PR3 – Design of new learning materials

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Short Description:

The goal of this activity is to develop new educational materials, according to specific needs of the training providers, with the idea of reusing these adapted materials in their training offers. The localisation processes focus on adapting free and open licensed educational materials and deal mainly with translation of text lectures by using the Digital Europe eTranslation service. In total 3 courses were translated to English and eight courses were localised and translated to local languages.

Keywords:

BIRGIT Project, BIM and GIS integration, vocational training, new courses, localization

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Dissemination Level		
PU	Public	X
RE	Restricted to other programme participants (including Commission services and project reviewers)	
CO	Confidential, only for members of the consortium (including EACEA and Commission services and project reviewers)	

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Introduction

1.1. The BIRGIT project

Both in the public and private sectors, the construction and geospatial industries are demanding new approaches for urban planning, asset design and management. Digitization is one of the key developments to reduce costs, environmental impact and carbon footprints. One of the fundamental approaches in this development is by bringing together Building Information Modelling (BIM) and Geographic Information Systems (GIS) technologies. By connecting construction and geospatial information management, we can increase the efficiency of the construction processes, improve transparency and reliability, and better manage assets such as buildings, roads, and other essential public facilities.

There is a lack of skilled personnel and VET courses addressing the competencies required to achieve BIM-GIS integration. Existing VET programs across Europe for civil engineers, architects, land surveyors, geographers and other professionals working on the built environment and urban management, usually include courses in BIM or GIS, but not their intersection. As a consequence, professionals of these domains rarely know how to solve problems where a unified approach to BIM and GIS data management are needed.

The industry is however moving fast and new technologies are now being implemented within private companies and public authorities. This development clearly characterises one structural problem in the current education system, namely that new technologies and collaboration patterns put new requirements on education providers, who often have difficulties in coping with these requirements and a fast-changing society.

The project's main objective is to bridge the gap between supply and demand of these skills by improving the quality of the existing VET offer by providing new courses. New learning materials aiming at developing the necessary skills to integrate BIM and GIS will be developed. This material will specify learning outcomes addressing the achievement of knowledge on methods and mechanisms (mostly software tools and data modelling) but also on practical application cases. The

expected general impact will be the improvement of quality of the VET programs within the partnership an3 the possibility of using these courses by other training providers as well.

Project results (PR's) are the following:

- PR1 Industry requirements on BIM-GIS training programs and courses
- PR2 Localization of existing courses
- PR3 Development of new learning materials / course packages
- PR4 Testing and updating of learning material

1.2. PR3 Development of new learning materials

PR3 is the most extensive part of our efforts. Learning material which could be useful for the VET providers in our consortium were identified and the intended contents was sketched out. Very soon we came to the following distribution:

Basic knowledge like what is BIM and what is GIS was collected under one single heading. Most of this work has been performed by the Spanish partner.

Another aspect of BIM are these very recent developments of Digital twins,

This trend has gone so far in the last year that there are new developments for Digital Twins for everything, even humans and other living beings.

1.3. Structure of the document

Preparation of subtitles

Discussion and conclusion

2. Methodology

2.1. Popular description of the three course packages

2.2. Modified Scrum Methodology

A number of methods exist for agile and collaborative development, such as Dynamic System Development Method (DSDM), Scrum, Rational Unified Process (RUP) and many others. Scrum is a commonly used method for collaborative work, mainly applied in software development projects. According to the Scrum Guide (Schwaber and Sutherland, 2017) the method has also successfully been used in other types of projects. It may nowadays be considered as an industry standard for collaborative work, at least within the software development domain, although its limitation is sometimes expressed, and different improvements are suggested (Lowe, 2024).

Scrum is an iterative and incremental framework for managing product development. The method relies on assigned roles (product owner, developer, Scrum master etc), workflows (short development cycles called sprints, sprint planning meetings, daily Scrums, sprint reviews etc) and artefacts (product backlog, sprint backlogs, product increment etc). The Scrum methodology was earlier considered to work less well for teams which are geographically dispersed or working part-time and for teams whose members have very specialised skills and cannot pick up work of other team members. The wide usage of Scrum methodologies during the Covid-19 epidemic did however induce some changes in the methodology, which improved its usability. The expected remaining limitations were one of the main reasons for adapting the Scrum methodology to the specific requirements of developing learning material in geographically dispersed development groups, as outlined by Östman and Östman (2018). As a result, the modified Scrum methodology is based on three main concepts, the assigned roles, the workflows, and the artefacts.

