Southeast Florida FSUTMS Users Group
Cube 5.0 Hands-On Training Workshop

Sponsored by FDOT Central Systems Planning Office, FDOT-D4, & Citilabs

Date: Tuesday, July 1, 2008
Time: 10:00 AM
Location: FDOT-D4 Ft. Lauderdale Operations Center
5548 N.W. 9th Ave (Powerline Rd.), Ft. Lauderdale, FL 33309

AGENDA

10:00 ~ 10:15 **Welcome, Introduction, & Announcements**
Min-Tang Li, FDOT-D4

10:15 ~ 12:00 **Cube 5.0 Training Section I**
Wade White, Citilabs

12:00 ~ 13:30 **Lunch Break (on your own)**

13:30 ~ 15:30 **Cube 5.0 Training Section II**
Wade White, Citilabs

15:30 ~ 15:45 **Break**

15:45 ~ 16:30 **Questions and Discussions**

16:30 **Adjournment**

Next Meeting: 9:30 AM, Friday, August 15, 2008.

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Using Embedded ArcGIS Features In Cube 5

Cube 5 Hands-On Workshop
July 1, 2008
Wade White, AICP

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About Cube 5.0 – A Review

- New Cube Graphics Window for mapping GIS data
- ESRI ArcGIS Engine – same display technology used by ArcGIS Desktop
- Cube Geodatabases – same data storage format used by ArcGIS Desktop
- Existing models can run using Cube Geodatabase inputs & outputs
- New models can be built from GIS data in standard ESRI formats
- Maps featuring model data can be shared with GIS staff
- Many familiar user interface elements and tools

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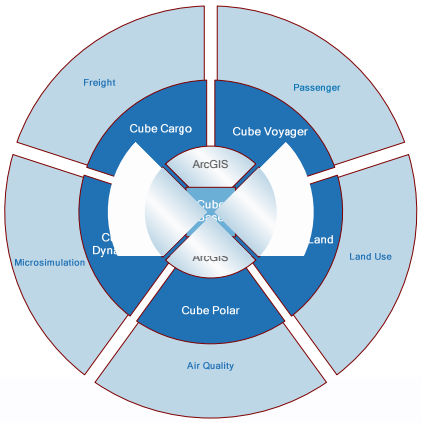
ArcGIS and Cube Compared

The ArcGIS Flower

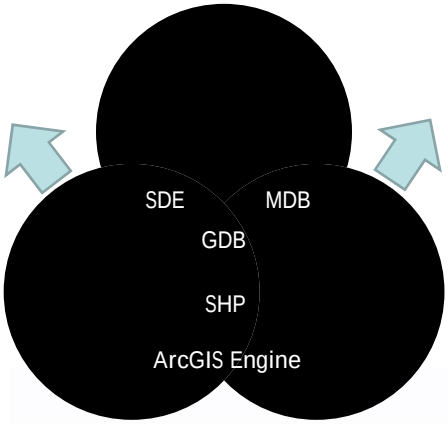
The Cube Flower



Related Technologies

- ArcGIS Desktop
  - ArcView
  - ArcEditor
  - ArcInfo
  - *ArcMap, ArcCatalog, ArcToolbox*
  - ArcPublisher/ArcReader
- Server GIS (replaces ArcSDE)
  - ArcGIS Server
  - ArcGIS Image Server
  - ArcIMS (web delivery)
- Geodatabase types
  - Enterprise
  - Workgroup
  - Personal
  - File
- Developer Tools
  - Scripting (Python etc...)
  - Automation (VBA etc...)
  - Extensions
  - Applications

- Microsoft Office
  - Access
  - Excel
  - VBA
- SQL Server
- Visual Studio



- Cube Base
  - Cube Graphics
  - Application Manager
  - Scenario Manager
- Cube Voyager
  - Cube Cluster
  - Cube Avenue
  - ...Cube Land
- Cube Analyst
- Cube Cargo
- Cube Dynasim
- Accession
- Polar

- ...Cube Web

- TP+
- TRANPLAN
- TRIPS

Importing & Managing Data

- Creating & Opening Geodatabases
- Importing Feature Classes From Legacy Formats
  - Point, Line, and Polygon Shapefiles
  - Cube Voyager Highway & Transit Networks
- Copy Feature Class To & From Other GDBs
- Building Networks From Feature Classes
- Setting Spatial Reference & Projection
- Export to Legacy Formats
- Model Considerations

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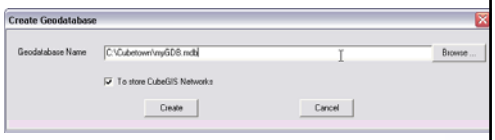
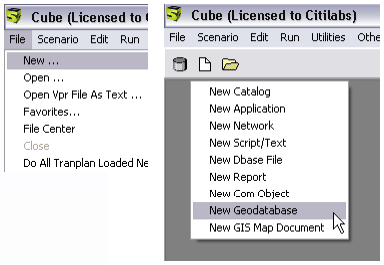
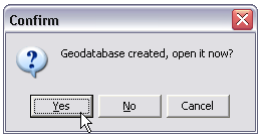
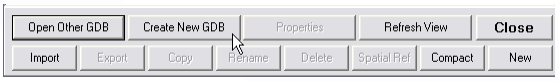
Getting Started

- Creating a Cube Geodatabase









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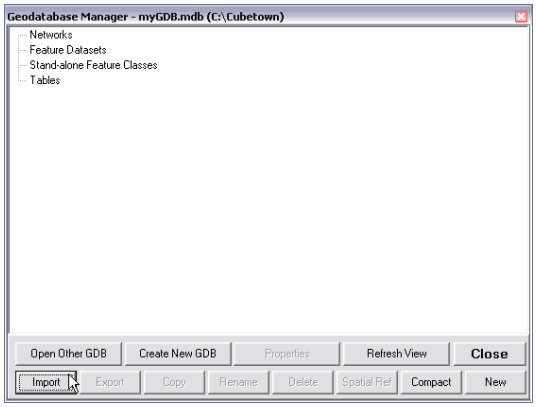
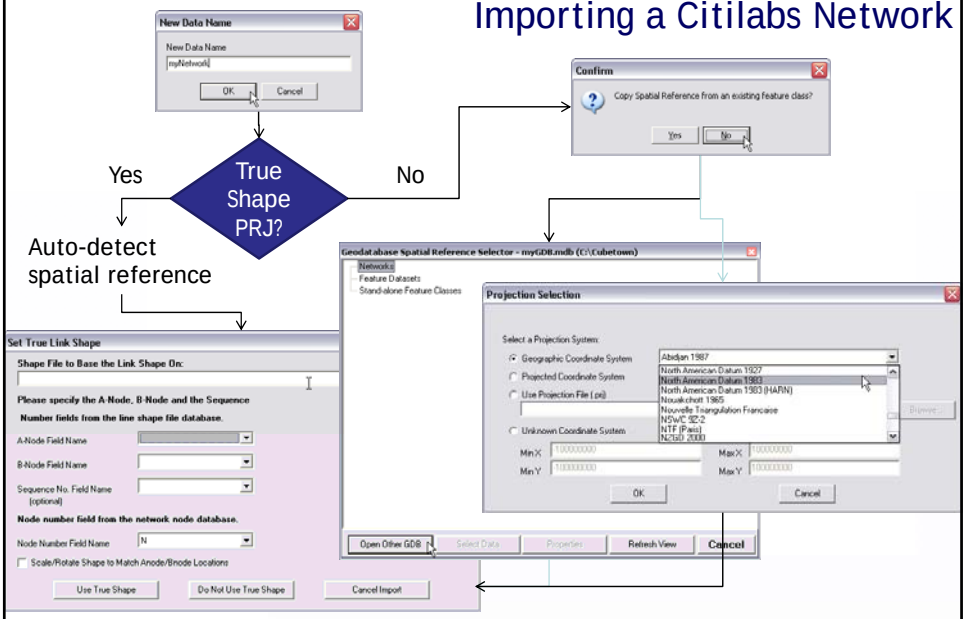
Importing Feature Classes From Legacy Formats

- Supported formats:
  - Citilabs Network Files (*.net)
  - Text PT Line Files (*.lin)
  - Text NT Leg Files (*.ntl)
  - ESRI Shape Files (*.shp)
  - xBase DBF Files (*.dbf)

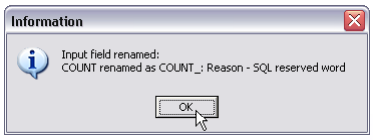


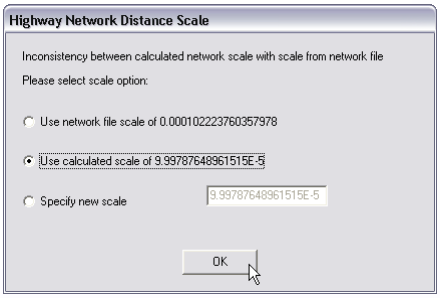
Importing a Citilabs Network



Automatic Import Checks

- SQL reserved words
- Network distance scale





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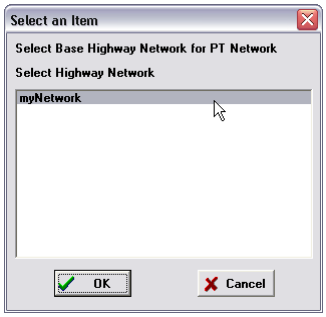
Importing Transit Lines

- Select the highway network to which the transit data correspond
- You can change this setting later using the Synchronize button (available only when transit data are highlighted in the geodatabase browse.



