Benefits at Sea

In Naval operations, 3D Visualization can aid the Warfighter when subsurface features become a factor. For instance, it can make acoustic target detection and tracking more intuitive and effective. It can provide the sonar operator with better target state estimations and more informative display tools. Figure 3 shows a typical sea surface and subsurface 3D scene.

Underwater topography affects both surface and subsurface Naval operations. 3D Visualization can help ensure that the water offshore is deep enough for transport ships to operate as near to the beach as tactical situations will allow. It can help to ensure that final approaches are free of sandbars, banks, shoals, reefs, offshore islands, rocky outcroppings, and other obstacles.

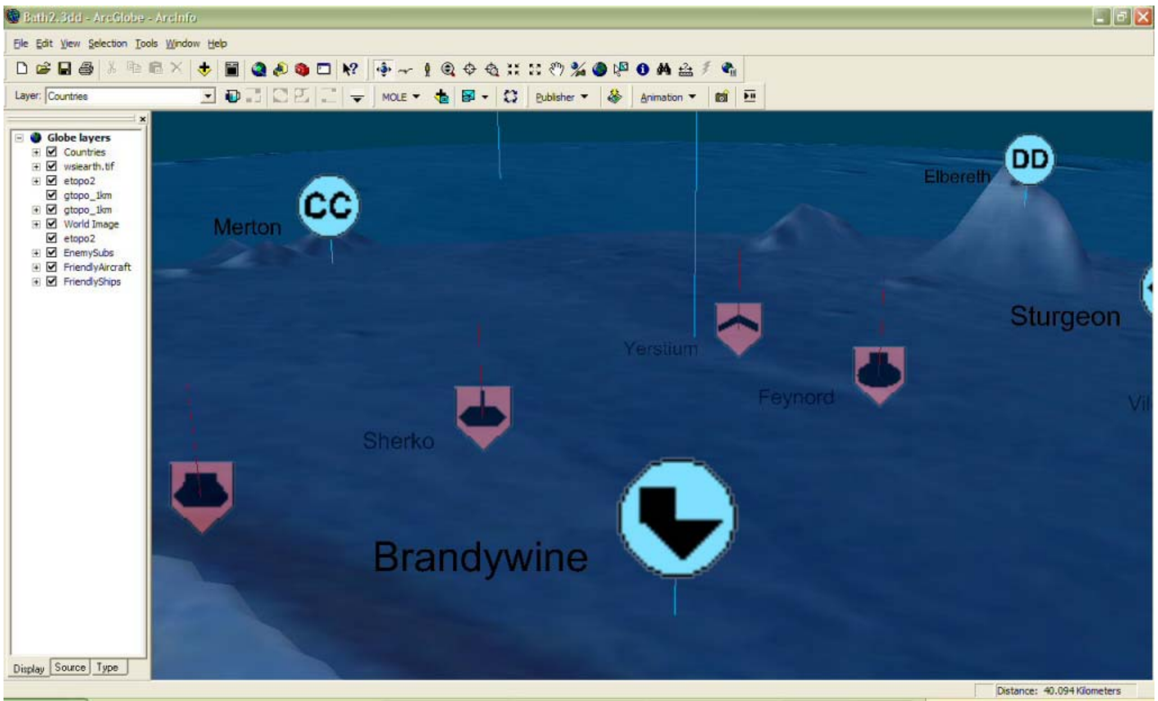

Figure 3. Sea Surface and Subsurface Scene in ArcGlobe using MOLE

3D Benefits for Air Operations

Air Operations can also benefit greatly from 3D. Air operations can use the third dimension to visualize the scene from the surface vertically up to the maximum altitude of air defense systems. Air campaigns make use of Air/Airspace Coordination Orders (ACOs) to coordinate the many assets involved such as air defense systems and aircraft. ACOs can benefit greatly from a 3-D display.

Figure 4 depicts four friendly aviation units flying within the pattern that is specified by the ACO. Two of the units are rotary wing (helicopters). The other two are fixed wing. Within the 2D view, one might say that all four aviation units are within the ACO control zone. However, when you look at the four units from a 3D view, you will quickly recognize that one fixed wing unit is flying at an altitude that is higher than what is specified by the ACO.