The participants in the development process were having the roles of product owners, Scrum masters and developers. One objective of the BIRGIT project is to develop learning material in English, which then is to be localised based on local needs and used by training providers in their regular training offers. The development was organised into three learning material (LM) packages (Introduction to BIM, 3D GIS and BIM-GIS introduction). For each LM package, product owners were assigned. Their role was to participate in sprint meetings and to assure that the learning material was usable when the training courses were to be

implemented. Since each LM package was to be implemented at several training providers, several product owners were assigned for each LM package. For each LM package, a Scrum master was also assigned. Their roles were to solve problems, plan the activities, backlog management, reallocate resources if needed, and communication facilitation.

The workflows being used during the LM development processes consists of sprints, Scrum meetings, sprint meetings and quality reviews. The development cycle starts with a sprint meeting, where the objectives of the developments are presented by the product owners as well as the length of the sprint. The sprint then is the period when the actual development takes place. The usual length of a sprint was around 2 months in this project, which is somewhat longer as compared to common software development projects. The development within a sprint is monitored by the Scrum master, who also leads the bi-weekly sprint meetings. During these sprint meetings, various issues are discussed. In software development projects, daily Scrum meetings are usually applied. However, in this type of development, Scrum meetings every second week were found to be more appropriate. But due to this and the long physical distance between the developers, much of the Scrum meeting discussions were related to coordination, resulting in lengthy Scrum meetings. At the end of a sprint, a new sprint meeting was conducted, and the product owners gave response to the work carried out and issued new directives for the upcoming sprint. When the learning material did reach a mature status, it was submitted for quality review. In this process, assigned quality reviewers were examining the products in terms of correctness and coherence with internal rules for graphical design.

The development work was supported by various forms (artefacts), such as Syllabus, product backlog and sprint backlog. The syllabus was intended to act as a product specification, having information such as structure (list of lectures and assignments), learning outcomes, intended audience, pre-required skills, language and format etc, see figure 1.

3. PR3 - Development of the Course "Introduction to BIM"

3.1 Course development process

The development of learning materials for "Introduction to BIM" followed an adapted version of the Scrum methodology, an agile framework used for managing product development that emphasised iterative progress, collaboration, and flexibility. By dividing the project into Sprints and holding regular Scrum meetings, the team effectively managed obstacles, shared ideas, and produced a comprehensive course divided into three blocks. Moreover, this approach allowed all participants to create working teams across countries and beyond each organisation's boundary. It served as an ultimately efficient tool to overcome different working styles and to produce standardised outcomes, and enabled the BIRGIT project to deliver innovative learning materials on BIM and GIS.

The process involved five Sprint reviews with an average of 4 Scrum meetings per cycle, starting from the 3rd of May 2024 and until the finalisation of all learning materials in March 2024. This summary outlines the process undertaken to create the course materials.

Sprint 1: Roles definition and Course Outline

During the first Sprint, the team has defined and distributed roles to facilitate the sprint process and then defined the overall structure of the course, objectives and target audience. Through collaborative discussions in Scrum meetings, the team identified key topics to cover and outlined learning outcomes for each block. They also established a timeline for development and delivery.

Roles were distributed as follows:

Scrum Leader - Sylvia Liuti (FORMA.Azione)

Product Owners - Andrei Escalier (Ocellus) and Vlado Cetl (UNIN)

Product Developers

1. IFC - Anders Ostman (Novogit);

2. Data Management in BIM – Danko Markovinovic (UNIN);

3. BIM Definition – Carlos Clemente (AIN);

4. LODs and benefits of BIM – Ariana Kubart (Ocellus)

To assist all participants in the tracking of the process, three tools have been created: Syllabus, Sprint Backlog and Product Backlog. All participants were asked to contribute, while the scrum leader coordinated and maintained (updated) them.

The scrum meetings were held online on 3 May, 17 May, 31 May, and 14 June, and the Sprint Review Meeting was held on 26 June 2023

Sprint 2: Content Creation

Sprint 2 was dedicated to the development of course content. Due to changes in team membership and differences in holiday periods in consortium countries, materials have been developed without a regular scrum meeting schedule, which has slowed down the review process and the improvement of learning materials.

The Sprint meeting was held on 26 September 2023, and it focused on the need for a re-organisation of the common virtual workspace on Teams, the choice of a common methodology in the definition of learning outcomes, and definition of a format: power-point slides + scripts (lecture notes). Moreover, there has been a planned systematisation of the review process.