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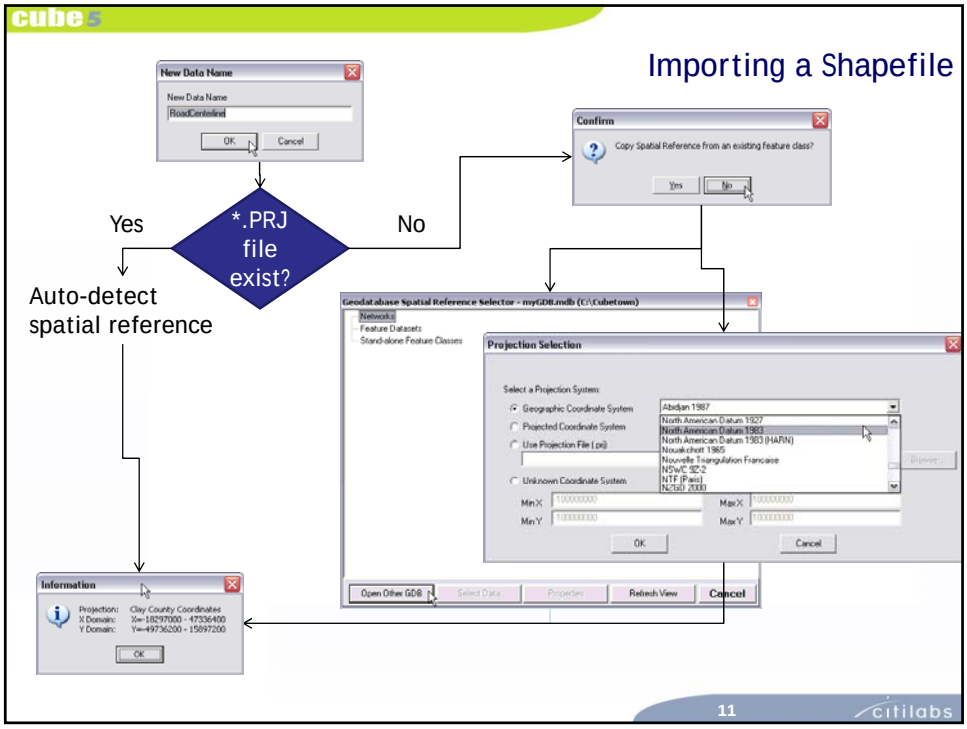
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Importing a Shapefile
New Data Name
New Data Name
RoadCenterline
OK
Cancel
*.PRJ file exist?
Yes
No
Auto-detect spatial reference
Confirm
Copy Spatial Reference from an existing feature class?
Yes
No
Geodatabase Spatial Reference Selector - myGDB.mdb (C:\Cubetown)
Networks
Feature Datasets
Stand-alone Feature Classes
Projection Selection
Select a Projection System:
Geographic Coordinate System
Projected Coordinate System
Use Projection File (.prj)
Unknown Coordinate System
Abidjan 1987
North American Datum 1927
North American Datum 1983
North American Datum 1983 (HARN)
Nouakchott 1965
Nouvelle Triangulation Francaise
NSWC 9Z-2
NTF (Paris)
NZGD 2000
Min X
Min Y
Max X
Max Y
OK
Cancel
Information
Projection: Clay County Coordinates
X Domain: X=-18297000 - 47336400
Y Domain: Y=-49736200 - 15897200
OK
Open Other GDB
Select Data
Properties
Refresh View
Cancel
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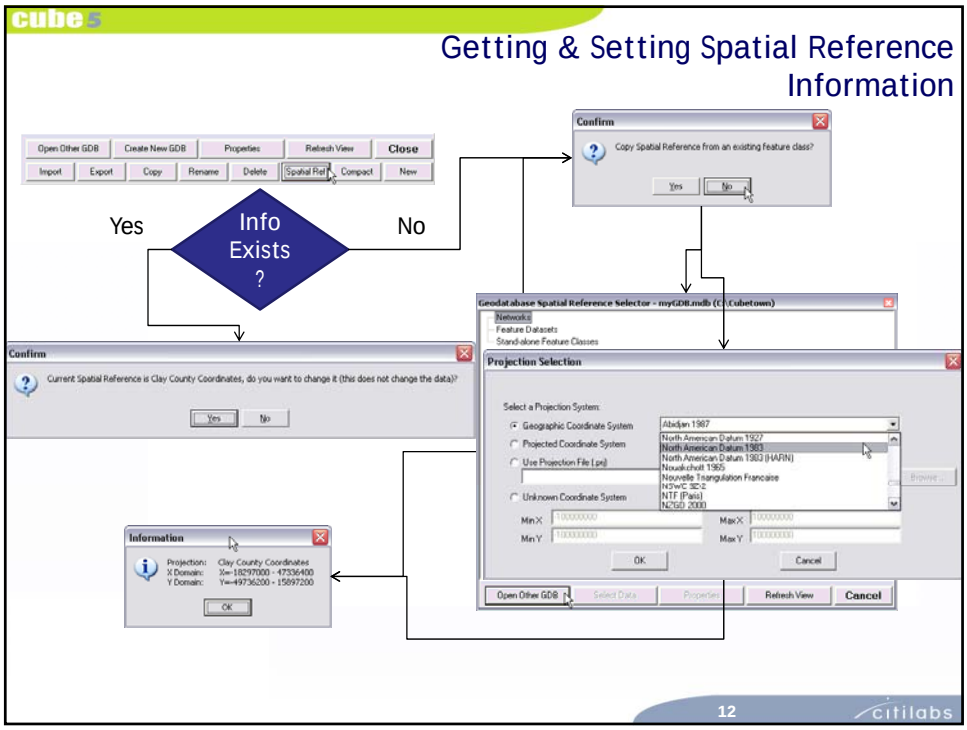
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Getting & Setting Spatial Reference Information
Open Other GDB
Create New GDB
Properties
Refresh View
Close
Import
Export
Copy
Rename
Delete
Spatial Ref
Compact
New
Yes
Info Exists ?
No
Confirm
Copy Spatial Reference from an existing feature class?
Yes
No
Confirm
Current Spatial Reference is Clay County Coordinates, do you want to change it (this does not change the data)?
Yes
No
Geodatabase Spatial Reference Selector - myGDB.mdb (C:\Cubetown)
Networks
Feature Datasets
Stand-alone Feature Classes
Projection Selection
Select a Projection System:
Geographic Coordinate System
Projected Coordinate System
Use Projection File (.prj)
Unknown Coordinate System
Abidjan 1987
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Min X
Min Y
Max X
Max Y
OK
Cancel
Information
Projection: Clay County Coordinates
X Domain: X=-18297000 - 47336400
Y Domain: Y=-49736200 - 15897200
OK
Open Other GDB
Select Data
Properties
Refresh View
Cancel
12
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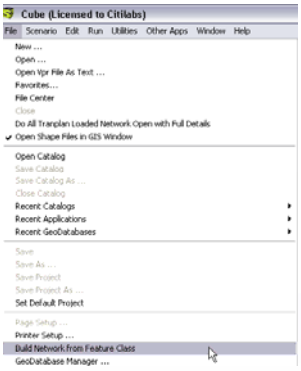
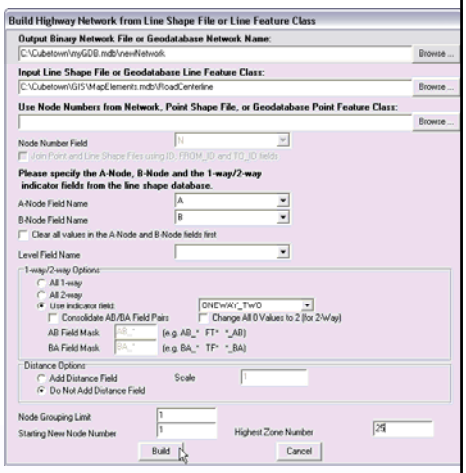
Building a Network

