



# Design of a Rail Maintenance Facility on Iconic Metro Project: Grand Paris Express

Louis-Marie BORIONE

BIM Manager



# Class summary

In this class, we will share Systra's experience on project Building Information Modeling implementation, and show how BIM can be used for rail infrastructure design.

You will also discover how BIM can be effective for track alignment, utilities, hydrology, catenary, and telecom when interfacing with architecture, structure, and MEP (mechanical, electrical, and plumbing) services.

- SYSTRA Presentation
- Project Presentation
- Production Organisation
- Civil Engineering Design
- Building Design
- Coordination

# Key learning objectives

At the end of this class, you will be able to:

- Discover BIM for typical rail infrastructure workflows
- Understand data exchange and interoperability between Revit and AutoCAD Civil 3D
- Learn how to implement a BIM process for a depot (industrial site, maintenance site for metro)
- Learn how to implement coordination and design reviews

# In front of you today...



**Louis Marie BORIONE**  
**SYSTRA BIM Manager**  
**SYSTRA**



**Lionel Fabre**  
**Technical consultant**  
**Autodesk**

## Key figures

### Education :

- Civil Engineer graduated from ESTP, Paris France

### Experience:

- 7 years in BIM Management and modelisation

### Main Project Achievements:

- Grand Paris Express T2
- BIM for Electrification Development

### Additional responsibilities :

- In charge of technical BIM Support

Speaker at AU2014





# Systra Presentation

A unique, decentralized engineering model  
A wealth of experience based on 60 years of railway operations



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 AUTODESK.



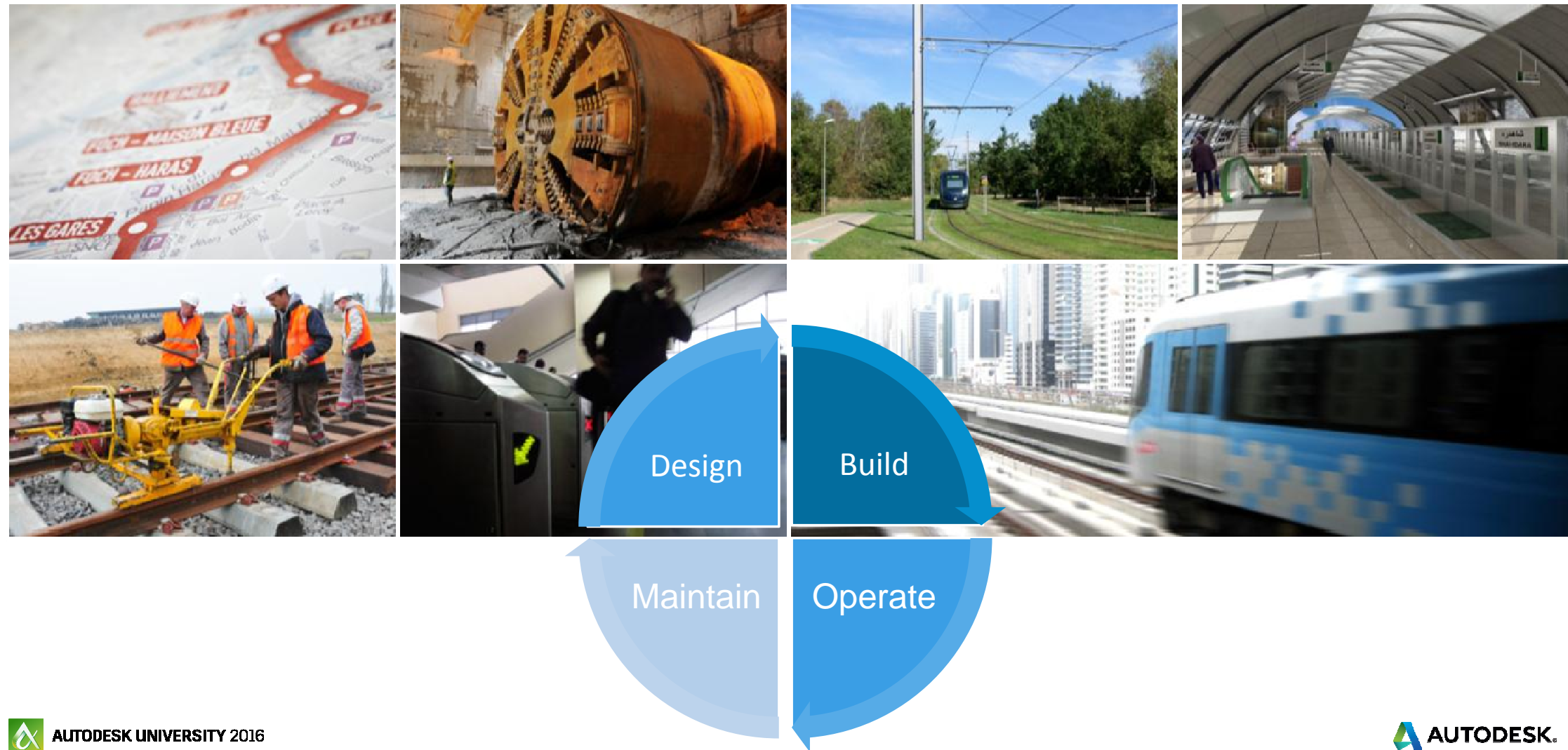
Key figures : **€623 million** sales turnover in 2015 (*658 million dollars*)



# SYSTRA is active in more than 80 countries



**SYSTRA is able to work on the whole lifecycle of a project thanks to our technical skills**



SNCF and RATP, key players in the French transport sector, are SYSTRA's main shareholders : Maintenance and Operations are in SYSTRA's DNA





# SYSTRA has worked on half of the world's metro systems

## SYSTRA engineering facilitates the travel of 50 million passengers per day



Paris Line 14



Dubai (red and green lines)



Santiago de Chile (lines 1, 2, 4, 5 and extensions)



Delhi, India



Makkah



Sofia Line 2, Bulgaria





High Speed Rail: SYSTRA has worked on half of the world's HSRs  
500 km / h – A World Record for New High Speed Railways



East European HSR, France



Mediterranean HSR, France



Rhin-Rhône HSR, France



Morocco, Casablanca-Tangiers



KTX, Korea

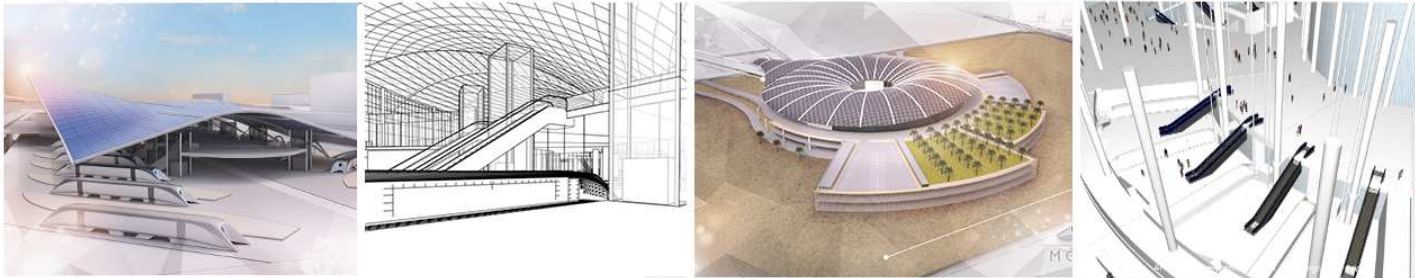
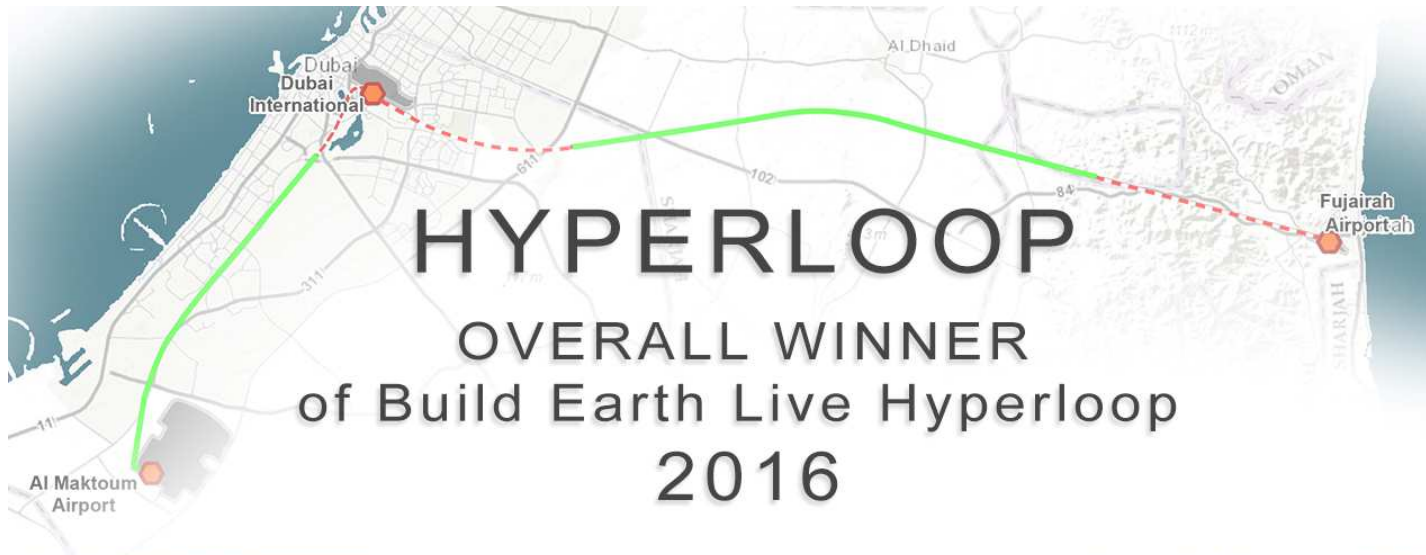