Sprint 3: Content Creation

The third Sprint started with a redefinition of roles in the team given the recombination of team members, with a subsequent reorganisation of workloads, adapted to the latest course structure and to the other course materials developed for PR3. Also, the review process has been restructured to allow all contributors to follow the procedure.

Roles were redistributed as follows:

Scrum Leader - Martina Morbidini (FORMA.Azione)

Product Owners - Andrei Escalier (Ocellus)

- Vlado Cetl (UNIN)

Lectures to be developed - Product Developers

1. BIM fundamentals – Carlos Clemente (AIN) and Esther Bautista Gil (AIN)
2. LODs and benefits of BIM – Ariana Kubart (Ocellus)
3. Data Management in BIM – Sanja Samanovic (UNIN);
4. BIM process workflow – Ariana Kubart (Ocellus)
5. IFC - Anders Östman (Novogit);
6. BIM for infrastructures and existing buildings - GISIG

Once roles and work flow processes had been re-established, the cycle focused on the design of course materials. Reviewers worked closely with product developers to ensure a higher quality of the learning materials. Scrum meetings provided opportunities to address challenges and brainstorm offered possible solutions regarding course contents, assignments and quality of materials.

Scrum meetings were held on 10 October, 24 October, 7 November, and the Sprint Review on 21 November 2023.

Sprint 4: Fine tuning and review

During Sprint 4, the team Feedback loops were crucial in refining the course content and ensuring the standardisation of course materials through a regular update of the review folder and management tools. The materials were structured in 3 learning “Blocks”, each containing three lectures:

Block 1 – BIM Definition

Block 2 – Working with BIM data

Block 3 – BIM Applications

The Workload was also redistributed accordingly, and to each lecture two reviewers have been assigned who checked the coherence of material and content overlap across different lectures, and the adherence to the agreed structure and templates of other course materials created.

The scrum meetings were held online on 13 and 19 December 2023, on 16 and 30 January 2024 and on 13 February 2024. The Sprint Review Meeting was held on 27 February 2024.

Final Review and Delivery

After the finalisation of course materials, the date of final Review was set to 12 of March, the date of delivery of all materials version 1.0 in portable document format (pdf) and ready for publication. The scrum leader coordinated a comprehensive review of all content, resolved any remaining issues, and packaged the materials for distribution. Internal meetings and email exchanges facilitated last-minute adjustments and ensured that the course met the established criteria for completion.

3.2 Project Result 3 – Introduction to BIM

3.2.1 "Introduction to BIM" - Course Overview

The following table illustrates all developed learning materials:

BLOCK 1 – BIM Definition				
Lecture(s)	**Author(s)**	**Reviewer(s)**	**Materials created:**	**Translated into:**
Lecture 1.1 **Fundamentals of BIM**	Carlos Clemente (AIN); Esther Bautista Gil (AIN)	Ariana Kubart (Ocellus); Roderic Molina (GISIG)	PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian
Lecture 1.2 **Benefits and challenges using BIM**	Ariana Kubart (Ocellus)	Roderic Molina (GISIG)	PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian
Lecture 1.3 Level of Development and 3D – 10D BIM	Ariana Kubart (Ocellus)	Roderic Molina (GISIG)	PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian

BLOCK 2 – Working with BIM Data				
Lecture(s)	**Author(s)**	**Reviewer(s)**	**Materials created:**	**Translated into:**
Lecture 2.1 **Data Management in BIM**	Sanja Samanovic (UNIN); Danko Markovinovi c (UNIN)		PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian
Lecture 2.2 **BIM process workflow**	Ariana Kubart (Ocellus)	Roderic Molina (GISIG)	PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian
Lecture 2.3 **BIM Coordination**	Ariana Kubart (Ocellus)	Roderic Molina (GISIG)	PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian
Lecture 2.4 **IFC as a data exchange format**	Anders Ostman (Novogit)		PowerPoint Presentation Lecture Notes	Spanish; Swedish; Croatian
Assignment **IFC**	Anders Ostman (Novogit)		Assignment Solutions	Spanish; Swedish; Croatian

BLOCK 3 – BIM Applications				
Lecture(s)	**Author(s)**	**Reviewer(s)**	**Materials created:**	**Translated into:**
Lecture 3.1 **BIM for infrastructures and facility management**	Roderic Molina (GISIG)	Ariana Kubart (Ocellus);	PowerPoint Presentation Lecture Notes	Italian; Spanish; Swedish; Croatian.
Lecture 3.2 **BIM for Historical Existing ? Buildings**	Silvia Gorni (GISIG)		PowerPoint Presentation Lecture Notes	Italian; Spanish; Swedish; Croatian.
Lecture 3.3 **BIM softwares and tools**	tbd			

3.2.2 Structure of the Learning Offer

The Learning material “Introduction to BIM” is structured in three thematic learning BLOCKS, created and offered as a sequential learning path, but ultimately self-standing.

