LandXML.org 2.0

a

Data Exchange Standard

for

ePlan LandXML Deliverable

Nathan Crews, Principal Schema Architect, LandXML.org

Outline

- LandXML.org – 1999 Autodesk supported effort
- LandXML Standard Adoption
  - Registered Software Applications
  - Government Adoption
- LandXML-1.1 & 1.2 Schema
  - 3D Roads, construction staking, ePlan, EPSG coordinate system support, FAA airport survey
  - Survey data additions.
  - Storm water pipe and control structure changes.
- Autodesk drops financial support for LandXML in 2013

Autodesk particpating in Green Building XML Schema
www.**gbxml**.org/software.php (Strictly Architectural for BIM construction)

- LandXML-2.0 Schema (Strictly for survey/civil - support by Carlson)
  - New Goals started in March 2014 - **http://landxml.org/**

LandXML.org: Worldwide, Open Organization

- Initiated in December 1999 by former EAS-E initiative members FDOT, NDOR, Intergraph, Caice, and Autodesk.
- In March of 2000 started with 26 members.
- November 2007: LandXML.org expanded around the world to 41 countries and grown to over 673 representatives from 582 member companies/government agencies.
- January 2014: LandXML.org has a new primary sponsor, Carlson Software.
- March 2014 LandXML 2.0 Initiative launched.

LandXML.org Mission:
Open Design/Survey Data Exchange

- Specify an XML file format for civil engineering design and survey measurement data for:

1. Transferring engineering design data between producers and consumers.
2. Providing a data format suitable for long-term data archival.
3. Providing a standard format for electronic design and survey submission.
4. Support intelligent construction data flow from office to field and back to office.

LandXML is a Worldwide Standard

- LandXML-1.0
  - July 17, 2002 Ratified as an industry standard by LandXML.org.
  - Based on W3C XML Schema Recommendation May 2, 2001.
  - LandXML Software Developers Kit 1.0 and documentation.
- LandXML-1.1
  - Ratified July 21, 2006
  - LandXML Software Developers Kit 1.1
- LandXML-1.2
  - Ratified August 15, 2008
  - LandXML Software Developers Kit 1.2

Multi-Domain Data Interoperability

- LandXML is proving to be useful outside the civil engineering/survey domain.
  - Architects
    - Buildings do connect to the ground, utilities and roadways.
  - Construction
    - Automated machine control
    - As-built data collection
  - Geospatial applications
    - Import new design / survey projects quickly and efficiently.
    - Data exchange for site and road maintenance.
  - Traffic modeling
    - Model the proposed road, analyze traffic capacity and simulate impact.

How is LandXML data used?

- Exchange data between many civil engineering/survey desktop and CAD-based software applications.
- Create engineering reports.
- Send staking data to survey field instruments
- Import points, parcels, roads, surfaces into machine control and guidance for construction applications
- Submit online cadastral surveys.
- Import data into GIS applications.
- Provide design data for automated machine control.
- Create 3D project visualizations.

LandXML supported by many software applications

- 61+ Registered Software Applications from Autodesk, Bentley, CAiCE, Carlson, Eagle Point, Leica GeoSystems, MicroSurvey, Trimble Navigation, Tripod Data Systems, Topcon, the U.S. FHWA and many more.
- Adopted for use by many governments around the world.
- Many US DOT's and Canadian Provinces have made LandXML a standard deliverable

Government Adoption

- LandXML is the design data schema for the AASHTO TransXML standards.
- Required design document for many US State DOTs.
- Survey data standard for Land Information New Zealand's Landonline.
- Australia ePlan online cadastral survey system.
- Slovenia\Finland national 3D road model standard.
- Singapore and many Asian countries are users

LandXML-1.0 Stored Data

The Big 4 are in RED, implemented by all the survey/civil software firms

- Raw Field Data
  - Level Raw Data
  - Total Station Raw Data
  - Vector GNSS/Rinex Data
- Points, Point Groups & F2F
- Alignments,
  - Horizontal and Vertical
- Parcels, 3D Volumetric Parcels
- TIN Models
- Contours & 2D/3D Polyline