High Speed One, UK



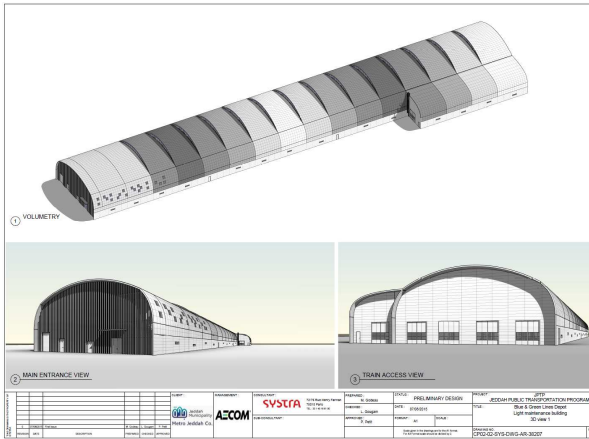


# Hyperloop BIM Station Design Competition WINNER

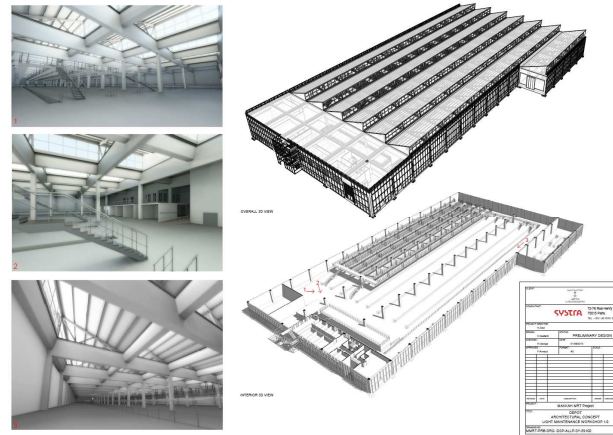


# Project Presentation

# Depots design by SYSTRA using BIM



### Jeddah metro maintenance building, Saudi Arabia

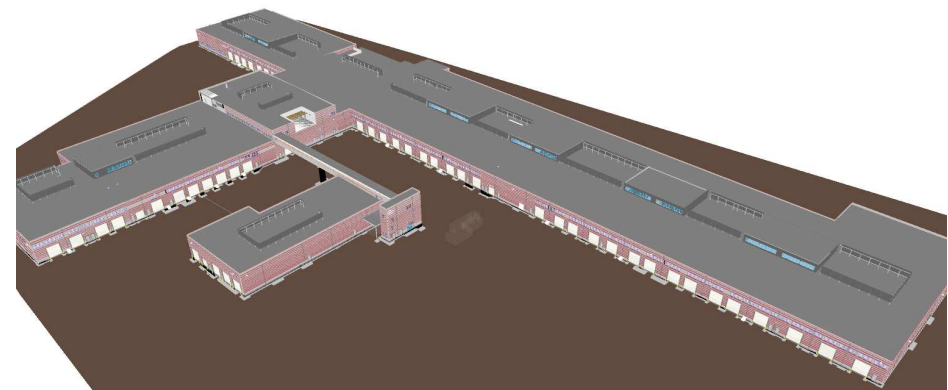


## Mecca metro Depot, Saudi Arabia

- High technical requirements
- Low architectural quality
- Industrial site far from residential district

