September 8th 2020 – BIM/GIS Integration Workshop

Contents

Session 1 - Fundamentals of BIM and GIS Integration – 8.30am – 10.00am

Paper #: 12 A structure of UML profiles for modelling of geospatial information in GIS, ITS and BIM

Authors: Knut Jetlund, Norwegian University of Science and Technology, Norway

This study aims to improve the interoperability between models of geospatial information from the applications domains of Geographic Information Systems (GIS), Intelligent Transport Systems (ITS) and Building Information Models (BIM). A state-of-the-art analysis showed that the Unified Modelling Language (UML) and Model-Driven Architecture (MDA) are used for modelling information in a geospatial context in all three domains, but with different approaches and levels of formality. A structure of formal UML profiles for modelling of geospatial information in GIS, ITS and BIM is suggested and tested for implementation. The Core Geospatial Profile (GCP) and general encoding profiles for the Geography Markup Language (GML) and the Web Ontology Language (OWL) are based on adapted concepts from ISO/TC 211 standards. Community specific profiles for conceptual models and encodings are based on UML profiles and the use of UML for specific information models in the three application domains. The studies and related research showed that the structure of UML profiles could be implemented and used for information modelling in the UML software Enterprise Architect and that existing profiles and information models could be adapted into the framework. Integration of information models in a common approach based on MDA and UML establishes a fundament for improved interoperability through a shared understanding of the digital representation of the real world.

Paper #: 17 The need for a differentiation between heterogeneous information integration approaches in the field of "BIM-GIS Integration": a literature review

Authors: Fritz Beck, Technical University of Munich, Germany; André Borrmann, Technical University of Munich, Germany; Thomas H. Kolbe, Technical University of Munich, Germany

The heterogeneous character of information models results in communication barriers between subsystems in railway organizations dealing with Building Information Modeling (BIM) and Geographic information systems (GIS). The integration of information is a promising way to bridge the heterogeneity of information models and satisfy the need for a more efficient communication. Integration efforts exploited in expert literature are often referenced using umbrella terms like "BIM-GIS Integration" or "GeoBIM", although dealing with different challenges and addressing different purposes. This paper highlights the need for a differentiation between integration efforts covered by the umbrella term "BIM-GIS integration". For this, a new approach for the categorization of information integration efforts was developed based on a literature research. Afterwards, challenges concerning information integration efforts in the field of "BIM-GIS Integration" were exploited and assigned to the respective categories to illustrate the importance of differentiation between heterogeneous information integration efforts.

Paper #: 41 Automatic Conversion of CityGML to IFC

Authors: Nebras Salheb, Delft University of Technology (TU Delft), Netherlands; Ken Arroyo Ohori, Delft University of Technology (TU Delft), Netherlands; Jantien Stoter, Delft University of Technology (TU Delft), Netherlands

The trend of increased usage of both BIM and 3D GIS and the similarity between the two has led to an increase in the overlap between them. A key application of such overlap is providing geospatial context data for BIM models through importing 3D GIS-data to BIM software to help in different

design-related issues. However, this is currently difficult because of the lack of support in BIM software for the formats and data models of 3D Geo-information. This paper deals with this issue by developing and implementing a methodology to convert the common open 3D city model data model into the most common open BIM data format, namely CityGML (Gröger et al., 2012) to IFC (buildingsmart, 2019b). For the aim of this study, the two standards are divided into 5 comparable subparts: Semantics, Geometry, Geographical coordinates, Topology, and Encoding. The characteristics of each of these subparts are studied and a conversion method is proposed for each of them from the former standard to the latter. This is done by performing a semantic and geometrical mapping between the two standards, converting the georeferencing from global to local, converting the encoding that the two standards use from XML to STEP, and deciding which topological relations are to be retained. A prototype implementation has been created using Python to combine the above tasks. The work presented in this paper can provide a foundation for future work in converting CityGML to IFC. It provides an insight into the relationship between the two standards and a methodology for the conversion from one to the other, and the process of developing software to perform such conversion. This is done in a way that can be extended for future specific needs.

