FDOT 3D Deliverables Support Resources

LandXML includes basic geometry element types, and is readable by the Department's software systems, from both Bentley and Autodesk. In addition, LandXML may be consumed by many software used by the highway construction industry including AGTEK, Trimble, Carlson, and others.

The LandXML format defines data exchange format for basic roadway geometrics including:

Point data	Profiles
Curve data	Pipe Newtorks
Spiral data	Terrain Model Surfaces
Alignments (with station equations)	Survey Data.
Cross Sections (surface and design sections)	

Note LandXML is also widely supported by many civil engineering software. Read more about LandXML at: http://www.LandXML.org

LandXML defines a specification for the exchange of cross section data. This format includes surface definitions such as existing ground terrain, and bottom of the proposed template, to define materials set forth in the Department's Design Standards Indexes 500 and 505

3D Design and Modeling is intended to facilitate Automated Machine Guidance (AMG) in construction. Both Bentley and Autodesk provide 3D Design tools and have been augmented through the Department's workspaces for the Department's projects and help support exporting data usable in AMG processes. AMG technology can reduce time and cost of construction because of greater productivity by equipment operators, fewer grade checks are needed, greener construction (less fuel and equipment wear), greater safety, less rework, and less survey staking required. Contractors invest in AMG for safety, productivity, and to stay competitive.

The benefits of 3D Design and AMG are well documented on the Federal Highway Administration web pages here: http://www.fhwa.dot.gov/construction/3d/

Some goals in providing the Engineering and CADD data to the contractor is to encourage the use of AMG in Construction and to facilitate more accurate bidding. Other automation is also possible and Building Information Modeling (BIM) processes have demonstrated this automation in other industries. Advertising projects with both the CADD and Engineering Data is desired (i.e. LandXML of the project geometrics and surfaces).

In general, projects characterized by the following are the best candidates for modeling and AMG:

- Projects with large amounts of earthwork or paving, including new road construction or significant reconstruction. Resurfacing, Restoration & Rehabilitation (RRR) projects involving variable cross slope and superelevation correction are also good candidates. When scoping projects, preliminary design and planning should question why 3D Design should not be used, rather than if it should. As a matter of guidance, the designer should consider that if controlled cross sections are going to be needed in the plans to communicate design intent to the contractor, then the project is a good candidate for 3D modeling.
- Projects with a good GPS environment for receiving satellite signals, or enough line of sight for using total station and laser controlled systems. The Department's Florida Permanent Reference Network (FPRN) provides statewide GPS coverage: http://www.fdot.gov/geospatial/FPRN.shtm

- Projects with designs that are based on accurate existing ground Digital Terrain Models (DTM).

3D Design workflow must start at the beginning of the project and create the needed data from survey, and is contingent upon data being tied to an AMG field usable coordinate system. The Department requires projects to be performed on the State Plane coordinate system, and the vertical datum is referenced at time of survey activities. After design, the overall reduction of construction costs by modeling and AMG should be realized. For design, the 3D workflow enables the project development team to visualize potential impacts and promote intense collaboration during the planning and design process. Discovering design errors by inspection of the 3D models will reduce costly change orders during construction.

The use of modeling will eventually require conversion of CADD data and other model data to AMG formats. This conversion is the responsibility of the contractor, as the contractor may have special needs that the designer may not anticipate. However, the formats of data delivered as prescribed by this Manual should enable successful translation by the contractor.

The electronic files delivered with the contract documents are provided as a courtesy to the contractor. The Department's Contracts Administration Office releases this CADD data with accompanying exculpatory language stating the contractor cannot use the data as a basis for claims. Contractors will be completely responsible for any data conversions or information derived from model data provided by designer. Post-design services may employ a designer to convert model data to needed AMG formats, or refine the models to meet contractor specific needs. Since the intention of the Department is to encourage 3D modeling and AMG in construction, requirements for accountability and certification of 3D models will also be forthcoming.

- ***Types of Modeling Data Needed***

Control

The survey control for the design of the project needs to be clearly transmitted to the contractor, including the coordinate system and datum of that control. This is important because the contractor must calibrate his AMG equipment to that control upon which the design model is tied. The State Surveying and Mapping Office provides instructions for establishment and densification of field survey control, and the State Construction Office's Proposed Specification: **0050700 Control of the Work** has further guidance for AMG operations.

Alignments/PGLs

LandXML file(s) of the controlling alignments and profiles that represent the controlling geometrics of the project will be delivered and can be extracted from other CADD files delivered. These tie all other data provided directly to the contract plans set. The data must be in the coordinate system of the control that can resolve to the field and be in harmony with all the other data that will be provided.

Surfaces

Surfaces created by survey can represent existing conditions and those created during design using CADD software indicate the designer's intent. Surfaces representing existing conditions at the time of the survey used for design (the pre-design existing (Ground) surface), as well as the finished construction (Top) surface are delivered. LandXML Triangular Irregular Network (TIN) surfaces would typically be delivered for most projects and the same surfaces also delivered as 3D design files in their native CADD systems. Surfaces represented by LandXML files can become unwieldy for larger projects (surfaces should be represented in LandXML files of less than 500 MB per surface-file), so it may be necessary to subdivide a project's surface data into logical sections when delivering large LandXML surface files.

For Example: A relatively small TIN surface (i.e. 32,208 points, 63,462 triangles) can be represented as a LandXML file of approximately 5 MB. So a LandXML surface file of approximately 100 times this data content (about 3 million points) could be manageable as LandXML. Since LandXML is text-based, it will also compress significantly when creating a ZIP to deliver the data (for example, a 50 Megabyte LandXML file of a TIN surface will ZIP down to approximately 10 Megabytes for delivery).

Surfaces delivered in MicroStation DGN or AutoCAD DWG 3D design formats (meeting the Department's CADD standards for symbology) are most usable when each surface is separated into their own drawing files. Points and Break lines should be contained in the surface files.

Note If the native to CADD system used to produce those surfaces mentioned above also stores surface data in alternative formats, as such the case with GEOPAK: i.e. a .TIN, a GEOPAK .DAT, or an InROADS / GEOPAK Roadway Modeler .DTM, then those files must also be delivered.

Surfaces may also be needed in more common formats used in software by the contracting industry. Contractors have communicated a preference for AutoCAD 3D design formats (3D DWG and 3D DXF) which are exportable by both MicroStation and AutoCAD tools. Some contractors have also communicated the need for finished top surfaces to be "smoother" and be represented differently than in TIN formats. These finished surfaces can sometimes be exported in alternate 3D representations called "mesh," "grid," or "lattice" surfaces depending upon which design platform is used.

- **Break Lines**

Hard surface breaks must be respected during construction (i.e. edges of pavement, shoulder breaks, etcetera) and need to be provided to enhance the surface data. These aid the field AMG equipment operator during grading and string-less staking operations by preventing the "shaving" that could occur as the equipment transitions the break.

- **Denigrating Geometry**

When finishing drawings, 2D & 3D controlling geometry is to be represented by basic vector geometry types such as lines, arcs, and polylines. This Geometry should not be combined into Blocks or Cells which destroys any attached original design intelligence.