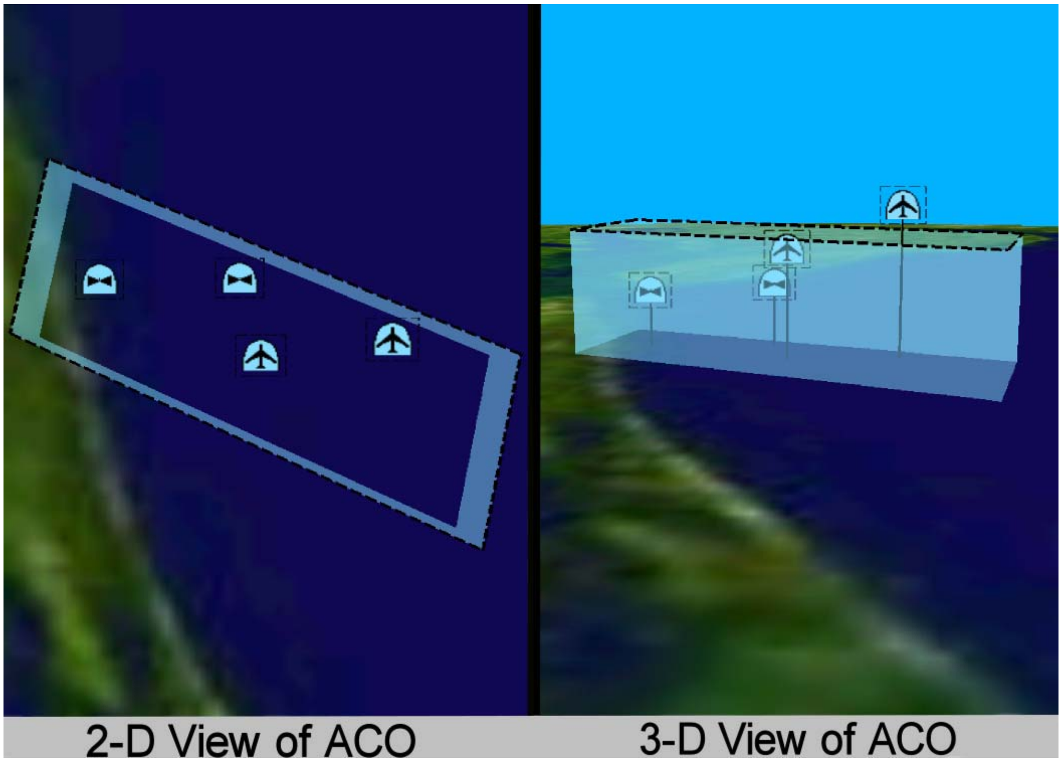

Figure 4. 2D versus 3D ACO Display in the TOC 3D Application

Representative 3D Defense Applications

This section presents several innovative applications that make extensive use of 3D.

Military Overlay Editor (MOLE)

The Military Overlay Editor (MOLE), included with ArcGIS Military Analyst, provides considerable support for 2D and 3D visualization of war fighting symbology in the ArcGIS framework. MOLE is designed to be an easy to use tool for battlefield visualization and planning. The primary purpose of MOLE is to render common war fighting symbology on maps in accordance with the symbology descriptions in the MIL-STD-2525B specification. For more information on MOLE, the reader should consult http://www.esri.com/software/arcgis/extensions/militaryanalyst/.

Pre-9.0 versions of MOLE supported military symbology display in 2D. With version 9.0, MOLE supported the draping of military symbology on the surface in ArcGlobe. With the release of MOLE 9.1, military unit symbology can be draped or billboarded and military tactical symbology can be draped or extruded. Figure 5 illustrates some of the 3D capabilities supported by MOLE.

The display of 3D symbology using MOLE 9.1 in ArcGlobe can be configured to suit user preferences. For example, the user can change symbology extrusion height, or change the color and width of unit callout lines. Moreover, all such configurations are done on a layer by layer basis, allowing the user to maintain different settings for various layers within the same display. Future releases of MOLE will provide the 3D user with even more control and flexibility.