- Input: MDB or SHP
- Output: MDB or NET





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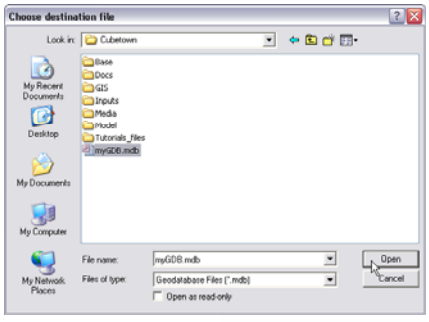
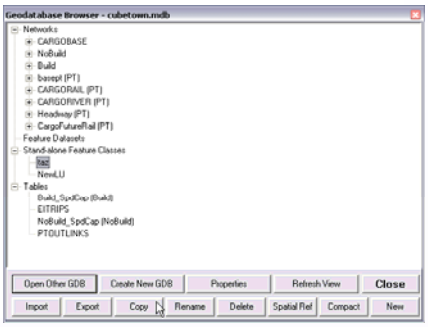
Copying Data Between GDB Files

- Open source GDB
- Select source data
- Select destination GDB





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Exporting Data to Legacy Formats

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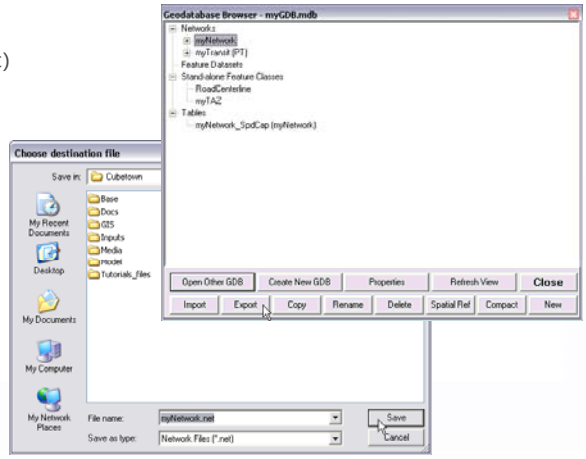
  - ESRI Shape Files (*.shp)
  - xBase DBF Files (*.dbf)



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The Geodatabase in Voyager

- The following modules can now read and write data (primarily attribute tables) to and from geodatabases:
  - MATRIX, GENERATION, FRATAR, DISTRIBUTION
  - NETWORK
  - HIGHWAY
  - PUBLIC TRANSPORT
- Legacy binary network files can still be used for intermediate model steps if desired.

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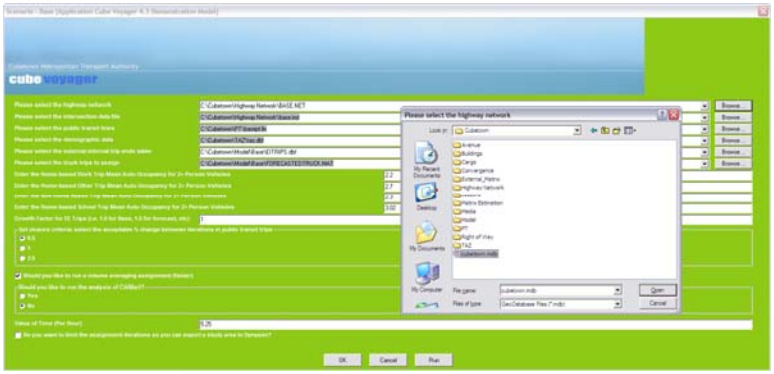
Referencing Geodatabases

- In general geodatabase feature classes can be referenced in script using the full path:
  path to geodatabase + "\" + *data name*
  e.g. C:\Cubetown\cubetown.mdb\BASE
- If multiple GDB networks are used in a NETWORK step, the GeometrySource field can be used to indicate which file should provide the shape of each link

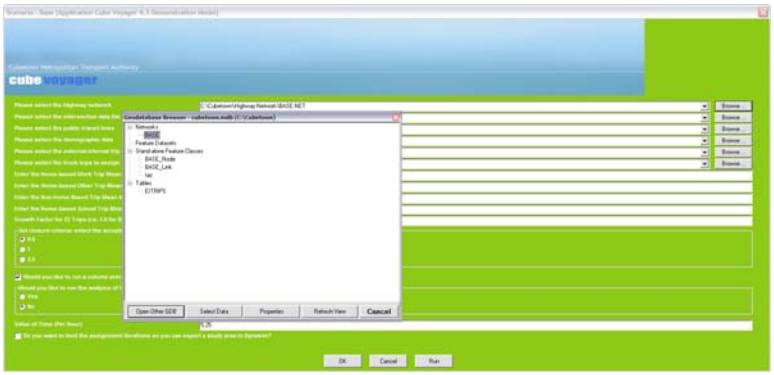
Linking With Scenario Manager

- Right-click the "Base" scenario to edit it. Click on "Browse…" next to the highway network to open "C:\Cubetown\cubetown.mdb".



The Geodatabase Browser

- The GDB browser appears when the MDB is opened. Click the "Select Data" button



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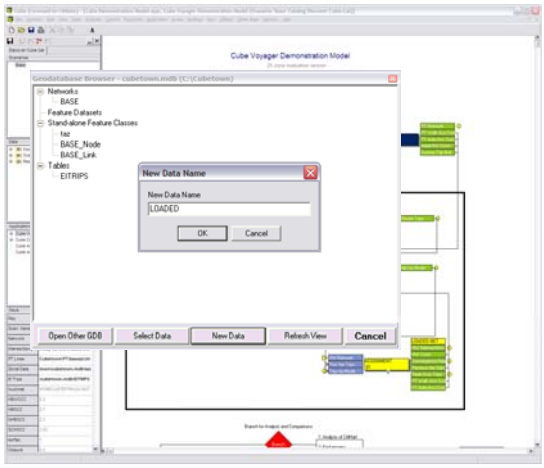
Linking With Application Manager

- You can also link GDB files directly in Application Manager.
- Right-click and select "Link to File" or "New File", then browse to the MDB file to open the geodatabase browser



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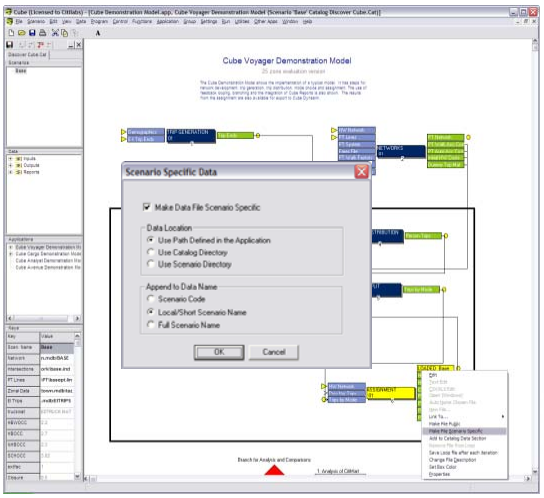
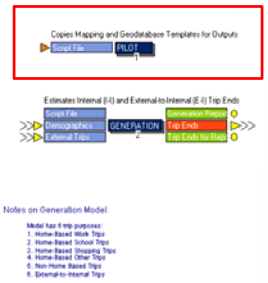
Scenario-Specific Data

You can make networks and tables output to the geodatabase scenario-specific by appending the short scenario name to the data name specified in the application. Right-click on the output HW Loads box for the ASSIGNMENT step and select "Make File Scenario Specific". In the Scenario Specific Data dialog, check "Make Data File Scenario Specific" and select the "Use Path Defined in the Application" Data Location option as well as the "Local/Short Scenario Name" Append to Data Name option.



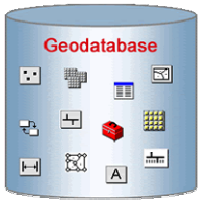
Scenario-Specific Geodatabases

- You can also create scenario-specific output geodatabases by copying an empty "template" MDB file to the scenario directory
- If you create a VPR file to accompany the MDB, you can copy it as well, providing ready-made line color and style settings to facilitate review
- The scenario-specific output GDB should have the same name in each scenario directory so that it can be linked in script e.g.: {SCENARIO_DIR}\output.mdb\HwyLoads
- An example of this is found in Cubetown ->



Model Considerations: GDB Use

- The personal geodatabase MDB file is a great format for sharing data across and within organizations in an enterprise GIS
  - Input: link to & use data provided by other departments
  - Check out of ArcGIS Server (SDE)
  - Output: easy to review outputs—just share the scenario MDB!
- But it has some performance drawbacks (slow read and write) inherited from ArcGIS
- Also there is a total size limitation
- Trade-offs: How pervasive should a GDB be? How many different GDB's per model? When should a scenario-specific GDB be used?



