AUTODESK UNIVERSITY

OG122715

BIMdustrial Plant: The History of an $800 Million Petrochemical Plant

Marco MELLACQUA
Maire Tecnimont

Elisa BACCHI
Maire Tecnimont

Davide DECAROLIS
Maire Tecnimont

Learning Objectives

- Discover how the BIM approach has been integrated in the company consolidated design workflow for industrial plants
- Understand the productivity improvements gained utilizing the BIM approach on industrial plant design
- Learn how to use Revit to manage the civil and structural design and documentation of an industrial plant
- Discover how these potential benefits have been capitalized on in a real megaproject

Description

The handover of a 3D model is an old standard practice in the industrial plant market—one that nowadays has to be integrated with the Building Information Modeling (BIM) approach. This presentation will walk you through the journey that an engineering, procurement, and construction (EPC) contractor took by implementing BIM inside its typical design workflow for an $800 million petrochemical plant in the Middle East. We will demonstrate how to perform civil and structural design using Revit software from conceptual up to construction documentation delivery, and how to take full advantage of 3D modeling for plant project coordination and information management. Thanks to this method of collecting and delivering model data in an efficient manner, it's possible to recognize potential risks, impacts, and conflicts—and to take action in order to bring the project to success. Finally, the class will briefly discuss the project and process BIM implementation benefits, together with the related risks for a general contractor.

AUTODESK UNIVERSITY

Speaker(s)

Marco MELLACQUA
Civil and Architectural Engineer - Maire Tecnimont

Marco is a Civil and Architectural Engineer at Maire Tecnimont a worldwide general contractor with a specific focus on the oil & gas, petrochemicals and fertilizer processing industries. He obtained his master's degree at Politecnico di Milano with thesis abroad on Building Information Modeling and Management at Northumbria University (UK). During the degree activities he collaborated to the research project, funded by the Italian Ministry of Economic Development, for setting up the Italian BIM construction database in order to push a radical innovation into the Italian construction sector. In the last years he is strongly involved in BIM methodology development, focusing on civil and structural workflows in the industrial plant design. m.mellacqua@tecnimont.it

Elisa BACCHI
Civil and Architectural Group Leader - Maire Tecnimont

Starting as university researcher at Polytechnic of Milan in 1997, Elisa Bacchi took the specialization in Industrial Plant civil engineering since 2001, finalizing the main work experiences within Maire Tecnimont Group since 2006, a leading provider of Engineering & Construction, Technology & Licensing, and Energy Business Development & Ventures worldwide, with a specific focus on the oil & gas, power, petrochemicals and fertilizer processing industries. Working as technical engineer and project coordinator about civil and architectural design for some of largest Industrial Complex under Tecnimont Construction scope of work, she was appointed Civil Project Leader since 2010, and actually Civil and Architectural Group Leader since 2013. She is leading on Tecnimont BIM System Methodology Development since 2010.
e.bacchi@tecnimont.it

Davide DECAROLIS
Civil and Architectural Engineer - Maire Tecnimont

Davide received his master's degree in Building Systems Engineering from the Politecnico di Bari, Italy. After spending one period working in a research project about innovative solution for energy efficiency in construction industry funded by the European community, he joined Maire Tecnimont Group (Oil and Gas and Petrochemicals International Player) in Milan as a civil and architectural engineer. Thanks to his aptitude for technology and innovation, he quickly became part of the BIM Development Group. Now he is involved daily in coordinating the structural modeling process and the related workflows for the ongoing projects of the Group. d.decarolis@tecnimont.it

AUTODESK UNIVERSITY

Maire Tecnimont Group

Maire Tecnimont is a multinational and multicultural Group comprising approximately 8,000 professionals in 50 operating companies in over 40 countries. Listed on the Milan Stock Exchange since 2007 and rooted in well-recognized Italian engineering brands, the Group is among the top-ranking worldwide players in our markets. We focus on our distinctive competences and technologies in the petrochemicals, oil & gas, fertilizer and power generation plants. We cover the entire value chain from end to end, delivering full EPC turnkey complex projects and offering a variable mix of services with high flexibility to maximize local content in every part of the world. Our vision is to be a world-class technology-driven, Engineering, Procurement and Construction Contractor. We want to make competence entrepreneurship and adaptiveness our key success factors.

Standard Practice in Industrial Plant Market

In the Industrial Plant market the handover of a 3D Model is a standard practice driven by contractual requirements. Specific guidelines are defined for the effective and uniform application of 3D Modeling to all Plant items together with the required software. Together with those guidelines are defined also the 3D Model Design Reviews in order to check the status and quality of the design, to manage inter-discipline interfaces and to support efficient and timely production of deliverables. Principally, the 3D Model Design Reviews facilitate and ensure cross-discipline:

- Design status alignment
- Design coordination
- Consistency
- Good Working Practice
- Consolidate layout with client

The EPC Contractor ensures the completeness of the model according to the typical milestone (30%, 60% and 90%).