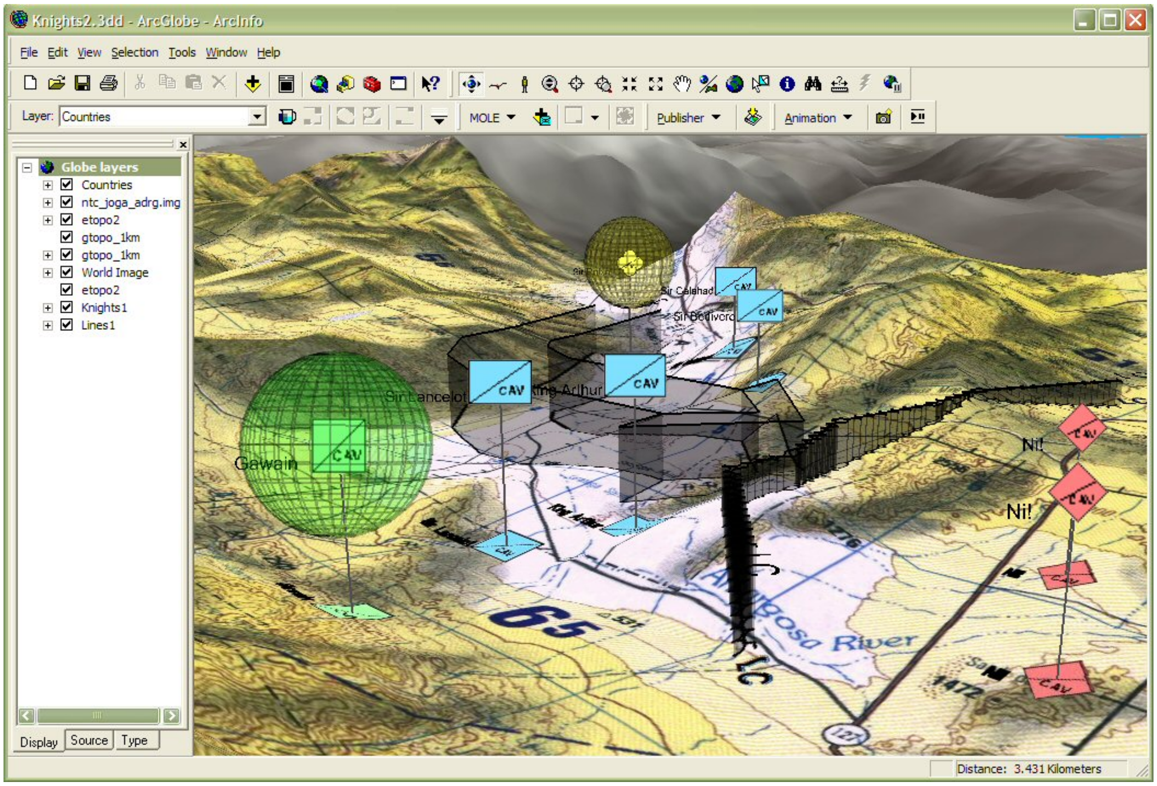

Figure 5. MOLE Graphics Shown Draped and Extruded with Callout Lines and Sensor Spheres

Tactical Operations Center 3D (TOC 3D)

The TOC 3D Application also demonstrates many 3D concepts and capabilities. The TOC 3D effort is being developed by Concurrent Technologies Corporation (*CTC*) under the Next Generation Command and Control System (NGCCS) TOC 3D Program. TOC 3D is an initiative by the U.S. Army Project Manager, Ground Combat Command and Control (PM GCC2) under the auspices of the Program Executive Office, Command, Control and Communications Tactical (PEO C3T). For more information on the TOC 3D Program, visit www.toc3d.com.

The TOC 3D Application integrates advanced GIS technologies, 3D Visualization, information management solutions, evolving communications architectures, and Internet technologies to meet the military's requirements to display battlespace-relevant data, including maps, intelligence information, operational assets, and live-feed data in an intuitive 3D space. This provides capabilities to combine and overlay complex data from multiple battlespace-relevant entities, quickly assess the battlespace, and enhance the Warfighters' decision-making capabilities.

The TOC 3D Application receives GIS, operational, and planning data and displays this data in an intuitive and interactive 3D environment. Planning and live operational elements can be displayed as geo-referenced military symbology (using MIL-STD-2525B and other standard military symbology sets) or 3D models. This data enables defenders to rapidly assess the battlespace and use this actionable information to better make decisions. In summary, TOC 3D is an integrated planning and monitoring solution for 3D situational awareness. It combines all relevant data into one application that can be used by defense practitioners to make better-informed decisions. Figure 6 shows a typical view of TOC 3D.