BLOCK 1 – BIM definition

BLOCK 2- Working with BIM Data

BLOCK 3 – BIM Applications

3.2.3 Intended Audiences

The primary intended audiences are VET providers and VET practitioners, who may be interested in using the learning materials for their courses.

VET students can be considered a secondary target audience, since they can also use the learning materials for self-learning.

3.2.4 Prerequisites

Due to the introductory aim of the course “Introduction to BIM”, no specific prerequisites are asked from the audience. Learning materials are offered in chronological order to guarantee that each lectures’ prerequisites are met, but it is not mandatory to follow the suggested order. In fact, since the learning materials are offered as support for VET providers, each learning material can be accessed separately.

3.2.5 Language requirements

All learning materials have been developed in English language and in pdf format. For each lecture a PowerPoint presentation and Lecture Notes in text format have been developed. Each learning provider has selected some or all learning materials and provided a translation into the national language.

3.2.6 Learning Materials

In the following section a quick showcase of all course lectures, with a brief summary and learning outcomes is presented. All materials are available for download in pdf format on the BIRGIT website.

BLOCK 1

L1.1 Fundamentals of BIM

The lecture introduces Building Information Modeling (BIM) as a digital process revolutionising construction, emphasising its role in enhancing efficiency, sustainability, and project success. It covers fundamental concepts, historical development, AECOO industry applications, data management, dimensionality, LOD standards, and ISO 19650. Emphasising collaboration and practical applications, the training equips students with essential skills for real-world BIM projects, ensuring they understand its transformative impact on the construction industry.

LOs

- Define the main concepts of Building Information Modelling.
- Identify the benefits of BIM for different stakeholders.
- Recognize the different stages of the BIM lifecycle.
- Describe the importance of BIM standards and best practices

L1.2 Benefits and challenges using BIM

This lecture explains the differences between CAD and properly performed BIM, with focus on BIM as a process, not only 3D models of assets. Further, the lecture provides an introduction into the life-cycle of an asset, from the early idea and design through construction to operation, and the role of BIM in these steps. The focus lies on benefits of BIM usage, but also names challenges of BIM implementation and possibilities how to deal with these issues.

LOs

- Explain differences between CAD and BIM
- Understand role of BIM in diverse phases of building life-cycle
- Name benefits of challenges of BIM use
- Discuss factors slowing down BIM implementation

L1.3 Level of Development and 3D – 10D BIM

Lecture 1.3. introduces the concept of “Level of Development” in the BIM process and explains how it changes during the assets life-cycle. Then, it opens up what diverse kind of information can be provided by BIM within the 3D-10D dimension of the process and how it can enhance issue solutions in the AEC industry

LOs

- Explain the role of different Levels of Detail in BIM
- Name diverse kinds of information which can be provided by BIM
- Relate the Level of Development and the 3D-10D concept to asset life-cycle

BLOCK 2

L2.1 Data management in BIM

The Data Management in a BIM module contains the necessary knowledge and skills to effectively manage BIM projects and handle data during their life cycle. Participants will develop skills for comparing and utilising cutting-edge technologies, tools, and software to ensure interoperability and collaboration among stakeholders and data exchange among applications.

LOs

- Formulate key principles for effective BIM project management.
- Compare the latest technologies, software, and tools to ensure seamless interoperability between different software applications.
- List and describe techniques to optimise data workflows through collaboration.
- Select a method for analysis of BIM data, to generate reports, and to create visualisations to support decision-making in BIM projects.

L2.2 BIM process workflow

The lecture explains what the BIM process looks like - from the initial stage, when a new project's conceptual idea is introduced, through planning and construction and further through many years of operation and maintenance. The main focus is to explain the role of the different documents that specify the requirements in the individual steps of the project life cycle. Another important topic of this lecture is the selection of appropriate data, which are needed in the different life-cycle steps.