In this scenario, due also to the contractual required software, Piping Department has always been at the forefront, playing a primary role in handling and managing the 3D Model. Nowadays, thanks to technologies development and tool interoperability improvements, this practice needs to be integrated with the Building Information Modeling (BIM) approach, ensuring to all other discipline, especially Civil & Structural, to effectively cooperate in the Plant 3D Modeling.

The BIM Challenge on a real Mega-Project

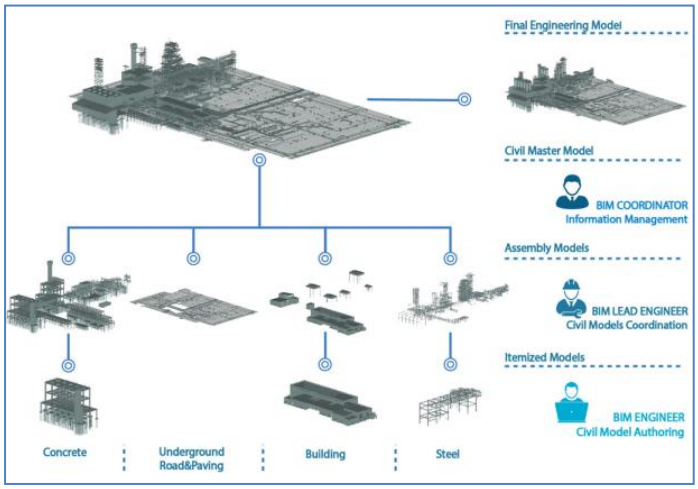
The Maire Tecnimont Group, after a period spent in standardization and library development, decided to improve the overall Plant design process effectively integrating the BIM methodology. After a couple of early test on small projects the methodology has been fully integrated in a project for the realization of a Polyethylene Plant (HDPE/LLDPE) and a Polypropylene Plant (PP) on an EPC basis of the value of USD 895 million in Oman.

The main actor of this development has been the Civil & Structural Department that integrates Revit and Dynamo in the design process that previously was developed fully in 2D.

Petrochemical Plant

The BIM Team

The success of the BIM implementation relies on the people involved in the project. On a mega project such as an Industrial Plant it is necessary to define properly roles and responsibilities in order to ensure the full control of the 3D Model and the related outputs. In this case history the collaboration is made harder by different time zones so a solid BIM Structure together with standards, work instructions and procedures have been the key of the success.



BIM Organizational Chart

The Civil BIM Design

The Civil Design for an Industrial Plant includes:

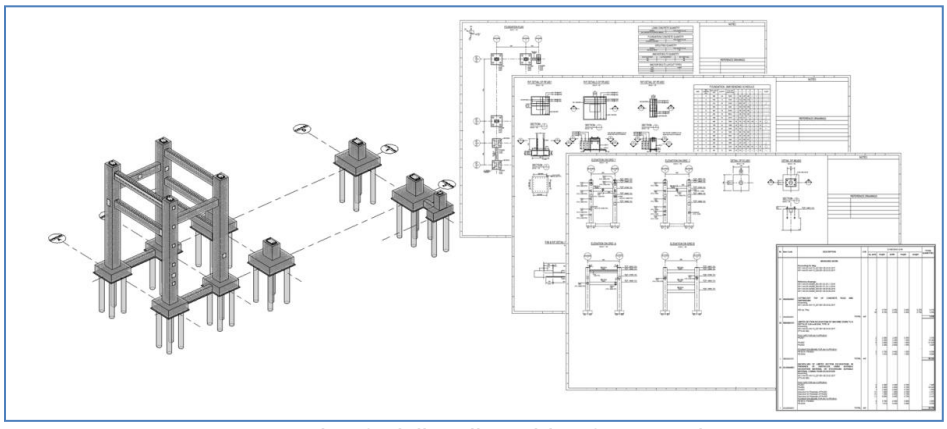
- Geotechnical Design
- Concrete Design
- Steel Structure Design
- Architectural Design
- Underground Utilities Systems
- Road & Paving

The tool used for the above mentioned activities are summarized below:

ENGINEERING ACTIVITY	AUTHORING SOFTWARE
Site Preparation	R
Piling	R
Reinforcement Concrete	R
Underground Utilities	R
Road & Paving	R
Steel Structure	Tekla
Architectural	R