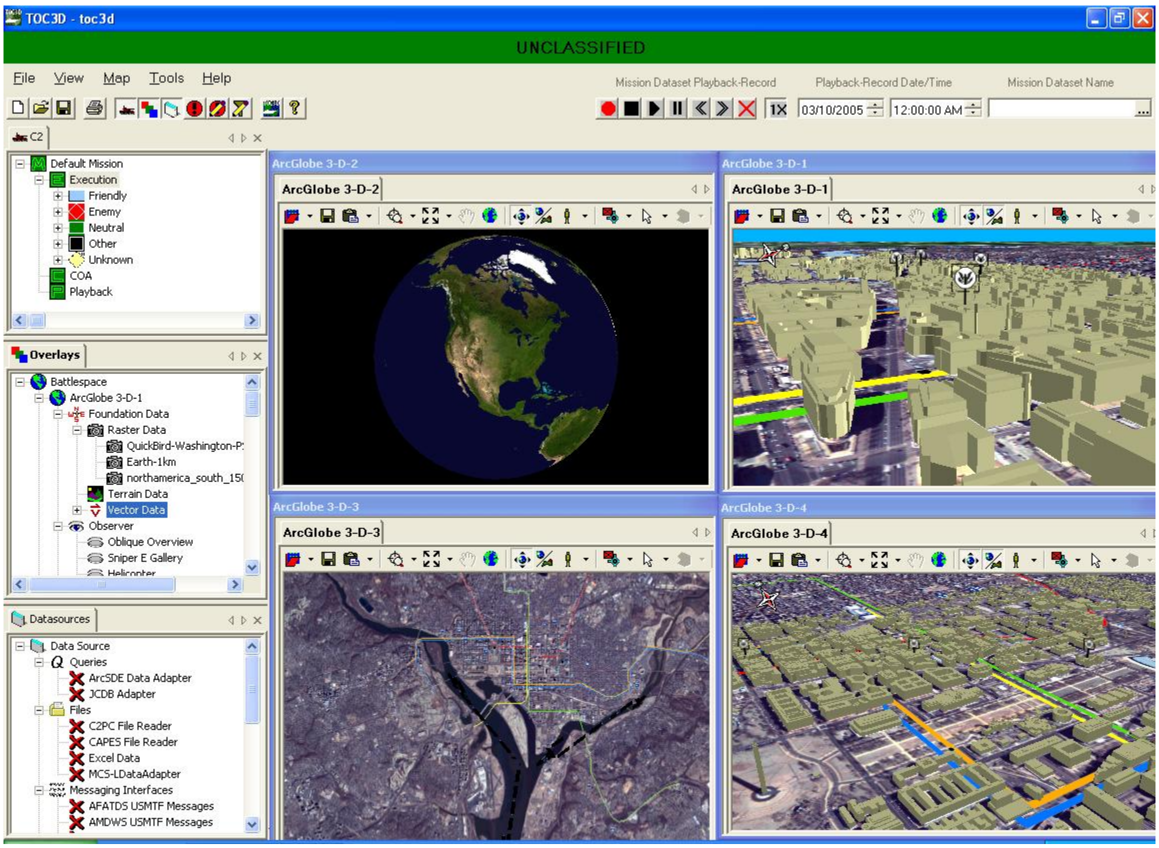

Figure 6. 3D Visualization in TOC 3D

Maneuver Control System 6.4

The Maneuver Control System (MCS) is being developed by the Command Communications-Electronics Command (CECOM) Software Engineering Center located at Fort Monmouth, NJ. The Maneuver Control System is an integrated architecture of hardware, software, Standardized Integrated Command Post System (SICPS), personnel, and procedures. MCS provides the battlefield commander with a Common Tactical Picture (CTP). This CTP displays a relevant view of the battlefield. MCS provides Corps through Battalion force level commanders and their staffs with the ability to collect, coordinate, and act on near real time battlefield information and to graphically visualize the battlefield.

The Maps and Overlays application provide MCS's core visualization capability. The Maps and Overlays application is used during both the planning and the monitoring of the battlefield situation. During planning it is used to create overlays, conduct terrain analysis, and build courses of action in support of the military decision making process. During operations, the friendly units, enemy units, and overlays are used to monitor the battlefield. Until recently, the Maps and Overlays component visualized all graphical data in 2D. With the integration of the ArcGlobe-based component within Maps and Overlays, a user can now easily visualize in 3D what may have been somewhat incomprehensible in 2D.

The Maps and Overlays product is noted for its PowerPoint like graphics implementation of the full MIL-STD-2525B symbol set, plus the ability to add special symbols to support operations such as Homeland Defense and Operation Enduring Freedom. With the addition of 3D to the Maps and Overlays product, the user can now visualize MIL-STD-2525B symbology and additional symbol sets in 3D as well as 2D. Figure 7 displays a typical view of the Maps and Overlays product in MCS using 3D visualization.

