PostGIS and X3D

Few steps through a full Wed 3D GIS
Summary

- Camptocamp Presentation
- Project Presentation
- GIS and 3D
- From Modeler to Render
  - Data production
  - Server Side
  - Web Service API
  - HTTP Client
- Conclusion
- Questions
Camptocamp, an Open Source Base Camp!

- **35 employees (CH and FR)**
- **about 50 to 70 % of growth per year since 2002**
- **3 activity domains**
  - Spatial solutions
  - Business solutions
  - Infrastructure solutions
- **4 services poles**
  - Consulting
  - Engineering
  - Supporting
  - Training
Project Presentation

- R&D project
- Collaboration between companies
  - TPLM3D (3D lasergrammetry specialists)
  - Camptocamp (OSS GIS specialists)
- Goals:
  - Prototype to Web 3D GIS application
  - Monument virtual visit
GIS and 3D

- Not yet widely used in Web application
- Google Earth as a 3D killer app!
- Web 3D will be the next GIS step
- Challenge 3D and OSS
  - 3D GIS datas available
  - 3D storage and manipulations tools
  - 3D robust viewers
From 3D Modeler to Renderer

3D Data (Blender, 3DSMAX...)

PostGIS Import
Collada2pgsql

PostGIS Storage

X3D Export
AsX3D

GEOS operator

Web Service
OGC W3DS

X3D 2.0 ;)
AJAX 3D

X3D Renderer
X3D Plugin

Data Production  Server-Side  Web Service API  HTTP Client
3D Data

- 3D Data
  (Blender, 3DSMAX...)

- PostGIS Import
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Collada Presentation

- Collada is
  - 3D format XML based
  - Promoted by Sony
  - Used in real world (in kml/kmz also)
  - Standard of the Khronos Group (http://www.khronos.org/collada/)

- Collada aim
  - To be an inter-application 3D format
  - Not supposed to be graphical rendered

- Collada supports:
  - Mesh geometries
  - Animation
  - Physics
  - Textures
  - ...
Collada Example

```xml
<source id="Cube-Position">
  <float_array count="24" id="Cube-Position-array">
    1.0 -1.0 1.0 -1.0 -1.0 1.0 ...
  </float_array>
  <technique_common>
    <accessor count="8" source="#Cube-Position-array" stride="3">
      <param name="X" type="float"/>
      <param name="Y" type="float"/>
      <param name="Z" type="float"/>
    </accessor>
  </technique_common>
</source>

<vertices id="Cube-Vertex">
  <input semantic="POSITION" source="#Cube-Position"/>
</vertices>

<polygons count="6">
  <input offset="0" semantic="VERTEX" source="#Cube-Vertex"/>
  <input offset="1" semantic="NORMAL" source="#Cube-Normal"/>
  <p>3 0 2 0 1 0 0 0</p>
  <p>5 1 6 1 7 1 4 1</p>
  <p>1 2 5 2 4 2 0 2</p>
  <p>2 3 6 3 5 3 1 3</p>
  <p>3 4 7 4 6 4 2 4</p>
  <p>7 5 3 5 0 5 4 5</p>
</polygons>
```
PostGIS Import

- 3D Data (Blender, 3DSMAX...)
- PostGIS Import
  - PostGIS Storage
  - GEOS operator
  - X3D Export
    - AsX3D
  - Web Service
    - OGC W3DS
- X3D 2.0 ;)
  - AJAX 3D
  - X3D Renderer
    - X3D Plugin

Data Production
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From Collada to PostGIS

- We need to import 3D Geometry into PostGIS
- A small collada2pgsql was written (Q&D mode)

Output example:

```sql
BEGIN;
    CREATE TABLE "geom3D"();
    SELECT AddGeometryColumn('', 'geom3D', 'the_geom', '-1', 'GEOMETRY', 3);
    INSERT INTO "geom3D" VALUES (geomfromewkt('POLYHEDRALSURFACE(((1.000000 1.000000 -1.000000...')));
    CREATE INDEX ind_geom ON "geom3D" USING GIST (the_geom GIST_GEOMETRY_OPS);
END;
```
PostGIS Storage

- 3D primitives needed
  - Defined in OGC SFS (Simple Feature for SQL 1.2)
    - TIN (Triangle Irregular Network)
    - PolyhedralSurface
PolyhedralSurface

- PolyhedralSurface
  - 3D data inside
  - Several Faces described (at least one)
  - Each Faces composed by 3 or more points
  - Cube Code Example:

    ```
    PolyhedralSurface(((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
                       ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)),
                       ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
                       ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
                       ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),
                       ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)))
    ```
TIN (Triangle Irregular Network)

- **TIN**
  - 3D data inside
  - Several Faces described (at least one)
  - Each Faces composed by exactly 3 points
    - Only difference between TIN and PolyhedralSurface
    - Quite common in 3D tools and render engine
  - Tetrahedron Code Example, TIN based:

```plaintext
Tin(((0 0 0, 0 0 1, 0 1 0, 0 0 0)),
     ((0 0 0, 0 1 0, 1 0 0, 0 0 0)),
     ((0 0 0, 1 0 0, 0 0 1, 0 0 0)),
     ((1 0 0, 0 1 0, 0 0 1, 1 0 0)))
```
TIN and PolyhedralSurface Properties

