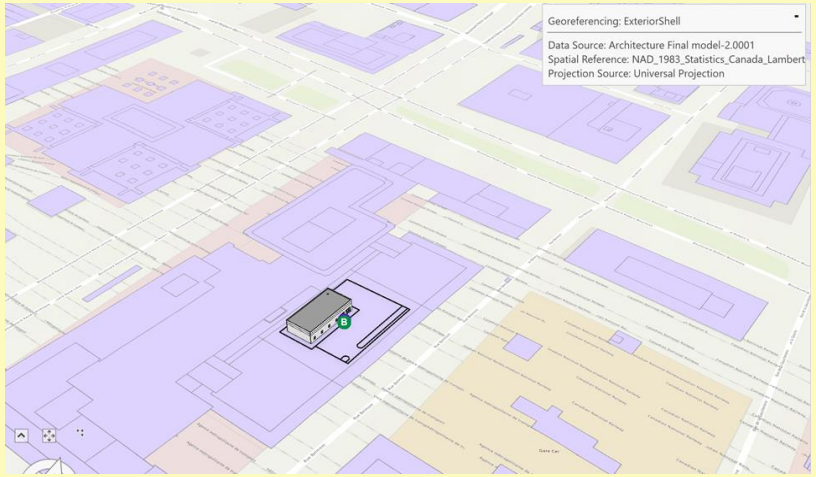
PHASE: DESIGN

BIM-GIS Integration Site Selection

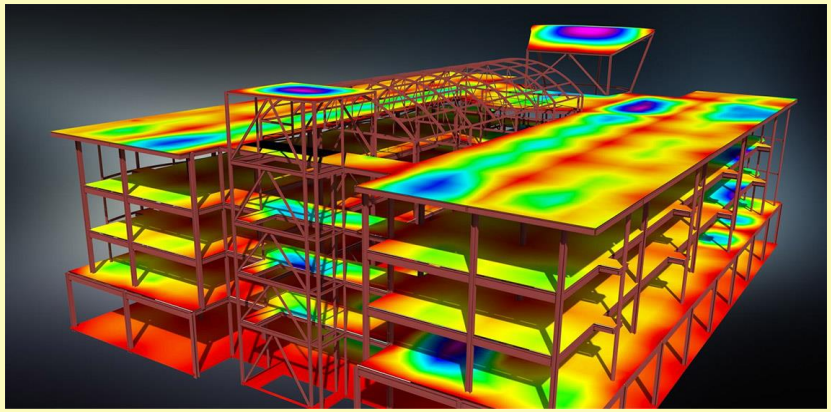
Software: ArcMap



One of the most important applications of the integration between BIM and GIS is site selection. In this project, the best location for a proposed building i suggested based on multiple criteria such as safety, security, public accessibility to the site, and the land use. Having such location with these specific attributes helps in different phases of the project from the design to the construction. Different software tools can help in selecting the proper site. However, having the integration previously mentioned can only be executed by ArcGIS pro version. Having some limitations to use this software tool has led to use another tool, from the same family, which is ArcMap. However, using this tool limits the capability of having such integration, and the scope of this project was narrowed down to only finding the best location regardless of the urban area and the integration with it. In terms of the analysis, a suitability analysis method was implemented to show a colored map based on prioritized criteria. This map represents several areas which are assigned to different suitability conditions from most to least suitable locations.