Relational Database Logic

- Tables and feature classes in a geodatabase can be *related* by common attribute fields via DBI *joins*
  - e.g. FILEI DBI[1]=MyGDB.mdb\Streets, SORT=ID
    FILEI DBI[2]=MyGDB.mdb\StreetTypes, SORT=Type_ID, JoinToDBI=1, JoinToFields=Type_ID
    FILEI DBI[3]=MyGDB.mdb\CapClass, SORT=Cap_ID, JointoDBI=2, JoinToFields=Cap_ID

Streets		
ID	Name	Type_ID
1	Wood	4
2	Davidson	7
3	Mercer	2
4	Green	3
5	Oak	1
6	Main	1
7	Barrett	1
…		

StreetTypes		
Type_ID	Lanes	Cap_ID
1	1	2
2	1	4
3	2	1
…		

CapClass	
Cap_ID	Capacity
1	850
2	1100
3	1250
4	1400
5	1800

Introducing DBI

- Similar to record processing plus lookup functionality plus support for MDB tables
- However, there is no automatic record-processing loop… the user must define behavior explicitly
- Allows the user to incorporate relational database logic (e.g. table joins) in Voyager without the need for external SQL

DBI Commands

```
FILEI DBI[1]=mygdb.mdb\data, ;fully qualified path to data name
   SORT=PrimaryKey, ;specify one or more sort fields
   AUTOARRAY=DataField, ;automatically make DataField array
   JOINTODBI=2, ;join to another DBI by FILEI no.
   JOINTOFIELDS=ForeignKey ;specify join field
```

COMP functions:

```
   DBIReadNext(1,R) ;move R records & read DBI 1
   DBIReadRecord(1,R) ;read record of absolute position R in DBI 1
   DBISeek(1,R) ;search for record matching value R in SORT fields
```

DBI Variables

- DI.#.NAME, where # is the DBI[#] index and NAME is the field name
- Special variables:
  - DBI.#: string variable containing the full data record
  - DBI.#.NUMFIELDS: the number of defined data fields
  - DBI.#.NUMRECORDS: the number of data records in file
  - DBI.#.RECNO: the number of the current record being processed.
- Current record info (dimensioned 1 to NUMFIELDS):
  - DBI.#.NAME: the name of the field
  - DBI.#.TYPE: the type of field (either 'N' for numeric or 'C' for character.
  - DBI.#.NFIELD: the numeric value for the field (0 if DBI.#.TYPE='C')
  - DBI.#.CFIELD: the string value for the field (Null if DBI.#.TYPE='N')
  - DBI.#.FIELDERR: a 1 if the field had a format conversion error
  - DBI.#.FIELDERRCNT: the cumulative count of errors for this field.

Multi-Field Lookup

```
RUN PGM=MATRIX
FILEO RECO[1] = "DBI_Examples.mdb\DataDiff",
  FIELDS= A, B, LIGHT_1, LIGHT_2, DIFF_LIGHT, HEAVY_1,
HEAVY_2, DIFF_HEAVY
FILEI DBI[2] = "DBI_Examples.mdb\database2",  SORT = A, B
FILEI DBI[1] = "DBI_Examples.mdb\database1",  SORT = A, B
ZONES=1

LOOP K=1, DBI.1.NUMRECORDS
C=DBIREADRECORD(1,K)
A=DI.1.A
B=DI.1.B
LIGHT_1 = DI.1.LIGHT
HEAVY_1 = DI.1.HEAVY
L=DBISEEK(2,A,B)
LIGHT_2 = DI.2.LIGHT
HEAVY_2 = DI.2.HEAVY
 DIFF_LIGHT = LIGHT_1 - LIGHT_2
DIFF_HEAVY = HEAVY_1 - HEAVY_2
RO.A=A
RO.B=B
RO.DIFF_LIGHT = DIFF_LIGHT
RO.LIGHT_1 = LIGHT_1
RO.LIGHT_2 = LIGHT_2
RO.DIFF_HEAVY = DIFF_HEAVY
RO.HEAVY_1 = HEAVY_1
RO.HEAVY_2 = HEAVY_2
WRITE RECO=1
ENDLOOP
ENDRUN
```

- Two tables, same size
- For each record in 1:
  - Get A, B, LIGHT, HEAVY
  - Find match in 2
  - Get LIGHT, HEAVY values
  - Compare
  - Write record to output

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Join Example

```
RUN PGM=MATRIX
FILEI DBI[1] =
"C:\DBI\Examples\DBI_Examples.mdb\SFZONEDATA"
FILEI DBI[2] =
"C:\DBI\Examples\DBI_Examples.mdb\DU_SIZE_FACTORS",
SORT=SIZERANGE JOINTODBI=1  JOINTOFIELDS=SIZERANGE
FILEO RECO[1] =
"C:\DBI\Examples\DBI_Examples.mdb\SFSIZE",
  FIELDS=ZONE_,SF1PER,SF2PER,SF3PER,SF4PER,SF5PLUS

; This example computes the number of single family
; dwelling units in each of 5 dwelling unit size classes
ZONES=1 ;if no MATI, must define the zones
LOOP k=1,DBI.1.NUMRECORDS ;process all records in DBI 1
x=DBIReadRecord(1,k) ;read the kth record from DBI file 1
;access fields on the current record of the joined DBI files
RO.ZONE_=DI.1.ZONE_
RO.SF1PER=ROUND(DI.1.SFDU*DI.2.PCT1PER)
RO.SF2PER=ROUND(DI.1.SFDU*DI.2.PCT2PER)
RO.SF3PER=ROUND(DI.1.SFDU*DI.2.PCT3PER)
RO.SF4PER=ROUND(DI.1.SFDU*DI.2.PCT4PER)
RO.SF5PLUS=DI.1.SFDU-RO.SF1PER-RO.SF2PER-RO.SF3PER-
RO.SF4PER

; write the current values of reco fields reference on the
RECO file
WRITE RECO=1
ENDLOOP

ENDRUN

ENDRUN
```

- Two tables, same size, joined on SIZERANGE
- For each record in 1:
  - Get DBI 2 HH size factor for sizes 1-4
  - Multiply by SF DU & get 5
  - Write record to output
- Join auto-positions DBI 2 at matching field record

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Custom Looping

```
RUN PGM=MATRIX
FILEO RECO[1]=
"DBI_Examples.mdb\DBFMATRIX",
 FIELDS=I,J,MATVALUE
FILEI DBI[1] = "DBI_Examples.mdb\AlfaBeta"
FILEI MATI[1] = "MATRIX.MAT"
FILEO MATO[1] = "DGMAT00A.MAT",
  MO=1
MW[1] = MI.1.1

:REPEAT
C = DBIREADNEXT(1)
RECREAD = RECREAD + 1
IF (I = DI.1.ZONE_)  MW[1] = MW[1] * DI.1.BETA
IF (I = 0) GOTO :REPEAT
JLOOP
ro.I=I
ro.J=j
ro.MATVALUE=MW[1]
WRITE RECO=1
ENDJLOOP

ENDRUN
```

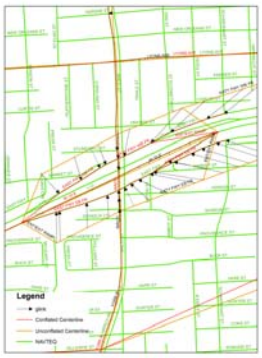
- DBI within I loop
- For each I zone in MATI:
  - Get ZONE_
  - Find matching DBI record
  - Multiply MI.1.1 by BETA
  - Write output matrix
- Uses labels to control looping behavior

Database Normalization

- The process of transforming a flat table into multiple related tables = normalization
- Benefits:
  - The core network contains only what a given model needs
  - Additional purpose-specific views can be created for a particular application or mapping task
- Costs:
  - Additional processing time to create needed tables required
  - Currently only available in MATRIX DBI: dump to TXT/DBF/MDB and re-merge with network
  - Not available on-the-fly yet (coming soon)

Importance of Network Conflation

- In an enterprise GIS, data is shared across and within organizations, yielding new insights & greater productivity
  - Facility operations & asset management databases
  - Traffic count data and summary information
  - Safety & performance monitoring datasets
- Attribute linkages are much easier to create if layers are conflated i.e. share geometry
- Without conflation different transportation infrastructure datasets remain separate; only relatable by overlaying on maps



Options for Network Conflation

- Option 1: Use Cube GIS Tools to snap nodes and generate true shape equivalencies, then import to a geodatabase for maintenance
- Option 2: Import to geodatabase and edit shape vertices in the Cube GIS editor window
- Option 3: Use ArcGIS Desktop (if available) to edit & conflate data and then import/build network in Cube
- Option 4: Citilabs & partners offer bundled data & services to provide a turnkey solution with custom software for maintenance