LOs:

- Revise for role and content of an Exchange Information Requirement document in a BIM process
- Explain the importance of a BIM Execution Plan
- Understand the value and usage of Class Systems and a Model View Definition
-

L2.3 BIM Coordination

This lecture opens an important topic of the BIM process, i.e., its coordination. It starts explaining how individual disciplines design their specific models, which are then merged to an interdisciplinary model. The student shall learn to understanding why, how and by whom this is done. Further, the lecture explains how the data and models are shared for successful access and communication within a project's many stakeholders. The lecture's last topic deals with issues that can slow down the process of BIM implementation and introduces the BIM maturity level, which depends on how many of the issues have been solved.

LOs

- Explain the role of discipline-specific BIM models
- Understand why the specific models are merged to final model
- Assess the main advantages of the Common Data Environment
- Describe the crucial steps in BIM implementation and how they relate to BIM maturity level

L2.4 IFC as a data exchange format

The aim of this lecture is to briefly describe the structure and content of an IFC file. The background of the standard is described as well as its importance for the development of the BIM sector. The overall content of the BIM schema is then described, as well as the basic structure of the STEP format, which is the de-fact o standard used for serialising the IFC model. An example of how to interpret an IFC file is also provided.

LOs

- Explain the role of IFC in the building and construction industry.
- Explain basic concepts used in IFC, such as
  . Objects and entities, inheritance and properties
  . Basic IFC entities such as IfcWall
- Describe the basic structure of an IFC file in STEP format.
- Analyse the content of an IFC file and relate its STEP entities to the IFC standard

Assignment

The aim of this assignment is to clarify the structure and content of an IFC file. The learner will open the textual version of an IFC file and element by element relate each property to the corresponding part of the IFC standard specification.

LOs

- Examine the records in an IFC STEP file.
- Explain the properties specified by the IFC records.

BLOCK 3

L3.1 BIM for infrastructure and facility management

This lecture introduces the use of BIM in infrastructure and facility management. It explains the fundamental principles of applying BIM in civil engineering projects, the combined use of GIS data, examples of applications, and available technical solutions. The second part focuses on BIM implementation in facility management, covering applications such as space management, asset management, maintenance planning, energy efficiency, safety, and more.

LOs

- Understand the fundamental principles and benefits of BIM in the context of infrastructure and facility management.
- Describe the application of BIM in various infrastructure and civil engineering projects.
- Understand the benefits of using GIS data in BIM infrastructure projects.
- Identify and assess different technical solutions to be used in BIM infrastructure projects.
- Identify and assess the effectiveness of BIM implementation in different facility management tasks and practices

L3.2 BIM for Existing Historical Buildings

This lecture introduces the use of BIM to manage historical buildings and structures. It presents the key benefits of using HBIM for historic buildings and the steps to perform the entire process - from the preliminary data acquisition to the modelling and its maintenance. Finally, it presents some examples of possible applications and 3 real cases.

LOs

- Understand the specialised application of BIM and its key benefits in the context of the historical building and structures
- List the steps of the HBIM process
- Describe concrete possible applications of HBIM

3.2.7 Conclusions

The course “Introduction to BIM” has been developed to respond to the needs discovered in PR2; to develop comprehensive and introductory learning materials on BIM: definition, uses and applications. The learning materials can be used as a structured course, as modular learning paths, or as individual lectures.

3.3 Development of Learning Material on 3D GIS, City Models, and Digital Urban Twins

3.3.1 Development characteristics

The development of learning materials on "3D GIS, City Models, and Digital Urban Twins", followed the modified Scrum methodology as described above.

The process involved four sprints with an average of 4 Scrum meetings per cycle. In addition to these sprints, quality review processes were activated for the nearly completed final products. In total, the development process covered around 10 calendar months.

The main artefact being used in the development cycles are the syllabus (product specification), product backlog, sprint backlog and quality review form.

The Scrum roles being assigned are specified in table 1.

Role	***Person***
Product owner	Erik Escalier (Ocellus) Sanja Samanovic (University North)
Scrum master	Anders Östman (Novogit)
Product developers	3D City Models: Ariana Kubart (Ocellus) 3D data processing: Vlado Cetl (University North) Digital urban twins: Anders Östman (Novogit)

Table 1. Scrum roles in the development of learning material on 3D GIS, City Models, and Digital Urban Twins.

3.3.2 Modifications of the proposed methodology

The Scrum methodology is an agile approach to development, where there is an option of incorporating changes in the requirements as the development proceeds. This feature was seen as very important in the development of the BIRGIT learning material.

