The “Smart” Pit: Boost Your Plant Underground Utilities Design with Revit and Dynamo

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Learning Objectives
- Learn how to use Revit and Dynamo for the underground utilities design of a real Oil & Gas Plant
- Learn how to build “smart” pits using the Revit Family Editor
- Understand how to automate and synchronize your utilities design with Dynamo
- Learn how to connect your calculation report to the model

Description
This class will discuss and present the smart way to use Revit software and Dynamo software for underground utilities design. This design process, especially for oil and gas plants, is in a constant state of change; hence, it is necessary to find a way to save hours of tedious work. We can achieve this goal by developing “smart” families able to move and adapt according to calculation, simultaneously respecting design and clients’ standards. We can synchronize the families’ data with the hydraulic calculation by using Dynamo to connect the calculation report to the model with a simple “run.” In this way, the pipes routing gets updated, and with this, all quantities and drawings, reducing considerably the time related to these activities.

Speakers
In the last two years, Luca was a Structural and Underground Engineer and BIM developer at Maire Tecnimont Oil and Gas/Energy International Player. He obtained Bachelor's degree at Politecnico of Bari and master's degree at Politecnico of Milan in Building Systems Engineering. Luca developed the dissertation on Building Information Modeling and Management at the BIM Academy of Northumbria University. He took also part at the research project “Innovance”, 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 2014 Luca started the development of BIM in Maire Tecnimont, focusing on Underground Services. Recently he has started a new experience as CAE Systems Engineer, again in Tecnimont SPA. He is involved in the definition and application of TCM BIM’s Standard and Methodology. (l.virno@tecnimont.it)
Elisa Bacchi. 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)

Fabio is a Structural and Underground Engineer at Maire Tecnimont a worldwide general contractor specialized in the oil & gas and petrochemical industry. He received his master's degree in Building Systems Engineering from the “Politecnico di Bari”, Italy. Despite his young age, Fabio made several work experiences in which he grown his BIM and project management expertise focusing especially on energy and utilities. He also collaborated with the City of Milan for the European project “Horizon 2020”, focused on smart cities and energy efficiency. In the last year, he has become the Company focal point for computational design. (f.bitetto@tecnimont.it)

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 service 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.

The “smart” Families Evolution:

Several steps compose the process of building an optimized library. You can have a great experience in the Revit Family customization, but this could be not enough. At the beginning of the BIM development process in Maire Tecnimont, the only available objects library was the Revit Default Library. Today the Group counts over 800 Civil Objects (Custom Family and System Type Family), available and accurately customized for ongoing projects.

The “smart” Pit

Obtain a Pit family with automatic functionalities at the first shot is not easy. Many revisions and several attempts are necessary. The class is focused on the development of the Pit, a simple item (a box that joins two or more pipes), whose peculiarities make it “Smart”. Furthermore, at the beginning of each new Oil and Gas project can be necessary to implement it with Client Specification and Requests.
The snaps below (Figure 1 and Figure 2) show different revisions of the same family, completely different one from the other. Category, parameters, formulas together with other micro-choices can change considerably the impact on the project.

![Figure 1](image1.png)

![Figure 2](image2.png)

At the development beginning, the family category was set as “Pipes Fittings” since in the sewer systems the pit represents a junction between gravity pipes. This was not the correct solution because the pit used to automatically follow the pipes slope. Therefore, during the first pilot project, the generic model category has been used and many formulas and functionalities have been added (Figure 2). Finally the increasing of experience and the use of Dynamo helped to finalize the setting of “Pipe accessory” as final family category.
The connector’s Power

The use of the Pipe accessory category combined with the proper use of MEP connectors is the right way for reducing time wasting during the design process.
The first problems faced in building the Pit family, necessary to perform a gravity system routing, was the Pipes Connector Component. The requirement of the component is have one sloped pipe inside the pit hole, avoiding the Revit auto-routing function that normally creates siphons and transitions. It has been managed to overcome this point using as System Classification “Global” and enabling “yes” in “Allow Slope Adjustments” (Figure 3).

Figure 3

In this way it is possible to create the correct “systems types”, set different colors for a better understanding and for checking purpose, assign attributes and all the other useful functionalities.