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Master Networks

- Store all links in a single network feature dataset and extract multiple alternatives/years
- Example attribute list:
  - ANODE: the "from" node of the link
  - BNODE: the "to" node of the link
  - ONEWAY – [optional] field which is equal to 1 if one-way street, 2 otherwise. If not used it is assumed that a separate reverse direction link exists
  - BASE_LANES – the base year number of lanes for the facility
  - BASE_FTYPE – the base year facility type code
  - EC_LANES – the E+C number of lanes
  - EC_FTYPE – the E+C facility type code
  - LR_LANES – the long-range (planning horizon) number of lanes
  - LR_FTYPE – the long-range (planning horizon) facility type
  - Y2010_CONFIG – a string indicating which version of the attributes to use in the 2010 network, or "DEL" to indicate that the link should not be present in 2010.
  - Y2020_CONFIG – same as above for 2020
  - Y2030_CONFIG – same as above for 2030
  - ALT2020_CONFIG – just add a field like the above to create a new scenario

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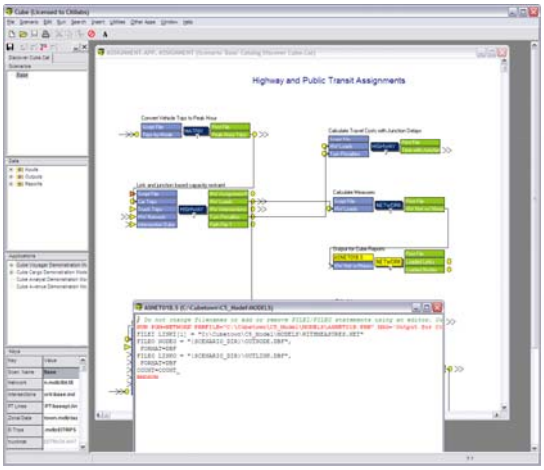
Reserved SQL Words

Because the Geodatabase Manager checks for and automatically renames attribute fields with names that conflict with SQL reserved words, you may need to modify some scripts to re-compute the desired variables.

For example, the Highway Assignment report uses the COUNT field to compare observed and estimated traffic volumes on the network, but this field was automatically renamed to COUNT_ during the import process. Therefore, in the NETWORK step that creates the DBF file used by Cube Reports, we must re-calculate "COUNT=COUNT_".



Working With Data

- Ways to Open and View Data
- A Tour of the User Interface
  - Zooming, Panning & Navigation
  - Selection & Query Tools
  - Search & View Management
  - The Graphics Toolbar
  - The Datasets Menu
  - The Editing Toolbar
- Adding Data to the Map
- Working With Layers in the Table of Contents
- Editing Feature Class Geometry
- Editing Feature Attributes

Ways to Open and View Data

- File > Open…
- Geodatabase Manager > Double-click on data
- Geodatabase Manager > “Add To Map” button
- File > New Map Document
- Datasets Menu
- Right-click on table of contents > Add data
- Double-click on item in Data Pane
- Double-click on item in Application Manager
- Click “Edit” button in Scenario Manager (applier’s mode only)…

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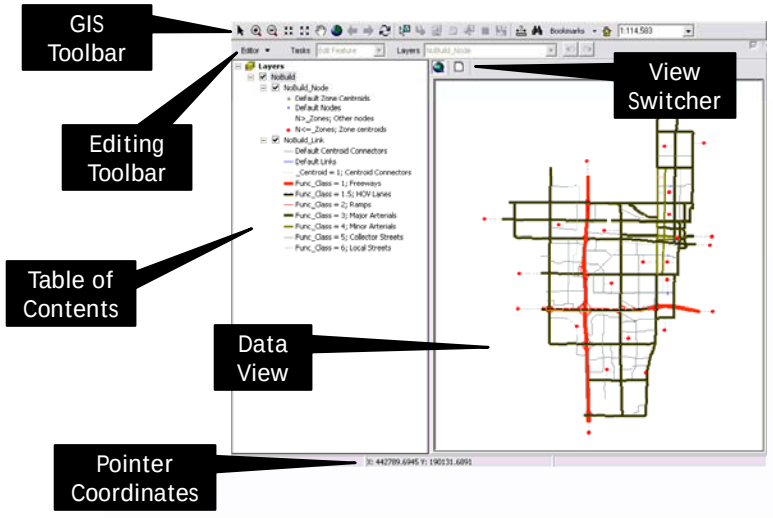
The GIS Window



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The GIS Toolbar: Navigation

- Pointer tool
- Rectangular zoom in/out
- Fixed zoom in/out
- Pan tool
- Zoom to full extent
- Previous / next extent
- Refresh map window

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The GIS Toolbar: Selection

- Select Features Pointer
- Select By Graphics Tool
- Select Features On Screen Button
- Clear Selection Button
- Zoom to Selection Button
- Select All Button
- Switch Selection Button

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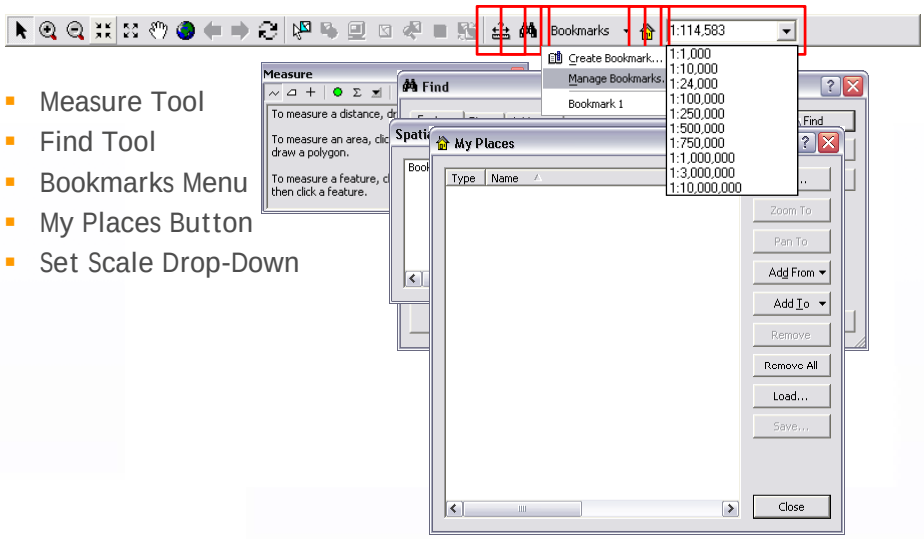
The GIS Toolbar: Search

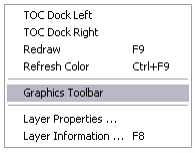


- Measure Tool
- Find Tool
- Bookmarks Menu
- My Places Button
- Set Scale Drop-Down

The Graphics Toolbar

- Enabled via “Graphics Toolbar” command on View menu

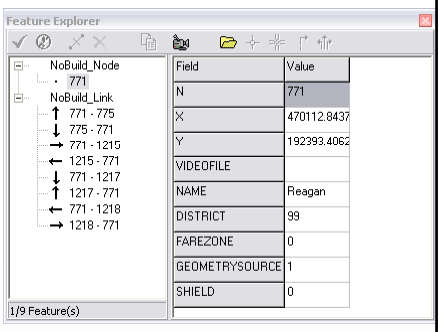
- Graphical shapes are non-geographic map elements
- Similar to Drawing Layer in Cube 4 Network Window
- Can be used to:
  - select features (polygon/screenline functions)
  - make annotation symbols (change color)
  - set / show view extent (using My Places)
- Draw graphical shapes
- Align graphical shapes (layout only)
- Adjust graphical drawing order & grouping
- Nudge & rotate graphical shapes



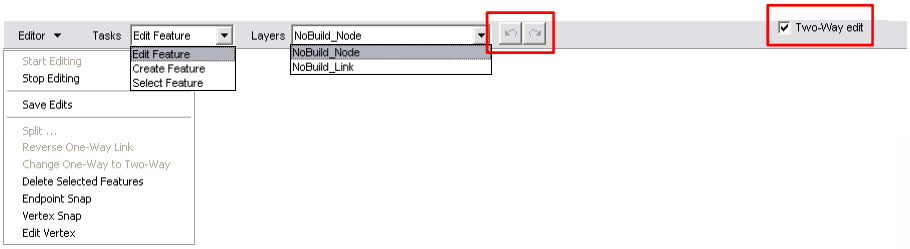
The Datasets Menu

- Feature Explorer:
  lists attributes of features you click on
- Select By Attributes:
  selects multiple features using a SQL query
- Set Selectable Layers:
  removes layers from selection (all included by default)

- Commands to add data
  - Geodatabase data (including model data)
  - Shapefiles
  - CAD data
  - Raster data (geo-referenced image files)



