CES468990

BIM Autodesk Software in an Engineering Consulting Company

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Learning Objectives

1. Apply the BIM methodology to projects with a focus on its management.
2. Use Autodesk tools to support the management of the enterprise.
3. Conduct constructive simulations.

Description

The use of BIM in an Engineering Consultancy company is very much a question of predicting field problems, in order to anticipate resolutions and thereby avoid rework, delays and possible negative impacts for the client. The use of BIM, as well as Autodesk tools, has enabled us to reach this level of maturity of delivering value to the end customer, in order to ensure that some studies and concepts can be virtualized and stressed in advance, causing the least possible impact on the constructions.
The objective of using BIM in a Consultative Engineering company is certainly given by the role of manager, therefore, we have as main characteristics of use the thought of monitoring and managing the enterprise, using the models for validations and changes in scope, planning assistance, attack plan analyzes, earth moving analyzes, etc.
These described items were contemplated by the Brazilian / multinational company Concremat Engenharia, bringing BIM to a reality adapted to the real needs of the ventures in which it participates, using tools such as Autodesk Infraworks, Autodesk Map3d and Autodesk Navisworks. This way of implementing BIM and Autodesk tools increasingly brings the methodology closer to the construction field, stimulating the main stakeholders to make decisions based on studies carried out through construction virtualization.
We will show in this presentation how we structure and adapt the methodology to our reality, and we will bring 3 case studies where in this way we could obtain significant gains both in quality and in the reduction of hours used to carry out the studies and also elimination or reduction of the impacts of project error in field. We will conclude by bringing our perceptions of the future and what we are preparing for the national scene for some time to come.

Speaker(s)

[Add your bio(s). Photos are not required, but you can add one if you choose.]

Alexandre Praxedes

Graduated in Environmental Engineering, PMP and specialist in BIM Applied to the Implementation of Infrastructure Works, he has 9 years of experience in the area and great experience in the preparation of the BIM Execution Plan and works with BIM models for Infrastructure, such as studies for implementation of construction sites and accesses, studies of movements on land and rock, quantitative survey, programming and control in 4D and constructive simulations. Currently leads the technical team of BIM implementation for construction and assembly.

Guilherme Borges

Guilherme Borges has been working with Engineering projects and research involving BIM since 2012. The research also started in the Civil Engineering degree at Universidade Federal Fluminense, with an emphasis on structural analysis using the Autodesk Robot. In the MBA he carried out studies focused on construction site logistics using 4D in the Navisworks software and now in his master's research at Universidade de São Paulo he focuses on infrastructure projects supported by the BIM methodology. At Concremat-CCCC, he works in the Strategic Studies and Innovation sector, seeking BIM solutions for the most diverse segments in which the conglomerate operates.

Leonardo Factori

Graduated in Architecture and Urbanism, Specialist in BIM Applied to the Implementation of Infrastructure Works, he has 5 years of experience in the area and experience in the area of Engineering Projects, such as, for example, building project execution. More recently, with a theoretical and practical bias towards BIM, studying the various applications and bringing it to practice in infrastructure projects..

Lucas Borba

Graduated in Architecture and Urbanism in 2006, specialist in BIM and working with more than 10 years, Autodesk Certificated in Revit Advanced, Civil 3D and Infraworks. He has been helping companies to implement BIM in the architecture sector since 2012, recently he had the challenge of implementing BIM at Concremat in the logistics and Sanitary sector, since then he has been working with engineers and developing standards and manuals for the company. As a BIM enthusiast, he knows in depth and works with all software in the Autodesk AEC Collection.

Use of BIM in a Consultative Engineering company

Company presentation

Concremat was founded in the 1950s, by Professor Mauro Vigas, being the first systemic structure control laboratory in Brazil. Years later, in the early 1970s, Concremat expanded its operations, investing in technology, diversifying its activities and becoming a reference in engineering services in the country.
In the early 2000s, more specifically in 2008, Concremat began operating in the international market with the management contract for the construction and assembly works of the Palomino Hydroelectric Plant in the Dominican Republic.
In 2016, Concremat was rated as a leading company in the engineering segment in Brazil and has maintained its leadership year after year since then.
Finally, in 2017, when it completed 65 years of existence, Concremat became part of CCCC group - China Communications Construction Company.

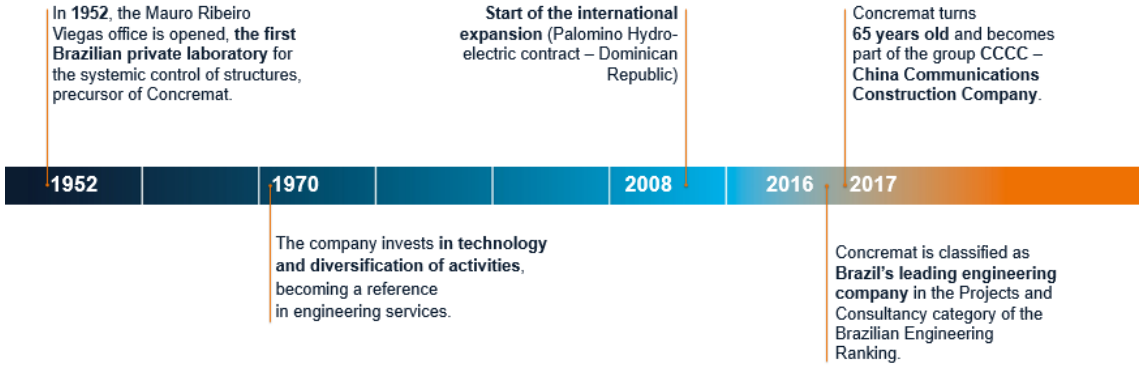

Figure 1 – Company timeline

China Communications Construction Company Limited (CCCC) is ranked 3rd in the Engineering News-Record international ranking and 93rd in the Global Fortune 500 ranking (2019), making it one of the world leaders in the construction and infrastructure projects segments, with over 100 years of experience in this market.
The Chinese conglomerate participated in the construction of almost all medium and large port terminals in China. The group is among the largest port and railroad builders in the world and is the leader in the dredging and container crane manufacturing segment.
In 2019, CCCC had revenues of US$ 88.14 billion.
During its more than 100 years of experience, CCCC has expanded its operations internationally, reaching operations in more than 155 countries and regions.
Currently, it has 210 branches and offices around the world and more than 60 fully owned or partially owned subsidiaries.

