Paths Toward CAD and GIS Interoperability

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Gistic Research, Inc
## CAD and GIS: The Difference (I)

<table>
<thead>
<tr>
<th>Item</th>
<th>CAD</th>
<th>GIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>Initiated by academia, driven by private industry</td>
<td>Driven by government projects</td>
</tr>
<tr>
<td>Users</td>
<td>Architects, engineers, land surveyors</td>
<td>All</td>
</tr>
<tr>
<td>Geometry</td>
<td>Man-made objects Design, presentation through detail geometric specifications</td>
<td>Natural Environment Analysis and presentation through abstraction &amp; attribution</td>
</tr>
<tr>
<td>Topology</td>
<td>None</td>
<td>Important</td>
</tr>
<tr>
<td>Modeling space</td>
<td>2D/3D orthogonal</td>
<td>Geodetic or various projected spatial reference systems</td>
</tr>
<tr>
<td>Geo-references</td>
<td>None or Ground surface</td>
<td>Grid surface</td>
</tr>
<tr>
<td>Scale/Extents</td>
<td>Large scale, small extents</td>
<td>Small scale, large extents</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Higher</td>
<td>Lower</td>
</tr>
</tbody>
</table>
# CAD and GIS: The Difference (II)

<table>
<thead>
<tr>
<th>Item</th>
<th>CAD</th>
<th>GIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attribution</td>
<td>Via symbol (style, color etc), layers, text label, cell, etc</td>
<td>Database</td>
</tr>
<tr>
<td>2-D Geometry primitives</td>
<td>Include curve (circle and spline)</td>
<td>Circle has limited support; spline is not supported</td>
</tr>
<tr>
<td>Data organization</td>
<td>Layers or levels in single document</td>
<td>Each data layer is unit at the database level</td>
</tr>
<tr>
<td>RDMBS support</td>
<td>Limited</td>
<td>Good</td>
</tr>
<tr>
<td>Formats</td>
<td>Proprietary: DWG, DGN, etc</td>
<td>Proprietary: Shapefiles, SDE, etc</td>
</tr>
<tr>
<td></td>
<td>Intermediate: DXF, IGES</td>
<td>RDBMS spatial types: Oracle, IBM, ProgreSQL, MSSQL, etc</td>
</tr>
<tr>
<td></td>
<td>Common: Oracle Spatial?</td>
<td>Standards: OGC standards</td>
</tr>
</tbody>
</table>
Why CAD-GIS Integration

- GIS & CAD have more differences than similarities; they are destined to co-exist
- GIS needs data; there is an abundance of survey and design data developed and maintained in CAD files
- Design engineers need geographic context in which objects are to be designed and built in CAD
- In a project development cycle -

<table>
<thead>
<tr>
<th>Phase</th>
<th>Main Data Source</th>
<th>Integration direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan</td>
<td>GIS</td>
<td></td>
</tr>
<tr>
<td>Design/Build</td>
<td>CAD</td>
<td>GIS -&gt; CAD</td>
</tr>
<tr>
<td>Operate</td>
<td>GIS</td>
<td>CAD -&gt; GIS</td>
</tr>
</tbody>
</table>
Polls

- Which direction of CAD-GIS conversion is more important in your organization?
- List assets in your organization stored in CAD that need to be converted to GIS
- List assets in your organization stored in GIS that need to be converted to CAD
Interoperability via Data Conversion

- Via intermediate formats (such as DXF, IGES) that are supported by both CAD and GIS Software vendors
- Direct convert via 3rd-party tool such as FME by Safe Software
Interoperability via Common Format

CAD and GIS software supports read-and-write to some common formats that should meet the following criteria:

- Open Standards
  - OGC Simple Feature, SQL/MM, Simple Features 2.0
- Support Curves
  - Oracle Spatial
  - SQL Server 2012
- Supports NURBS Curves
  - Oracle 12
UDOT ROW: Project Objectives

- Select the best path for converting DGN files to GIS in Oracle Spatial
- Identify additional CAD standards
- Integrate with existing ROW application
CAD Drawing Evaluation

- Survey data is not fully available for CS projection into UTM
- Lack of conformance to existing CAD standards
- Existing CAD standards need to be extended to support conversion
- Historical CAD drawings and survey data may not be available
Selection of Paths

- 4 Approaches
  - Bentley
  - Bentley + ESRI
  - Bentley + ESRI with Interop Kit
  - Bentley + FME

- 5 Major Criteria
  - Coordinate System
  - Oracle Export
  - QA/QC
  - Automation
  - License
CAD to GIS Conversion Issues

- Spatial Reference System
  - Project CS vs Statewide standard CS: UTM 12N
  - Survey Plane vs. Projection Plane
- Geometry
  - Multiple spatial types
  - Curves
- Topology
  - Build ROW parcels and associate text labels with parcels
- Attribuition
  - Organizational CAD standards
  - Extraction of Annotation
  - Attribute and Object association
- QC
  - Orphans, Bad text label, Topology errors, Duplicate labels etc.
## UDOT ROW - Phased Implementation

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I</td>
<td>Capture and QC parcel info in ACTIVE projects into Oracle Spatial and tie geometry with ROW application (This phase is critical as it also handles on-going maintenance of parcel fabric once it is built in Phase II.)</td>
</tr>
<tr>
<td>Phase II</td>
<td>Spatially-enable entire ROW inventory by building statewide ROW parcel fabric in Oracle Spatial database</td>
</tr>
<tr>
<td>Phase III</td>
<td>Build web-based ROW applications for internal or public consumption</td>
</tr>
</tbody>
</table>
UDOT ROW - Phase I Diagram

UGear Phase I System Flow Overview
UDOT GIS-Enabled Application for ROW

UGear Admin

Web Application to setup the project for GIS loading:
- define the DGN files to be loaded
- define the project coordinate systems
- define recipient's) of QC messages
- browse processing log and error log
- schedule script execution time

By Administrator

Begin

FME Process
- Geometry filter
- Area calculation
- CS transformation
- Exclude parcels without tags, to error log
- Write parcels with tags to ROW parcel table in Oracle

SDE/Oracle

STG_ROW_PARCELS
STG_ROW_ERR_LOG

Additional QC
- Comparing spatial with non-spatial ROW database
- Duplicate parcel attributes
- Incomplete parcel attributes
- Spatial relationship among existing/take/remainder

Automated Process

Status email to predefined recipients
# Resource Impact

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>UDOT Staff</th>
<th>Consultant Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Staff</td>
<td>Time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Essential Skills</td>
<td>Time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Title</td>
<td>Essential Skills</td>
</tr>
<tr>
<td>Projection</td>
<td>Admin - Ensure the Proj CS parameters are available and correct. Enter into the Admin application. Consultant - Provide the info on a timely manner</td>
<td>Admin</td>
<td>ROW Business, Survey</td>
</tr>
<tr>
<td>System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QC</td>
<td>Admin - Advice consultants on fixing the errors. Consultant - Fix the QC issues</td>
<td>Admin</td>
<td>ROW Business, CAD</td>
</tr>
<tr>
<td>CAD File Prep</td>
<td>Consultant - Preparing the DGN files per new standards</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>