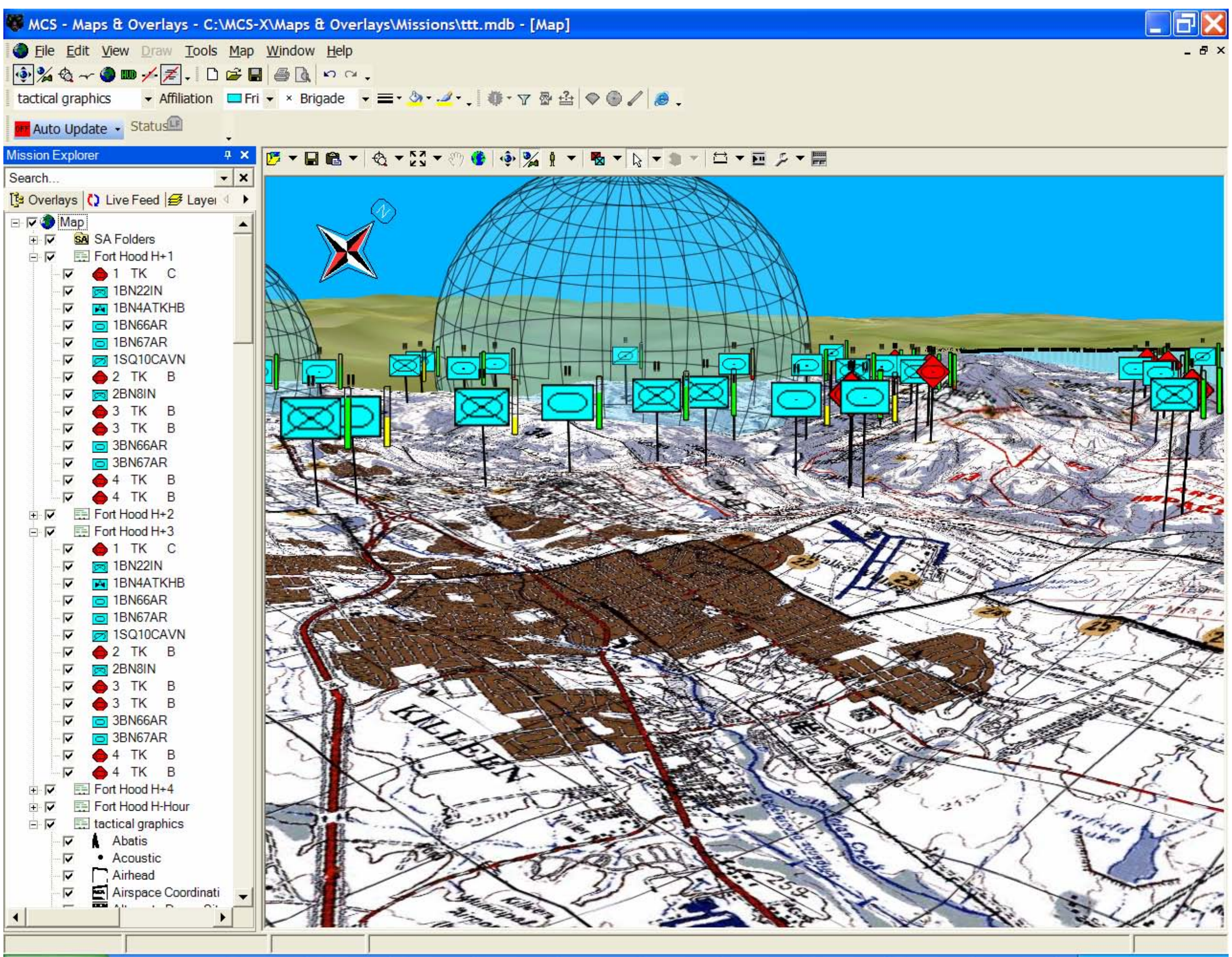

Figure 7. 3D Visualization in MCS

Methods for Adding 3D Support to Custom Applications

Adding 3D capabilities to custom applications in ArcGIS is relatively easy. In most cases, the methods for using layers in 3D are very similar (if not identical) to those mechanisms used in 2D. This section demonstrates several methods that defense developers can use to add 3D support to their applications.

Adding 3D Feature Layers

The first method is to simply add the layer to the map/globe. This is accomplished in nearly the exact way as is done in 2D. The only minor difference in ArcGlobe is the additional helper method *AddLayerType* is often used to make adding layers to the globe easier. Another minor and expected difference is that the loaded features need to have altitude/"Z" values in order to be displayed in 3D at the correct altitude (otherwise they are draped). Appendix A shows Visual Basic for Applications (VBA) source that can be used for loading a layer in ArcGlobe from a GxDialog.

If the developer wants the loaded layer to be symbolized using 3D models, then 3D Marker Symbols can be associated with the layer. Appendix B provides VBA source for accomplishing this task.

Adding MOLE Layers in 3D

If the developer is using MOLE to display MIL-STD-2525B symbology, adding 3D support is also quite simple. To accomplish this, the developer simply loads the layer as would normally be done in 2D. Then the developer need only set the 3D Display Options to set such 3D settings as draped/extruded symbology, callout lines, and symbology default altitude. Appendix C shows the VBA source that may be used for loading a MOLE layer in 3D.

