Borsa di studio attivata ai sensi di quanto disposto dal D.M. n. 1061 del 10/08/2021

Titolo del progetto: Development of a methodology for the integration of UAS laser scanning techniques and satellite remote sensing data into a BIM-GIS models adopted to optimize green infrastructures design

La borsa sarà attivata sul seguente corso di dottorato accreditato per il XXXVII ciclo:
INFRASTRUTTURE E TRASPORTI

Responsabile scientifico: Carla Nardinocchi
Area per la quale si presenta la richiesta: GREEN
Numero di mensilità da svolgere in azienda: 6
Numero di mensilità da svolgere all'estero: 6 presso Fachhochschule Nordwestschweiz, Hochschule für Architektur, Bau und Geomatik, Institut Digitales Bauen
Azienda: Survey Lab srl
Il Dipartimento è disponibile a cofinanziare per un importo pari a euro: 10000
Dipartimento finanziatore: DIPARTIMENTO DI INGEGNERIA CIVILE, EDILE E AMBIENTALE con delibera del 22.09.2021

Progetto di ricerca:
Introduction
In recent years, the issues of energy efficiency and environmental impact have become increasingly important worldwide. It is essential to apply sustainability strategies within the construction industry to reduce the use of natural resources and the impact on the territory. Environmental studies show that the construction sector contributes globally to the depletion of 30% of raw materials, 25% of water, 12% of soil, generates 25% of the world's solid waste and 40% of solid waste in developed countries (Dong and Ng, 2015).
To obtain optimal results is important to intervene in the preliminary phase of the design or during the feasibility studies. For example, the use of traditional 2D design software, allows to carry out the energy analysis only at the end of the process, limiting the possibility of improving the energy performance of a building. The methodology provided by Building Information Modeling (BIM) is ideal; it allows, in fact, to monitor each phase up to post-construction and to integrate strategies regarding sustainability from the beginning of the design process.
The methodology
BIM is a tool for the analysis, development, and maintenance of buildings. The National Building Information Modeling Standard (NBIMS-US™V3) and the International Organization for Standardization (ISO, 2016) define it as multidimensional digital representation of a work, existing or under construction, which allows you to share information on the physical and functional characteristics and not only the geometric ones he. The data collected concerns the properties of materials, components, systems and technical elements, the construction phases, maintenance operations, disposal at the end of the cycle.
The main advantage of BIM is related to the rapid availability of information and ease of visualization that allow you to compare different design hypotheses (Jianwang Wang, 2015) to optimize their environmental impact: unable to consider a work isolated, it is necessary evaluate how it interacts with the outside world, for example by carrying out analyses on exposure to sunlight or its interaction with site conditions and soil morphology.
It becomes essential to integrate BIM models with Geographic Information System (GIS) models for the management of spatial data. GIS is a tool that allows you to analyze, represent and, interrogate entities or events that occur on the territory. It is a system designed to acquire, store, manipulate, analyze, manage, and present all kinds of geographical

data. BIM, however, was born as a tool for the management of individual buildings and only recently is extending to the modeling of large infrastructures that consider large areas, introducing complex problems from a cartographic and geodetic point of view.
The development of effective methods for GIS-BIM integration will also make it possible to use advanced methods to certify the degree of sustainability of a work based on Multi Criterial Analysis (MCA) or Life Cycle Assessment Procedures.
In this context, the Digital Elevation Models (DEM) extracted with advanced 3D surveying techniques, both based on Unmanned Aircraft Systems (UAS) for photogrammetry, laser scanner and on satellite and ground-based remote sensing data have acquired more and more importance for their direct conversion to BIM, although demanding the development of automatic and optimized procedures to achieve the requirements of the model.
The case study
This research project intends to investigate the possibilities of BIM-GIS integration to carry out a multi-criteria analysis for the design of the Einstein Telescope laboratory in Sardinia which involves the construction of large construction (20 square kilometers) both on the surface and underground.
As part of the feasibility study of ET, it is planned to create a system that integrates parametric BIM model within a GIS dedicated to the project to be used for quantitative economic and environmental analysis, as well as to consider the requirements of the scientific community (e.g., low level of anthropogenic noise, depth, and size of underground environments, etc.).
Among the most relevant environmental constraints, that have given rise the need to be able to carry out a multi-criteria analysis on the model by varying the parameters of both design (BIM) and positioning (GIS), are the reuse of the excavated material, the distance from the windfarms (existing and of future construction), the hydrogeological conditions and the presence of parks and other natural reserves.
It’s fundamental to plan:
•the method of disposal and reuse of large volumes of excavated material, for example by identifying disused quarries and other suitable places.
•the supply of the high amount of energy needed to power the plants for pumping water from the tunnels, for ventilation, etc. proposing a "low carbon" infrastructure based on the use of renewable energy sources in a region that has enormous potential (large extensions of territory not anthropized, wind conditions, solar radiation).
Starting from the state of the art of BIM-GIS systems, in continuous evolution at a commercial, scientific, and normative level, the project is part of the GREEN research themes with the aim of using innovative techniques for the collection of spatial data and the developmentof an effective system for the design of a complex work, such as the ET laboratory, focusing on the environment and sustainability.
The proposed project is part of the ongoing work for the candidacy of the Sardinia Region to host the ET laboratory that has just been included in the European roadmap (ESFRI) as a large research infrastructure to be carried out through a large international collaboration, coordinated at Italian level by the National Institute for Nuclear Physics (INFN).