(LandXML-2.0 Planned Updates)

- Hydro Networks
  - Storm
  - Sanitary
  - Pipe
- Grading Elements
  - Corridor Model
  - X-Sections
  - Ground Model
  - Proposed Model
- Structure Model
  - Culvert

LandXML-2.0

- The intent for this revision is to make corrections and add support for additional data based on 12 years of real world use.
- Add a new LandXML.org goal:
  - Support intelligent construction data flow from office to field and back to office.

LandXML-2.0 Schema Goals

- Update LandXML 2.0 schema to use current W3C standards
- Support Signing and sealing – Electronic Signatures (FLDOT)
- Incorporate 3D Road model improvements from worldwide input.
  - As-built data collection and association with design data
  - Enhance data model to better suite intelligent construction data flow to and back from construction.
  - Add flexible road template definitions.
- Enhance
  - Sanitary sewer pipes, structures and networks.
  - Storm water open system culverts, ditches, ponds and allow combined closed/open networks.
  - Add Material Table for element appearance
  - Add field survey data processing tables.
- Define a mimetype, .lxz, for compressed (zipped) LandXML files, aka LandXML Project File.

DesignCrossSectionTemplate Table

The DesignCrossSectionTemplateTable contains 1 to N DesignCrossSectionTemplate elements that details a typical cross section or cross section component. Each template contains a unique integer index value that is referenced in the Alignment CrossSects collection using the DesignCrossSectionTemplateTableIndex attribute. This saves a tremendous amount of space in the LandXML file, especially for large projects.

```
<DesignCrossSectionTemplateTable>
	<DesignCrossSectionTemplate index="1" name="PavementLeft">
		<DesignCrossSectSurf name="Pave1" side="left" closedArea="true" area="8.039785">
			<CrossSectPnt code="Crown">0. 0.</CrossSectPnt>
			<CrossSectPnt code="ETW">-12. -0.24</CrossSectPnt>
			<CrossSectPnt code="ETW_SubBase">-11.999 -0.91</CrossSectPnt>
			<CrossSectPnt code="Crown_SubBase">0. -0.67</CrossSectPnt>
			<CrossSectPnt code="Crown">0. 0.</CrossSectPnt>
		</DesignCrossSectSurf>
	</DesignCrossSectionTemplate>
	<DesignCrossSectionTemplate index="2" name="PavementLeft2">
		<DesignCrossSectSurf name="Pave1" side="left" closedArea="true" area="2.009725">
			<CrossSectPnt>-12. -0.24</CrossSectPnt>
			<CrossSectPnt code="EPS">-15. -0.36</CrossSectPnt>
			<CrossSectPnt code="EPS_Sub">-14.999 -1.03</CrossSectPnt>
			<CrossSectPnt>-12. -0.91</CrossSectPnt>
			<CrossSectPnt>-12. -0.24</CrossSectPnt>
		</DesignCrossSectSurf>
	</DesignCrossSectionTemplate>
	<DesignCrossSectionTemplate index="3" name="PavementRight">
```