Using Custom OpenGL Graphics

While the 3D visualization capabilities provide by ArcGIS 9 are significant and extensive, there are times when the developer may need to extend the rendering capabilities that are provided by ArcGIS "out of the box." Examples of such extensions include sensor cones, track lines, as well as many other highly specialized graphic objects that are not necessarily supported by the default ArcGIS 9 installation.

When highly customized rendering is required, 3D Analyst provides the additional capability to perform highly customized 3D rendering using OpenGL extensions. These OpenGL extensions provide the ability to render complex and highly customized 3D graphic components in the 3D Analyst products. OpenGL is a platform-independent API that allows developers to directly access the Graphics Processing on the deployment platforms. OpenGL originated in the early 1990's on high-end graphics workstations as a solely C/C++ API, but has, in the intervening years, become available on nearly every mainstream hardware and software platform and is callable from a wide variety of programming languages. For more general information and the latest news on OpenGL, consult www.opengl.org.

For more information on using OpenGL with ArcGIS, the reader can consult the ArcGIS Developer Help. The reader can also consult "Developing 3-D Analyst Enhancements Using OpenGL" written by Jeremiah Montgomery and Christopher Moore and included with the ESRI 2004 International Users Conference proceedings. This paper demonstrated in detail how to integrate OpenGL-based custom rendering solutions into 3D Analyst. It explained OpenGL development and then showed how to integrate OpenGL-based software components into 3D Analyst products such as ArcGlobe.

Figure 8 demonstrates some of the advanced rendering capabilities that are possible using OpenGL extensions in ArcGlobe.