The initial idea was that the content of the learning material to be developed should be specified in the Syllabus as learning objectives and be based on the needs analysis carried out in PR1. However, since the industry sector representatives were more familiar in expressing their needs in terms related to topics and sub-topics, the usage of learning objectives was not applied in PR1. This had the consequence that the initial version of the syllabus was mainly providing information on topics

and subtopics. It was left to the product owner and the development team to express their understanding of the learning objectives and develop suitable learning material to meet these objectives.

Some modifications were also made to the artefacts being used. For instance, information about used and planned development work was found to be unnecessary and consequently removed from the initial artefacts.

After the finalisation of learning materials, a final review was initiated, where the Scrum master should review all content and assure the project guidelines, such as the usage of British English, were appropriately applied. As a final step, the material was packaged for distribution.

3.3.3 Learning material on 3D GIS, City Models and Digital Urban Twins

The learning material being produced is structured in three different blocks, where each block has one main author.

3.3.3.1 City models

The learning material on City Models consists of three lectures, where each lecture consists of a powerpoint file and a more elaborated text document. These lectures deal with topics such as the main concepts and different types of 3D geographical modelling, 3D raster/voxel models, reality-mesh models, semantic city models and 3D data standards, mainly CityGML.

The City Model block is currently a theoretical block, and it has not yet any practical assignments developed.

3.3.3.2 3D data processing

The learning material on 3D data processing consists of three practical assignments and four lectures. Each lecture is delivered as slides in a powerpoint file and more detailed instructions in a text document. The practical assignments consist of a text document where the assignment task is

specified together with a proposed solution of the task. This document is supported by a powerpoint file, suitable for instance for introducing the assignment to students.

The topics being covered are mainly related to processing and integration of different types of land surveying data, from various types of sensors, various levels of details, various ways of data processing (CAD or GIS), various geometry types etc.

3.3.3.3 Digital urban twins

The learning material on digital urban twins consists of the lectures and one practical assignment. Each lecture is delivered as slides in a powerpoint file and a more detailed instructions in a text document. The practical assignment consists of a text document where the assignment task is specified together with a proposed solution of the task.

The first lecture deals with definitions and main concepts being used in digital urban twins. The remaining part of the learning material is targeting the management of sensor network and especially sensor networks for urban air quality. Consequently, the remaining two lectures deals with sensor data standards and an introduction to air quality. The practical assignment is then devoted to issuing sensor alarms based on real-time readings of air quality sensors.

3D GIS, City Models and Digital Twins

PRODUCT OWNER(S)

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VERSION NUMBER

0.4

URL

COURSE OVERVIEW

3D geospatial data are increasingly becoming available, for instance through open data portals. To combine these data sets, a solid understanding of geometric and semantic modelling is required, as well as appropriate tools and processes for the usage and analysis of data. Maintaining a 3D urban database also put additional requirements on processes as compared to the 2D case. The needs for proper management of 3D geospatial data are becoming more recognized together with the implementation of new technologies, such as digital twins.

PROMINENCE

Earlier versions of this course

OWNERSHIP

Author(s) and licenses

Figure 1. Extract of a product specification (syllabus)

During each sprint meeting, the status of the development was reviewed, and comments provided by the product owner. To document these comments, a product backlog was used, see figure 2. This backlog was implemented as an excel file and described the status and the current sprint goal for each LM component.

PRODUCT BACKLOG, COURSE 3D GIS, City Models and Digital Twins

PRODUCT BACKLOG 2023-11-14

Component	Sprint Goal	Status	Review 2023-10-08	Review 2023-11-05
City Models				
L1: Concepts of 3D modelling of the built environment	Ready for localisation	Slides are pending	Comments by EE, SS, HH and RM	
L2: Semantic city models	Ready for localisation	Slides are pending	Comments by EE, SS, HH and RM	
L3: 3D GIS data standards	Ready for localisation	Slides are pending	Comments by EE, SS, HH and RM	
L4: Creation, use and examples of existing city models	Ready for localisation	Slides are pending	Comments by EE, SS, HH and RM	
A1: 3D theory - self-testing quizzes and short reflections about semantic 3D models, usage,	Ready for localisation?	Pending		

Figure 2. Extract of a product backlog

The third artefact used in the development was the sprint backlog, which describes the status and problems to be addressed in more detail, see figure 3.