Material Table

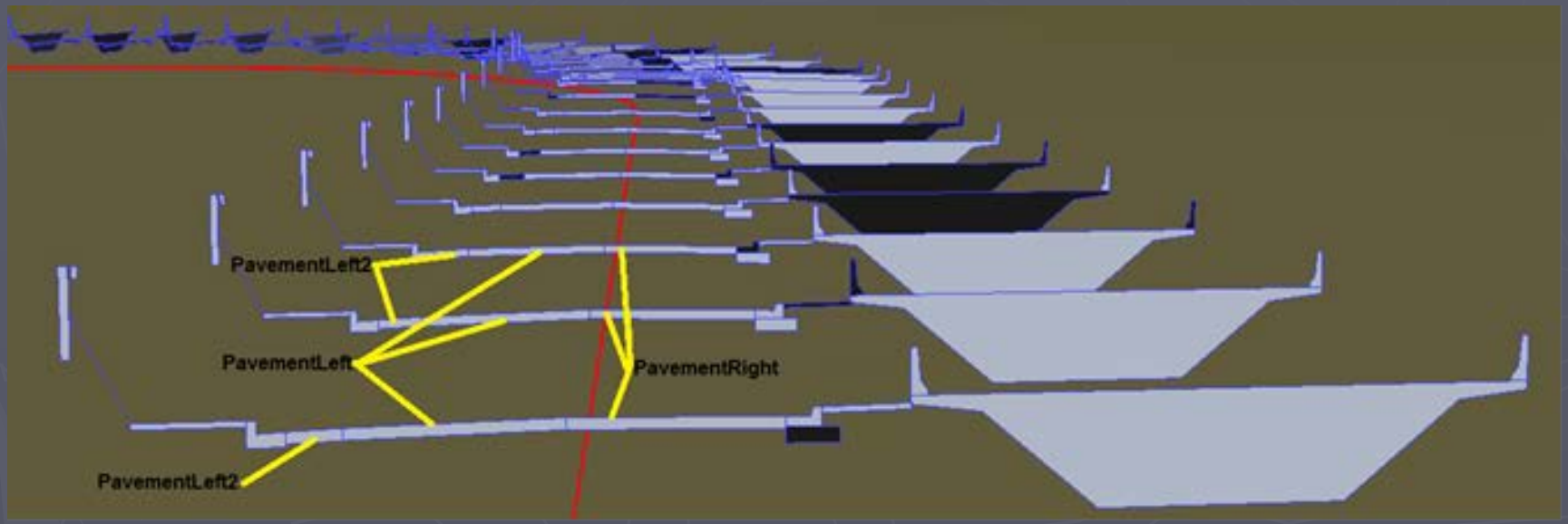
A long requested feature was to allow graphical appearance definitions for various elements and data types. Materials include typical visual properties like color, linetype, layer name, width, depth as well as textures for 3D objects like TIN surface faces and any CoordGeom, CGPoints, cross sections elements.

```
<MaterialTable name="Site">
        <Material index="1" name="pavement" color="black" texture="asphalt" />
        <Material index="2" name="concrete" color="grey" texture="concrete"/>
        <Material index="3" name="gravel" color="grey" texture="gravel" />
        <Material index="4" name="grass" color="green" texture="grass"/>
        <Material index="5" name="swamp" color="green" texture="sparsegrass"/>
        <Material index="6" name="pavementStriping" color="yellow" width="4" layerName="Pavement Marking" />
</MaterialTable>
<...>

<Alignments name="Site 1">
        <Alignment name="Alignment_-_(1)" length="786.773755501829" staStart="0." desc="">
        <CoordGeom>
  <...>
        </CoordGeom>
        <CrossSects>
                <CrossSect sta="0.0" name="0+00.00">
                        <DesignCrossSectSurf DesignCrossSectionTemplateTableIndex="1" m="1"/>
                        <DesignCrossSectSurf DesignCrossSectionTemplateTableIndex="2" m="1" />
                        <DesignCrossSectSurf name="Curb" side="left" closedArea="true" area="1.9886625" m="2">

<...>
```