Paper #: 73 Towards a canonical mapping for IFC-CityGML data integration

Authors: Helga Tauscher, Dresden University of Applied Sciences, Germany

Much work has been carried out on the topic of BIM-GIS integration. As a techical challenge in particular, research and development tackle the standard data formats of the two areas and aim for the conversion between, linking of or overarching querying over data sources of these formats. Usually, these operational cases (conversion, linking, querying) are examined in isolation or even treated as mutually exclusive and competing approaches. With Triple Graph Grammars, we propose to apply a method that allows to derive solutions for these operational cases from a common generic ruleset. We demonstrate this approach in a proof-of-concept implementation using eMoflon. Our work focusses on IFC and CityGML and we present and discuss a first end-to-end demonstration of integrating these standards with the proposed method. Going forward such representation of the correlation between IFC and CityGML, declarative, independent of particular operational implementations, can serve as a container to capture and document acknowledged integration schemes for IFC and CityGML, complementing these two standards with a specification of their correlation.

Session 2 - Keynote, Applications of BIM and GIS Integration 1 – 10.30am - midday

Paper #: 15 A review of digital twin developments in Australia

Authors: Alan Smart, ACIL Allen Consulting Pty Ltd, Australia

Over the past 10 years there has been growing interest in Australia in integrating BIM models of the build environment into broader 3D digital twin models that can incorporate BIM with 3D data on infrastructure and property boundaries. Three State Governments (Queensland, New South Wales and Victoria) are pursuing projects to digitise their cadastres which will ultimately facilitate broader use of 3D digital twin models. One example is illustrated in the work of the Queensland Government in developing a 3 D Cadastre and, in conjunction with the private sector, testing concepts for digital twin models. This work commenced in 2017, when a working group comprising the Queensland geospatial industry and the Queensland Government developed a "3D Queensland Strategy" The vison of this strategy was to transition from centuries of survey practice and law to a modernised and 3D digital system suitable to the needs of the twenty first century. The vision would be realised, in part, by establishing a 3D digital cadastre capable of supporting other 3D digital models in planning, design, construction and resource management generally.

Click here for full abstract

Paper #: 81 The EuroSDR GeoBIM Project – Developing Case Studies for the Use of GeoBIM in Practice

Authors: Claire Ellul, University College London, United Kingdom; Francesca Noardo, TU Delft, Netherlands; Jantien Stoter, TU Delft, Netherlands; Nicola Moretti, Politechnico di Milano, Italy; Avril Behan, TU Dublin, Ireland

Although the use of location-based data (location coupled with semantic information) within Geographical Information Systems (GIS) and from Earth Observation (e.g. satellite) sources has been long established for decision makers, this has only recently been reflected in the construction sector with a more recent move from Computer Aided Design (CAD) to Building Information Modelling. BIM has opened up an additional source of valuable location-based data, with particular focus on the architecture, structural and engineering detail of both buildings and infrastructure projects. As with most if not all location data, while BIM can be used on its own, major benefits are to be derived from integration with other data sources. When this is done with GIS, the result is known as GeoBIM and although there are some similarities between the two, challenges to integration are both technical and non technical, in particular the need for clear Case Studies to motivate both developers and senior management. There are synergies to be gained from a multi-national, coordinated approach when addressing these challenges, where participants can benefit from eachothers' experience and where the needs of users and the National Mapping and Cadastral Agency (NMCA) perspective underpin the research. This paper summarises final outcomes and findings of the EuroSDR GeoBIM research project, which was set up to provide the required multi-national, user-centric collaborative framework, which had as its overall aim the development of best practice guidelines for GeoBIM, and due to its situation within EuroSDR has an NMCA focus. The paper updates information with regard to GeoBIM projects and maturity in the participant countries, and provides an overview of the two Case Studies developed.

Session 3 - Applications of BIM and GIS Integration 2 – 1.00pm – 2.30pm

Paper #: 7 An Integrated BIM-GIS Platform for Representing and Visualizing 3D Cadastral Data

Authors: Dimitra Efstathia Andrianesi, National Technical University of Athens, Greece; Efi Dimopoulou, National Technical University of Athens, Greece