Implementation of a BIM solution for Structural Analysis and Design

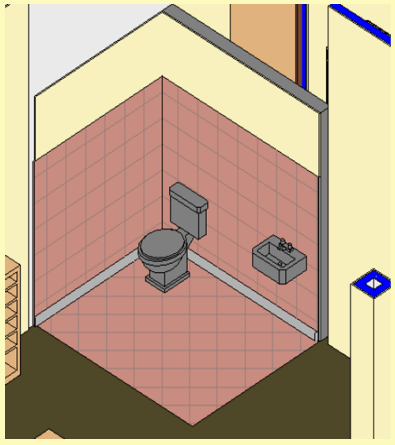
Software: STAADPro and Robot Structural

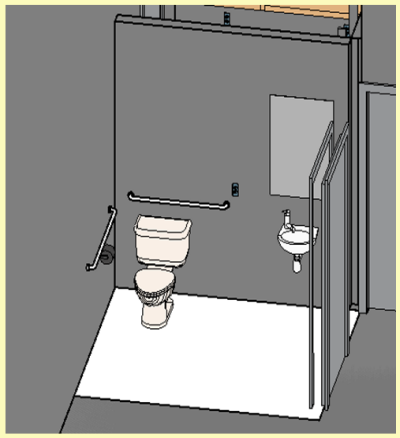


This project studies correlation between BIM and Structural analysis and design. Furthermore, make conceptual comparison between when BIM is used at structural design process and when it does not. In order to do so, firstly, structural model is created in Revit structure software, then it is imported to Robot structure, both of which are Autodesk products. Structural analysis and design process would be easier since there is no need to remodel structural elements such as beams, column, rebar, etc. which is one of the beauties of using BIM in this procedure. The other one is easy ability to export structural model from Robot to any BIM-integrated soft wares to make changes. Another positive point of doing the process with the help of BIM is reducing level of uncertainty about changing structural model because of architecture modification since it is easily reflected in structural model and there is no need draw structural elements in Robot again.

Automated Code Validation

Software: Autodesk model checker for Revit





With the tremendous growth of Building Information Modeling (BIM), an interesting aspect of it has been explored in this study. Building codes are a set of predefined rules; for countries and provinces; which need to be considered while designing and executing a construction project. Past studies focusing on BIM-based code validation in order to facilitate the work of designers and other responsible parties were the foundation of this research.
In our project, after studying the National Building Code of Canada (NBC), one of the articles of NBC was scoped. Various clauses in that article, and the set allowable limits were identified. Further, a BIM platform was implemented to make a set of these rules and apply to various models. The implementation framework and identified technicalities while doing so are mentioned henceforth. The study ends with all the results and conclusions, and there is also a focus on the limitations faced.

Daylight Analysis with BIM

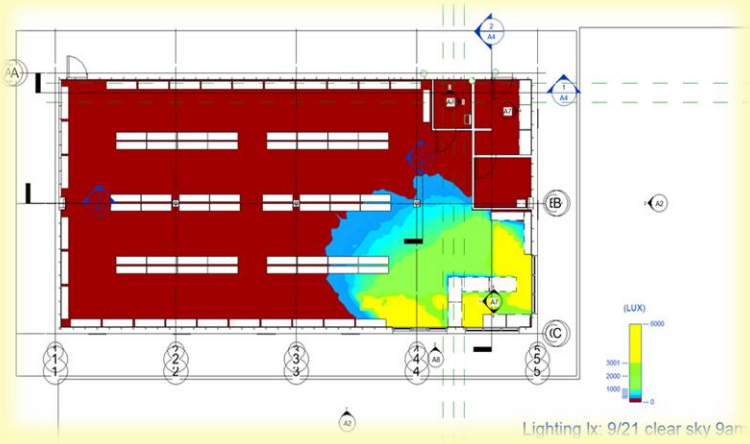
Software: Insight 360

Use of natural light as an internal illumination source in commercial buildings can increase the amount of sale by being less dependent on artificial light, improving workers' productivity and customer satisfaction. Therefore, an integrated evaluation of daylight during design phase and benefiting in design decisions regarding building elements such as material of surfaces, windows to wall ratio, windows places and internal obstacles as well as building size and orientation. The purpose of this project is to increase the illuminance of a single-story commercial building, placed in Montreal, by changing the interior shelves material color and also adding windows to the north and south elevations. To reach this approach, Revit software with Insight360 plug-in is used because of being totally integrated. The results show that using a lighter color for surface materials has a significant increase in the amount of illuminance in compared to adding more windows which means a simple decision during design phase can have a significant effect in operation phase.

BIM-based LEED Analysis

Software: Green Building Studio (Autodesk Insight)