DesignCrossSectionTemplate & Material Table

```
<Alignments name="Site 1">
        <Alignment name="Alignment_-_(1)" length="786.773755501829" staStart="0." desc="">
                <CoordGeom>
                        <Line dir="91.936570834317" length="238.855298020636">
                                <Start>5033.066801316007 8749.624449342362</Start>
                                <End>5271.785677137384 8741.552787858835</End>
                        </Line>
                        <Curve rot="ccw" chord="217.940983137521" crvType="arc"
delta="78.735838307338" dirEnd="173.367933299697" dirStart="94.632094992359"
external="50.424566363425" length="236.083461506652" midOrd="38.982669939521"
radius="171.797065325838" tangent="140.954680433351">
                                <Start>5271.785677137384 8741.552787858835</Start>
                                <Center>5257.911815035447 8570.31684652365</Center>
                                <End>5428.559263054616 8590.15822094971</End>
                                <PI>5412.27997105228 8730.169672581249</PI>
                        </Curve>
                        <Line dir="175.737912914315" length="311.834995974542">
                                <Start>5428.559263054616 8590.15822094971</Start>
                                <End>5451.73448692316 8279.185595606119</End>
                        </Line>
                </CoordGeom>
                <CrossSects>
                        <CrossSect sta="0.0" name="0+00.00">
                        <DesignCrossSectSurf  DesignCrossSectionTemplateTableIndex="1" m=”1”/>
                        <DesignCrossSectSurf DesignCrossSectionTemplateTableIndex="2" m=”1”/>
</CrossSect>
                </CrossSects>
<...>
```

DesignCrossSectionTemplate Table



Adopt W3C XML Digital Signature Standard

For a complete reference to the proper usage of this specification see http://www.w3.org/standards/xml/security.

