GeoBIM: Data for a “Single Source of Truth” for Infrastructure

focus on asset management

Dr Claire Ellul - University College London

- With many thanks to: Nicola Moretti, Francesca Noardo, Gareth Boyes, Jacynthe Pouliot, Jantien Stoter, Lars Harrie and others
About Me

- Potted History
  - Electrical engineer
  - GIS consultant
  - MSc Geographical Information Science (at UCL)
  - GIS consultant
  - PhD in 3D GIS
  - Lecturer/Reader in Geographical Information Science
Overview

• **Some Definitions**
  - Single source of truth
  - GeoBIM
    • Similarities and Differences
  - Asset and Facilities Management

• **Asset Management and GeoBIM**
  - Opportunities

• **Towards the ‘Single Source of Truth’**
  - Research Challenges
What is a “Single Source of Truth”

• Every piece of information is stored only once (Holzmann 2015)
  • everyone keeps all the information up to date all the time
  • that there is no conflicting information in the data store
  • one source of information, multiple users
BIM and GIS

• BIM: A digital-based building design process that uses a single comprehensive system of computer models rather than separate sets of drawings.
  - The models are more than just 3D CAD, they are rich in added information.

• GIS: "computer-based information system that enables capture, modelling, storage, retrieval, sharing, manipulation, analysis, and presentation of geographically referenced data". (Worboys and Duckham 2004)

• BIM and GIS are both special cases of information systems (Lee, et al., 2006)
GeoBIM

GeoBIM: Bridging the gap between Geo and BIM

Integration in both directions -> Geo data into BIM and BIM data into Geo or even a ‘single source of truth’

https://3d.bk.tudelft.nl/projects/geobim/
<table>
<thead>
<tr>
<th>Similarity</th>
<th>BIM</th>
<th>GIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model the built environment in 3D</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Model indoor and outdoor features</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Data can be managed in a database management system</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Spatial and non-spatial data editing and management tools provided</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2D and 3D visualization</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Represent the word as is, but also model historic and future representations</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Model at varying scales and detail</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
# GIS and BIM - Differences

<table>
<thead>
<tr>
<th>BIM</th>
<th>Geo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single house contains 1000 elements</td>
<td>House contains a few elements only</td>
</tr>
<tr>
<td>Spatial data digital plan design &amp; construction</td>
<td>Spatial data is source of information</td>
</tr>
<tr>
<td>Data management for project sites/ Focus on data functionalities in native software</td>
<td>Focus on data flows within Spatial Data Infrastructure (data quality, validation, responsibilities)</td>
</tr>
<tr>
<td>Industry dominated</td>
<td>Government dominated</td>
</tr>
<tr>
<td>Sharing data complex; benefits for sharing are not always clear</td>
<td>Open data/sharing data is seen as public good</td>
</tr>
<tr>
<td>Geometry is designed (parametrized)</td>
<td>Geometry is measured (B-Rep)</td>
</tr>
</tbody>
</table>
GeoBIM - Why Integrate?
AM and FM

• Asset Management: the coordinated activity of an organisation to realise value from assets
  - Balancing costs, risks and opportunities to achieve an organisation’s objectives

• Facilities Management: management of buildings and their systems
  - such as electrical, plumbing, lighting, air conditioning, but also cleaning services, gardening, etc

(with thanks to Nicola Moretti)
AM core functions

Strategic
- Risk mgmt
- Sustainability mgmt*
- Financial mgmt
- Value mgmt
- Quality mgmt

Tactical
- Resilience mgmt**
- LCC
- Condition inspection/monitoring
- Energy mgmt
- Property mgmt

Operational
- Commissioning process
- Project mgmt
- Data management
- Facilities mgmt***

*Including environmental management
**Including Configuration management and Terotechnology
***Including Dependability and Equipment management

(with thanks to Nicola Moretti)
Overview

• Some Definitions
  - Single source of truth
  - GeoBIM
    • Similarities and Differences
  - Asset and Facilities Management

• **Asset Management and GeoBIM**
  - Opportunities

• Towards the ‘Single Source of Truth’ - Research Challenges
Built Asset Life Cycle

Current approach - asset re-surveyed at commissioning and again downstream to collect the information required for AM and FM
The Opportunity #1 - BIM

• The UK Government Construction Strategy (GCS) requires that:
  - Government will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016.