AGILE SPRINT BACKLOG, 3D GIS, City Models and Digital Twins, Sprint 4

LEARNING RESOURCES	ASSIGNED TO	STATUS	SPRINT GOAL	2023-12-13	2024-01-16	2024-01-30	2024-02-13	
1. City Models				Status	Status	Status	Status	St
L1.1: Concepts of 3D modelling of the built environment	Ariana	Draft	Ready for localisation	Draft	Slides missing	For review by 13/2	Hopefully 16/2	
L1.2: Semantic city models	Ariana	Draft	Ready for localisation	Draft	Slides missing	For review by 13/2	Hopefully 16/2	
L1.3: 3D GIS data standards	Ariana	Draft	Ready for localisation	Draft	Slides missing	For review by 13/2	Later	
L1.4: Creation, use and examples of existing city models	Ariana	Draft	Ready for localisation	Draft	Slides missing	For review by 13/2	Later	
A1.1: 3D theory - self-testing quizzes and short reflections about semantic 3D models, usage, own experience	Hans	Not started	Ready for localisation	Help needed	Quest by Hans	Tbr Roderic and Vlado	Later	
A1.2: Save and convert 3D data	Ariana	Not started	Deleted	-	-			

Figure 3. Extract of a sprint backlog

All artefacts were stored on a shared space in the project file repository.

In the remaining part of the section on 3DGis, City Models and Digital Twins we list the developed learning materials by lecture name, a short summary and the intended learning outcomes.

Concepts of 3D modelling of the built environment

Lecture summary

This lecture provides the introduction to 3D geographical modelling and is possible to take without previous knowledge of 3D GIS. It starts with several different concepts of 3D visualisation and explains how they differ according to area of usage. The student learns briefly about voxels models and more deeply about creation of reality-mesh models, with real-world examples.

Learning outcomes

At the end of this lecture, the learner is expected to be able to:

- Understand main concepts and different types of 3D geographic modelling

- Understand principles of 3D raster / voxel models
- Describe creation and advantages of reality-mesh models

Lecture: Semantic 3D city models

Lecture summary

This lecture focuses fully on semantic models as the state-of-the art-approach of the city modelling and basis for applications like smart cities and digital twins. It goes through advantages of models with semantic information and explains how such models are created. In the last part, the lecture shows several examples of existing semantic models as well as of their use in societal planning.

Learning outcomes

At the end of this lecture, the learner is expected to be able to

- Explain the semantic part of the city models and differences compared to graphical 3D models
- Summarise the main steps of semantic model creation
- Name examples of existing models as well as of their possible applications

Lecture: 3D GIS data standards

Lecture Summary

The last lecture of this block describes the 3D city models on data level. It introduces the student into the CityGML conceptual model and describes its modules and how they can be used in diverse aspects of city modelling. It goes more deeply into certain representation, e.g. geometric, topologic or time, because knowledge of these is important for understanding the process of

BIM-GIS integration. Further, the lecture provides information on different CityGML encodings as well as other 3D formats.

Learning Outcomes

At this lecture the learner is expected to be able to:

Name several ways how 3D data can be stored, with focus on CityGML encodings. Summarise the main parts of the CityGML conceptual model and how it is used. Understand the aspects of CityGML that are important for conversion to and from BIM.

Lecture: 3D GIS data standards

Lecture summary

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Learning outcomes

3.4 PR3 - development of learning material BIM - GIS integration

The members of the main development team of this material were

Scrum Master: Olga Bjelotomić Oršulić

Product owner: Erik Escalier

Vlado Cetl

Over six months, the BIRGIT team has diligently worked on the development of a comprehensive learning package aimed at facilitating the integration of Building Information Modelling (BIM) and Geographic Information Systems (GIS). At the beginning of developing the learning materials, we have divided this working package, referred to as PR3, into three distinct submodules regarding the theme, with the third module specifically dedicated to BIM GIS integration. Our approach to this endeavour has been marked by continuous planning, iterative development, and regular collaboration.

Throughout the development of learning materials for the PR3 project, our team adopted Agile principles, particularly the Scrum framework, to manage the project's progress effectively and ensure effective collaboration. The Scrum methodology was integral to our approach, facilitating agile development and iterative progress towards our project goals. Scheduled meetings were held every one to two weeks, providing a platform for team members to review progress, address challenges, and refine the direction of the syllabus and learning materials. These Scrum meetings served as crucial touchpoints, ensuring alignment among team members and fostering a space of collaboration and adaptability. We have relied on usage of backlog management from the Scrum methodology, encompassing both the product backlog and sprint backlog, which enabled us to prioritise tasks effectively and adapt to changing requirements, as well to share the progress between all team members on a common platform. The scrum method was applied during the development of learning materials, through the Scrum master defined from a team members, development team and project owner.