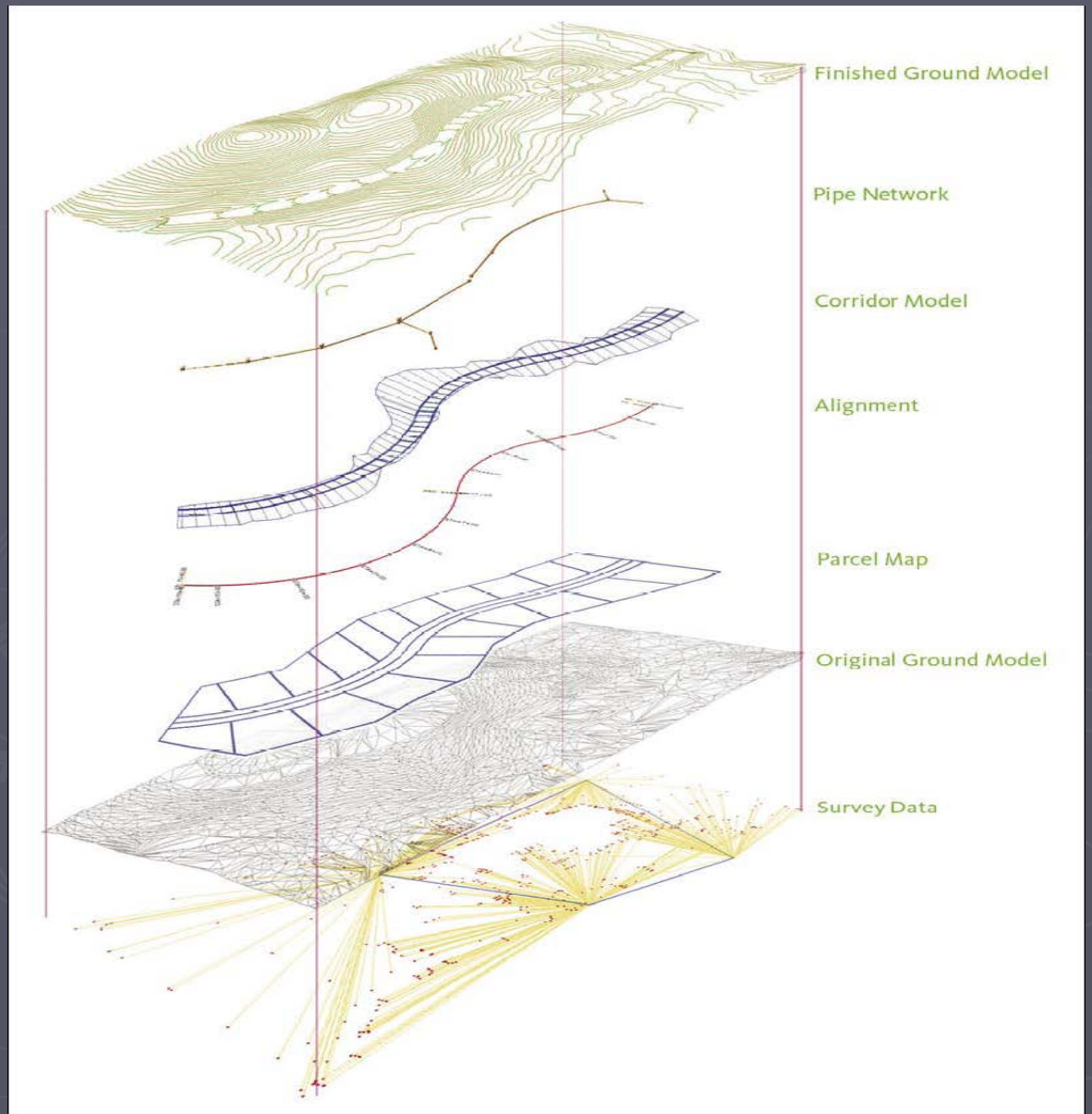
Electronic Signatures

The fundamental value to using this XML envelope is that the exact contents between the <LandXML><.LandXML> elements can be validated to see if any change has been made to any value contained within after signing. Adding or removing even a single space will be detected and not pass validation.

LandXML Digital Signature applied using FDOT XML Signing Tool.

DOT's are very interested in documenting who authorized what and when, so errors or issues found in the field can be traced back to its author and/or shown the latest revisions were not followed