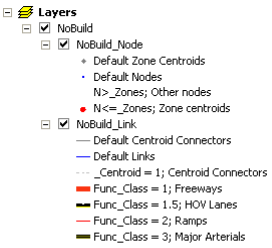
The Editing Toolbar

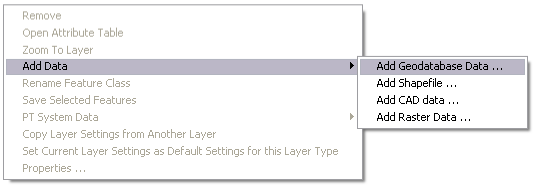


- Editor drop-down menu
- Tasks drop-down menu
- Layers drop-down menu
- Undo/redo buttons
- Two-way editing link editing option

The Table of Contents

- The Table of Contents lists all the layers and symbol settings
- Right-click on the white-space in the Table of Contents to get a context menu you can use to add a layer.
- Select Add Geodatabase Data





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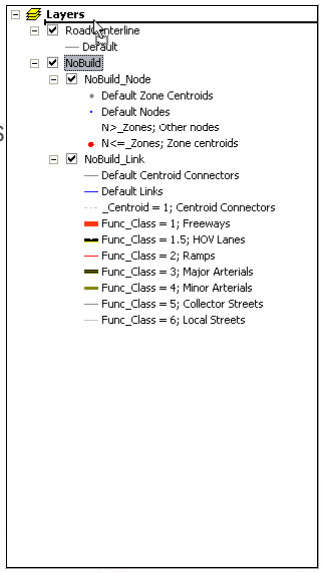
Managing Multiple Layers

- Layers at the top of the Table of Contents are drawn after layers at the bottom
- You can drag and drop individual layers in the list to change the drawing order
- Always move the network layer as a group.
- If the network layer group is separated, the data linkage remains intact but the software will no longer recognize the feature classes as part of a network.



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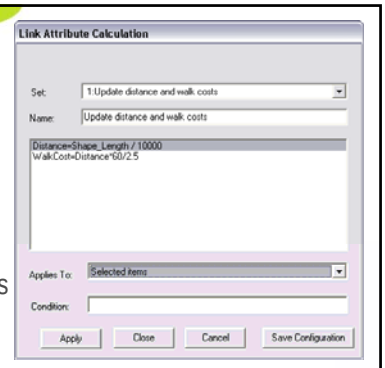
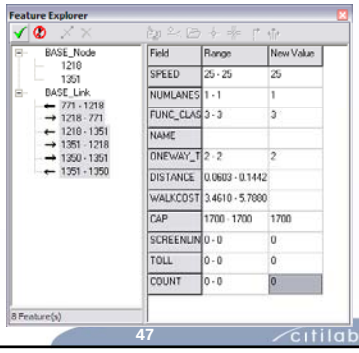
Making Attribute Calculations

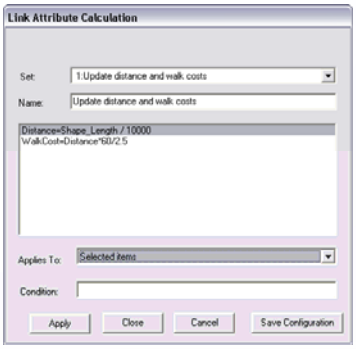
- Cube now uses the built-in Shape-Length system attribute to re-calculate distances when editing network links.
- Other attributes can be calculated selectively or for an entire area
- Selections can be created using graphics objects such as polygons (subareas), polylines (cordons), and ovals/rectangles
- The feature explorer also has a "range" mode that allows you to select and update multiple features interactively



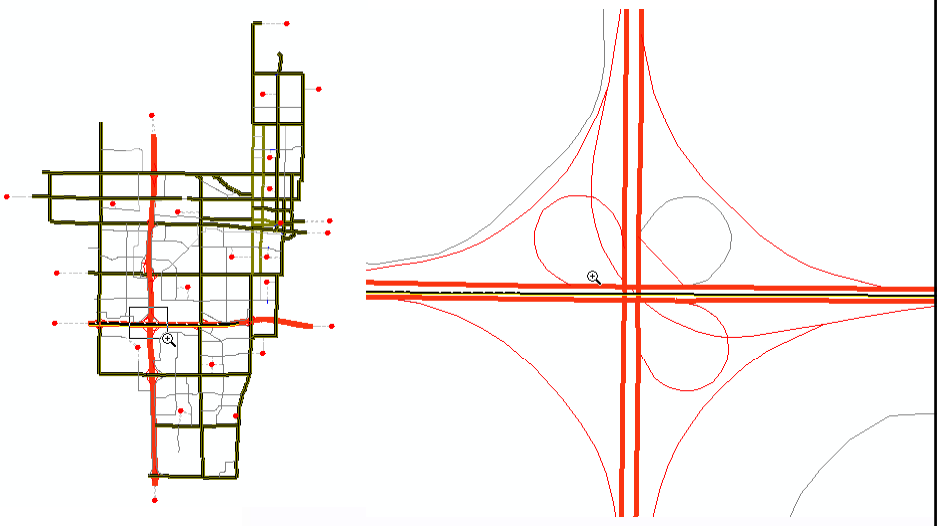


Using What You Know

1. On the editing toolbar, select Start Editing
2. From the Layers drop-down menu, select NoBuild_Link
3. Activate the Select Features tool on the GIS toolbar
4. Draw a rectangle on an area of the network
5. Click on the Zoom to Selected Features button to zoom in
6. Create a spatial Bookmark for the area
7. From the Link Menu, select Compute
8. On the Applies To drop-down, select Selected Items
9. Click Apply, then click Close.
10. On the Editor menu, select Stop Editing
11. Confirm that you want to save edits
12. Click on Go Back to Previous Extent



Zooming In On the Network



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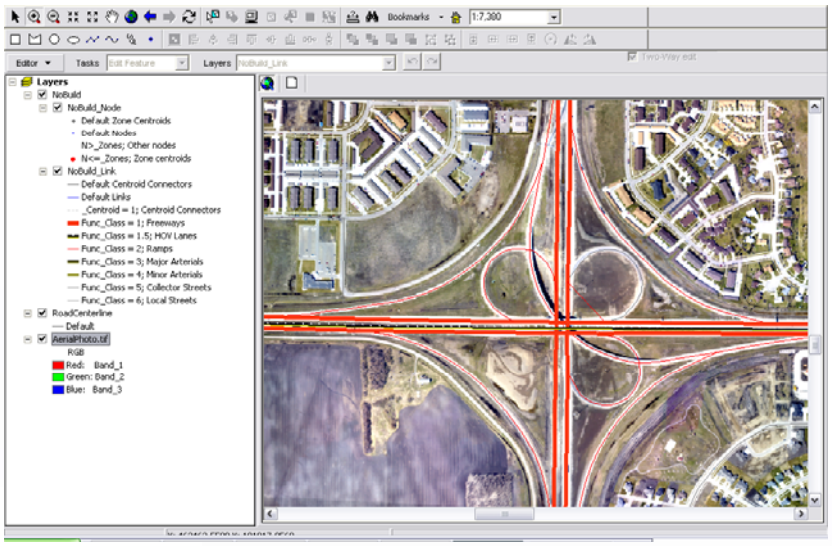
Compare With an Aerial Photo



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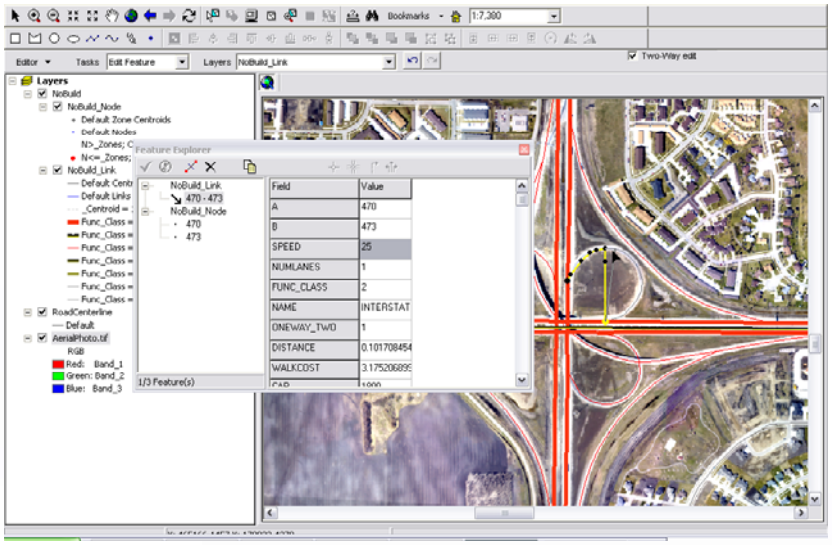
Edit Link Vertices



