BIM-GIS integration as dedicated and independent course for Geoinformatics students

Merits, challenges, and ways forward

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Outline

► Introduction

► Course development
  ● Development framework
  ● Need assessments
  ● Determining goals and objectives

► Conceptualizing content
  ● Selecting and developing materials and activities
  ● Organizing the contents and activities

► Evaluation

► The way forward
Introduction

- BIM and UIM are becoming the new norm in the AEC and Geospatial research and industry, part of many applications: design, construction, and urban management.

- Executing a project that required BIM and UIM technologies/systems and data, requires a high level of expertise from the two disciplines BIM and UIM. BIM experts from civil engineering and architecture and UIM experts from the geospatial domain.

- Current teaching at University level - BIM courses are mainly assigned to Civil Engineering and Architecture - UIM expertise is taught in the geospatial domain like Geodesy, Geomatics or Geoinformatics.

- The outcomes of this research propose both a course outline and contents of lectures and learning materials. introduced by a course offered at the Chair of Geoinformatics at (TUM).
Course development

- Course initiative - Prof Kolbe - the chair of Geoinforamtics TUM, 2016

- Independent course, intermediate - advanced level of Geoinforamtics is required.


  - Need Assessment
    - What are my student’s needs?
    - How can I assess those needs so that I can address them?
  
  - Determining goals and objectives
    - What are the purposes and intended outcomes of the course
    - What will my students need to do or learn to achieve these goals
  
  - Conceptualizing content
    - What will be the backbone of what I teach?
  
  - Selecting and developing materials and activities
    - How and with what I teach the course
    - How will I organize the content and activities
  
  - Evaluation
    - How will I assess what students have learned
Need assessment

- Based on literature review reported in other paper by the authors (Hijazi et al. (2017))

- Result are a list represents the issues that Geoinformatics students need in order to conduct projects that include information from both BIM and UIM domains.

Integration approaches

- CityGML
- IFC

Problems in Geoinformatics can be better resolved by BIM

Use cases

- Indoor navigation
- Emergency response
- Flood management
- Cadastral
- Design
- Energy
Need assessment - Integration from...

Method
- Building Information Modeling (BIM)

System
- 3D CAD
  (+ Simulation)

Data Model
- e.g. Industry Foundation Classes (IFC)

Topography / Urban Information Modeling (TIM / UIM)
- 3D GIS
  (+ Simulation)

- e.g. CityGML

- e.g. CityGML

- e.g. Industry Foundation Classes (IFC)

- 3D CAD
  (+ Simulation)

- Building Information Modeling (BIM)

- Topography / Urban Information Modeling (TIM / UIM)
Goals and objectives / Conceptualizing content

- Recognize the importance of BIM as a data source for Geospatial information science and system

Theory and application of CAD-BIM/GIS integration

- Why BIM is important for Geoinformatics
- What functions in GIS are useful for BIM
- Thorough understanding of the capabilities and the information structure of BIM.

CAD/BIM evolution

- Practice 2D/3DCAD and BIM editors using AutoCAD and Revit as BIM editor
- To develop the ability to create and modify BIM models using BIM editors such as Revit Architecture.
Goals and objectives / Conceptualizing content

- To develop the ability to browse the BIM files and extract required information.

**IFC as AEC exchange format**

How building information are organized in IFC file

- To develop the ability to integrate BIM models in GIS accurately and quickly.