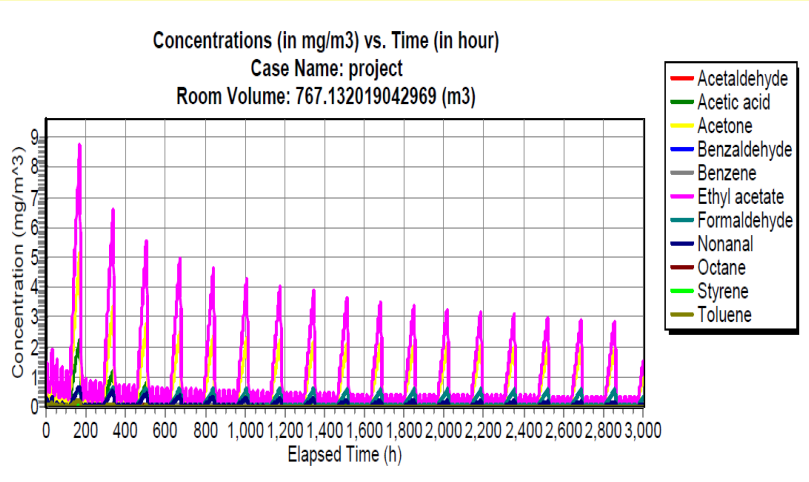
The most important decisions regarding the sustainable components of building are taken at pre-design and pre-construction stage. Our problem for the project is LEED analysis which targets the sustainability component of the buildings. LEED (Leadership in Energy and Environmental Design) is the most widely accepted sustainable building rating system. After literature review, we found that only selected credits for 3 categories which are Energy and Atmosphere, Water Efficiency and Indoor Environmental Quality can be documented using BIM. Credits for Energy and Atmosphere and Water Efficiency can be achieved using Autodesk Green Building Studio and Daylighting Credit in Indoor Environmental Quality can be achieved using Revit and Insight plug-in for Revit. In Daylight analysis, we found that Insight considers the artificial lighting for the daylight analysis as well which leads to unreliable results and hence we need to remove all the artificial lights from the model to get reliable results. Software tools we used are powerful for LEED analysis but care needs to be taken, so that reliable results can be derived for pursuing LEED certificate.



Indoor Air Quality Analysis with BIM

Software: IAQuest and EnergyPLus

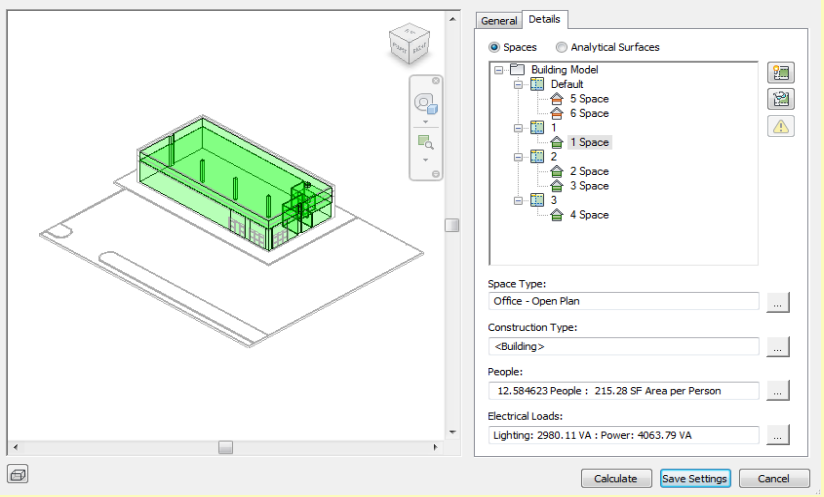
Every construction project is designed in a way that provides its users a desirable experience. It can be either in thermal comfort, visual comfort, Acoustic comfort or a favorable air flow. By the development of technology building information modeling has offered an integrated platform to simplify controlling all these processes. In this project, the 3D BIM model created in Autodesk Revit has been used to test occupants' thermal comfort in energy plus software and air quality in IAQuest software. The results show the existing contamination in the air because of the material used in the building that will be decreased by the ventilation system designed for the building and satisfied the LEED V4. Also, Because of the weather condition in Montreal, an alternative design has been proposed by changing five aspects of the preliminary design which include: designing shades for openings, expanding southern window, using thermal bridging, inverted ceiling and double-glazed windows. The result has then been compared to the preliminary design showing a better performance during operation hours.