Figure 2 – Performance CCCC

Since the early 1980s, CCCC, through its subsidiaries, has been operating consistently across Latin America, developing and financing significant infrastructure projects.
Believing that the region is strategic for the consolidation of a global infrastructure corridor, CCCC has been carefully analyzing the respective logistical bottlenecks, thus concentrating its investments on key enterprises.
In this way, the company implemented a strategic development system based on three pillars: Integration, Location and Investment.
In addition, it is engaged in building three platforms, one of which is for Regional Management (CCCC South America Regional Company), one for Localized Operation (Concremat) and one for Miscellaneous Investments (CCCC South America Investment Holding).

Figure 3 – Business Structure

Ao longo dos seus 68 anos de atuação no mercado de AECO (Arquitetura, Engenharia, Construção e Operação), a Concremat construiu um legado baseado em competência e confiança. Este legado é fortemente representado pela Visão, Missão e Valores da Companhia.

- Visão: Ser líder de mercado.
- Missão: Elevar a qualidade e eficiência dos investimentos em engenharia e infraestrutura, construindo um legado para o futuro.
- Valores: Temos fome por aprender e inovar | Nos preparamos para os desafios com alicerce em equipes e parceiros | Cuidamos das relações com ética, confiança e segurança | Assumimos responsabilidade

e realizamos.

Over its 68 years of experience in the AECO market (Architecture, Engineering, Construction and Operation), Concremat has built a legacy based on competence and trust. This legacy is strongly represented by the Company's Vision, Mission and Values.

- Vision: Be a market leader.
- Mission: Increase the quality and efficiency of investments in engineering and infrastructure, building a legacy for the future.
- Values: We are hungry to learn and innovate | We prepare for challenges based on teams and partners | We take care of relations with ethics, trust and security | We assume responsibility and we do it.

In recent years, Concremat has been standing out in the national engineering and construction market in relation to leadership and innovation.

Proof of this is that since 2016 the company has been leading the Brazilian Engineering Ranking in the Designers and Managers Category.

In addition, Concremat is the only consulting company among the top 5 of the Construction and Engineering sectorial ranking of the Valor Inovação Brasil Award and 71st place in the general ranking.

Figure 4 – Recognitions and Awards

Concremat has operations throughout the Brazilian territory and, in recent years, it has also been expanding its operations in the Latin American market.

Thus, to make its operations viable, Concremat has established a strategic presence in the main regions and/or countries in which it operates.

Currently, the company has 11 regional offices in the main capitals of Brazil, such as São Paulo, Rio de Janeiro, Brasília, Belo Horizonte and Salvador, among others, in addition to branches and/or offices in Paraguay, Bolivia, Peru, El Salvador and the Dominican Republic..

Figure 5 – Concremat Performance

With over six decades of experience, Concremat has accumulated experience in several segments of the AECO sector:

- Transport and Logistics;
- Mobility and Urban Development;
- Buildings and Retail Networks;
- Sanitation and Water Resources;
- Energy;
- Industry and Mining;
- Oil and Gas.

To this end, our teams work synergistically, sharing competencies and providing an integrated view of the development of an enterprise.

Figure 6 - Concremat Pratice Areas

Based on its expertise and know-how in the AECO segment, Concremat has developed its own project management methodology based on the main references and good market practices, such as: FEL, PMBOK, PRINCE2, LEAN, Agile, AACE etc.

The technical approach of this own methodology is based on 3 pillars:

- Processes;
- Qualified Teams;
- Tools.

Currently, Concremat has a Network of Experts with more than 120 professionals from different specialties gathered in a single platform for solving problems.

The company also has a Network of Technical Partners with more than 460 companies and professionals providing services from all over Brazil, duly evaluated and registered.

In addition, Concremat maintains an Innovation Committee active with the mission of providing innovative initiatives, giving visibility and guiding investments and supporting the scale process. In 2020, the Committee will evaluate 29 projects, totaling more than R$ 1 million in investment.

Concremat currently has 2,890 employees in its technical and operational staff, of which 1,403 have undergraduate, graduate, master's, doctoral and postdoctoral degrees.

Most of this population is aged between 30 and 50 years old (62%), with a slight balance between the population under 30 and over 50 years old (21% and 17%, respectively).

Attraction, retention and development are increasingly strategic pillars in the organization. The company believes that training and human development help to understand and seek the best solutions for its clients.

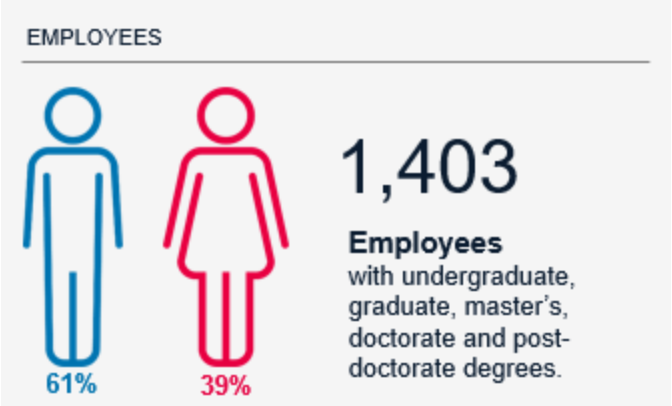

Figure 7 – Concremat Employees Profile

Concremat has an Integrated Quality Management System, which includes the safety and health of employees and ensures that environmental conditions are respected.

Currently, the company has the following certifications:

- ABNT NBR ISO-9001:2015 - Quality Management System;
- OHSAS 18001:2007 - Occupational Health and Safety Management System;
- ABNT NBR ISO 14001:2015 - Environmental Management System;
- ABNT NBR ISO/IEC 17025:2005 - Testing and Calibration Laboratories.

In recent years, Concremat has been going through an evolutionary process in relation to the adoption and application of BIM in its routines and projects.

To better illustrate this evolutionary process, making a reference to the BIM maturity levels defined by Succar (2008), Concremat is currently at Level 2, looking for some applications at Level 3 in order to meet operating needs.

Figure 8 – BIM Maturity Level

The adoption of BIM at Concremat is divided into two fronts, one focusing on the implementation for Studies and Projects and the other focusing on the implementation for Construction and Assembly.

This adoption started in 2009 through the structuring of 4D and VDC (Virtual Design and Construction) for use in construction and assembly management contracts.

However, it was only in 2012 that BIM began to be used in construction management contracts, precisely with the application of 4D and VDC in an enterprise in the aeronautical segment (Revit + Navisworks + Synchro)

In 2014, the company used BIM to manage the construction and assembly of an automotive industry and a subway. In addition, it started structuring the methodology in the Oil & Gas studies and projects sector. (Revit + Navisworks + Synchro | Navisworks)

In the following year, Concremat used BIM to develop the design of a fuel terminal and to manage the construction and assembly of a wind farm (Revit + Open Plant + Synchro | Revit + Synchro).

In 2016, the BIM methodology was used to manage the works of a pharmaceutical industry and to develop standards for a network of the retail store segment (Revit + Navisworks | Revit).