The rapid urbanization over the last decades is leading to intensive land exploitation, and thus to the degradation of the city environment and the surrounding areas. This reality that applies at a global level, challenges new needs for sustainable growth and new ways to protect and ensure land property. It is of great importance, for the viable growth of every organized social structure, to protect land ownership and land-use in an appropriate way. Therefore arises the need for continuous and valid update of the complex Rights, Restrictions and Responsibilities (RRRs) within a developing 3D urban environment. For this environment, the interest focuses on ensuring land properties by improved methods of 3D information management, within modern land administration systems. The integration of Building Information Models (BIMs) and Geographic Information Systems (GIS) is expected to produce various advantages and play an important role in constructing 3D city models that successfully deal with every challenge in the urban landscape. GIS, in one hand, can manage and provide information about the existing environment, while on the other hand, BIMs focus on information regarding the design, construction and maintenance of a building /or complex structure inside that environment. This paper discusses the development of an integrated GIS and BIM 3D data platform enriched with 3D cadastral information This is illustrated with two use cases, a city block (No 464) in the area of Chalandri, Athens, and a four-floor building (at Kithaironos 21 street, in the same buildings' block), used for applying BIM technology.

Paper #: 34 Reconciling City Models with BIM in Knowledge Graphs: A Feasibility study of data integration for solar energy simulation

Authors: Weiming Huang, Lund University, Sweden; Perola Olsson, Lund University, Sweden; Jouri Kanters, Lund University, Sweden; Lars Harrie, Lund University, Sweden

Solar energy simulations are used to quantify the potential of the passive use (daylight, solar gains) and the active use (photovoltaics and solar thermal) of solar energy. The simulations can be performed at different scales e.g. buildings, neighbourhoods and cities, with different requirements on the data. For example, for the neighbourhood simulations we need simplified building geometries that can be retrieved from city models, and window information that can be extracted from BIM models (as in many cases window information is missing in city models). In this context, city models and BIM need to be integrated and reconciled. In this paper, we investigate two approaches to integrate and retrieve such information in a case study, where the BIM data is stored in IFC and the city model in CityGML (LOD2). The first approach is to perform a schema matching in an ETL tool, so as to convert and import window information from the IFC file into the CityGML model to create a LOD2-3 building model. We also investigate an alternative avenue, namely a semantic web approach, in which both the BIM and city models are transformed into knowledge graphs (linked data). City models and BIM utilize their respective but interlinked domain ontologies. Particularly, two ontologies are investigated for BIM data, i.e., the ifcOWL ontology and the building topology ontology (BOT). This paper compares different paths of such integrative data retrieval, as well as discloses the gaps mainly with the semantic web approach to further unlock its potential.

Paper #: 49 Impact of Information Management During Design and Construction on Downstream BIM-GIS Interoperability for Rail Infrastructure

Authors: George Floros, University College London, United Kingdom; Peter Ruff, Skanska-Costain-STRABAG Joint Venture, United Kingdom; Claire Ellul, University College London, United Kingdom

The need for efficient and sustainable infrastructure – always critical to a city - is further gaining momentum as urbanisation creates the challenge of sustainably designing, constructing and operating the built environment. The AECOO industry, directly responsible for addressing this challenge, has adopted the use of BIM and GIS to aid in this endeavour. Both BIM and GIS overlap with respect to capturing aspects of the built environment, but are not interoperable by nature. To ensure a consistent and structured way of managing the information produced within these environments, industry standards such as IFC are implemented. Research to date focuses on addressing the integration between BIM and GIS for buildings by delving into the IFC and CityGML interoperability, which has highlighted significant geometric and semantic barriers that in the stage of integration, cannot be easily manoeuvred. The purpose of this paper is to provide an insight regarding the information lifecycle during Design & Construction in the HS2 Rail Infrastructure project and investigate the impact of current information management processes - and in particular Standards such as IFC, - on BIMGIS interoperability and lifecycle management of an asset. Results demonstrate the levels of mis mapping during the export to IFC which varies depending on the infrastructure asset type. Discussion shows that these can be addressed by the introduction of additional semantic property sets to facilitate downstream BIM-GIS interoperability for O & M, enabling scope for future work.