Building System Analysis – HVAC System Design

Software: HAP (hourly analysis program)

In this project, simulation software HAP is employed for HVAC load calculation as a benchmark and the REVIT architectural model is used for heating and cooling load simulation. One of the advantages of using the architectural model instead of the MEP model is the possibility of considering plenum spaces for accuracy of load calculation. Therefore, we define spaces and thermal zones specified for load calculation. Specifying an internal and external load for each space and further associating each space to one thermal zone is the prerequisite to run HVAC load calculation. The report contains load reports, including the peak of heating and cooling load, total airflow for building, each zone, and space individually. Moreover, Revit exports data to HAP through gbxml standard for further verification and analysis. The gbXML file in HAP requires some modification due to incomplete transferred data from REVIT. Redefining the weather data, space wall area, and HVAC system are some of the main required adjustments.



LEED Assessment for HVAC System by BIM-GIS Integrated Model

Software: eQuest; Athena; QGIS

In this project, two steps were followed to calculate the total GHG emission of the HVAC systems, as a building component, during its entire life cycle (including transportation from alternative suppliers available in the market). In order to consider the comprehensive spatial analysis in the logistics, BIM- GIS integration was applied to procure the HVAC systems, then GHG emission was calculated based on the LEED certificate requirements.

In the operation phase of the building, the total GHG emission for the life cycle has been calculated using e-Quest and Athena software. For an effective assessment of the environmental aspect, we included information about each component of the HVAC system, including power consumption, heating, and cooling capacity, etc. In addition, the GHG emission of transportation was calculated by GHG protocol for mobile combustion and we found the supplier travel distance via QGIS.

PHASE: CONSTRUCTION

Application of BIM for Construction Cost Optimization

Software: Vico Cost Planner

Using Revit, we developed the 3D model of the building following an intelligent design approach that involves an interactive graphical user interface based on material properties. We developed an innovative framework based on sequential parameters which include the development of the 3D model, generation of cost-optimized models, analysis of the results and development of reports. To develop an accurate solution, we analyzed five different approaches considering the different parameters of design, cost, and materials. At the end, we decided to proceed with 4 Alternatives focused on cost optimization and produced the most inexpensive design model.

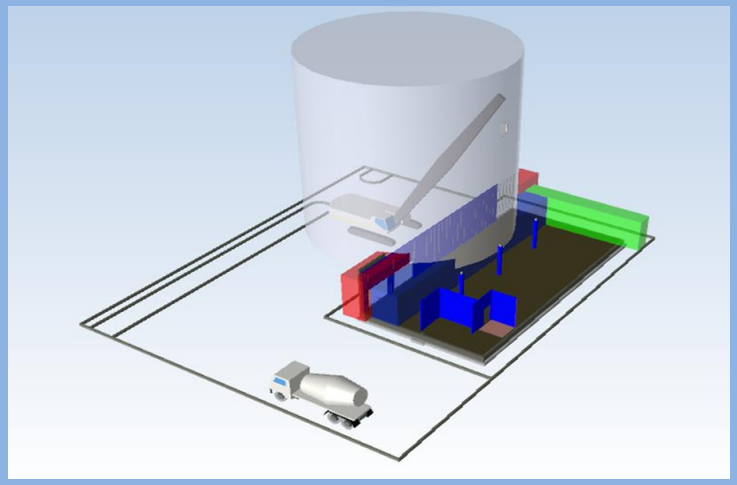
This report provides a thorough approach of implementing BIM for Cost optimization, design improvement along with usage of different cost-effective materials to reduce the overall cost and construction time of a construction project.

Construction Workspace Modeling & Management

Software: Synchro Pro

In this project, we were given a 3D model of a construction site and the main objective for us is to identify the workspaces and find or resolve any conflicts or clashes arising at any time. In order to do so, we need a Clash Detection Software. We opted Synchro pro over Navisworks because it is more effective in identifying and resolving 4D clashes.

Initially, we imported our 3D model from Revit to Synchro pro by converting the file into an IFC format. Over time, we recreated the schedule to the 3D model and started assigning tasks to resources. Workspaces are created with the help of this tool, and Dynamic clash detection tests were run to identify the clashes over time. We selected a phase of construction for this clash detection tests. Some clashes were detected and highlighted in the report.