In 2017, the opportunity to adopt the methodology for the Infrastructure Studies and Projects sector with a focus on logistics and sanitation was identified.

Over the past three years, Concremat has stepped up and directed efforts towards the adoption of BIM across the company.

In 2018, it hired a specialized consultancy to support the implementation of BIM in the Infrastructure Studies and Projects sector and began structuring a strategy for the adoption of BIM in all management, supervision and inspection contracts. In addition, it used the methodology In 2019, it started implementing BIM in the Infrastructure Studies and Projects sector and in the

Construction and Assembly field, used BIM in a BRT project and started using geoprocessing to monitor linear works (AEC Collection | Revit + Civil 3D | AutoCAD Map 3D).

Finally, in this year 2020, Concremat consolidated and internally disseminated the BIM manuals for Studies and Projects and in the Construction and Assembly front, used the methodology in a railway work and a mining dam and began the study of a tool for creation of Digital Twins (Revit + Infraworks + Navisworks + BIM 360 + Forge).

In its BIM trajectory, Concremat has 16 projects in its portfolio that have adopted and/or are adopting the BIM methodology, of which:

- 6 are inland transport segment;
- 1 is a waterborne transport segment;
- 1 is a sanitation segment;
- 1 is an environmental segment;
- 3 are energy segment;
- 1 is an oil and gas segment
- 3 are industry and building segments.

Figure 9 – BIM Portfolio

Such projects are distributed throughout the Brazilian territory, with emphasis on the state of São Paulo, which concentrates most applications and uses.

The structuring of BIM in a Consultative Engineering company

Starting the structuring of the BIM methodology in the company, the idea was to attack parts of the methodology that were not restricted to BIM for projects, the first step was to develop a matrix of possible deliverables that the methodology offered separated by the asset phase, a matrix based on in a PennState College documentation.
The matrix facilitated the visualization of the horizon of possibilities and the capacity of deliverables that we could offer to clients, enabling the development of BIM in different stages of construction and seeking to leverage gains for the Consulting part of the project. .

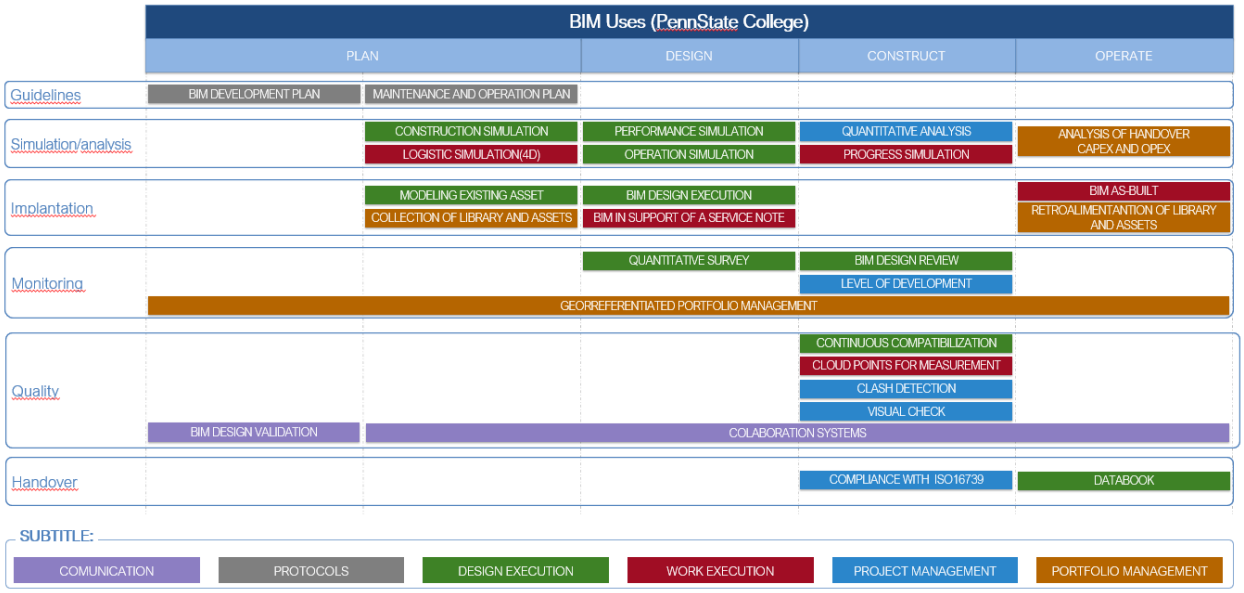

Figure 10 – BIM Products Grid

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Constructive Simulations of Projects

One of the important points in the structuring of BIM in a consultative engineering company is to simulate the constructions in order to build a virtualization of the intentions of the project, unifying the data and generating different possibilities, with the aim of enabling the analysis of different scenarios at the macro level serving as basis to support the guidelines and decision making of the enterprise.

This type of simulation has gained potential for application in the early stages of the project, with the potential return starting in the structuring of the project and peaking in the basic project phase. The great potential return of this application is the agility to find incompatibilities of ideas and enable quick solutions among the stakeholders.

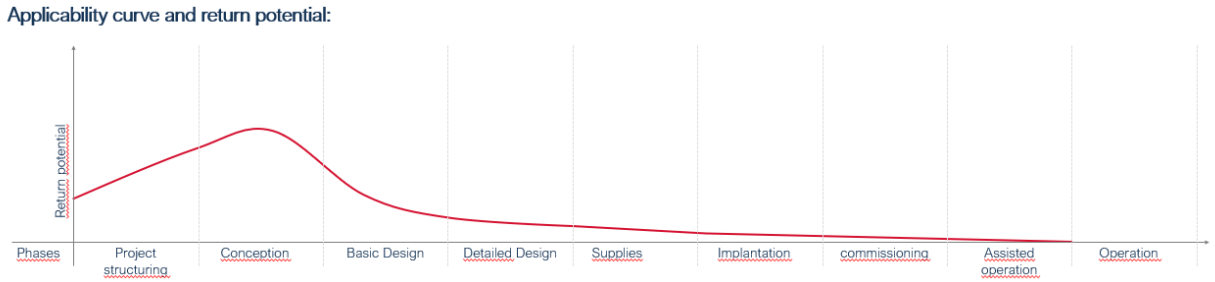

Figure 11 – Potential Return Curve

An example of a project that we use Autodesk Infraworks for simulations is that of a multimodal port with road and rail access with an internal railroad reverse loop. In the project in question, constructive simulations were used to simulate the constructive attack plan, facilitating the visualization of the asset's semiannual advance, enabling rapid changes and a better understanding of the schedule by those involved.