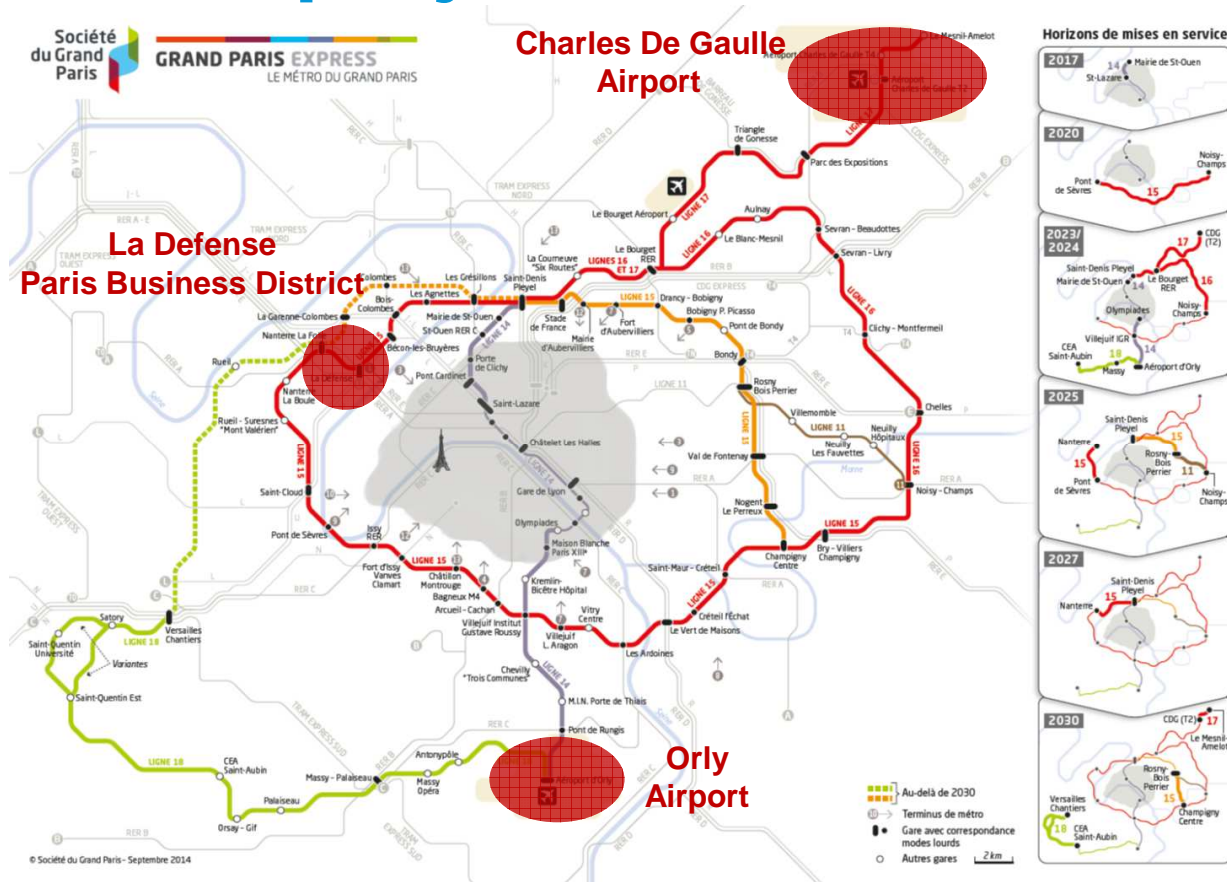


### Batna tramwat depot site, Algeria



### Washington Bus depot site, USA

# Grand Paris Express Metro project around Paris



200 km new line

68 new stations

1000 engineers working on the project

24.7 billions € for investment in infrastructure

Between 15 000 and 20 000 jobs created every year





# Vitry Depot - Project presentation

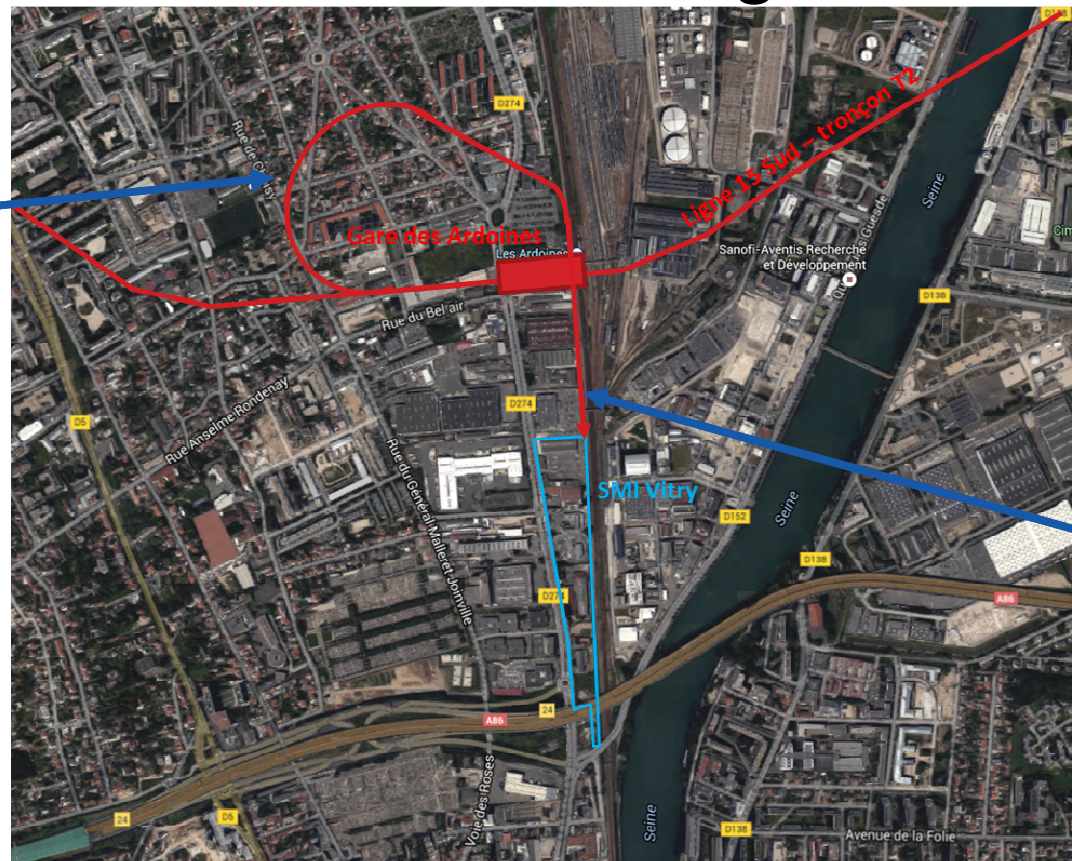
## Geographical situation



# Vitry Depot - Project presentation

## Connection to alignment

Cover  
Tunnel



Open cut



# Vitry Depot - Project presentation

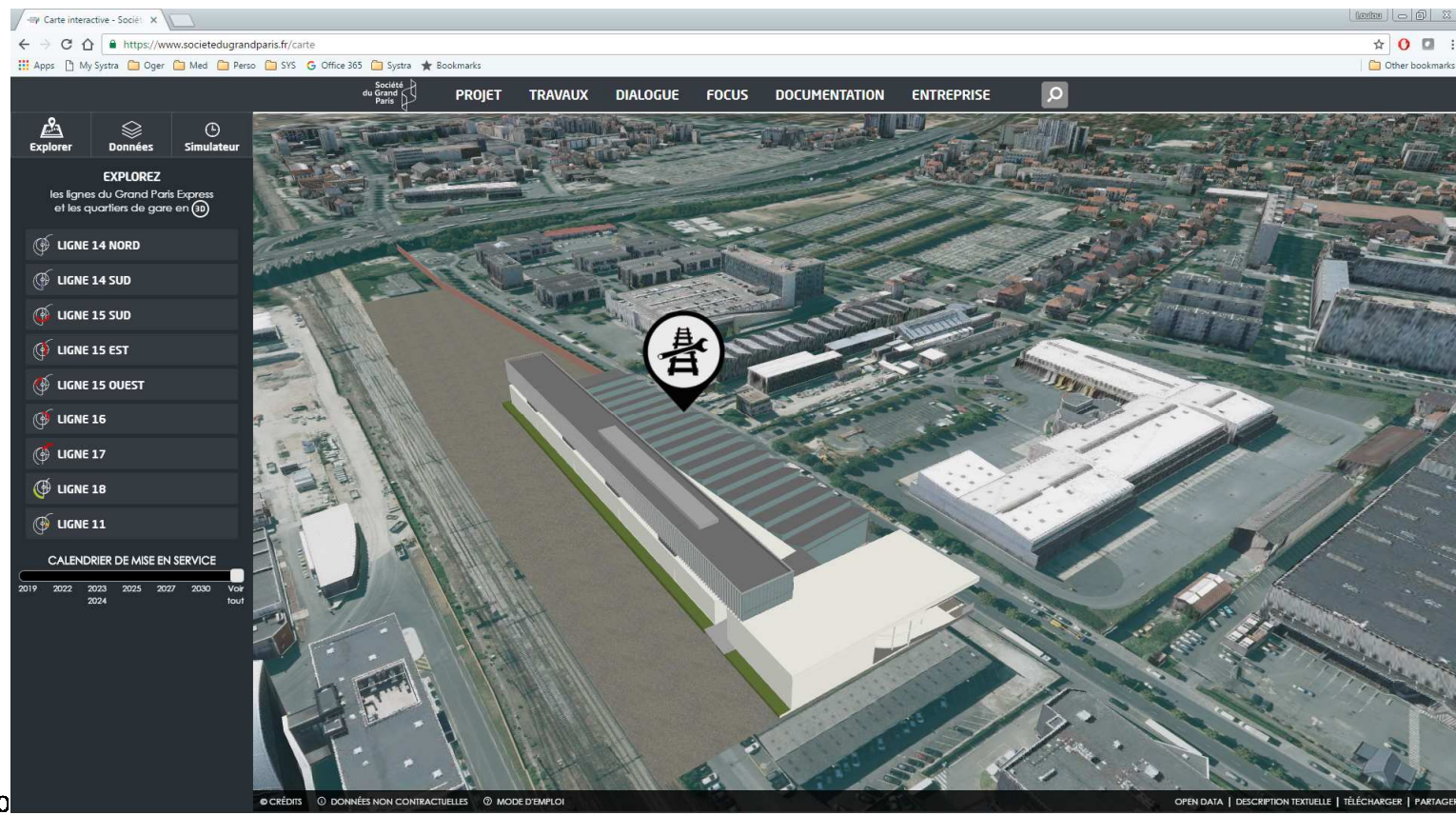
## Aerial View





# Vitry Depot - Project presentation

<https://www.societedugrandparis.fr/carte>



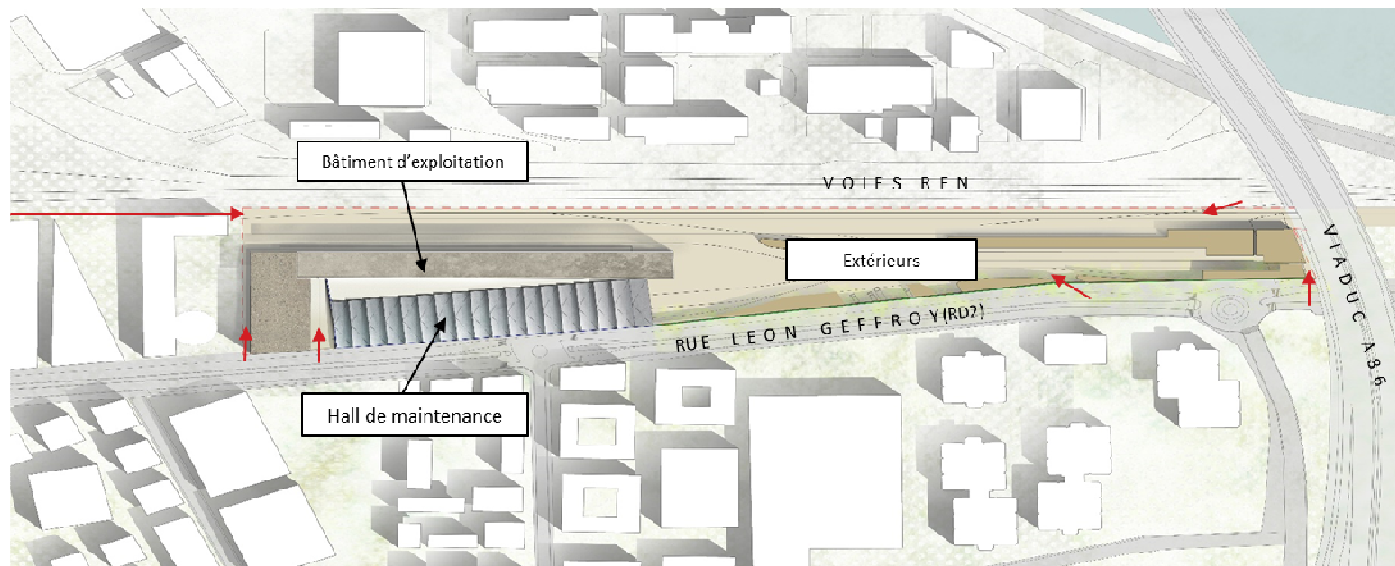
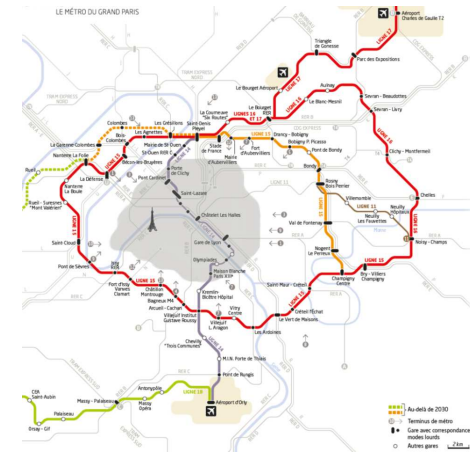
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# Vitry Depot - Project presentation

- Maintenance site for 60% of red line infrastructures
- Three main spaces:
  - Outdoor : lines, stock
  - Exploitation building : exploitation offices, parkings
  - Maintenance hall : standard and heavy maintenance



# Vitry Depot - Project presentation

## ■ Project Stakeholders

> Owner :

- Société du Grand Paris (SGP)



> Client technical assistance:

- Artemis



> Designer:

- Joint venture

- SYSTRA – Project management and Civil
- Marc Barani – Architecture
- Alto – Structure
- Jacobs - MEP

MARC BARANI architectes  
ATELIER BARANI



JACOBS

SYSTRA



AUTODESK UNIVERSITY 2016

# Project - BIM Objectives

## ■ Client Objectives

### ■ Project Management

- Decision making process
- Design Coordination

### ■ Communication

- Communication to public, local authorities
- 3D website
- Virtual reality

### ■ Technical asset management

- As-Built model and data management at several scale:
  - Urban development
  - Line section
  - Stations
  - Equipments

## ■ SYSTRA Objectives

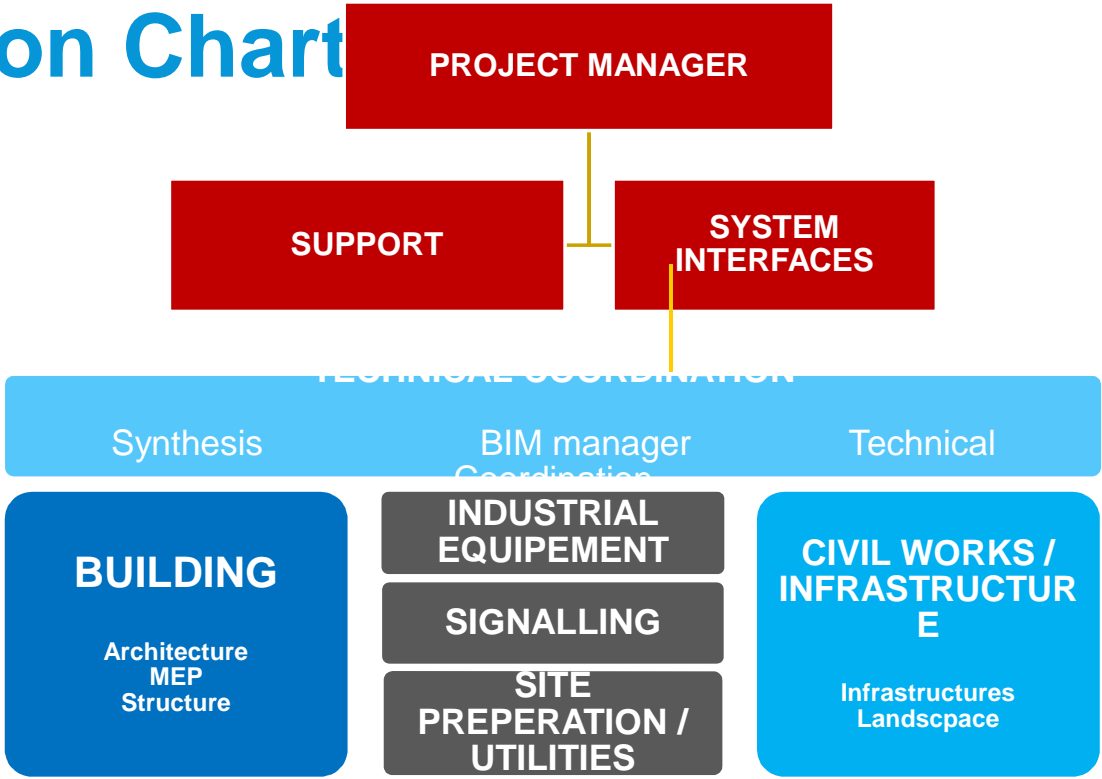
### ■ Drawing production

### ■ Synthesis

### ■ Quantity takeoff

# Production Organization

# Organization Chart



BUILDING



INFRA



# Models organisation

Civil 3D

Navisworks

Revit

Autocad

## Single Composite Model

Civil Works

3D  
objects

Building

Building  
(imported from  
Revit)

Existing  
Conditions  
(DTM)

Platform

Drainage

Equipement

Misc 3D objects  
with attributes

Civil Works  
(imported from  
Civil 3D)