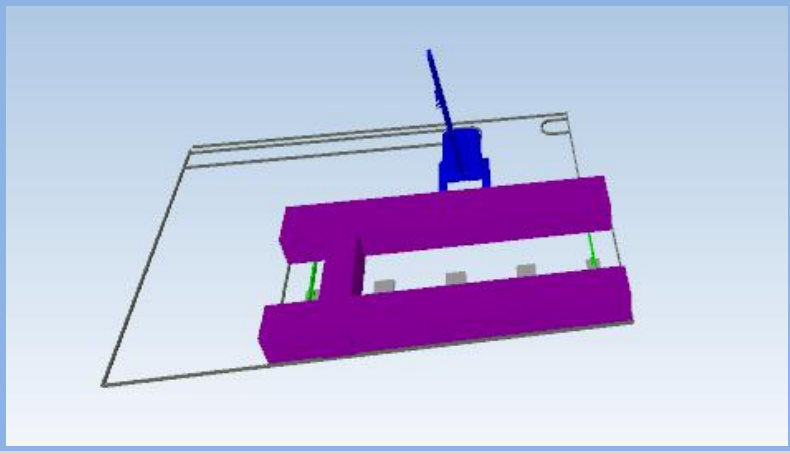


Construction Workspace Modelling and Management

Software: Bentley Synchro

The goal of this project is to achieve minimal scheduling clashes for construction project, using 4D BIM. The framework followed for the project is: (a) Creation of a 3D model for the Westside Video Store using Revit 2017; (b) Naviswork 2017 is used for detection of hard and soft clashes; (c) Schedule for the construction is introduced in the Synchro Pro 2019 to visualize the workspace clashes. The clash tests run for the project were focused on the labor crews; and (d) Rescheduling the project to avoid the workspace clashes.

The most challenging part of the project is understanding the need of schema to coordinate between Revit and Synchro Pro. The most interesting part of the project was seeing how the workspace is influential on the productivity, our understanding prior to beginning this project was just to gain knowledge on how to avoid physical clashes rather than spatial-temporal clashes.

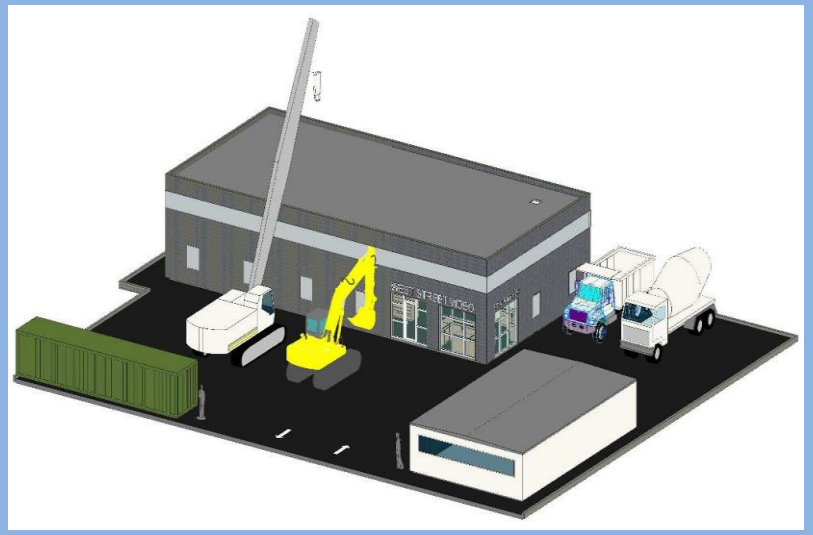


Construction Site Layout Analysis Using BIM

Software: Navisworks

The proposed term paper reports the feature of BIM, helping in analyzing the site layout during construction and the facility's direct distance for performing the facility site layout optimization. The most interesting part is that most of the time, the temporary facility which may look optimum in reel, would have a work clash in real which could be discover only during the simulation. The end goal of our project analysis would be to minimize the total inter-facility transportation cost.