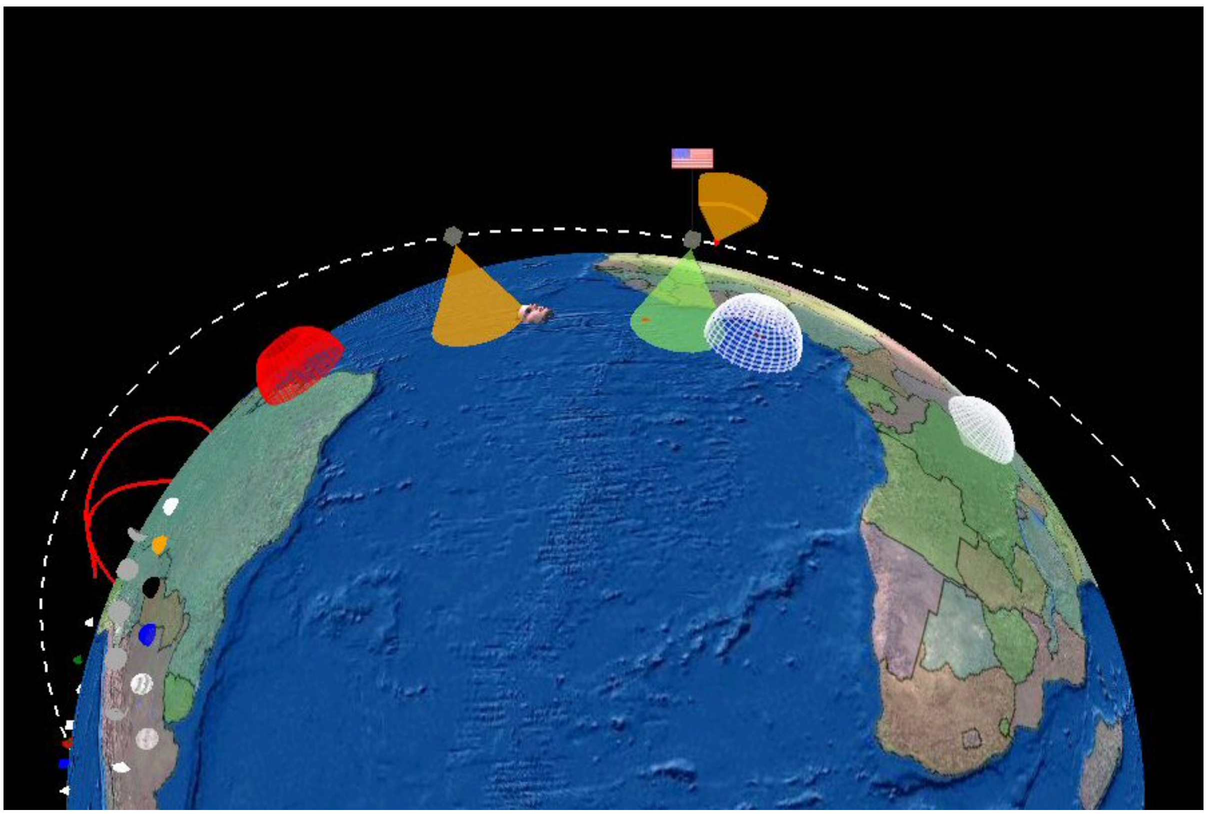

Figure 8. Using OpenGL to Perform Advanced Rendering

Conclusion

This article presented 3D Visualization concepts, capabilities, and benefits. The capabilities of representative 3D visualization applications, including MOLE, TOC 3D, and MCS, were described. This paper demonstrated how to integrate 3D functionality into custom applications using 3D features and OpenGL custom rendering solutions.

As this article has shown, 3D Visualization can be an effective tool in presenting rich display environments and enabling defenders to accomplish their critically important missions.

Acknowledgments

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Clark Swinehart, ESRI

Appendices

Appendix A – Load a Layer in 3D

The following VBA macro sample illustrates how to load a layer in 3D using the GxDialog.

To run this sample:

1. Ensure you have ArcGIS Desktop 9.0 or greater installed.
2. Open ArcGlobe.
3. Copy-paste this procedure into ArcGlobe's VBA Editor.
4. Run the procedure.
5. Load a Feature Class from the GxDialog

```
Sub TestLoad3DLayer()
    '
    ' Don't forget to add a references to ESRI Catalog and Catalog UI to get
    ' access to all of these types
    '
    Dim pGxDialog As IGxDialog
    Dim pGxObjectFilter As IGxObjectFilter
    Dim pGxDataset As IGxDataset
    Dim pDataset As IDataset
    Dim pSelection As IEnumGxObject

    Dim pFeatureClass As IFeatureClass
    Dim pFeatureLayer As IGeoFeatureLayer
    '
    ' Display GxDialog to select a feature data source (feature class)
    '
    Set pGxObjectFilter = New GxFilterPointFeatureClasses
    Set pGxDialog = New GxDialog

    Set pGxDialog.ObjectFilter = pGxObjectFilter

    pGxDialog.DoModalOpen 0, pSelection

    Set pGxDataset = pSelection.Next

    If Not pGxDataset Is Nothing Then
        '
        ' Create a feature layer from the selected GxObject
        '
        Set pDataset = pGxDataset.Dataset
        Set pFeatureLayer = New FeatureLayer
        Set pFeatureClass = pDataset
        Set pFeatureLayer.FeatureClass = pFeatureClass
        '
        ' Get the Globe from the Document
        '
        Dim pGMxDoc As IGMxDocument
        Set pGMxDoc = ThisDocument

        Dim pScene As IScene
        Set pScene = pGMxDoc.Scene

        Dim pGlobe As IGlobe
        Set pGlobe = pScene

        ' Set the Layer Name
        Dim pTheLayer As ILayer
```

```
        Set pTheLayer = pFeatureLayer
        pTheLayer.Name = pDataset.Name
        '
        ' Then Add the Layer
        '
        pGlobe.AddLayerType pFeatureLayer, esriGlobeLayerTypeFloating, False
    End If
End Sub
```

Appendix B – Use 3D Marker Symbols for a Layer Sample

The following VBA macro sample illustrates how to associate a 3D Marker symbol with an active layer. The 3D marker symbol can be loaded from any file containing a supported 3D model format such OpenFlight or 3D Studio Max..

To run this sample:

6. Ensure you have ArcGIS Desktop 9.0 or greater installed.
7. Open ArcGlobe.
8. Load a Point Feature Class
9. Copy-paste this procedure into ArcGlobe's VBA Editor.
10. Run the procedure.

```
Sub Test3DModels()

  ' Get the GlobeDisplay and the first layer in the TOC (a point feature dataset)
  Dim pGMxDoc As IGMxDocument
  Set pGMxDoc = ThisDocument

  Dim pScene As IScene
  Set pScene = pGMxDoc.Scene

  Dim pGlobe As IGlobe
  Set pGlobe = pScene

  Dim pGlobeDisp As IGlobeDisplay
  Set pGlobeDisp = pGlobe.GlobeDisplay

  ' Get the 1st Layer (sample assumes this is the layer we
  ' want to symbolize with 3DMarker
  Dim pLayer As ILayer
  Set pLayer = pScene.Layer(0)

  ' Choose/set properties and apply the Marker3D Symbol
  Dim pMarker3DSym As IMarker3DSymbol
  Set pMarker3DSym = New Marker3DSymbol

  ' Set thumbnail of new Marker 3D Symbol to nothing to overwrite the default
Marker3DSymbol thumbnail
  Set pMarker3DSym.Thumbnail = Nothing

  ' Change the next line to point to a valid 3D Model file
  pMarker3DSym.CreateFromFile ("{MyOpenFlight.flt | My3ds.3ds | etc.}")
  pMarker3DSym.UseMaterialDraping = True

  ' Set the Symbol Size big enough that we can see it
  Dim pSymbol As IMarkerSymbol
  Set pSymbol = pMarker3DSym
  pSymbol.size = 1000

  ' Set the Symbol for the layer
  Dim pRen As ISimpleRenderer
  Dim pGeoFeatLyr As IGeoFeatureLayer
  Set pGeoFeatLyr = pLayer
  Set pRen = pGeoFeatLyr.Renderer
  Set pRen.Symbol = pMarker3DSym

End Sub
```