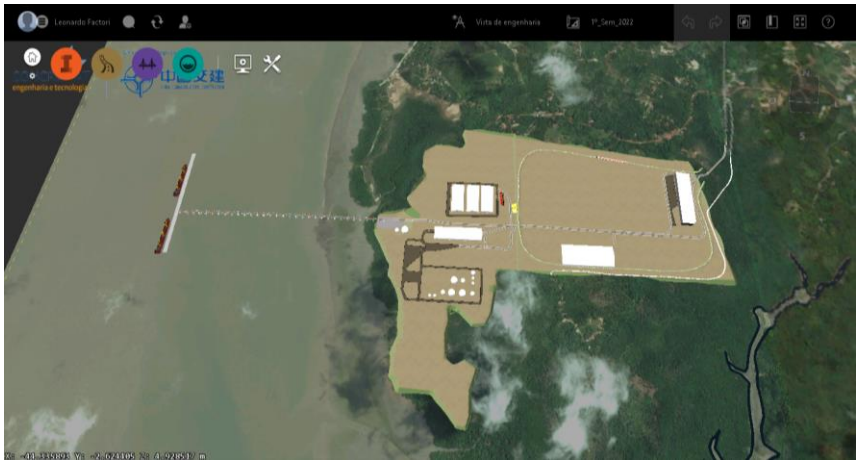

Figure 12 – Port Multimodal simulations

Another application possibility that brings gains for construction management companies is the earthmoving simulation made in Autodesk Infraworks, in the following case a comparative simulation was carried out between the projected excavation volume and the dump volume available for destination of the excavated material, in a water catchment dam. In the case in question, we had a practically incalculable return, where the difference of the material excavated for the destination area was approximately 10x below the necessary. Finding this difference at a construction planning stage eliminates an enormous risk in case the incompatibility is identified at the construction stage.

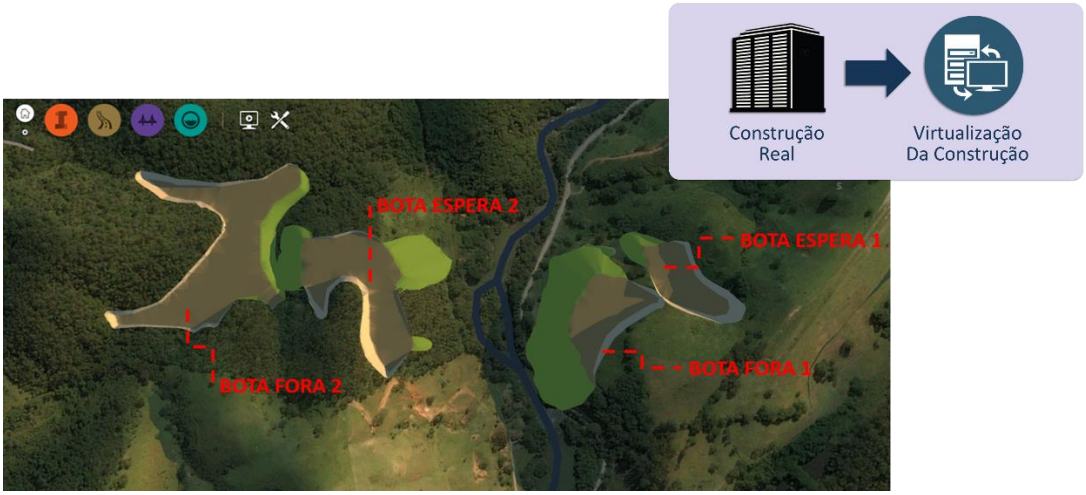

Figure 13 – Construction simulations in Dams

Logistics Simulations of Projects

Another important item in project management is to simulate the logistics of the project, known as 4D simulation, the process of linking the schedule to the construction model, bringing the evolution and virtualization of the stages of the work, segmented and sequenced, is important to view errors in the planning, inconsistencies, unwanted deviations, etc.
This simulation has its potential for return in the supply and deployment phases, for the supply phase the big gain is the potential of the tool to sequence the materials needed for construction in the planning weeks, facilitating the segmentation or acquisition of these materials.

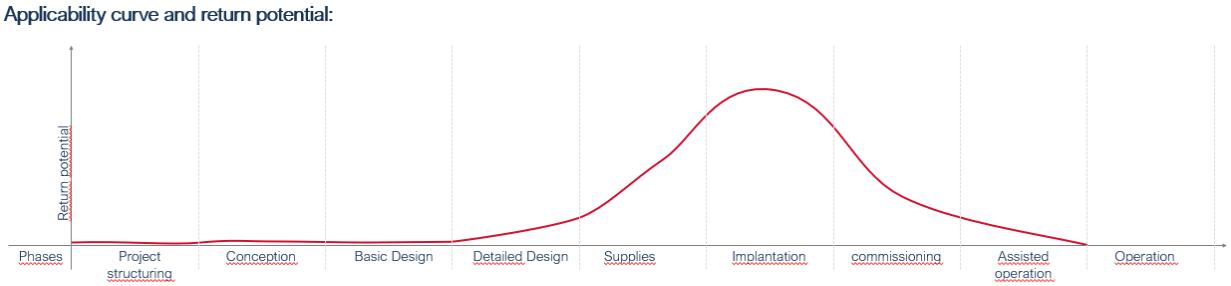

Figure 14 – Potential Return Curve

This simulation, performed in Autodesk Navisworks, in an industrial project of the automotive segment, served to visually show the executive planning of the work and, thus, to be able to compare with scenarios of completion, and projection of the planning, facilitating the visualization and spatialization of the construction time.

Figure 15 – 4D Simulation

Another application of the tool in the same project was the combination of the tool with Lean Construction, serving to simulate Takt's alternatives and define the best attack plan for the project.