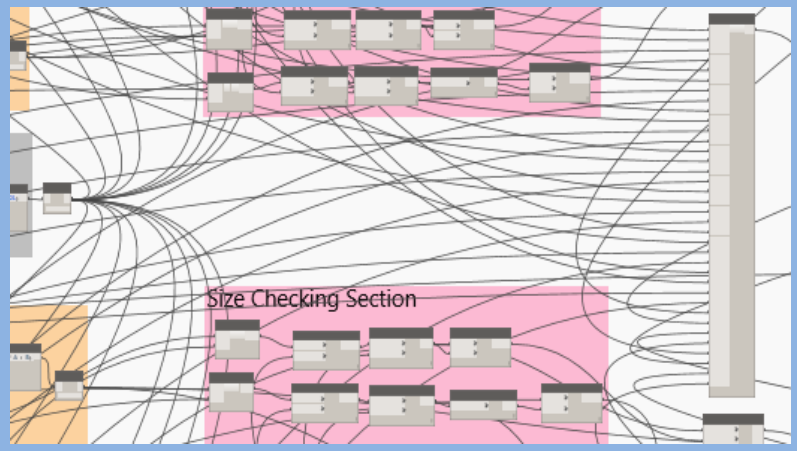
In order to achieve reasonable results, below strategy has been established: (1 (1) Determining the required facilities and model those facilities around the project site by using Revit; (2) Using QTO from Revit to determine the facility dimensions and area required (for storage area); (3) Introducing schedule at various project phase to determine the best optimum location for temporary facilities and determining any work space clashes using Navisworks; (4) Calculating and comparing the direct and actual travel distances; and (5) Concluding and analyzing on the best available site layout plan for our project.



BIM in Construction System Design: Concrete Formwork Design

Software: Dynamo

In this report, we have adopted a method that uses Dynamo as a tool, by inputting a series of algorithms into Dynamo to automatically process the extracted model parameters in order to optimize the concrete formwork design process. As a result, the dynamo code will offer suggestions on which combination of panel is better to use. Through the application of such codes on a project, we believe that this method can greatly reduce the time and cost parameters, as well as increase productivity, constructability and safety of project. However, there are some limitations in technical capacities of the Dynamo code that means this method may not be currently adopted as a solution for design, and more research and investment is needed for a functioning process.

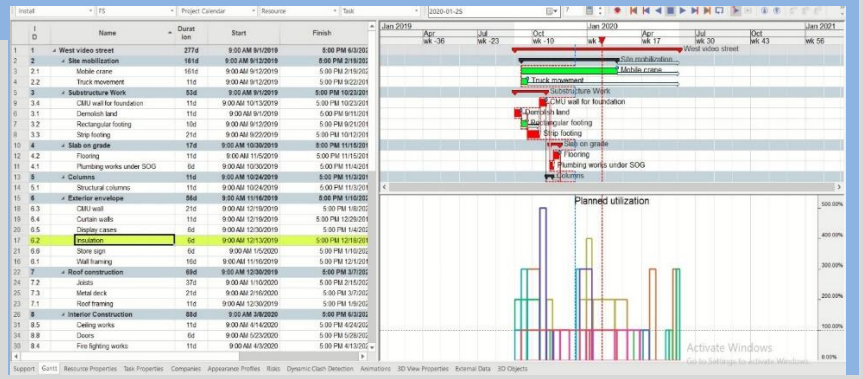


Resource Leveling with BIM

Software: Synchro Pro

Performing Phase Scheduling using Navisworks is an example of applying BIM which just integrates and visualize the process of design and scheduling. Therefore, conducting resource leveling with BIM is a clear need.

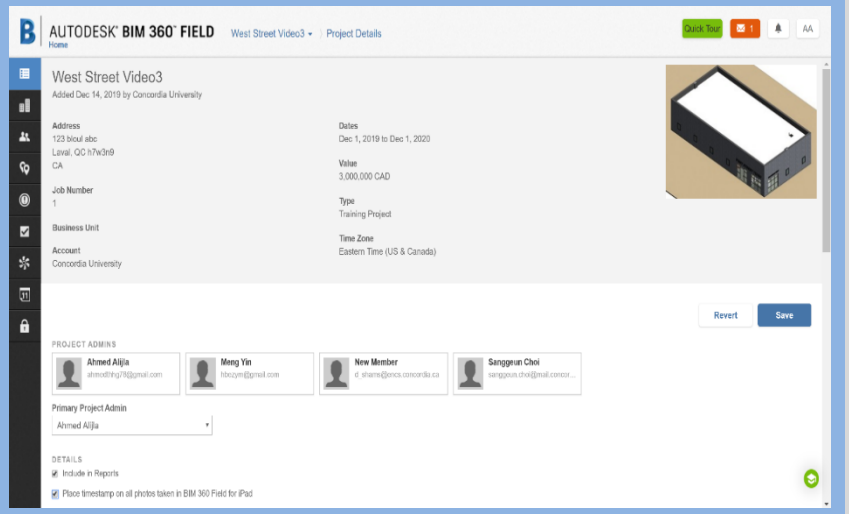
Through applying resource levelling in SYNCHRO it is understood, how beneficial is when it is possible to implement all those scheduling features in BIM friendly software. Using this software project manager can apply any needed change instantly on the model and provide all project stakeholder with better understanding of any probable changes to schedule.



