A GIS Database for Warehouse Operations

A Project for Geography 575
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Outline

• Background
• Design objectives
• Data
• Applications
  – Product distribution
  – Routing
• Limitations
• Conclusion
• GIS can be used to improve warehouse operations
  – ArcGIS’ Network Analyst can help:
    • Optimize product organization
    • Minimize the time clerks spend stocking shipments and assembling orders
• Application:
  – Velotech Inc. cycling retailer and warehouse

• Create a geodatabase that can:
  – Connect with a MS Access or other non-spatial database system to help manage products and warehouse operations
  – Optimize product locations
  – Determine the best routes for
    • Restocking products
    • Assembling orders
Data Structure

- Two databases
  - MS Access product information DB
  - ESRI Geodatabase
    - Feature dataset
    - Feature classes
    - Network dataset
    - Relationship classes
    - Tables

Product Database

- MS Access RDBMS Manages product attributes (color, size, sales, inventory, stock box size, etc.)
Product Database

- Can query DB and export tables for spatial analysis in ArcMap
- Can connect to ArcMap via OLE Database connection

Spatial Data

- Warehouse multipatch feature class created in Google SketchUp, imported into ArcScene
Spatial Data

• Used ArcScene’s 3D Editor to create point and line feature classes
  – Points for shelf locations
  – Lines for traversable paths

Spatial Data

• Shelf feature class attributes:
Spatial Data

- Created a network dataset with the point and line classes
  - Cost in walking speed (placeholder seconds)
  - Full connectivity
  - No turns modeled
  - No path names (no directions)

Application: Product Distribution

- Use an Origin-Destination Cost Matrix to optimize product locations by sales, box size, and location
  - Run OD Cost Matrix in Network Analyst
    - Assign location for origin
    - Assign locations for destinations
    - Solve
  - Combine shelf ranking results with product DB sorted by sales and stock box size
Application: Product Distribution

Step 1

- Export point table, now including ranks (ShelfODOOutput)
- Open in Excel alongside exported Access table with product ID, sales, and box size
- Integrate by sorting, copying
- Save new table (ProductsPlaced), import back into ArcGIS
- Join product ID, sales, and box size information into point feature class, save by creating new fields

Step 2
Integrating the Tables

Application: Picking an Order

- Add ordered products table to ArcMap document with geodatabase
- Join to Points file by product ID
- Query for points that host these products
- Add these locations to Vehicle Routing Problem tool in Network Analyst
- Add routes to VRP, define depot as Origin
- Solve and display
Application: Picking an Order

- Add pack-slip table to ArcMap document with geodatabase
- Join to Points file by product ID
- Query for points that host these products
- Add these locations to Vehicle Routing Problem tool in Network Analyst
- Add routes to VRP, define depot as Origin
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Application: Stocking a Shipment
Application: Stocking a Shipment

![Diagram of Stocking a Shipment]

Application: Stocking a Shipment

![Table of Stocking a Shipment]
Limitations

- Current topology point/line rules do not work with 3D
- Simplified version of warehouse, paths
- ArcGIS and Access do not fully integrate
  - Would need to create web application that integrates with both ArcGIS and Access in order to have Velotech staff & other users create a warehouse, run and re-run analyses easily

Limitations

- Need to automate second part of product distribution procedure, automate importation of order/shipment tables
- Though Network Analyst can perform its tasks using Z geometry, several issues remain:
  - Network Analyst does not have full functionality in ArcScene
  - ArcScene does not provide for labels or symbolization by sequence
Conclusions

• We have developed a geodatabase structure that can be used for our intended applications.
• Much more work is needed in automation, tool/model scripting, and development of a user interface in order for real businesses to use our product.
• 3D display and analysis with ArcGIS 10 leaves a lot of room for improvement.

Questions?