**Integration approaches i.e. mechanism**

Recognize the pros and cons for each approach

- Analyse BIM in Geocontext

**Use Cases**

Indoor Navigation, utility network, Thermal design
Selecting and developing materials and activities

- A number of lectures, labs, and agency visit.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures (14 Hours)</td>
<td>Weekly</td>
<td>Knowledge and theory of BIM, History of CAD, BIM, BIM/GIS integration approaches are introduced and discussed, use cases and, IFC standard, BIM vs. GIS data modelling</td>
</tr>
<tr>
<td>Agency visit (8 hours)</td>
<td>Once – Munich Airport</td>
<td>The visit familiarizes students with the CAFM tasks and operation which is based on BIM/GIS integration.</td>
</tr>
<tr>
<td>Labs (20 hours)</td>
<td>Weekly</td>
<td>Hands on experience on BIM and GIS tools using project based exercises</td>
</tr>
</tbody>
</table>
Organizing contents and activities

► Organized cyclically, macro level, experimental learning cycle.

► Students learn and revisit certain content in various ways:
  ● Lectures, labs and reflection activities.

► Course materials and activities are arranged in a way that the related knowledge and skills are covered

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,2</td>
<td>Fundamentals and CAD history up to BIM – current trends and future directions of CAD</td>
<td>2D, 3D, BIM – BIM Editors (Revit Architectural and MEP)</td>
</tr>
<tr>
<td>3</td>
<td>Why BIM is important for UIM</td>
<td></td>
</tr>
</tbody>
</table>
## Organizing contents and activities

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>What is the current capabilities in GIS could be useful for BIM people (brainstorming and discussion)</td>
<td>Brainstorming session</td>
</tr>
<tr>
<td>5-6</td>
<td>IFC as standard for BIM  Getting to understand IFC structure</td>
<td>BIM Server, FME, 3D GIS functionalities, My wall, My house</td>
</tr>
<tr>
<td>7</td>
<td>Integrating and Analysing BIM in GIS approaches and challenges</td>
<td>Generate 3D City Models using BIM</td>
</tr>
<tr>
<td>8-11</td>
<td>Use case: Indoor Navigation</td>
<td>CAFM applications: Extract indoor network for pedestrian navigation</td>
</tr>
<tr>
<td></td>
<td>Use case: Utility Network</td>
<td>CAFM applications: Extract network utilities for stream flow analysis</td>
</tr>
<tr>
<td></td>
<td>Use case: Thermal Design</td>
<td>Extract information for thermal design</td>
</tr>
</tbody>
</table>
Evaluation

► Outcomes are verified in the form of a written examination
  ● Students analyze problems in limited time
  ● implement solutions based on the intended learning outcomes of the course.

► Students present a project that encapsulate the concepts and techniques they learned during the course.
  ● This includes a spatial problem for indoor space; students are supposed to define the required information, extract it from BIM and analyze it in GIS.
There are differences existed between BIM/2DCAD/3DCAD. Describe these differences considering the following:

<table>
<thead>
<tr>
<th></th>
<th>2D CAD</th>
<th>3D CAD</th>
<th>BIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic Update</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Geometrie</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>5D</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Architecture elements</td>
<td></td>
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</tbody>
</table>
The following are BIM strength points to be used for GIS – explain how (Limit your answer to 100 word max for each point) (6 points)

• Evolving model

• Semantic Information

• Project hierarchy
Describe how BIM/GIS integration would be useful for the following use cases

• Flood management
• Building evacuation/ Fire fighting
• 3D Cadastra
• Traffic analysis
Evaluation

Using the IFC entities listed below; describe how you can provide the following (20 Points):

The volume of a building – equivalent to a building in CitGML LO2
Evaluation

Using the IFC entities listed below; describe how you can provide the following (20 Points):

The volume of a building – equivalent to a building in CitGML LO2
10.2. Zeichnen Sie die durch die folgenden IFC-Entitäten beschriebene Projektstruktur. (8 Punkte)