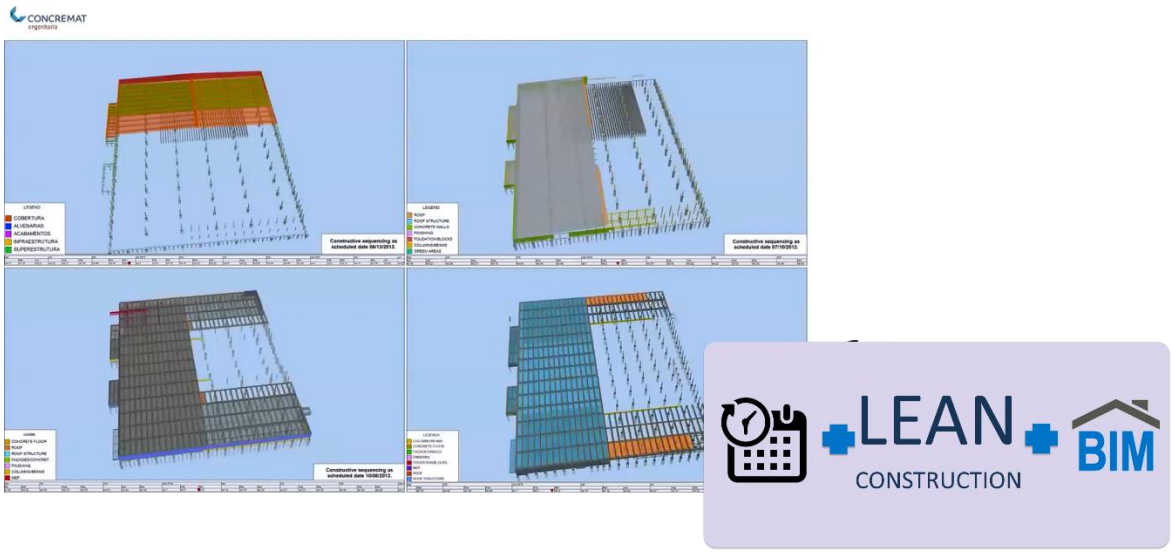

Figure 16 – Takt Simulation

Gestão de portfólio Georreferenciada

In works with linear characteristics, an important point to improve the total visualization of the project and facilitate decision making is the spatialization of the entire project. Taking this into account, the use of Autodesk Map3D allowing spatialization of the geometry of the projects, brings exponential gains in the phase of implementation, commissioning, assisted operation and operation of the asset.

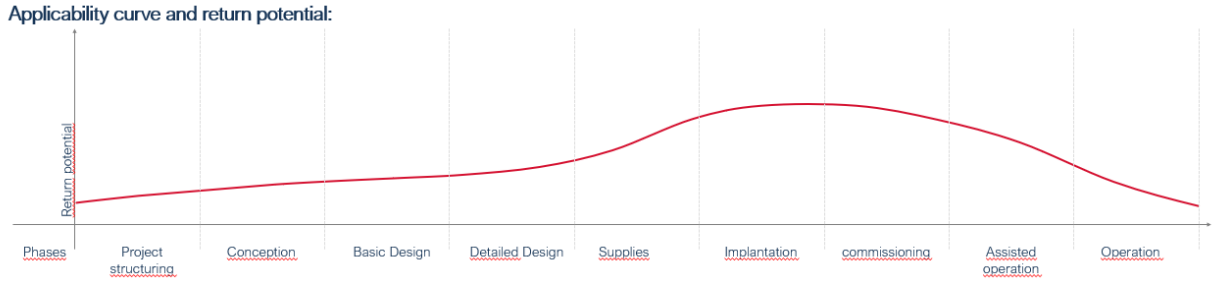

Figure 17 – Potential return curve

In the case of pipeline works, this gain is enhanced, due to the inability to visualize the asset, in the design of this pipeline in the city of São Paulo, Autocad Map3D, together with the structuring of a database, made it possible to link some design parameters and some parameters to monitor the status and monitor the progress of the works.

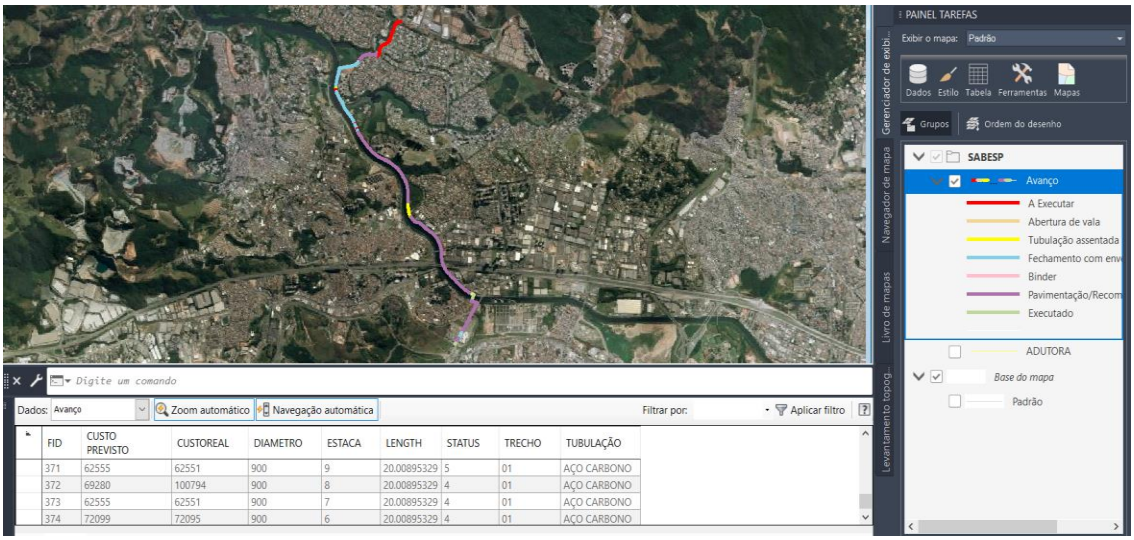

Figure 18 – Autodesk Map3d application

An important point of using Map3D linked to a database structured on a server is the possibility of integrating the same database with other systems, making it possible, for example, to structure graphical reports by means of Microsoft Power BI.