Paper #: 64 Knowledge Modelling for Heritage Conservation Process: from Survey to HBIM Implementation

Authors: Francesco Di Stefano, Università Politecnica delle Marche, Italy; Alban Gorreja, Università Politecnica delle Marche, Italy; Eva Savina Malinverni, Università Politecnica delle Marche, Italy; Chiara Mariotti, Università Politecnica delle Marche, Italy

This paper aims to develop a strategy for architectural knowledge modeling in order to actively support the built heritage conservation process by fostering collaboration among stakeholders and interoperability between datasets. The integration of two modeling systems, one ontology-based and one in BIM environment, seems to be the right way to meet this objective: the former is rather exhaustive to represent the semantic contents of conservation activities, especially non-geometrical data, the latter is absolutely suitable to represent the logic of the construction, above all geometrical-constructive aspects typical of any architectural organism. Thus, this study proposes a side-by-side approach to synchronize these different ways of representing reality by managing the complexity of cultural heritage on the one hand and of technology tools, such as information systems, on the other. The proposed methodology was tested on the city walls of San Ginesio (Macerata, Italy) and included different steps considering the in-use technologies (notably geomatics and information technologies) as key enablers to acquire, hierarchically order, model and enrich the knowledge of that heritage site. The result is a knowledge-led strategy moving from survey to HBIM implementation, as a way to enhance representation and management in architectural heritage processes.

Session 4 - Applications of BIM and GIS Integration 3, FME and 3D Data with 1Spatial – 3.00pm – 4.30pm

Paper #: 28 BIM and GIS Integration for Infrastructure Asset Management – a Bibliometric Analysis

Authors: Manuel Garramone, Politecnico di Milano, Italy; Nicola Moretti, Politecnico di Milano, Italy; Marco Scaioni, Politecnico di Milano, Italy; Claire Ellul, University College London, United Kingdom; Fulvio Re Cecconi, Politecnico di Milano, Italy; Mario Claudio Dejaco, Politecnico di Milano, Italy

The integration of Building Information Modelling (BIM) and Geographical Information Systems (GIS) is gaining momentum in digital built Asset Management (AM), and has the potential to improve information management operations and provide advantages in process control and delivery of quality AM services, along with underlying data management benefits through entire life cycle of an asset. Work has been carried out relating GeoBIM/AM to buildings as well as infrastructure assets, where the potential financial savings are extensive. While information form BIM maybe be sufficient for building-AM; for infrastructure AM a combination of GIS and BIM is required. Scientific literature relating to this topic has been growing in recent years and has now reached a point where a systematic analysis of current and potential uses of GeoBIM in AM for Infrastructure is possible. Three specific areas form part of the analysis – a review of BIM and Infrastructure AM and GIS and Infrastructure AM leads to a better understanding of current practice. Combining the two, a review of GeoBIM and Infrastructure AM allows the benefits of, and issues relating to, GeoBIM to be clearly identified, both at technical and operational levels. A set of 54 journal articles was selected for in-depth contents analysis according to the AM function addressed and the managed asset class. The analysis enabled the identification of three categories of issues and opportunities: data management, interoperability and integration and AM process and service management. The identified knowledge gaps, in turn, underpin problem definition for the next phases of research into GeoBIM for infrastructure AM

Paper #: 30 GeoBIM for digital building permit process: learning from a case study in Rotterdam

Authors: Francesca Noardo, Delft University of Technology, Netherlands; Teng Wu, Delft University of Technology, Netherlands; Ken Arroyo Ohori, Delft University of Technology, Netherlands; Thomas Krijnen, Delft University of Technology, Netherlands; Hasim Tezerdi, Municipality of Rotterdam, Netherlands; Jantien Stoter, Delft University of Technology, Netherlands

Among the digitalization processes which are being raised in Europe and in the world, the building permit process is seen as one of the priorities by municipalities, governmental institutions and standardization organizations. However, in current practice, the building permit issuing as well as the integration of geoinformation with BIM (GeoBIM) suffers from a number of complex subissues. These issues still remain and prevent the development of successful methodologies. In this paper, the building permit use case is explored within a project in close collaboration with the municipality of Rotterdam. A very specific case study in Rotterdam was selected as a starting point, which allowed us to develop the needed methodology for the implementation of an effective tool. In this paper we highlight the interpretation and formalization of regulation for building height, overhang and tower ratio. While these rules are specific to a zoning plan in Rotterdam, we believe that the methodology and encountered issues in formalizing the rules, applying the rules on delivered models and integrating various data sources (BIM and GIS specifically) are general to most building codes.