The project's timeline commenced with the identification of the key areas to be covered within the BIM GIS integration submodule. Through a series of discussion- and brainstorming sessions, we outlined the syllabus, aiming to strike a balance between theoretical concepts and practical application. This initial phase laid the groundwork for the subsequent development stages.

As the project progressed, we iteratively refined the syllabus and developed appropriate learning materials tailored to the needs of our target audience. This iterative approach allowed us to incorporate feedback from stakeholders (i.e., project owners), address emerging trends in BIM and GIS technologies, and adapt to evolving educational requirements, setting up the required model of the learning materials to presentations followed by more detailed notes in a separate text document.

This period put in learning materials development has been characterised by significant progress in the development of the PR3 project package for BIM GIS integration. During the initial phases of the PR3 project, our team encountered challenges in precisely delineating the content for each submodule, particularly regarding the integration of BIM and GIS within the broader curriculum. We grappled with determining which topics and concepts were best suited for inclusion in the BIM GIS integration submodule, and which might be more appropriate for the other two submodules. This process involved extensive discussions, brainstorming sessions, and even some trial and error as we sought to strike the right balance of the domain covered in the third submodule with regard to the other two submodules. It required careful consideration of the depth and breadth of each topic, as well as the overarching learning objectives of the project as a whole. Despite the initial uncertainties, our collaborative efforts eventually yielded a coherent syllabus that effectively delineated the scope of the BIM GIS integration submodule, laying the groundwork for subsequent development.

As we embarked on the development of the learning materials for the BIM GIS integration submodule, our early iterations faced significant scrutiny and feedback from reviewers within the team. The first versions of the materials did not fully meet the expectations and standards set forth by the team, highlighting areas where improvements were needed. Reviewers provided valuable insights and critiques, pointing out areas for clarification, expansion, and refinement. While initially challenging, this feedback-driven process proved instrumental in guiding the subsequent iterations of the learning materials. We took this feedback to heart, leveraging it as an opportunity to reassess our approach, address any shortcomings, and pivot in a slightly different direction as needed. Through iterative development and continuous refinement, we were able to produce learning materials that not only met but exceeded the expectations of the reviewers, ultimately resulting in a more robust and effective educational resource for our target audience.

Furthermore, one of the most significant challenges encountered during the development of our learning materials revolved around the creation of practical exercises, primarily due to the scarcity of advanced free and open-source solutions in the field. While some open-source options were emerging, they were still in nascent stages of development, leaving a gap in readily available resources. Additionally, commercial solutions, albeit more robust, were often prohibitively expensive and inaccessible to many due to their commercial nature. Addressing this challenge required extensive deliberation and multiple meetings within the team, during which the issue was thoroughly discussed. Initially, attempts were made to develop exercises using free versions of software solutions. However, after careful consideration, it was temporarily decided not to include practical exercises within this module. Nevertheless, as the development of learning materials progressed, the topic of practical exercises resurfaced, prompting a reassessment of our approach. Ultimately, a decision was made to explore the possibility of creating a practical example using a commercial solution. While this decision represented a pivot from our initial stance, it was motivated by a desire to enhance the hands-on learning experience for our audience. However, it's worth noting that this aspect of the project is still in a state of flux. Given the complexity of the task and resource constraints, there remains

uncertainty regarding our ability to fully realise this component by the project's completion. Thus, this aspect of the project remains under active development and will continue to be evaluated as we progress.

3.4.1 Syllabus of BIM GIS integration

Below, the final syllabus of the third BIM GIS integration submodule is given:

B1: BIM-GIS integration – introduction and workflow

- Lecture 1.1: Intro to BIM-GIS integration
- Lecture 1.2: Integration Workflow
- Lecture 1.3: Data conversion

B2: BIM-GIS in project's life-cycle

- Lecture 2.1: Integration in Planning Phase
- Lecture 2.2. Integration in Construction
- Lecture 2.3. Integration in Facility Management
- Lecture 2.4. Integration in Environmental projects
- Lecture 2.5. Integration in EIA and LCA

B3: BIM-GIS integration Use Cases

- Lecture 3.1. Use case - flood analysis for planning phase
- Lecture 3.2. Use case - in urban planning and design process
- Lecture 3.3. Use case - in assessment of urban energy performance
- Lecture 3.4. Use case - in construction of tower cranes
- Lecture 3.5. Use case - in traffic simulations

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