BIM Tools

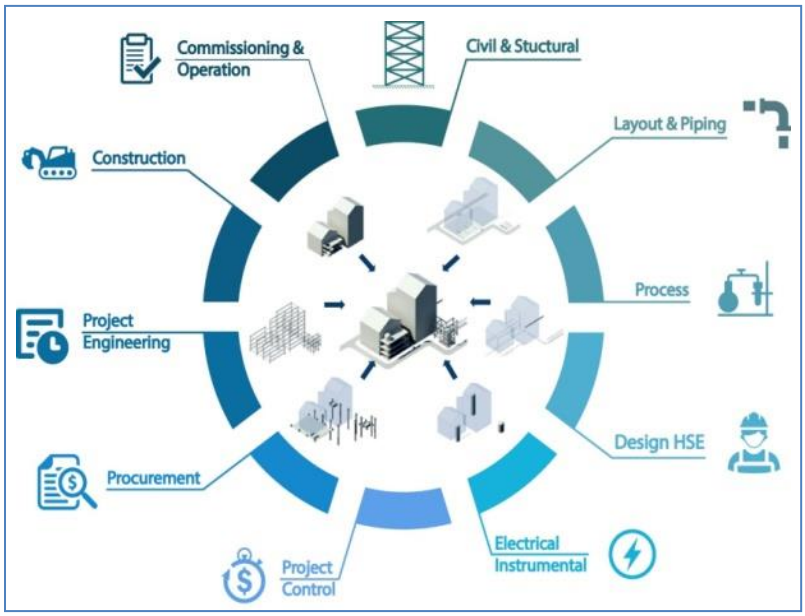
Each Civil Model born as a preliminary “dummy” model for populating the entire Plant 3D Model and check in early stage the layout consistency in order to spot challenges earlier. This allows the Project Team to make, in a 3D environment, the Plant Layout optimization in a timely and cost-effective manner. All the “dummy” models are then detailed following the planned engineering progress. From each Model are extracted Construction Drawings, MTOs and other Project Management deliverables such as “3D-Model Progress”, “Engineering Status”, etc.



Example of Civil Deliverables from Revit

Cross-discipline design coordination

Plant Design asks to implement a methodology with the aim of transferring the entire civil modeled items with the relevant attributes to Intergraph Smart 3D (contractual model authoring software) allowing a comprehensive modeling of a project. Vehicle of information and geometry is the IFC format. This format can be converted and published as a reference into the Intergraph Smart 3D environment. Above ground clash detection is performed and regulated inside this environment. Instead for what concern below ground clash detection it is fully performed in Revit.
Navisworks is the chosen tool for design coordination also because it is the most common software to be used for Contractual 3D Model Reviews. The Plant 3D Model session is updated and shared on daily basis with the all team in order to access always the latest information. Navisworks is a powerful tool also to review and track visually data such as holds or engineering status of items.



Plant 3D Model involved disciplines

AUTODESK UNIVERSITY

Data Management: the BIM value

The data driven approach is the core of the integration and coordination. It offers control, visibility and efficiency reducing at the same time the project risks.

Revit and especially Dynamo offer the possibility to take full control of the project data for civil design in:

- Key Quantities Monitoring: the Revit Assembly file (Revit Links Collection) allow to the project coordinators to have full control of key quantities per civil item or per WBS. This helps in keep the quantity balance under control and takes action when required.
- Indexes Monitoring: Usually the schedules are tight and sometimes the hurry can affect the design. In this scenario, Dynamo is a powerful tool to read and compare quantities of different objects, generating indexes useful to the Project Specialists. It is possible, for instance, to compare concrete and reinforcement quantities in order to check their ratio and consequently the principles of good design avoiding materials waste.
- Sub-Contractor Management: The time between design input (construction documents) and the construction at site is always affected by the material procurement process. In a BIM scenario the quantities can be anticipated to the subcontractors establishing tolerances percentage on what is declared. This can be done for example on structural rebars, embedded items, anchor bolts for speeding up the construction process.
- Accounting Automation: The accounting process in an EPC scenario is always a tedious long-winded procedure. With a pushed standardization of Revit Contents and applying the computational power of Dynamo and C# Coding it is possible to reduce the effort and save precious time.
- Project Planning: In an EPC project the division of the works in construction lots is necessary to meet the scheduled targets. The civil “dummy” modeling helps to split the Plant in construction lots. This step gives to all the involved actors a clear picture of the scope of work together with the related preliminary quantities in a very early stage.
- Constructability Analysis: In a mega-project like an Industrial Plant there are thousands of deliverables and keep traceability of the engineering status of the documents is difficult. In a BIM process deliverables are extracted directly from the model so it takes a blinking of an eye to assign the engineering status to the modeled objects. This procedure can be improved automating it with a Dynamo Script. Once the information are set, it is possible to extract them in a list or visualize them applying color legends, simplifying constructability analysis and speeding up the work at site.
- Project Progress: In an EPC context it is necessary to plan, monitor and determine the project growth in order to manage the process and eventually take remedial action if required. This difficult activity can be simplified and supported automating the extraction of the project progress curves. It is necessary to set up the Models for hosting the required data and then take sort and export them through Dynamo in order to obtain output sheet to share with the Project Managers.