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Mapping & Reviewing Outputs

- The Layout View
- Example Maps
  - Street Base Mapping
  - Transit Mapping
  - Node/Point Chart Maps
  - Intersection Level Of Service Maps
  - Multi-Bandwidth Maps
  - Desire Line Maps
  - Path File Select Link Analysis
- Cube Posting Options
- Saving Settings in the VPR file
- Sharing maps using MXD files

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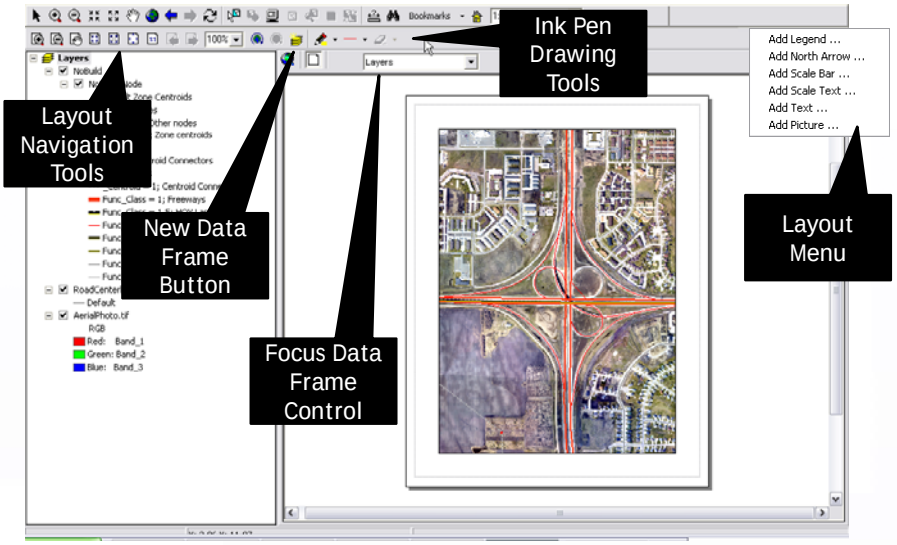
The Layout View



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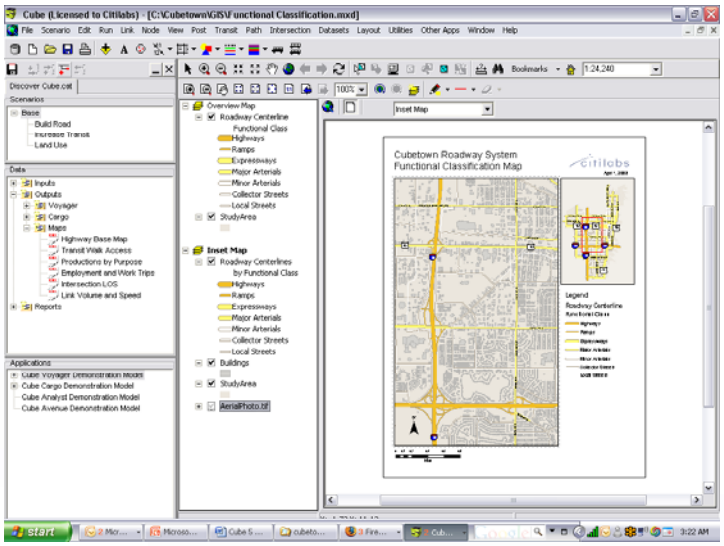
Example Maps



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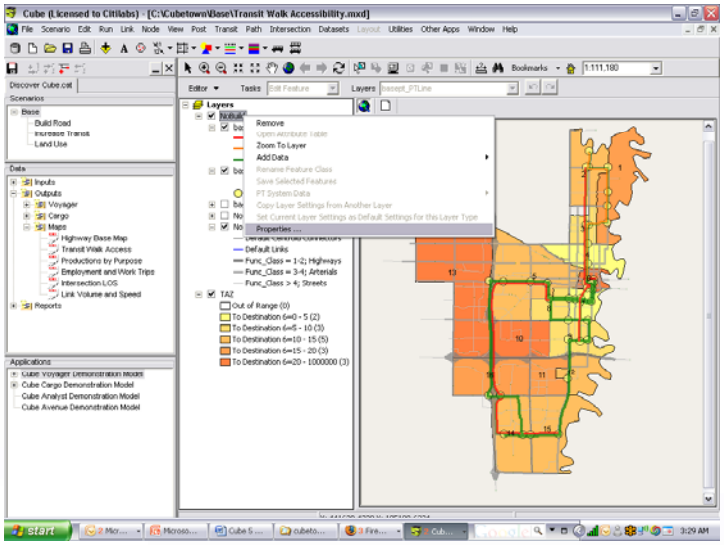
Transit Walk Access Map



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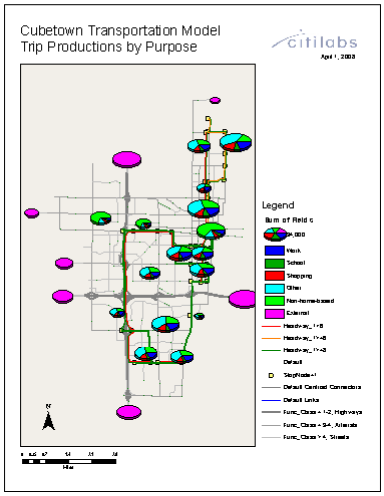
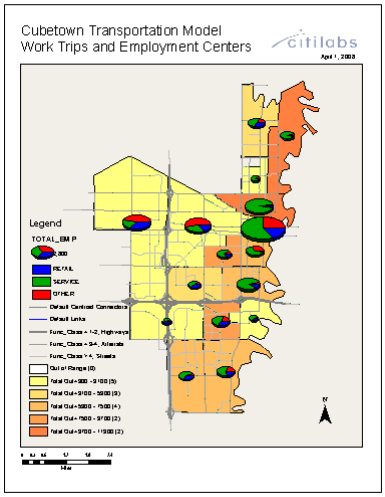
Node/Point Chart Maps





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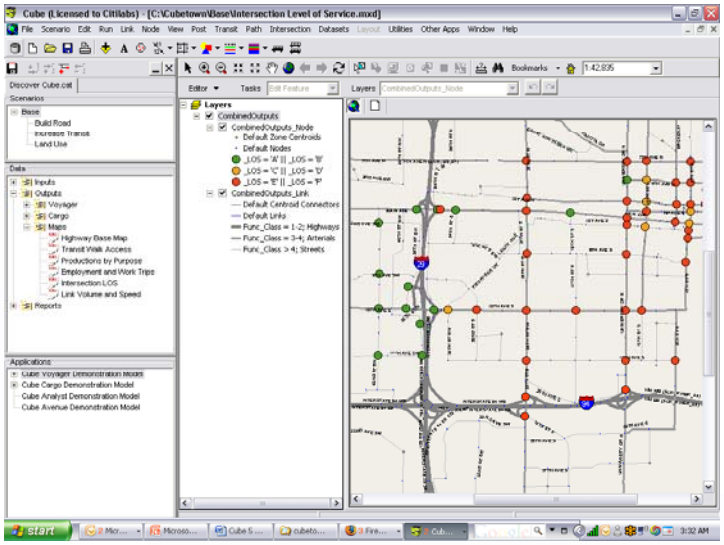
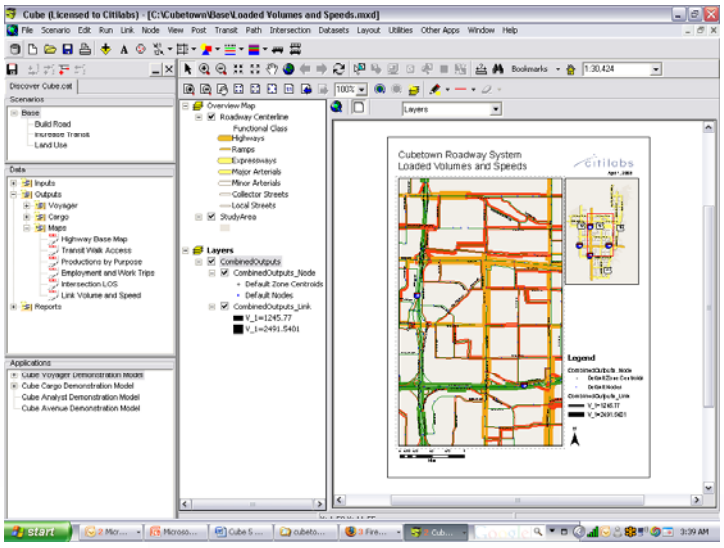
Intersection LOS Map