- Properties:
  - Contiguous collection of polygons, which share common boundary segments
  - Polygons have just one ring (no holes)
  - Two contiguous polygons have the same orientation:

Valid Polyhedral Surface

Invalid Polyhedral Surface
GEOS Operator

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GEOS IsValid Checker

- IsValid function implemented in GEOS for TIN and PolyhedralSurface check
  - Valid Geometry check example:

```sql
select isvalid(geomfromewkt('TIN(((1 2 3, 5 4 6, 3 4 5, 1 2 3)),((5 4 6, 8 9 7, 3 4 5, 5 4 6)))'));
```

```
isvalid
---------
t
```

- Orientation check:

```sql
select isvalid(geomfromewkt('TIN(((1 2 3, 5 4 6, 3 4 5, 1 2 3)),((5 4 6, 3 4 5, 8 9 7, 5 4 6)))'));
```

```
NOTICE: Two neighbour faces are not in the same orientation at or near point 5 4 6
isvalid
---------
f
```

- Isolated face check:

```sql
select isvalid(geomfromewkt('TIN(((1 2 3, 5 4 6, 3 4 5, 1 2 3)),((5 4 6, 8 9 7, 3 4 5, 5 4 6)),
((10 10 0, 11 11 1, 10 12 0, 10 10 0)))'));
```

```
NOTICE: Isolated face at or near point 10 10 0
isvalid
---------
f
```
X3D Export

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X3D (Extensible 3D Graphics) Format

- ISO Standard
- Initiative of Web3D Consortium
- VRML successor
- XML based
- X3D supports information about:
  - geometries
  - appearances
  - navigation
- Designed to be directly rendered (instead of Collada)
AsX3D Export Function

- AsX3D PostGIS function implementation
- Export a geometry in X3D format
  - Example:

```sql
select asx3d(geomfromewkt('Tin(((0 0 0, 0 0 1, 0 1 0, 0 0 0)),
((0 0 0, 0 1 0, 1 0 0, 0 0 0)),
((0 0 0, 1 0 0, 0 0 1, 0 0 0)),
((1 0 0, 0 1 0, 0 0 1, 1 0 0)))'));
```

```xml
<IndexedFaceSet coordIndex="0,1,2,-1,3,4,5,-1,6,7,8,-1,9,10,11">
  <Coordinate point="0 0 0, 0 0 1, 0 1 0, 0 0 0, 0 1 0, 1 0 0, 0 0 0, 1 0 0, 0 0 1, 1 0 0, 0 1 0, 0 0 0, 1 1 0, 0 1 0, 0 0 1"/>
</IndexedFaceSet>
```
PostGIS and GEOS

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Data Production Server-Side Web Service API HTTP Client
PostGIS and GEOS Implementation

- Patch Pg3D
  - PostGIS and GEOS devel mailing list
  - MessageID: <46F7F057.7080408@camptocamp.com>

- Available Functions:
  - asewkt
  - asewkb
  - asx3d
  - asgml
  - assvg (2D data export)
  - summary
  - isvalid
PostGIS and GEOS Next Step

- To be discussed
  - PostGIS and GEOS 3D pg3D patch commit?

- Next development
  - OGC SFS 1.2 others 3D Functions API:
    - **NumPatches () : Integer**
      Returns the number of including polygons
    - **PatchN (N: Integer): Polygon**
      Returns a polygon in this surface, the order is arbitrary.
    - **BoundingPolygons (p: Polygon): MultiPolygon**
      Returns the collection of polygons in this surface that bounds the given polygon “p” for any polygon “p” in the surface.
    - **IsClosed (): Integer**
      Returns 1 (True) if the polygon closes on itself, and thus has no boundary and encloses a solid
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OGC W3DS (Web 3D Service)

- **W3DS**
  - Specification for 3D visualization of geographic data
    - Kind of WMS for 3D data
    - Version 0.3.0 (Discussion Paper)
  - API define:
    - Interaction between client and 3D scene
    - How the client can navigate through the 3D scene
X3D Renderer

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X3D Renderer

- X3D is rendered directly on browser
  - A specific plugin is needed:
    - FreeWRL
    - FluxPlayer (Flux)
    - BSContact (BitManagement)
    - ...
  - Client-Side scripting is allowed with Javascript and DOM manipulation
AJAX 3D

Data Production

Server-Side

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AJAX 3D

- Same concept than AJAX in 2D world!
  - XMLHttpRequest call
  - createX3DFromURL
  - Some examples on http://ajax3d.org

- Not well supported by X3D plugins
  - Flux plugin do it right
AJAX 3D perspective

- Real time parts of scene loading
- Allows to navigate smoothly in big 3D scenes
  - It let's imagine an OpenLayers like for X3D.

Initial Loaded Scene

On the Fly Scene Load
Conclusion

- Only a first step to obtain full Web 3D GIS platform
- 3D Storage and manipulation
  - Performance
    - 3D spatial indexes
    - 3D Generalization data (or LOD logic)
  - Treatments
    - 3D primitives in PostGIS and GEOS
- X3D viewer
  - Clearly not yet mature and cross platform!
  - Still lot of work to have a 3D OpenLayers like
  - Alternative viewers solutions to explore: Google Earth, AutoDesk 3D Renderer...
Contacts

- TPLM3D
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Thanks and Reactions

- Thanks for your attention!
- Questions and reactions...