BIM Application for Construction Site Safety Check

Software: Autodesk BIM 360 FIELD

For this study, BIM technology is applied for different uses including 3D Modeling for design and site layout using Revit software, and 4D Modeling and simulation for better visualization and identification of potential hazards and risks using Navisworks. Furthermore, “BIM 360” was selected as a main software in this project due to its capabilities regarding to site safety check. “BIM 360” is a cloud-based platform which enables to add safety standards and helps better communication among responsible parties for better understanding of potential incidents.

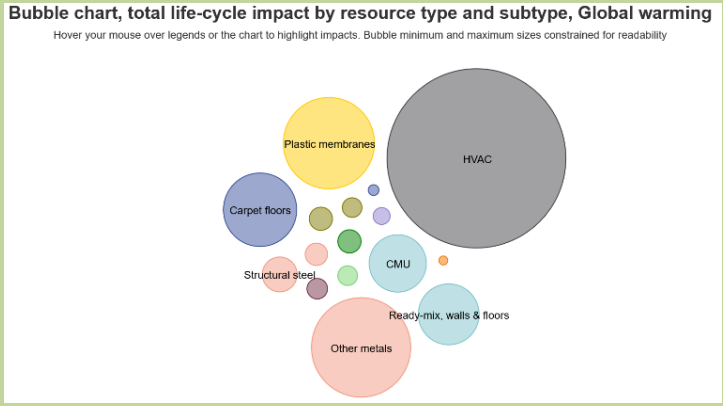


PHASE: OPERATION

Lifecycle Analysis Using BIM

Software: One-Click LCA

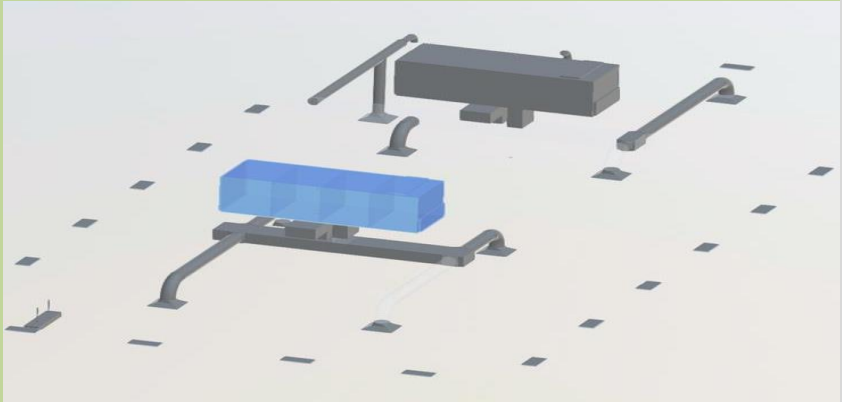
The core of the sustainability assessment of a building is Life Cycle Energy Analysis (LCA), considering global warming and organized carbon coefficients. There are several assessment methodologies suggested reducing the environmental impacts and the energy use of building systems. One of the most effective software tools in this era is “one-click LCA” which is used in this study. Using this software tool, we came up with some significant findings. Firstly, we could adjust the material and condition into the particular region which helped to increase the level of accuracy. Secondly, the results covered both carbon emission quantities and global warming effects. Lastly, according to its assessment, more effective alternatives for material selection were found. This report focuses on identifying energy loss problems, introduces assessment techniques and tools to facilitate sustainable construction.