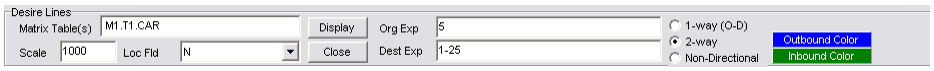


Link Volume and Speed

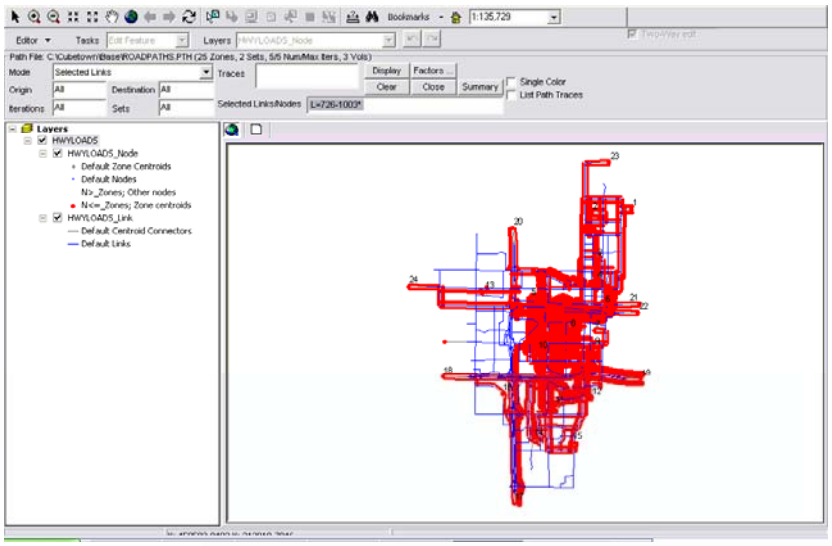


Creating a Desire Lines Map

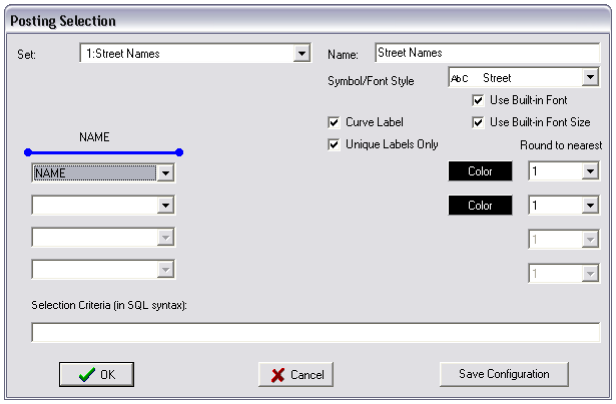
1. Open the output Mode Trips matrix
2. Open the output HW Loads network
3. From the Node menu, select Link to Matrix
4. Double-click on the Available Linkage and click Close
5. Go to Post > Desire Lines
6. Enter M1.T1.Car in Matrix Tables, 1000 in Scale, 5 in Org Exp, 1-25 in Dest Exp, and select 2-way
7. Click on the Display button to view desire lines



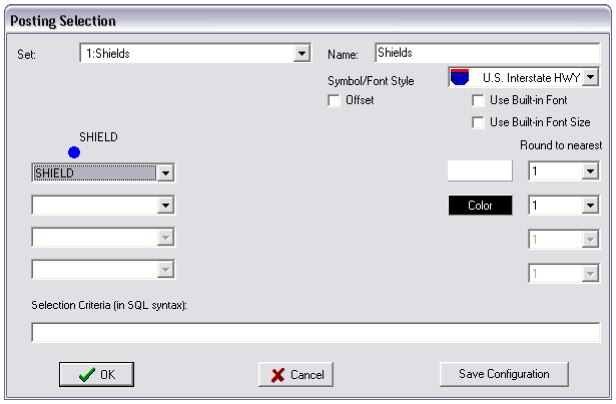
Path File Select Link Analysis



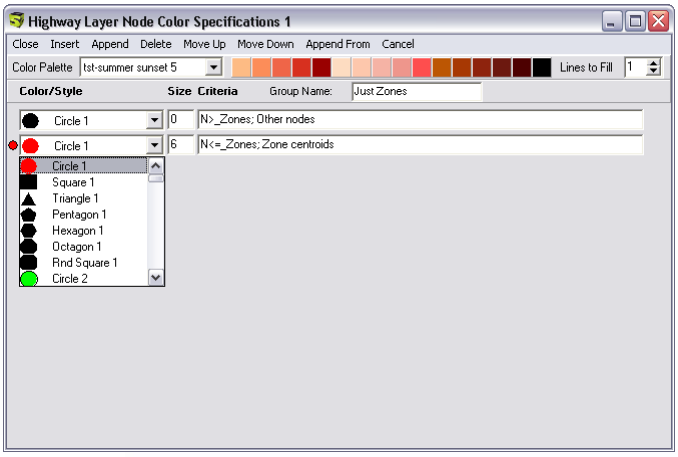
Link Posting Selection Options



Node Posting Selection Options



Node Color Specifications



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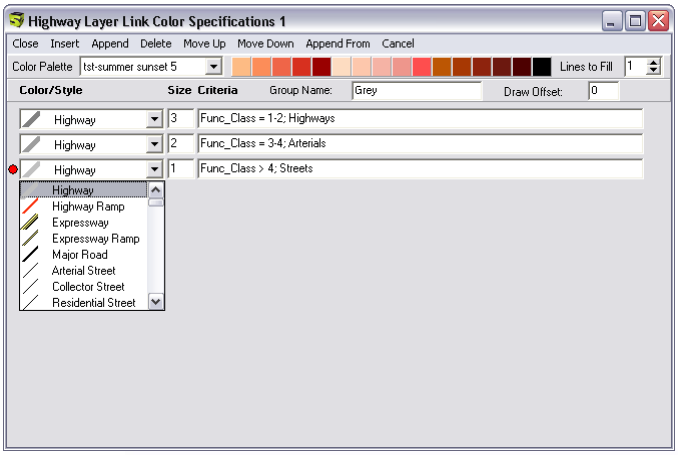
Link Color Specifications



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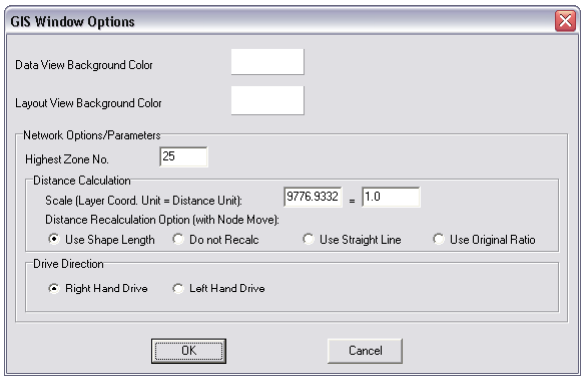
Network Options



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The roles of VPR and MXD files

- The Visual Project (VPR) file is still used in to track and store settings made in Cube 5, including:
  - Line/Node/Area color and symbol sets
  - Attribute posting and label symbol & style sets
  - Selection sets
  - Other network options
- A VPR is created for each MDB, with the same name as the MDB
- You can import settings from an existing VPR file for another MDB
- The MXD file is an ArcGIS-compatible map document, containing a "snapshot" of the current symbol style settings, with no link to VPR
- Changes stored in the VPR do not affect the MXD and vice versa!

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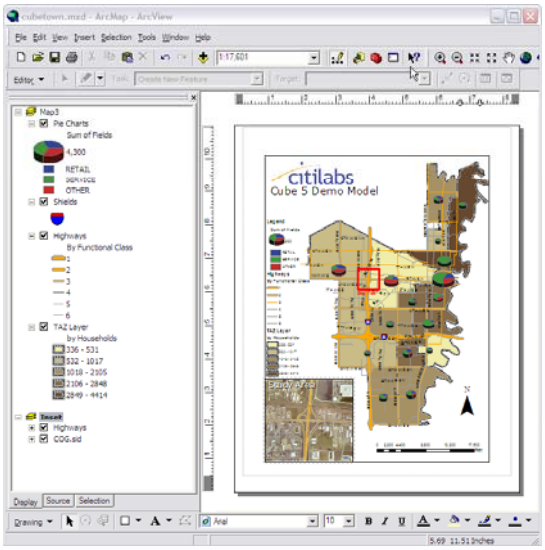
cube 5

Share With GIS Staff

You (or other GIS users) can also create maps for Cube 5 using ArcView 9.2. Add advanced elements such as multiple inset frames with extent rectangles or semi-transparent layers, and specify detailed symbol style and legend settings. Once your map is saved as an *.mxd file it can be opened in Cube 5 as well.



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