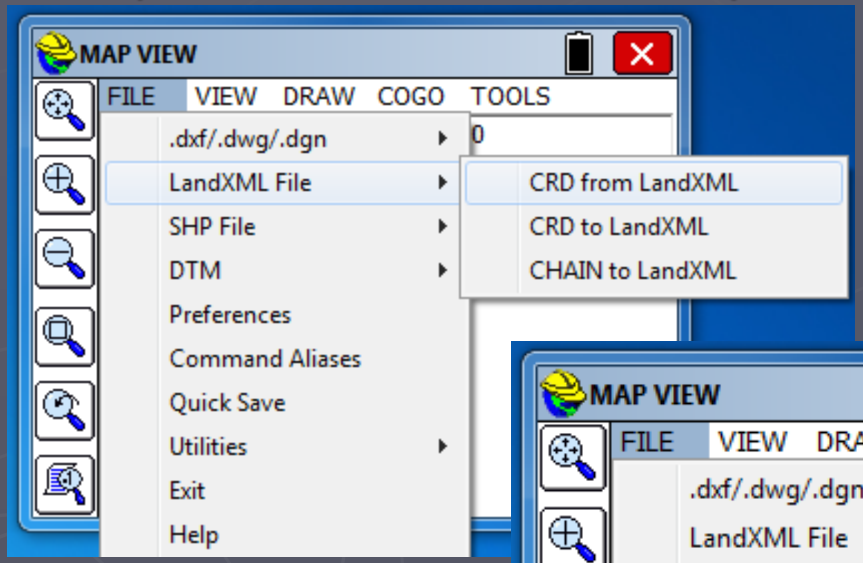
LandXML Data Model

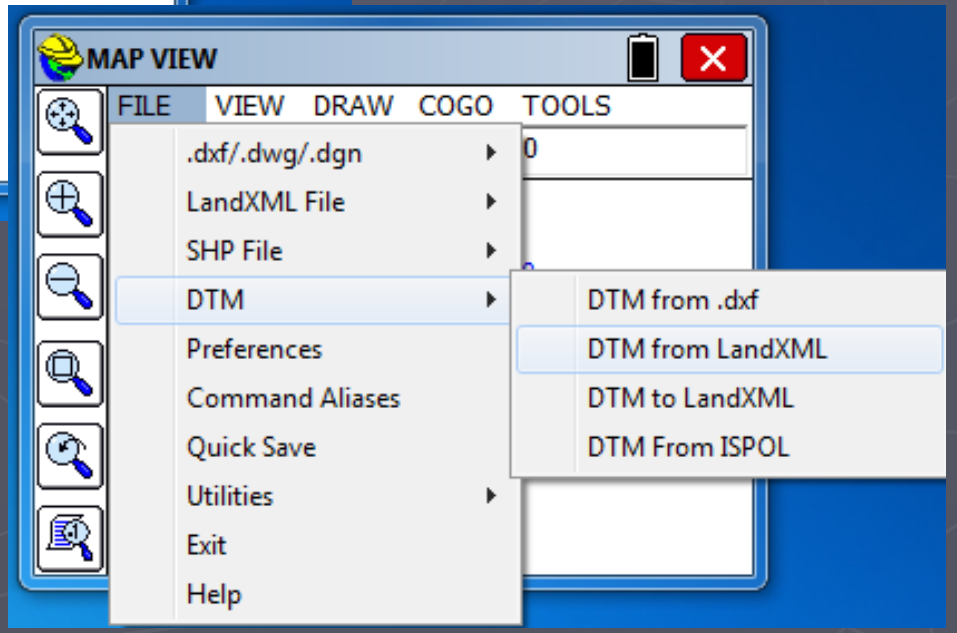


Carlson SurvCE uses LandXML/RoadXML Files

- LandXML Import/Export w/SurvCE on the Surveyor2 DC

15+ DOT's using SurvCE in the field





LandXML 2.0 Data Model To Do List for Data & COGO

- Project Based
  - Project name and description.
- Application
  - Application used to produce the data.
- Author
  - Who created the data.
- Units
  - Linear, angular, area, time, temperature, pressure, diameter, volume, flow and velocity.
- Coordinate Systems
  - Grid and Projected coordinate systems
  - EPSG (European Petroleum Standards Group) codes
- Cogo Points
  - The basic 3D point with name, number, description, code and purpose.
- Cogo Geometry
  - Contiguous Lines, circular curves, spirals, irregular lines and chains.

LandXML Data Model
Design Geometry Data

- Parcels
  - Closed parcel coordinate geometry
  - Area, centroid, owner, class, type
- Alignments
  - Road centerline 2D coordinate geometry.
  - Profiles: vertical design alignments and sampled ground profiles.
  - Cross Sections: design cross sections and sampled surface sections.
  - Superelevations
  - Station Equations
- Surfaces (digital terrain models)
  - TIN – The computed Triangulated Irregular Network of 3-point triangle faces.
  - Grid – 4-point grid faces.
  - Source Data: breaklines, contours and points used to compute the TIN or GRID.

LandXML Data Model
Design Geometry Data

- Roadways (3D road model)
  - Alignments (profiles, design and sampled Xsections)
  - Surfaces (top and sub-surfaces)
  - PlanFeatures
  - Lanes and Intersections
- PipeNetworks
  - Stormwater/Sanitary sewer pipes and structures.
- PlanFeatures
  - Generic geometric data like fence lines, curbs, building outlines, and planting areas.