Georeferencing

Architecture

Structure

MEP

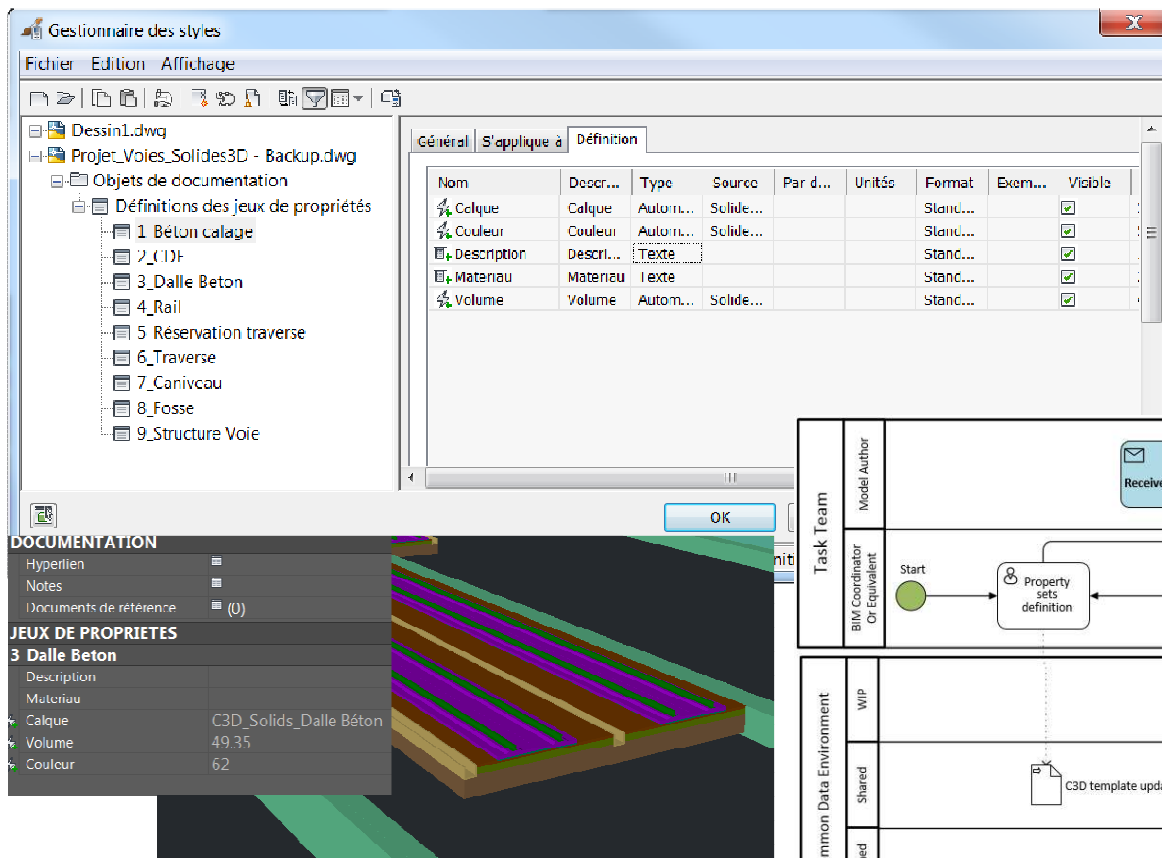


# Autodesk Consulting Services

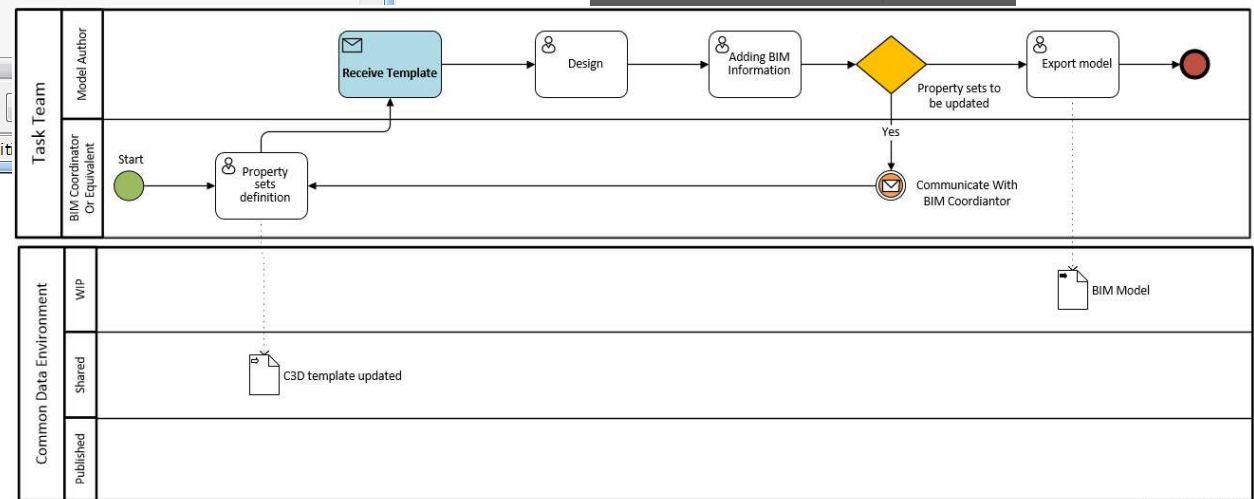
- Civil 3D Experience limited to drainage design in 2013
- First project with Civil 3D for entire infrastructure
- First depot project with BIM approach for both building and civil works
- Autodesk Consulting Services required for:
  - Training
  - Production Organisation
  - Fast track

# BIM requirements

## Classification, model categories and Property sets



E...	Nom	A...	Ge...	V...	Cou
0	C3D_Solids_Base	?	?	?	b
	C3D_Solids_Béton Bitumineux	?	?	?	4
	C3D_Solids_Béton Calage	?	?	?	b
	C3D_Solids_Caniveau	?	?	?	b
	C3D_Solids_CDF	?	?	?	b
	C3D_Solids_Dalle Béton	?	?	?	b
	C3D_Solids_Fosse	?	?	?	b
	C3D_Solids_Grave Bitume	?	?	?	b
	C3D_Solids_Mur de soutènement	?	?	?	4
	C3D_Solids_Poutre	?	?	?	b
	C3D_Solids_Rail	?	?	?	2
	C3D_Solids_Réservation Traverse	?	?	?	b
	C3D_Solids_Roulement	?	?	?	4
	C3D_Solids_Structure Voie	?	?	?	b
	C3D_Solids_Traverse	?	?	?	2



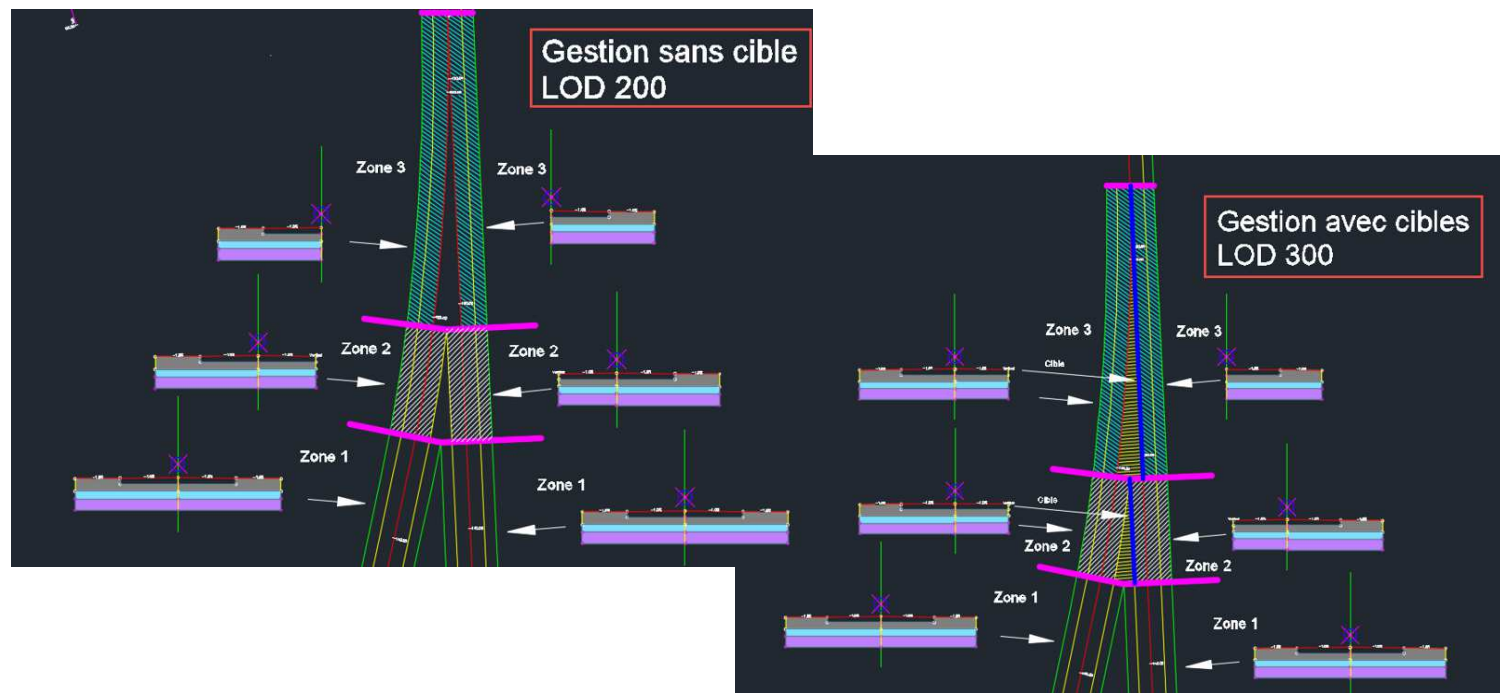
© 2016 Autodesk





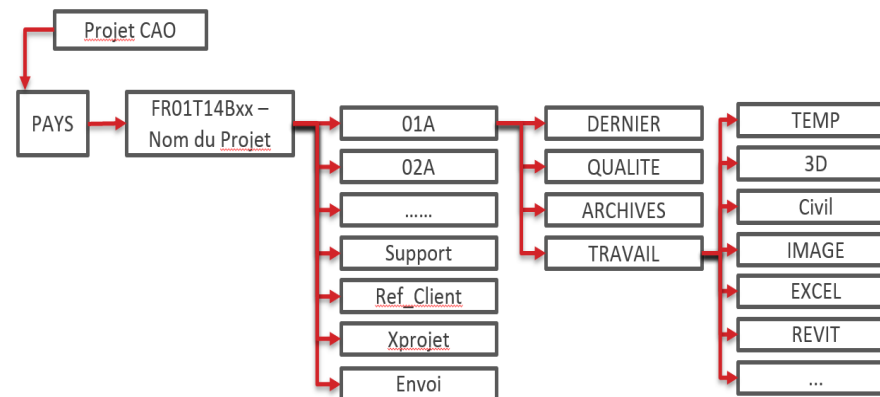
# BIM requirements LOD

- Specification of the Level of detail

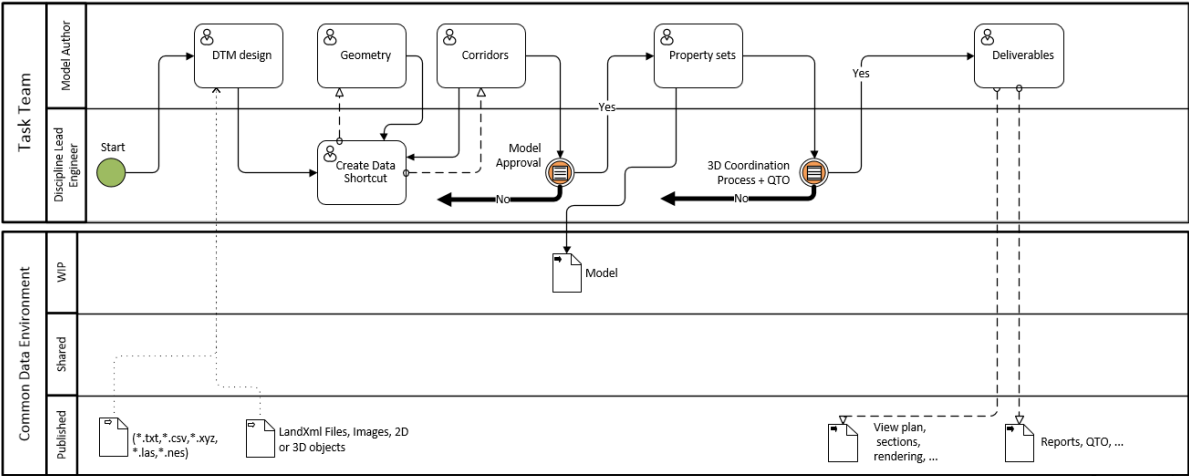


# Folder structure

- Based on an internal development (iSYSTRA)
  - Improve the drawing production process
  - Ensure coherence between project & graphic aspect
  - Control the spread of deliverables (DWG)
  - Control archiving and traceability of DWG documents