Figure 4.
Not just a simple standard

The development of custom families is the base of the standardization process. The Underground library is an opportunity to standardize most of the objects used to design the utilities systems of the plant. In an EPC project, Standard drawings are produced to define the minimum construction requirements used as guide lines by sub-contractors. After the development of BIM methodology in the Company, these documents have been generated as a Revit file. This choice turns the paper in a smart updatable output (Figure 5). At the start of each project (and during the project itself) the BIM Coordinator manages the standards, updates it and finalizes the family types to be used for design process.

Figure 5
Design your Plant Underground Utilities with Revit:

Two of Company ongoing projects and two completed projects have been designed using Revit and a full BIM approach. To date, the Underground utilities are at 100% modelled in Revit, as it is understandable from *Figure 6 and 7*.

- Accidentally Oil Contaminated Sewer
- Oil Water Sewer
- Clean Water Sewer
- Sanitary Water
- Fire Water
- Electrical Circuit
- Instrumental Circuit
- Secondary Cooling water

*Figure 6*

Once the Library is made and rules are defined, routing a single utility line becomes very easy. During the development, has been reduced to the minimum the number of the basic manual modeling activities thanks to use of Dynamo.

*Figure 7*
In the above represented case history have been modeled the underground utilities systems of 350.000 mq plant, in particular:

- Accidentally Oil Contaminated Sewer
- Oil Water Sewer
- Clean Water Sewer
- Sanitary Water
- Fire Water
- Electrical Circuit
- Instrumental Circuit
- Secondary Cooling water

From the model have been issued more than hundred construction drawings and have been solved an innumerable quantity of clashes.

**The plus to use Revit**

Today, all the advantages in using Revit and all BIM oriented software are well known. Even if a proper process of detailed customization is not immediately activated, Revit basically offers to the Users an important reduction of hours thanks to the smart drawings and quantity takeoffs generation and the clash detection functionality.

*Figure 8*
Speed Plant Design with Dynamo:

The strong engagement of Maire Tecnimont BIM Group in Dynamo visual programming gave start to a new phase of the BIM Development. Below some examples of design boosting through Dynamo Scripts.

Tag your items

An essential point to be fixed for a correct Information Management and for processes automation is the identification and the marking of any single items in the modeled. To achieve this goal, has been defined an internal Standard Tagging Procedure that has been incorporated in each BIM object (Figure 9).

Figure 9

The tagging activity is important for many goals, but it is also a time-consuming activity, if not automated. For this reason, has been used Dynamo (Figure 10) to tag all the objects in one click.
Estimate your quantity

In the *Figure 11* another example of script is shown. It has been created in order to obtain the quantities of any single objects, directly from the model.
Consequently, it is possible to export the pit schedule and all related quantities to generate project estimation documents like the accounting sheet used for giving evidence of pay amounts to sub-contractors (Figure 12).

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Figure 10

"Calculate" your Plant

The last and most important functionality automated by Dynamo is the synchronizing of the calculation report (Figure 13) data into the model. After that the designer does the calculation, for each modeled pit, all calculated Invert elevation data are reversed into the model.

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<table>
<thead>
<tr>
<th>PIPE BETWEEN MANHOLES</th>
<th>DRAINAGE AREA</th>
<th>PIPE LENGTH</th>
<th>PIPE ELEVATION</th>
<th>ENERGY LINE/DATE</th>
<th>WATER LEVEL UPSTREAM</th>
<th>WATER LEVEL DOWNSTREAM</th>
<th>WATER SEAL</th>
<th>WATER SEAL OVER TOP</th>
<th>TOP &gt; 0.15</th>
<th>FGL TOP</th>
</tr>
</thead>
<tbody>
<tr>
<td>LINE</td>
<td>from to CB Area CB Area cum.</td>
<td>L</td>
<td>L</td>
<td>Pipe Bottom Level</td>
<td>Pipe Bottom + Pipe Diameter</td>
<td>Water level in Upstream Manhole</td>
<td>Water level in Downstream Manhole</td>
<td>Water Seal</td>
<td>Water Seal Over TOP</td>
<td>TOP &gt; 0.15</td>
</tr>
</tbody>
</table>

```

Figure 11

In the phase of preliminary modeling, for the BIM Engineer is enough to drafts pits and flat pipes. After the calculation, the BIM Coordinator runs the script (Figure 14) and it automatically updates all Invert Elevation the routing.
It is not just a dream

To have a “real” vision of the matter, below some examples of underground utilities from the Revit model to the site (Figure 15, 16).

Figure 12

Figure 13

Figure 14