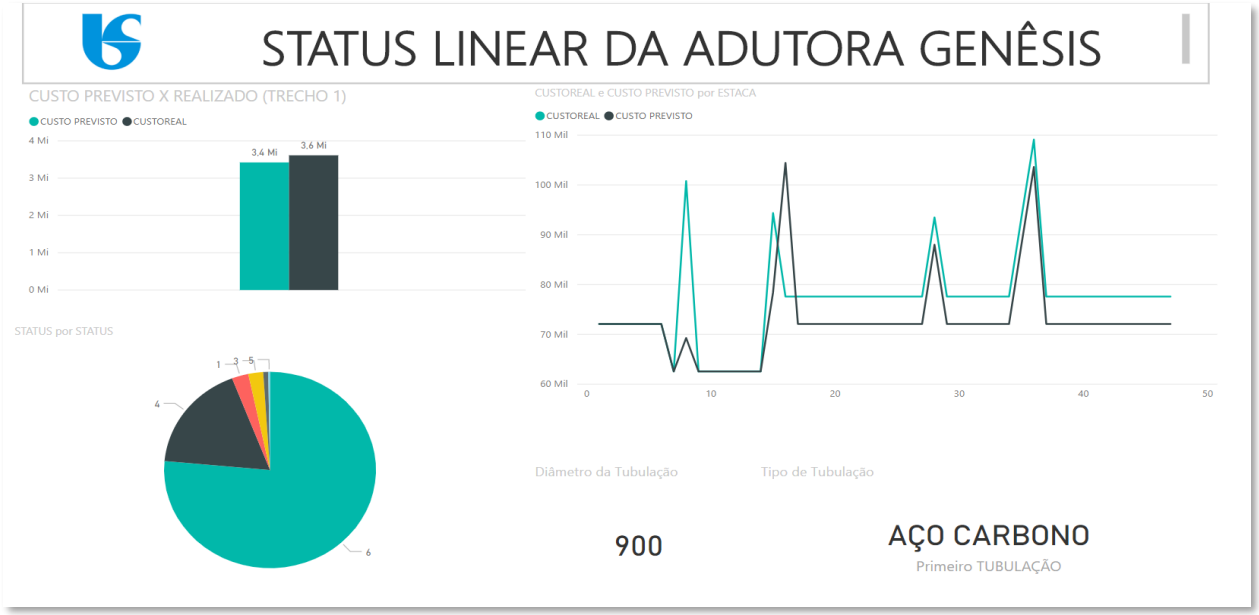

Figure 19 - Power BI integration with Map3D

This strategy of adopting the use of Map3D for the management of georeferenced portfolios is repeated in some energy transmission projects, bringing the spatialization of the transmission line and its elevation towers.

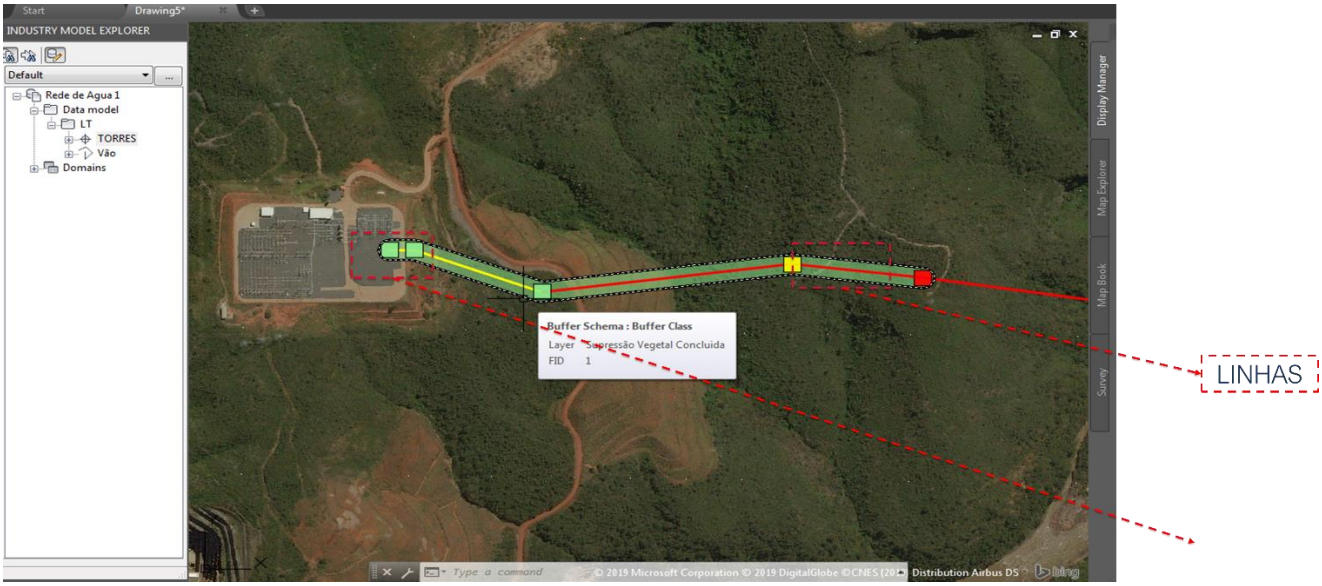

Figure 20 - Map3D in Transmission lines

Model quality and consistency management

After the company's strategy of implementing BIM in the Studies and Projects Unit, which had most of the work portfolio focused on Sanitation and Logistics, in 2018 a consultancy was conducted with the company Frazillio Ferroni, a BIM implementation consultant and Autodesk authorized reseller, and during the process all data from the project portfolio, installed hardware and software were collected and an interview was conducted with the work team.

At the end of the consultancy, a structuring plan was drawn up with milestones for immediate start, in the medium and long term, with divisions for Sanitation, logistics and in common between the disciplines. The need to acquire software and hardware, train the team and restructure the work methodology was also raised.

In 2019, a professional was hired to act as BIM Manager and be part of the study and project team, directing the implementation of BIM, preparing the necessary manuals for the team and guaranteeing the milestones defined by the consultancy.

Below are some key points that were raised during the implementation of BIM in the Center:

Software:

The Center opted for the acquisition of the Autodesk AEC Package due to the greater market acceptance and ease of use by the team that already came from an Autocad base, with the package most of the projects in progress would be covered, leaving some gaps for sanitation projects, Civil 3D plugins were purchased for these.

Hardware:

With a greater load of software, the need to acquire new hardware and update some of the team's machines was raised. During the consultancy, 2 hardware situations were raised, the minimum necessary and the recommended. All machines on the team have been upgraded or replaced to meet recommended requirements.

Team Training

The entire team was trained in BIM-oriented software, Infraworks, Civil 3D and Revit trainings were carried out for implementation strategy.

The team's future objective is to conduct training in Plant 3D for specific demands.

Structuring the methodology

For a good implementation of the methodology, the center team developed internal procedures and guides aimed at the use of BIM, for the software, manuals for internal use were prepared, defining the usage standards.

The E&P team had a challenge to implement BIM with disciplines that are not internal and outsourced partners are used to prepare the project, such as topography, for these partners, a specific manual was prepared and sent at the time of contracting, where the minimum to be delivered, formats and standardization adopted by Concremat are defined.

For the year 2019, a goal was outlined defining some disciplines and percentage of the team trained in BIM, this goal was surpassed by the company after the definition of the pilot project.

Pilot Project

At the option of the management team of the Center for Studies and Projects, it was not chosen to carry out a fictitious pilot project, after analysis it was opted for use in a real project that would be started. This project in question was not sold in BIM and it was not a requirement to use the methodology but by strategy and for training the team the BIM methodology was used.

Relevant items in the implementation

According to a survey carried out after the implementation of BIM in the Team, the following items were raised that were important during the implementation phase:

- Team Engagement;
  - The entire work team was receptive to the new way of working.
- Incentive by the company's management;
  - The guidance for the use of BIM came from the company's board.
- Investment funds for the implementation of BIM;
  - A budget was allocated to use with everything related to the implementation of BIM during 2019;
- Hiring a professional to direct the implementation;
  - At the beginning of the implementation, the hiring of a professional directed the efforts towards the implementation of BIM.
- Preparation of manuals and guides;
  - During the initial phase, all BIM manuals were prepared.
- Goal setting during the year for implementation;
  - With a well-aligned goal, the team was able to outline the plans and reach the goal.