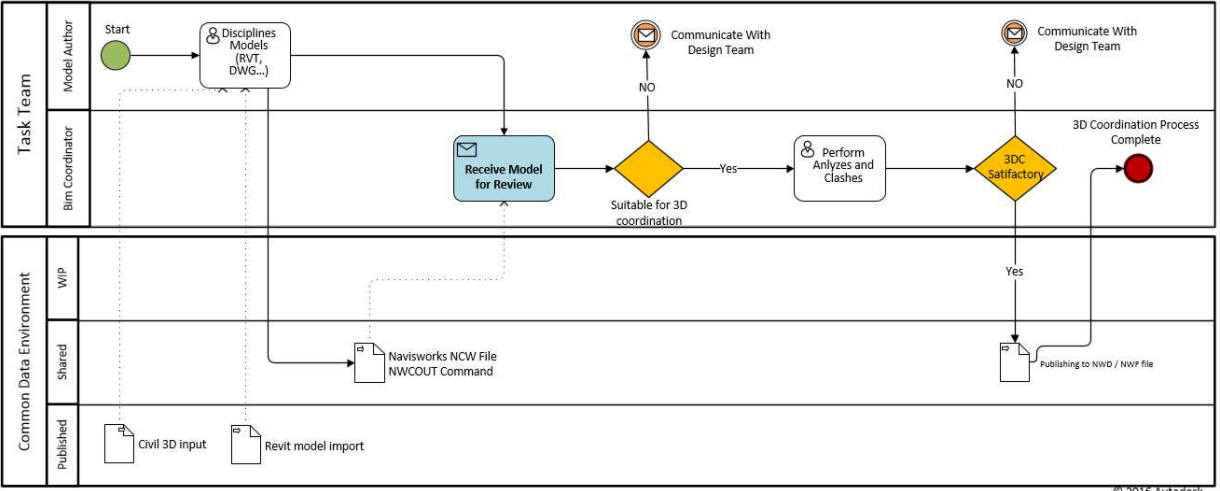


# Autocad Civil 3D design & coordination workflow



## 3D Coordination

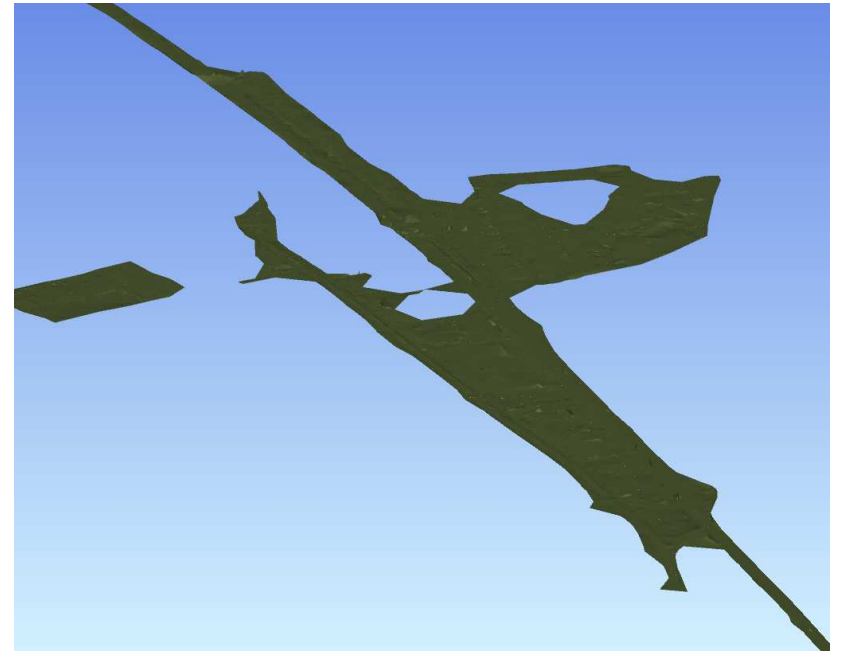
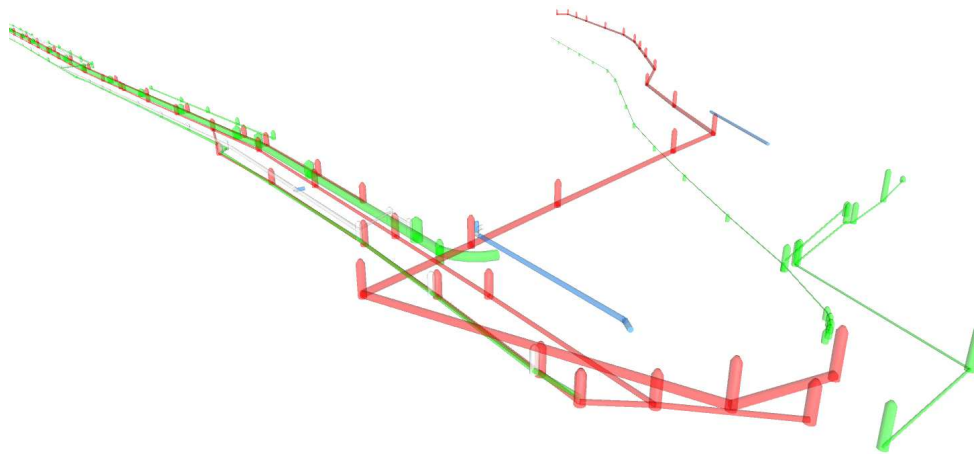
## Model Authoring



# Civil Design

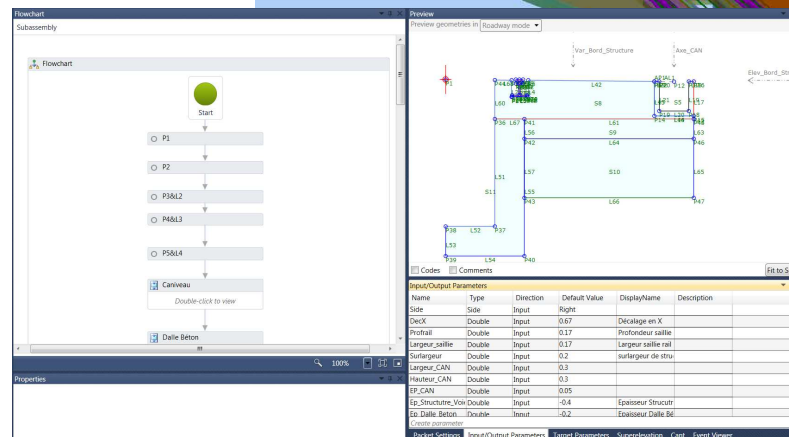
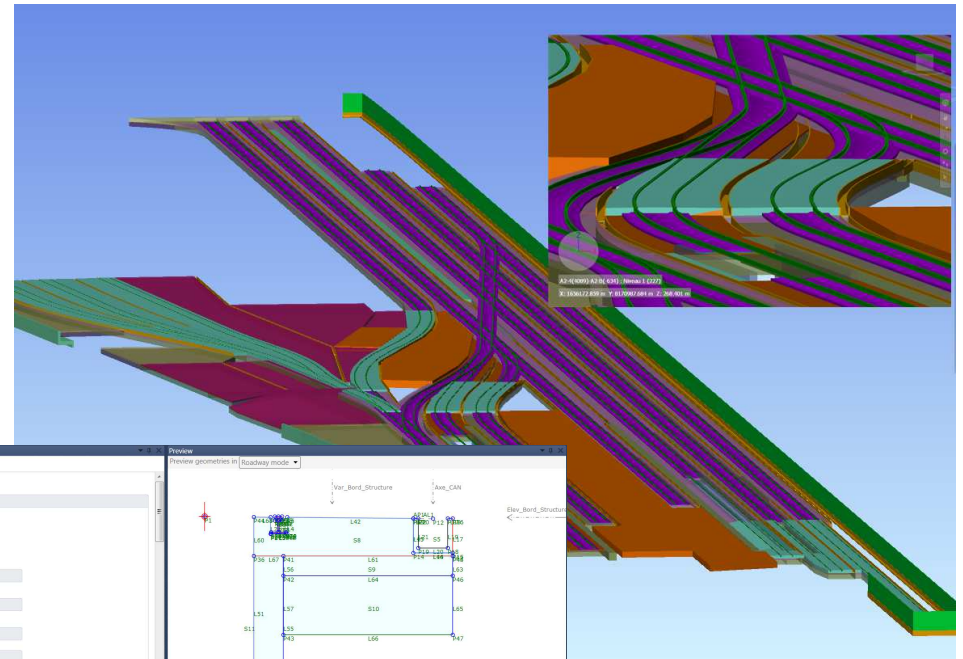
# Design Authoring Civil 3D

- Existing condition modelling
  - Terrain model
  - Drainage (dry & Wet utilities)