Appendix C – MOLE Add 3D Layer Sample

The following VBA macro sample illustrates the loading and configuring of MOLE layers for 3D use in ArcGlobe. To test loading a layer with this sample, use one of the MOLE test datasets that are provided with the MOLE tutorial data (available with the MOLE install).

To run this sample:

1. Ensure you have ArcGIS Desktop 9.1 with the 3D Analyst and MOLE extensions installed.
2. Open ArcGlobe.
3. Copy-paste this procedure into ArcGlobe's VBA Editor.
4. Run the procedure.

```
Sub TestLoad3DMoleLayer()
    '
    ' Don't forget to add a references to ESRI Catalog and MOLE
    ' Object Libraries to get access to all of these types
    '
    Dim pGxDialog As IGxDialog
    Dim pGxObjectFilter As IGxObjectFilter
    Dim pGxDataset As IGxDataset
    Dim pDataset As IDataset
    Dim pSelection As IEnumGxObject

    Dim pFeatureClass As IFeatureClass
    Dim pLayer As ICachedGraphicFeatureLayer
    Dim pForceElementLayer As IForceElementLayer
    Dim pFeatureLayer As IGeoFeatureLayer
    '
    ' Display GxDialog to select a feature data source (feature class)
    '
    Set pGxObjectFilter = New GxFilterPointFeatureClasses
    Set pGxDialog = New GxDialog

    Set pGxDialog.ObjectFilter = pGxObjectFilter

    pGxDialog.DoModalOpen 0, pSelection

    Set pGxDataset = pSelection.Next

    If Not pGxDataset Is Nothing Then
        '
        ' Create a feature layer from the selected GxObject
        '
        Set pDataset = pGxDataset.Dataset
        Set pFeatureLayer = New FeatureLayer
        Set pFeatureLayer.FeatureClass = pDataset
        '
        ' Create a MOLE layer and attach the feature layer to it
        '
        Set pLayer = New ForceElementLayer
        Set pLayer.FeatureLayer = pFeatureLayer
        Set pForceElementLayer = pLayer
        '
        ' Set the desired size for symbols in the layer
        '
        pForceElementLayer.Size = 0.05
        '
        ' --------- Set the 3D Display Options/Settings -----------
```

```
        '
        Dim pDDDSettings As I3DSettings
        Set pDDDSettings = pLayer
        '
        ' NOTE: This is the only 3D specific code, all of the other code in this
        '       macro is just general MOLE usage, regardless of 2D/3D Application
        '
        '
        ' Set the 3D Display Option - this indicates if the symbols should be
        ' displayed as Draped (on the terrain), Extruded (elevated from the terrain),
        ' or Both (Draped and Extruded)
        '
        pDDDSettings.DisplayOption = mole3DDisplayBoth

        '
        ' Set the Extrusion Height in meters
        '
        pDDDSettings.DefaultElevationMeters = 10000
        '
        ' Set the visibility of the Symbol Callout Lines
        '
        pDDDSettings.EnableCallouts = True
        '
        ' --------- Done Setting the 3D Display Options/Settings -----------
        '

        '
        ' Get the Globe from the Document
        '
        Dim pGMxDoc As IGMxDocument
        Set pGMxDoc = ThisDocument

        Dim pScene As IScene
        Set pScene = pGMxDoc.Scene

        Dim pGlobe As IGlobe
        Set pGlobe = pScene

        '
        ' Then Add the Layer
        '
        Dim pTheLayer As ILayer
        Set pTheLayer = pLayer

        pTheLayer.Name = pDataset.Name

        pGlobe.AddLayerType pLayer, esriGlobeLayerTypeDraped, False
    End If
End Sub
```

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