Studies and Projects Team Cases

Bus Corridor (Pilot Project)

The bus corridors project was not contracted by the Client in BIM, however for use strategy and for internal training of the team, the methodology was used and this project was used as a pilot, BIM was used in the disciplines of Architecture, Landscaping, Drainage, Paving and Logistics.

The AEC, Revit (Architecture and Landscaping), Civil 3D (Drainage, Paving, Logistics and Landscaping) and Infraworks (Logistics) software packages were used to prepare the project.

The Project consists of 2 bus corridors with approximately 8km in length each in a metropolitan city, where changes would be made to the road layout, widening the road, changing paving and re-urbanizing the area.

The team had the challenge of preparing the project on time even with the implementation of a new methodology.

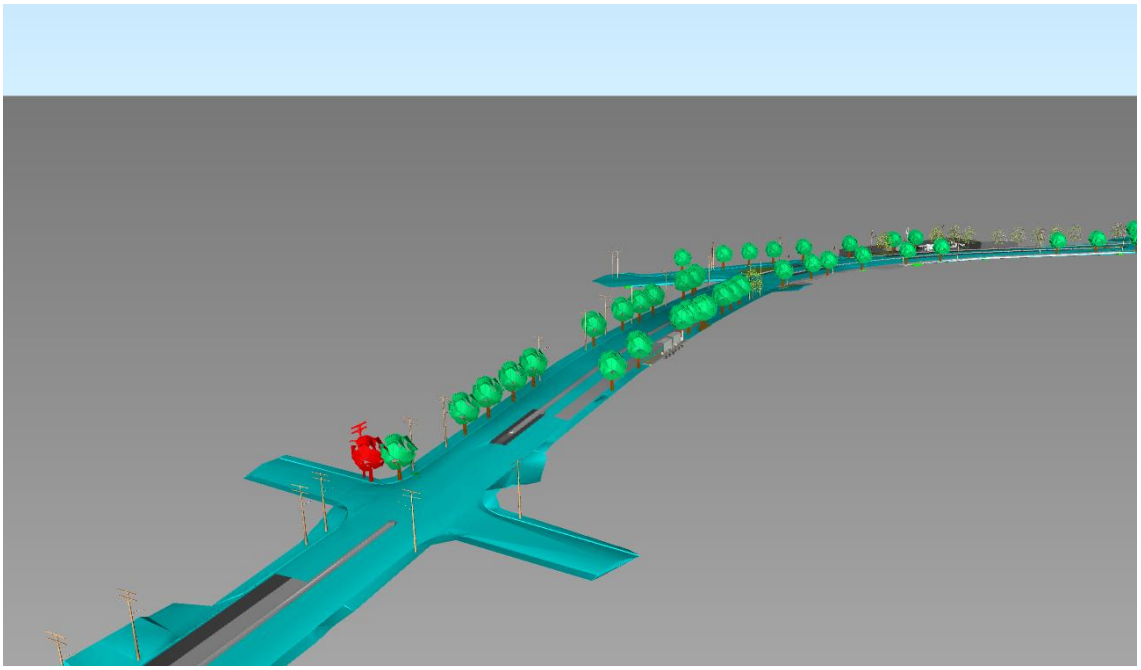

Figure 21 -Bus Corridor

Figure 22 - Bus Corridor

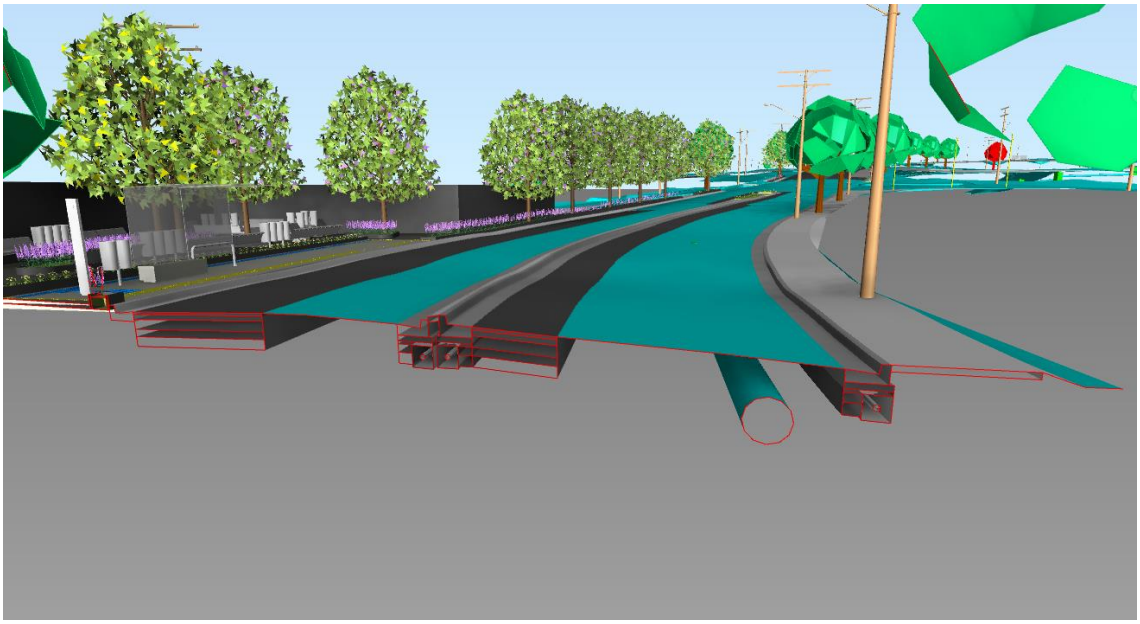

Figure 23 - Bus Corridor

At the end of the project, the deadlines were met and all documentation delivered to the client, without deviations.

Animal treatment farms in degraded areas

Conceptual project where LOD 200 is being used, BIM was chosen because of the possibility of replicating these models in other areas of the company.

Revit was used for buildings, Civil 3D for drainage and Infraworks for elaboration of the conceptual study model.

Interactive design and a lot of interaction between the layouts are presented to the client in design review meetings directly on Infraworks and changes are made dynamically.