- #1=IFCPROJECT('abcdefghijklmnopqrs101', #101, "sample project", $, $, $, $(#1000), $(#1010));
- #3=IFCSITE('abcdefghijklmnopqrs103', #103, $, $, $, $, $, ELEMENT., $, $, $, $);
- #4=IFCBUILDING('abcdefghijklmnopqrs104', #104, 'sample building', $, 'office', #1501, $, 'sample building at 100 main road', ELEMENT., 129350., 128750., $(#1020));
- #8=IFCBUILDINGSTOREY('abcdefghijklmnopqrs108', #108, $, $, $, $, $, ELEMENT., $);
- #9=IFCBUILDINGSTOREY('abcdefghijklmnopqrs109', #109, $, $, $, $, $, ELEMENT., $);
- #10=IFCBUILDINGSTOREY('abcdefghijklmnopqrs109', #109, $, $, $, $, $, ELEMENT., $);
- #11=IFCRELAGGREGATES('abcdefghijklmnopqrs110', #110, $, $, #1, (3));
- #12=IFCRELAGGREGATES('abcdefghijklmnopqrs111', #111, $, $, #3, (4));
- #13=IFCRELAGGREGATES('abcdefghijklmnopqrs113', #113, $, $, #4, (8, #9));
- #286=IFCSPACE('3LweZaMsz0nR$8x1w5Bjie', #6, "W-001", $, 'Wohnen und Aufenthalt', #284, #300, "Elternschlafzimmer", ELEMENT., .INTERNAL., 0.);
Building besteht aus 2 Building Part, eines besteht aus 2 Storey oder andere aus 3 Storeys.
5. Draw the connectivity relationships represented using the following IFC entities?

```plaintext
#240=IFCFLOWSEGMENT('ABCDEFGHIJKLMNOPQRSTUVWXYZ', 'C', '', $, $, $);
#242=IFCDISTRIBUTIONPORT('ABCDEFGHIJKLMNOPQRSTUVWXYZ', 'C0', '', $, $, $, .SOURCE);
#243=IFCRELCONNECTSPORTTOELEMENT('ABCDEFGHIJKLMNOPQRSTUVWXYZ', 'C', '', $, $, $, $, #242, #240);
#244=IFCDISTRIBUTIONPORT('ABCDEFGHIJKLMNOPQRSTUVWXYZ', 'C1', '', $, $, $, .SINK);
#245=IFCRELCONNECTSPORTTOELEMENT('ABCDEFGHIJKLMNOPQRSTUVWXYZ', 'C', '', $, $, $, $, #244, #240);
#246=IFCRELDEFINESBYPROPERTIES('ABCDEFGHIJKLMNOPQRSTUVWXYZ', 'C', '', $, $, #240, #247);
#310=IFCFLOWFITTING('ABCDEFGHIJKLMNOPQRSTUVWXYZ', 'T', '', $, $, $);
#312=IFCDISTRIBUTIONPORT('ABCDEFGHIJKLMNOPQRSTUVWXYZ', 'TO', '', $, $, $, .SOURCE);
#313=IFCRELCONNECTSPORTTOELEMENT('ABCDEFGHIJKLMNOPQRSTUVWXYZ', 'T', '', $, $, $, #312, #310);
#315=IFCRELCONNECTSPORTTOELEMENT('ABCDEFGHIJKLMNOPQRSTUVWXYZ', 'T0', '', $, $, #314, #310);
#317=IFCRELCONNECTSPORTTOELEMENT('ABCDEFGHIJKLMNOPQRSTUVWXYZ', 'TO', '', $, $, #316, #310);
#405=IFCRELCONNECTSPORTS('ABCDEFGHIJKLMNOPQRSTUVWXYZ', 'T0', '', $, $, #312, #224, $);
```
Indoor navigation
Utility Network
The way forward

► Considering new topics
  ● BIM for infrastructure – IFC under development e.g. tunnels, alignments – corresponding to objects classes in geospatial domain

► A revision to the civil engineering curriculum and topics consider integrated technologies
  ● Environmental - Geotechnical - Hydrology – Transportation

► Consider your feedback on the provided topics
  ● Consider things as strength and weakness in the course,
  ● provide a rank to the current covered materials in the course.
  ● propose other topics to be covered in the course
Thank you