Titolo del progetto (inglese): Development of a methodology for the integration of UAS laser scanning techniques and satellite remote sensing data into a BIM-GIS models adopted to optimize green infrastructures design

Progetto di ricerca (inglese):
Introduction
In recent years, the issues of energy efficiency and environmental impact have become increasingly important worldwide. It is essential to apply sustainability strategies within the construction industry to reduce the use of natural resources and the impact on the territory. Environmental studies show that the construction sector contributes globally to the depletion of 30% of raw materials, 25% of water, 12% of soil, generates 25% of the world's solid waste and 40% of solid waste in developed countries (Dong and Ng, 2015).

To obtain optimal results is important to intervene in the preliminary phase of the design or during the feasibility studies. For example, the use of traditional 2D design software, allows to carry out the energy analysis only at the end of the process, limiting the possibility of improving the energy performance of a building. The methodology provided by Building Information Modeling (BIM) is ideal; it allows, in fact, to monitor each phase up to post-construction and to integrate strategies regarding sustainability from the beginning of the design process.

The methodology

BIM is a tool for the analysis, development, and maintenance of buildings. The National Building Information Modeling Standard (NBIMS-US™V3) and the International Organization for Standardization (ISO, 2016) define it as multidimensional digital representation of a work, existing or under construction, which allows you to share information on the physical and functional characteristics and not only the geometric ones he. The data collected concerns the properties of materials, components, systems and technical elements, the construction phases, maintenance operations, disposal at the end of the cycle.

The main advantage of BIM is related to the rapid availability of information and ease of visualization that allow you to compare different design hypotheses (Jianwang Wang, 2015) to optimize their environmental impact: unable to consider a work isolated, it is necessary evaluate how it interacts with the outside world, for example by carrying out analyses on exposure to sunlight or its interaction with site conditions and soil morphology.

It becomes essential to integrate BIM models with Geographic Information System (GIS) models for the management of spatial data. GIS is a tool that allows you to analyze, represent and, interrogate entities or events that occur on the territory. It is a system designed to acquire, store, manipulate, analyze, manage, and present all kinds of geographical data. BIM, however, was born as a tool for the management of individual buildings and only recently is extending to the modeling of large infrastructures that consider large areas, introducing complex problems from a cartographic and geodetic point of view.

The development of effective methods for GIS-BIM integration will also make it possible to use advanced methods to certify the degree of sustainability of a work based on Multi Criterial Analysis (MCA) or Life Cycle Assessment Procedures.

In this context, the Digital Elevation Models (DEM) extracted with advanced 3D surveying techniques, both based on Unmanned Aircraft Systems (UAS) for photogrammetry, laser scanner and on satellite and ground-based remote sensing data have acquired more and more importance for their direct conversion to BIM, although demanding the development of automatic and optimized procedures to achieve the requirements of the model.

The case study

This research project intends to investigate the possibilities of BIM-GIS integration to carry out a multi-criteria analysis for the design of the Einstein Telescope laboratory in Sardinia which involves the construction of large construction (20 square kilometers) both on the surface and underground.

As part of the feasibility study of ET, it is planned to create a system that integrates parametric BIM model within a GIS dedicated to the project to be used for quantitative economic and environmental analysis, as well as to consider the requirements of the scientific community (e.g., low level of anthropogenic noise, depth, and size of underground environments, etc.).

Among the most relevant environmental constraints, that have given rise the need to be able to carry out a multi-criteria analysis on the model by varying the parameters of both design (BIM) and positioning (GIS), are the reuse of the excavated material, the distance from the windfarms (existing and of future construction), the hydrogeological conditions and the presence of parks and other natural reserves.

It’s fundamental to plan:

•the method of disposal and reuse of large volumes of excavated material, for example by identifying disused quarries and other suitable places.

•the supply of the high amount of energy needed to power the plants for pumping water from the tunnels, for ventilation, etc. proposing a "low carbon" infrastructure based on the use of renewable energy sources in a region that has enormous potential (large extensions of territory not anthropized, wind conditions, solar radiation).

Starting from the state of the art of BIM-GIS systems, in continuous evolution at a commercial, scientific, and

normative level, the project is part of the GREEN research themes with the aim of using innovative techniques for the collection of spatial data and the developmentof an effective system for the design of a complex work, such as the ET laboratory, focusing on the environment and sustainability.
The proposed project is part of the ongoing work for the candidacy of the Sardinia Region to host the ET laboratory that has just been included in the European roadmap (ESFRI) as a large research infrastructure to be carried out through a large international collaboration, coordinated at Italian level by the National Institute for Nuclear Physics (INFN).