Evaluation of Building Maintenance Strategies Based on Cost

Software: Autodesk BIM 360 Ops and COBie extention

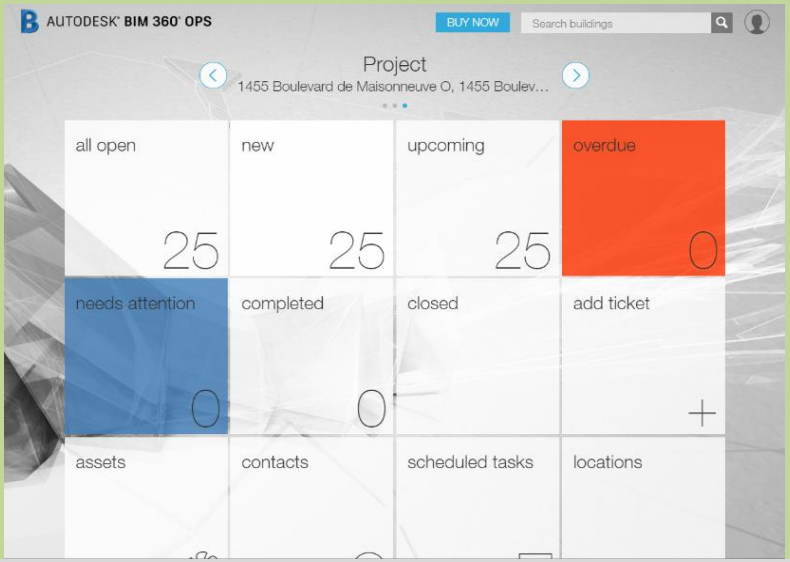
For this project, we tried to solve the building maintenance scheduling problem based on cost minimization, by using BIM. The use of BIM made the maintenance scheduling much faster, easier and more reliable. It saved time for everyone responsible for maintenance. BIM also enhanced the process of sharing information, reporting the problems in the building as well as simpler historical data storage for every asset of the building. While working on the project we found out that interoperability standards are not as easy to work with and require knowledge as well as training. Also, for the BIM 360 Ops, software training and keeping all the people at the same desk is required for its successful operation. There was another major problem of the initial cost as the software available in the market charges a lot of money for their product, and hence not everyone prefers to use them, reducing the use of BIM in Industry.



Building Maintenance Schedule

Software: Autodesk BIM 360 OPS

Traditionally, Facility Mgmt. department prepares maintenance order schedules on paper manually or through CMMS/CMMF based software. Both are inefficient way of making maintenance schedule specially for the large list of assets, for staff it is very tedious work when it comes to find the data from the 2D pdf drawing, it is time consuming and inaccurate. From the owner’s prospective, paper-based system is costly and inefficient. They need to keep adequate number of staffs only to find the related information of the facility. Developed BIM based FM system has tremendous advantage to the owner, repair crew and facility end-user. BIM provides a virtual image of the facility, linked with related data in the model. Accordingly, BIM offers capability of providing orders to responsible parties, and notifying the owner in case of delays. In this project we aim to adopt this technology to provide maintenance support in real-time. Before going to site repair crew can get detail about the kind of work, where it is located, resources and equipment needed for repair work. Attached image and video of maintenance procedure also help crew during operation period.



Evacuation Planning and Disaster Management using BIM

Software: Pyrosim and PathFinder

The critical issue in the incidence of any hazard for occupants evacuating the building and fire fighters is the lack of information about the hazard and spatial configuration. This causes ambiguity and inefficiency in the decision-making process. This research develops a 3D visualization using BIM, to simulate a virtual fire inside the building and study how the occupants would respond to the varying conditions inside the building. Information from a BIM (model) was entered into Fire Dynamic Simulator (FDS) for an accurate prediction of fire situation. Pyrosim provides a database of material parameters. Each material has its specific properties which help in providing an accurate simulation model. After that we used Pathfinder to determine the safe evacuation routs from the damaged building with the minimal loss of life and injury and also evaluate the time required by the occupants to safely evacuate the building. The building condition may vary every minute; therefore accurate information is necessary to assist in a rescuing operation, which can be provided by Pathfinder

Building Maintenance Scheduling

Software: Dynamo

This project is about providing preventive maintenance schedules of HVAC system elements within the BIM (model) so that facility management team can have direct access to the hierarchy of maintenance tasks that should be performed.

We started our project using Autodesk Revit to build the maintenance schedules. First, we defined the related maintenance functions as project parameters. Then, to generate future maintenance dates for the next three years (from the installation date), we used the Dynamo tool. So, in the end, we ended up with the maintenance schedules that consist of;

- Names of the HVAC equipment components for the maintenance;
- The installation date; so we can set the maintenance plan based on it;
- The intended maintenance functions; and
- Maintenance Intervals; to know when the exact date of next maintenance tasks would be.