• £2bn per annum to be saved through the widespread adoption of BIM (Wix and Nisbet 2008 cited in Government and Industry in Partnership Report 2012)
The Opportunity #2 - 3D City Models

• Created by national mapping agencies but also by private companies
The Opportunity #3 - IoT and Smart Cities

• Location is fundamental to fully understand and process data from sensors and deliver on the promise of smart cities
Opportunity #4 - Location and Infrastructure Asset Management

- Many large infrastructure projects are using BIM for construction
  - Possibility to re-use the expensive BIM data for asset management
Overview

• Some Definitions
  - Single source of truth
  - GeoBIM
    • Similarities and Differences
  - Asset and Facilities Management

• Asset Management and GeoBIM
  - Opportunities

• Towards the ‘Single Source of Truth’ - Research Challenges
Building a “Single Source of Truth” for AM/FM

- We **should** be able to take advantage of GeoBIM, to re-use data from the plan/design/build phases of a built asset in the commission/operate/modify phases
  - Saves extensive re-survey costs

- However ... what are the challenges?
Challenge #1 - Different Conceptual Models and Standards

Challenge #1 - Different Conceptual Models

Schema matching principles

## Challenge #1 - Different Conceptual Models - Syntactic comparison

<table>
<thead>
<tr>
<th>GUS Type</th>
<th>Network ADE Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas_pipe</td>
<td>Abstract_Pipe</td>
</tr>
<tr>
<td>Hydro_network</td>
<td>Abstract_NetworkFeature</td>
</tr>
<tr>
<td>Sewer_junction</td>
<td>SimpleFunctionalElement</td>
</tr>
<tr>
<td>Standpipe</td>
<td>Abstract_Pipe</td>
</tr>
<tr>
<td>Sanitary_pipe</td>
<td>Abstract_Pipe</td>
</tr>
</tbody>
</table>

Class name comparison (String matching based on Edit distance)
Challenge #1 - Different Conceptual Models - Syntactic comparison

<table>
<thead>
<tr>
<th>GUS Type</th>
<th>Network ADE Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas_pipe</td>
<td>Abstract_Pipe</td>
</tr>
<tr>
<td>Hydro_network</td>
<td>Abstract_NetworkFeature</td>
</tr>
<tr>
<td>Sewer_junction</td>
<td>SimpleFunctionalElement</td>
</tr>
<tr>
<td>Standpipe</td>
<td>Abstract_Pipe</td>
</tr>
<tr>
<td>Sanitary_pipe</td>
<td>Abstract_Pipe</td>
</tr>
</tbody>
</table>

Class name comparison (String matching based on Edit distance)
Challenge #2 - Data Granularity for AM and FM

• What data needed for each asset type, at what granularity
  - How to describe location?
  - Generalisation/aggregation processes?
  - What is a useful space for asset management?
Challenge #2 – Data Granularity for AM/FM - A DSS for maintenance prioritisation

With a low budget (not sufficient to bring FCI=0), the algorithm leads the prioritisation of maintenance interventions enabling

- a more efficient operative expense
- improved use of the resources

Planned vs optimised maintenance expenditure

(with thanks to Nicola Moretti)
Challenge #3 - Long Timelines

- For large infrastructure projects, BIM data can be collected 10 years before it is needed for asset management.
  - No one assigned to define asset management needs this early in the project.
  - However, these needs need to be defined to ensure BIM is created for reuse.

(with thanks to Gareth Boyes)
Challenge #3 - Long Timelines

(with thanks to Gareth Boyes)
Challenge #4 - Data Quality

- “Fit for purpose” for construction is not the same as “fit for purpose” for asset management
- Different application of the same standards by different people (ifcStair, ifcStairFlight)
- Duplicate information
- Information not up to date
Challenge #5 - “single” source of truth

• In reality
  - Could be federated, multiple data repositories
  - AM/FM software should link to information from multiple sources
Other Challenges

• Lack of GeoBIM Awareness and Knowledge
  • In particular amongst Asset Managers
  • FM also mostly reactive

• Lack of Asset and Facilities Management Awareness and Knowledge
  • In particular amongst Geo and BIM people

• Lack of Investment
GeoBIM: Data for a “Single Source of Truth” for Infrastructure

• We think:
  - Location could be very useful in Infrastructure Asset Management
  - GeoBIM offers a great opportunity to save money during the commissioning of an asset

• But we’re not quite there yet ...
Next Steps

• Wanted - Data
  - In particular data related to infrastructure asset management
    • Maintenance plans, interventions and schedules
    • Corresponding 2D or 3D models
    • Costs (if available)

• This will allow us to better understand
  - The granularity of data needed for asset management and if/how it corresponds to data from GeoBIM
  - How to develop better KPIs for asset management, informed by location data (BIM and Geo)
Next Steps

- **Wanted - People**
  - Interviews with stakeholders - AM/FM
    - What does your role involve
    - What (if any) location data do you use, at what level of aggregation, sourced from where?
    - How can GeoBIM (and a digital twin?) help?
      - At what level of granularity would the data be needed?
      - Is it possible to move seamlessly from BIM for construction to BIM for operation?
      - Interoperability with other data sources?
Thank You

c.ellul@ucl.ac.uk