Figure 24 - Animal treatment Farm

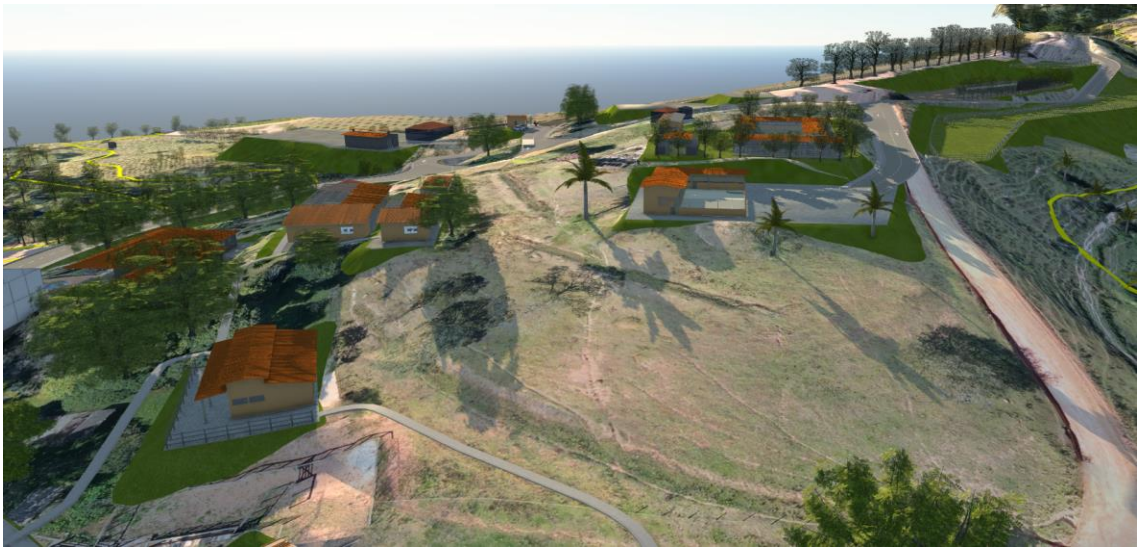

Figure 25 - Animal Treatment Farm

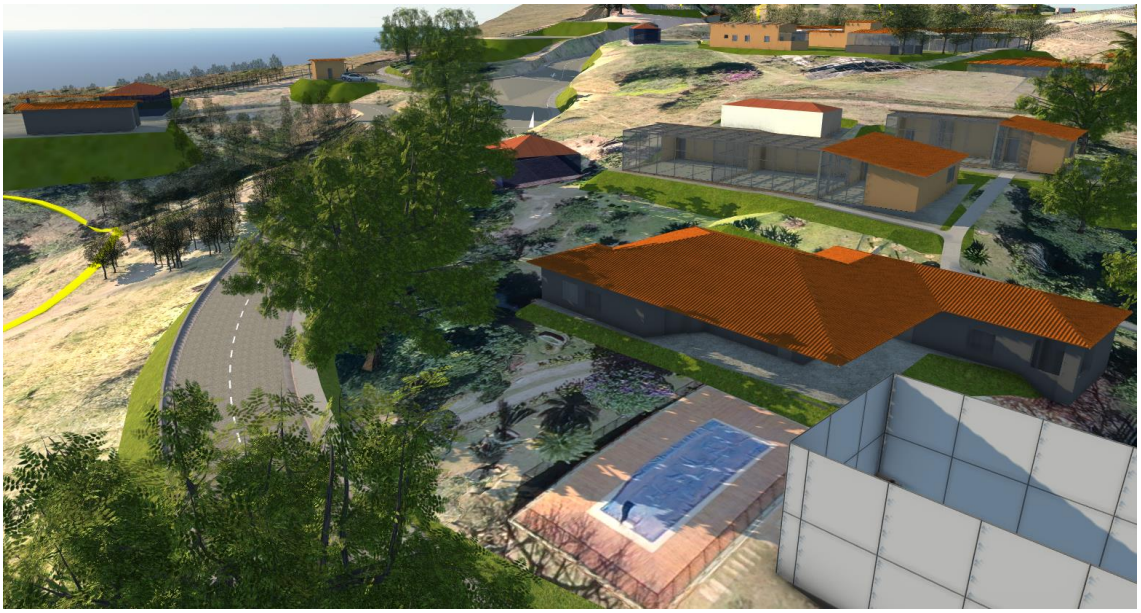

Figure 26 - Animal Treatment Farm

Process agility with the use of Dynamo

To streamline some processes considered repetitive, we are using Dynamo, creating schedules within Revit and Civil 3D.

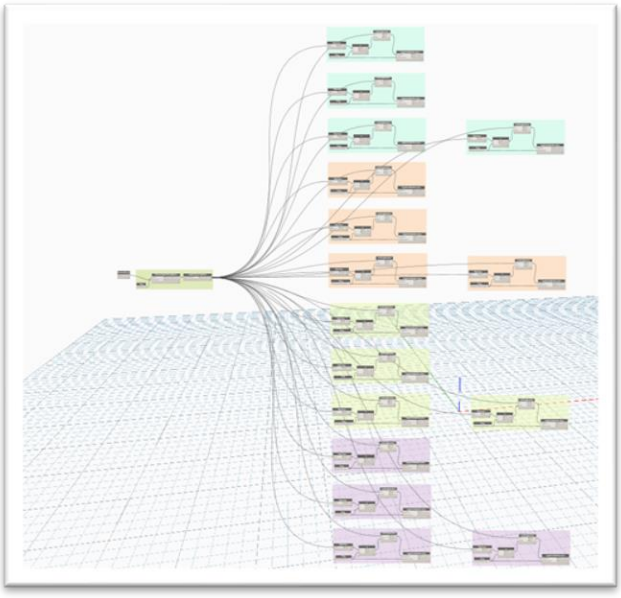

Figure 27 - Dynamo Application

One of the solutions adopted by the Studies and Projects unit to streamline decision-making and the process of drawing drawings was the Dynamo used in Civil 3D with COGO Points, georeferenced points with attributes. COGO Points are a great native feature of Civil 3D, which has several advantages of use, such as the extraction of data and quantitative spreadsheets for each element or group of elements.

Through visual programming using Dynamo, it is possible to insert the attributes in each of the COGO Points, which are located in a specific group. These groups are responsible for defining the graphical representation, 2D and 3D, standardized by Concremat, facilitating the visualization and optimizing the time spent in the elaboration of the drawings and models to detect interferences. This process is currently being used in the post-treatment of the models received from the topographic survey.

With the use of Dynamo for Revit, there was a reduction of around 85% in the time spent in the elaboration of both concrete form drawings and hydromechanical drawings in sewer elevation projects. This idea came about when rework was initiated when starting a new elevator project and, as most of these structures are standard and change dimensions based on a flow dimensioning calculation spreadsheet, Dynamo was used to link the flow worksheet. calculation in the Revit model, automatically generating a model and detailed technical drawings.

Another advantage was the reduction of work during the phase of verification of the drawings by the technical specialist of the discipline, since the drawings are generated exactly as calculated in the flow sheet.