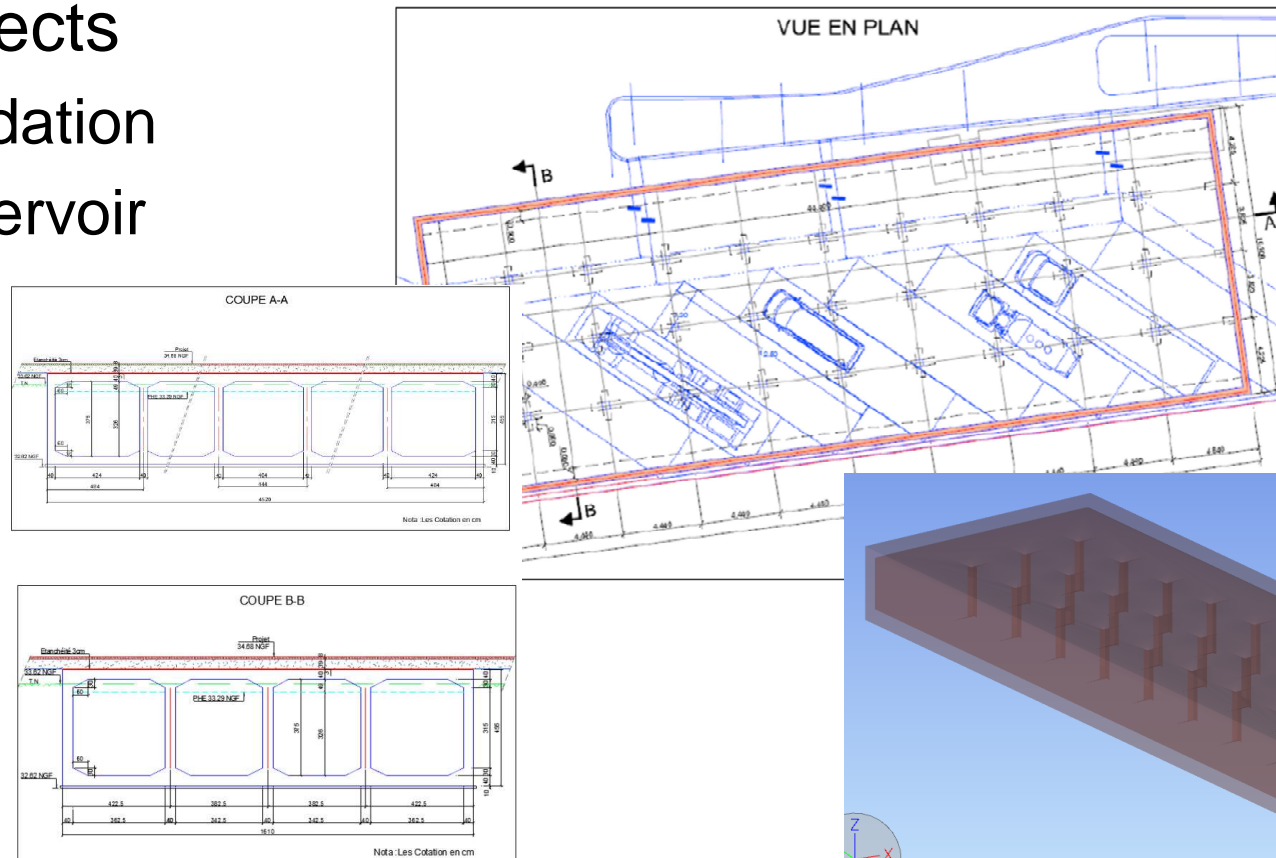
# Design Authoring Civil 3D

- Platform
  - Assemblies using SAC
  - 3D Solids from corridors
  - Grading



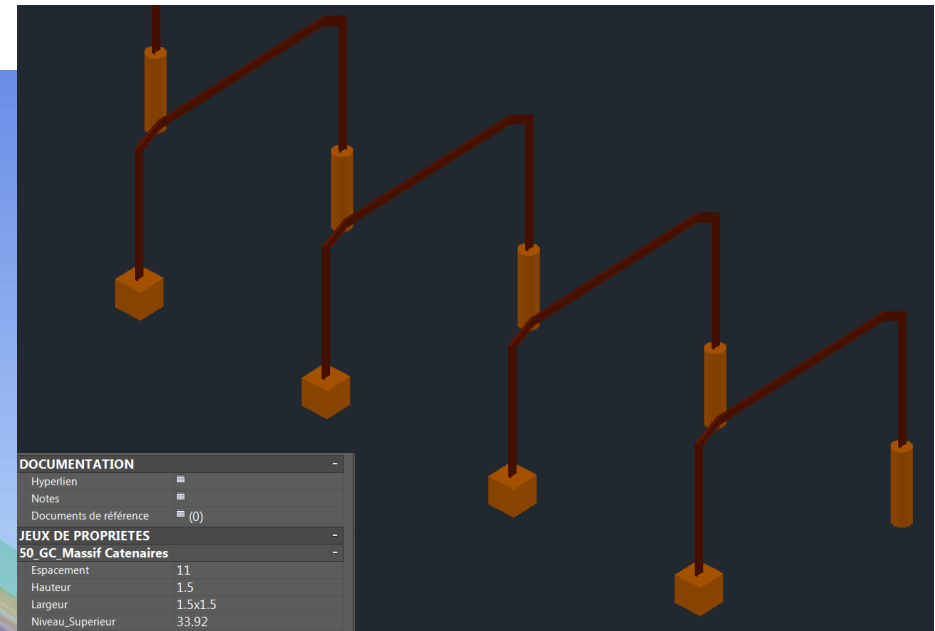
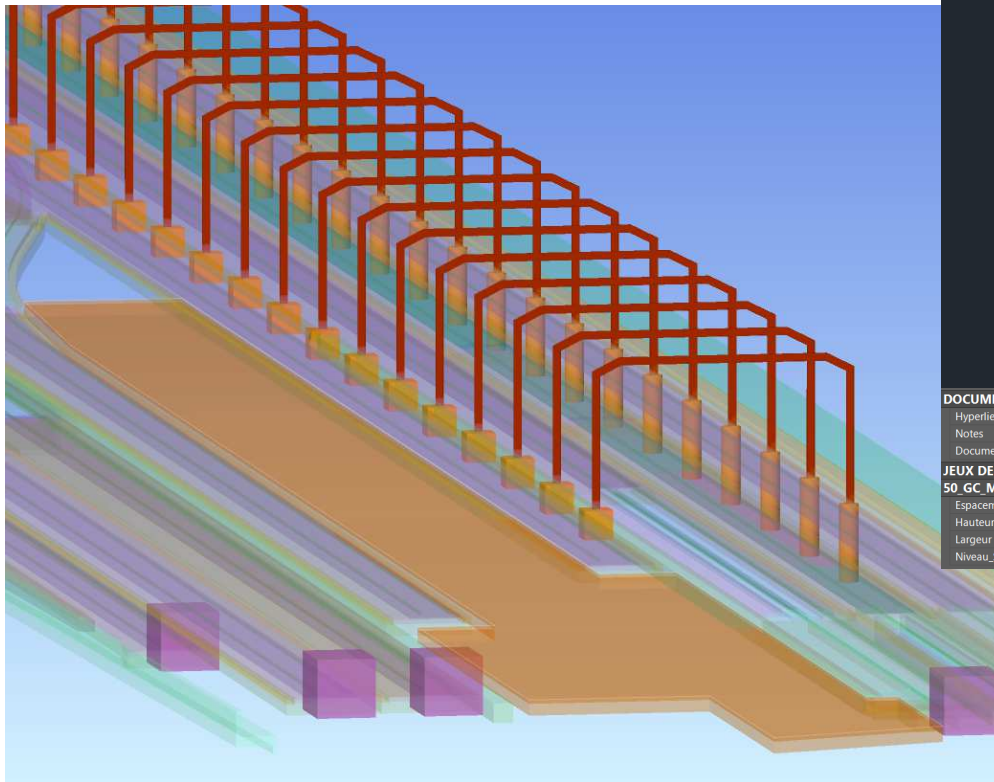
# Design Authoring AutoCAD

- 3D Objects
  - Fondation
  - Reservoir
  - ...



# Design Authoring AutoCAD

- Catenaries design

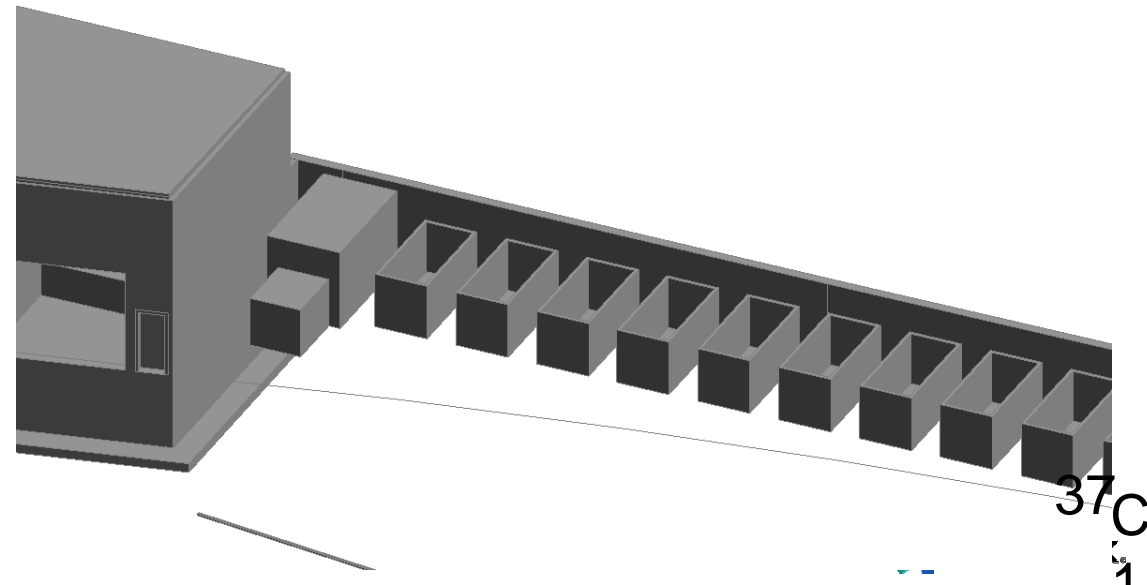
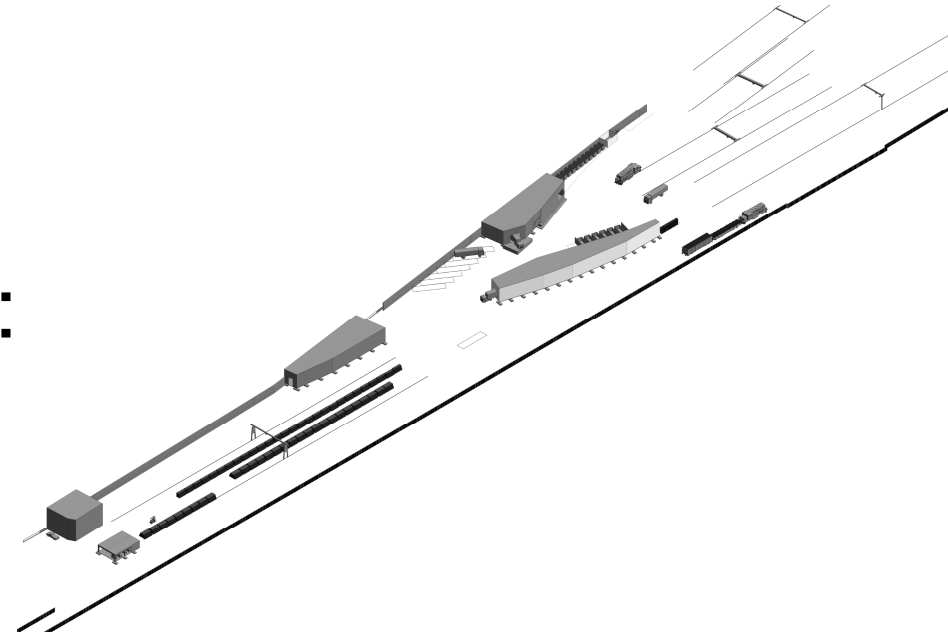
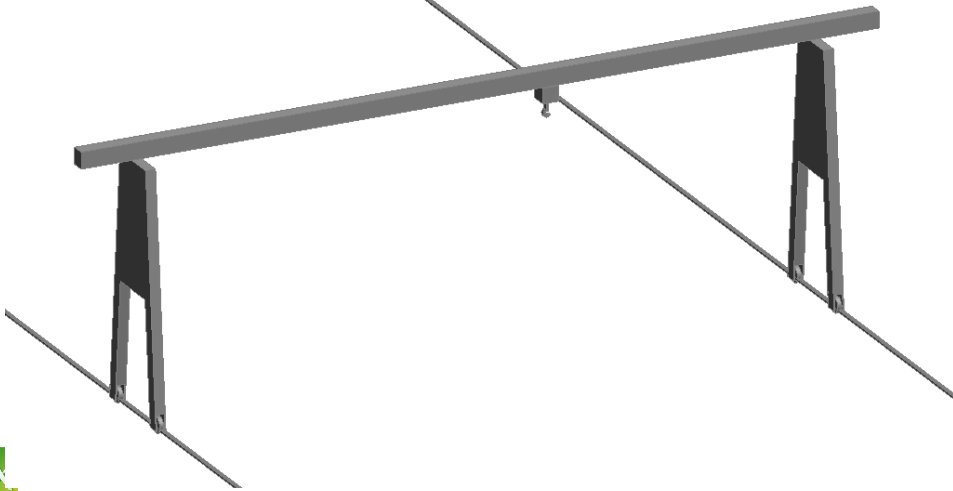




# Design Authoring Revit

## Equipements model Including:

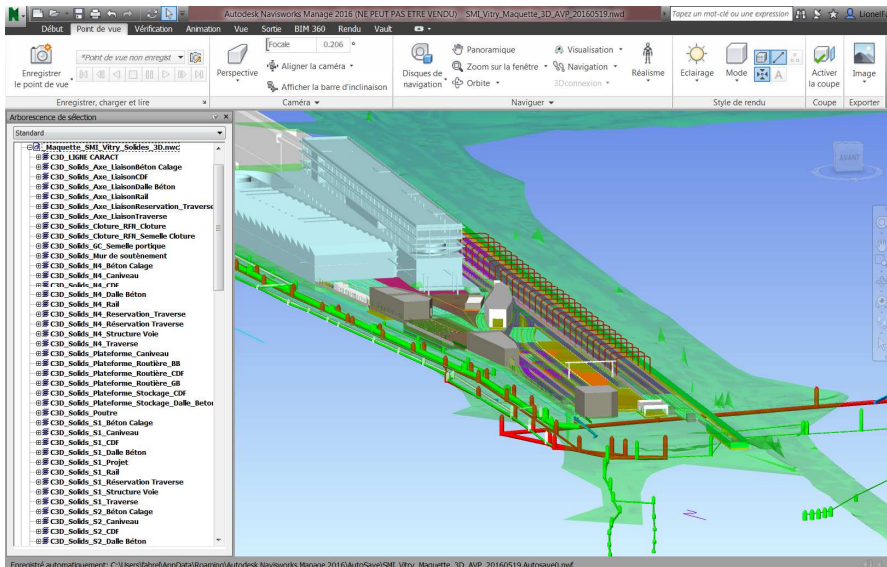
- Bridge cranes
- Work train
- Stock
- Dumpsters, compactors



37C  
1

# Quantity Takeoff Navisworks

- Systra customized classification (based on unifomat)
- Using AutoCAD Civil 3D Attributes



The screenshot shows the 'Classeur de Quantification' (Quantity Classification) window in Navisworks. The window displays a table with columns for 'Éléments', 'WBS', 'Etat', 'WBS', 'Nom', 'Volume', and 'Poids'. The table lists various construction elements and their associated WBS codes, volumes, and weights.