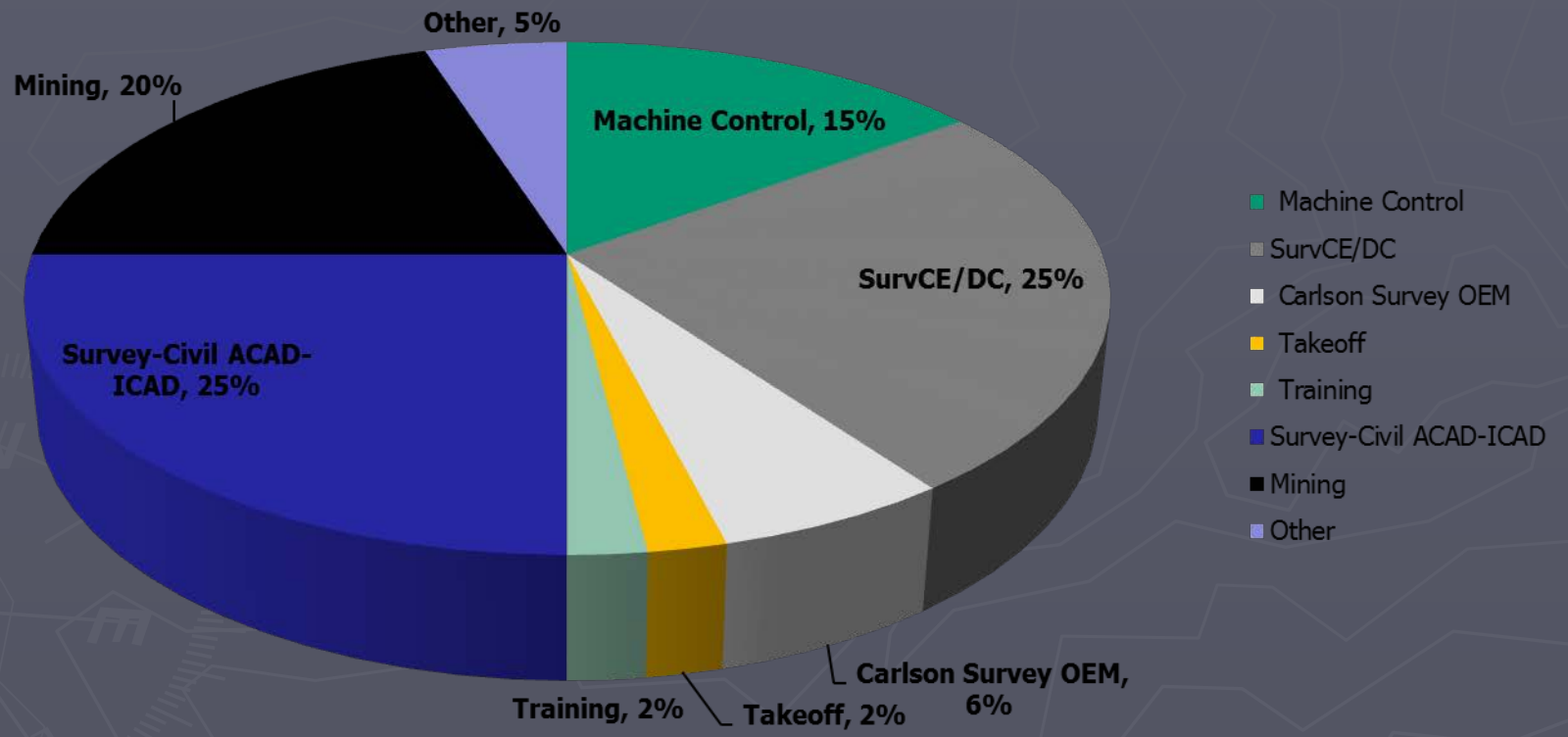
LandXML Data Model
Survey Data

- Monuments
  - Survey monument data
  - Survey order, class, type, description.
- Survey
  - Raw and reduced survey observations.
  - Optical, EDM and GPS supported.
  - Equipment, personnel and data collection parameters.

Summary

- The LandXML-1.0, 1.1 and 1.2 standard is supported by many applications.
- LandXML-2.0:
  - Improve the usefulness of design/survey data for 3D road/site modeling, machine control and GIS interoperability.
  - Support broader intelligent design data flow from office to field and back to office.
- The work continues...

Carlson Software



https://www.youtube.com/watch?v=ioyNQjDfPq0&feature=youtu.be

https://www.youtube.com/watch?v=vLdZCpNYjeE