Éléments	WBS	Etat	WBS	Nom	Volume	Poids
Building Sitework	G					
Site_Projet	G.20					
10_Voies	G.20.10					
20_Plateforme_Routière	G.20.1					
30_Plateforme_Stockage	G.20.2					
50_Genie_Civil	G.20.3					
60_Hydro	G.20.4					

Etat	WBS	Objet	Point de v...	Comment...	LongueurModèle	LargeurModèle
	G.20.10.1	Solide 3D				
	G.20.10.1.1	Solide 3D				
	G.20.10.1.2	Solide 3D				
	G.20.10.1.3	Solide 3D				
	G.20.10.1.4	Solide 3D				
	G.20.10.1.5	Solide 3D				

WBS/RBS	Description	Commentaires	Groupe1	Groupe2	Groupe3	Élément	Ressource	Objet
88 G.20.10.2.30	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (30)
89 G.20.10.2.31	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (31)
90 G.20.10.2.32	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (32)
91 G.20.10.2.33	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (33)
92 G.20.10.2.34	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (34)
93 G.20.10.2.35	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (35)
94 G.20.10.2.36	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (36)
95 G.20.10.2.37	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (37)
96 G.20.10.2.38	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (38)
97 G.20.10.2.39	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (39)
98 G.20.10.2.40	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (40)
99 G.20.10.2.41	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (41)
100 G.20.10.2.42	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (42)
101 G.20.10.2.43	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (43)
102 G.20.10.2.44	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (44)
103 G.20.10.2.45	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (45)
104 G.20.10.2.46	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (46)
105 G.20.10.2.47	Building Sitework		Building Sitework	Site_Projet	10_Voies	CD		Solide 3D (47)



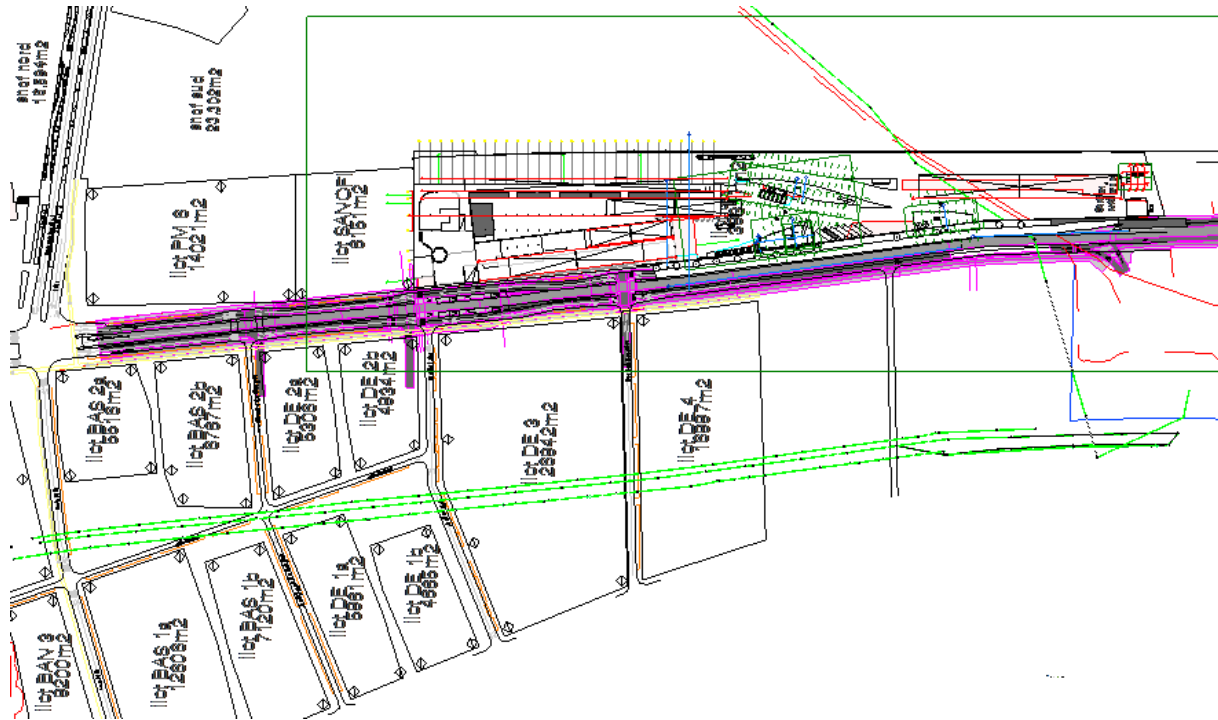
# Lessons Learnt

- Data management
  - Specification of the model
  - Layer convention & folder structure
  - Data shortcut
- Possibility to model objects using different tools
- Additional non-BIM modelling
- Use of Navisworks for QTO

# Building Design

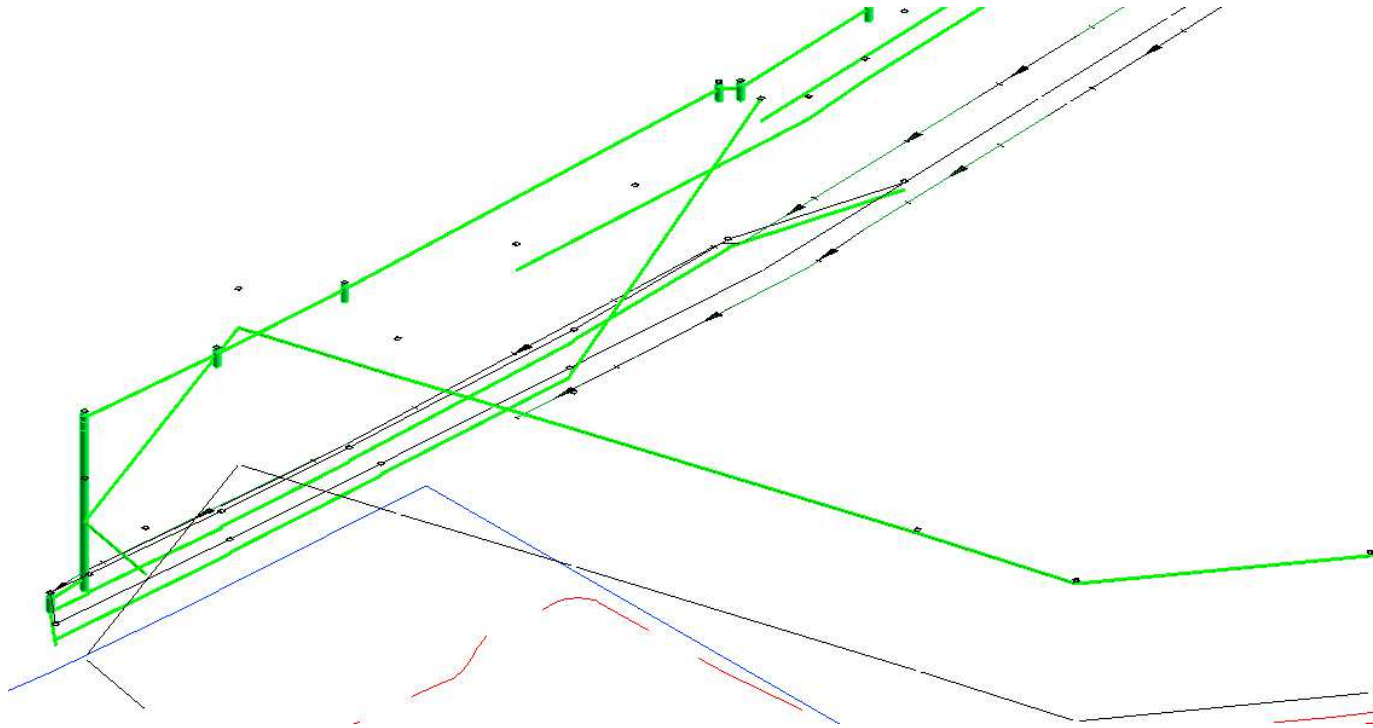
# Geo referencing Revit

- Specific Revit file for referencing DWG



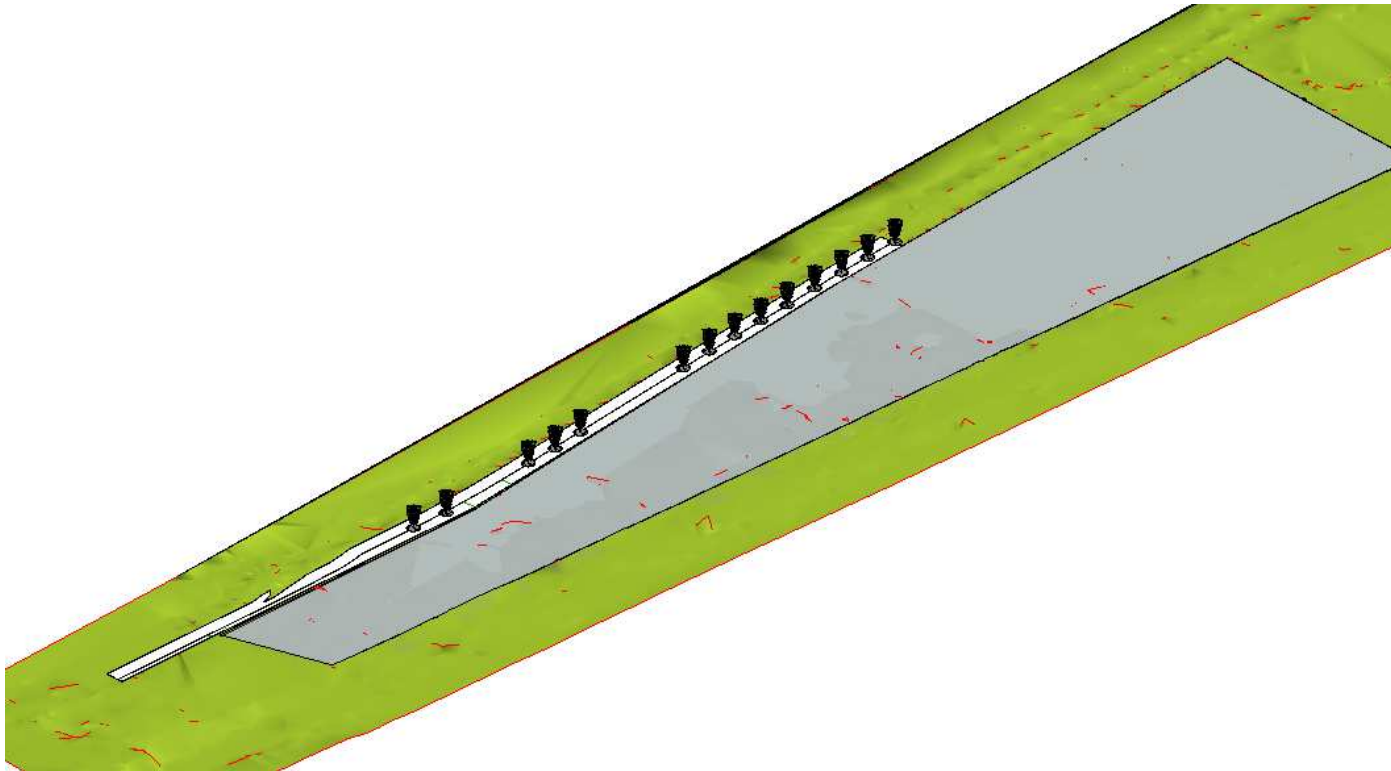
# Civil 3D Objects in Revit

- Civil 3D platform objects are imported in a Revit family



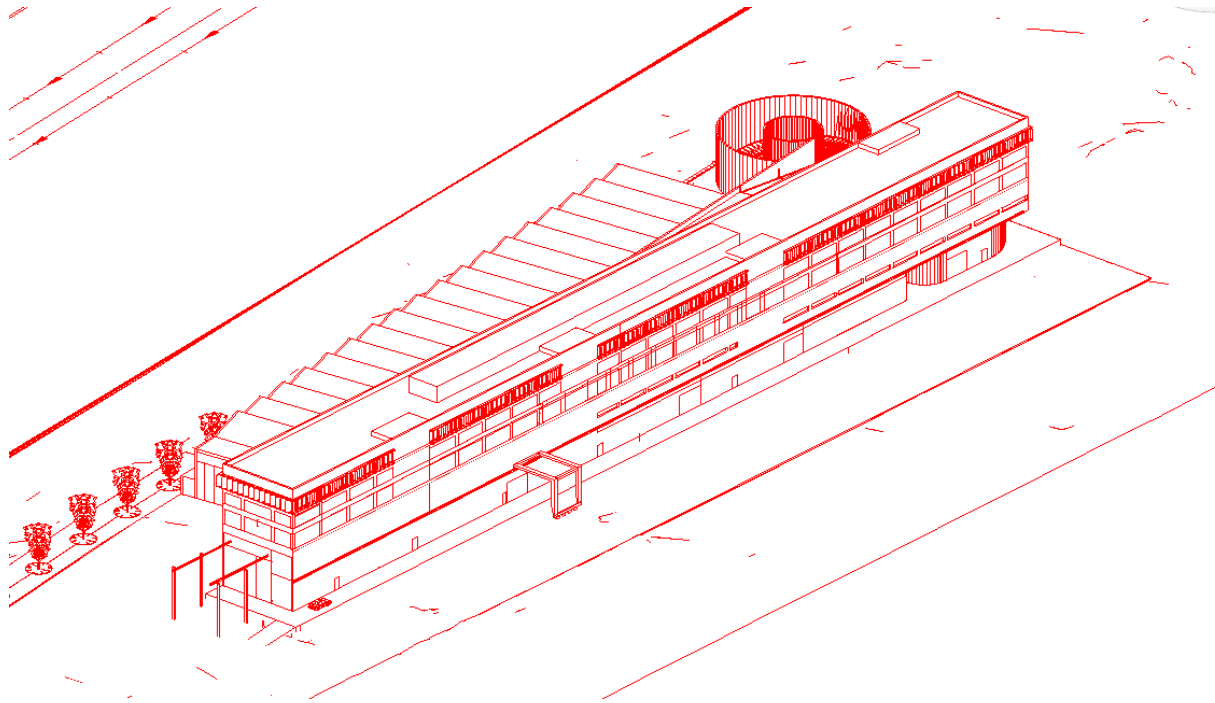
# Topography in Revit

- Using Civil 3D Revit Addon



# Design Authoring

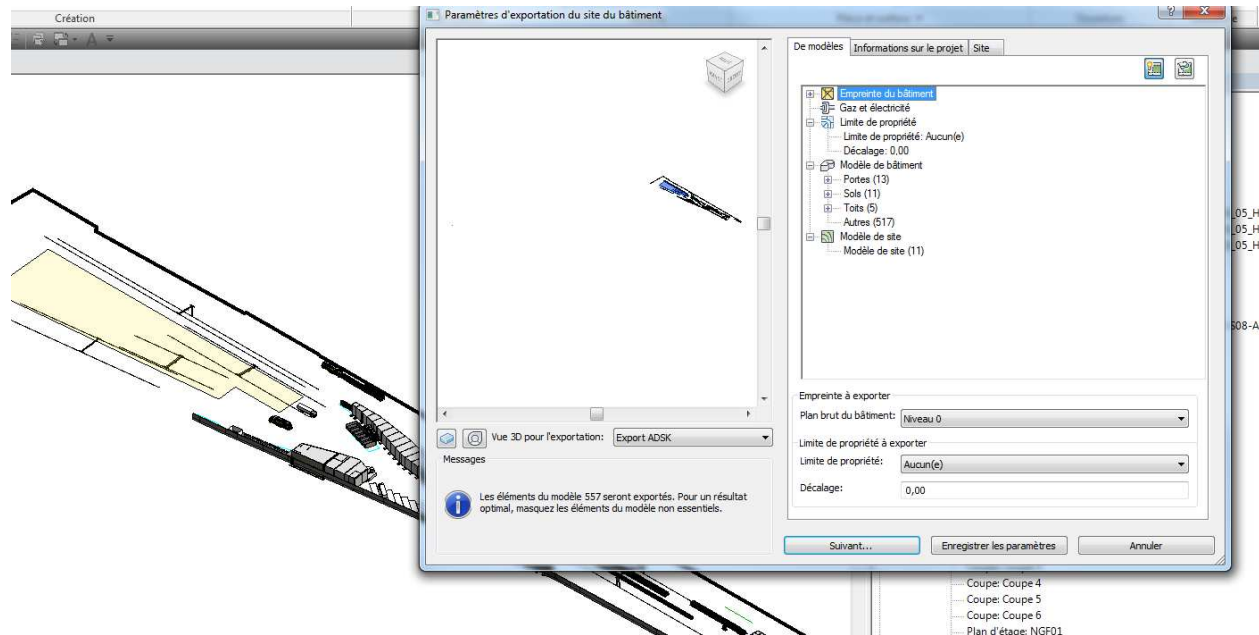
- Architect Marc Barani model using Sketchup Imported in an rfa





# Revit To Civil 3D

- Exporting Revit model as « Building Site » (adsk file)

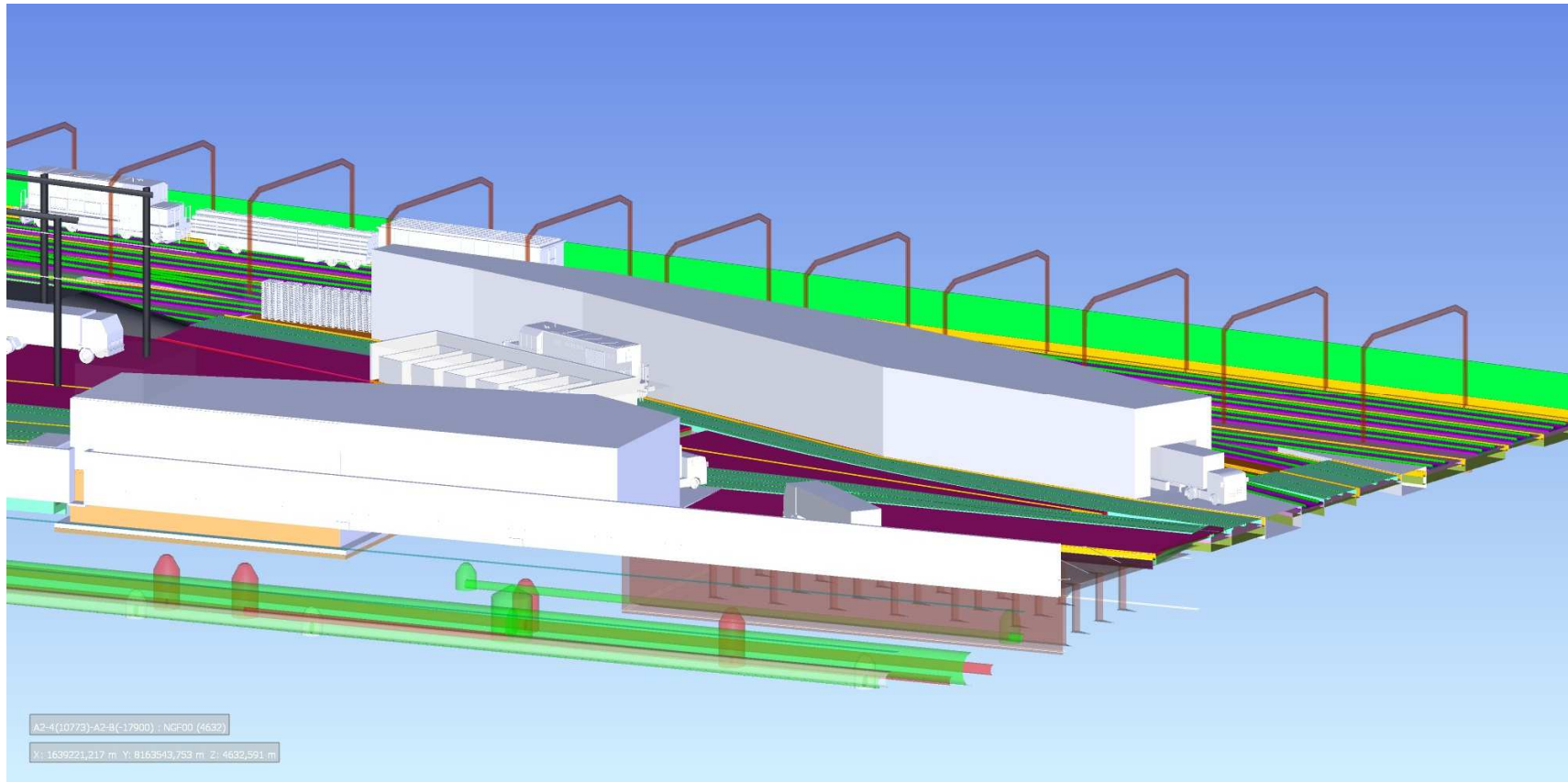


# Lessons Learnt

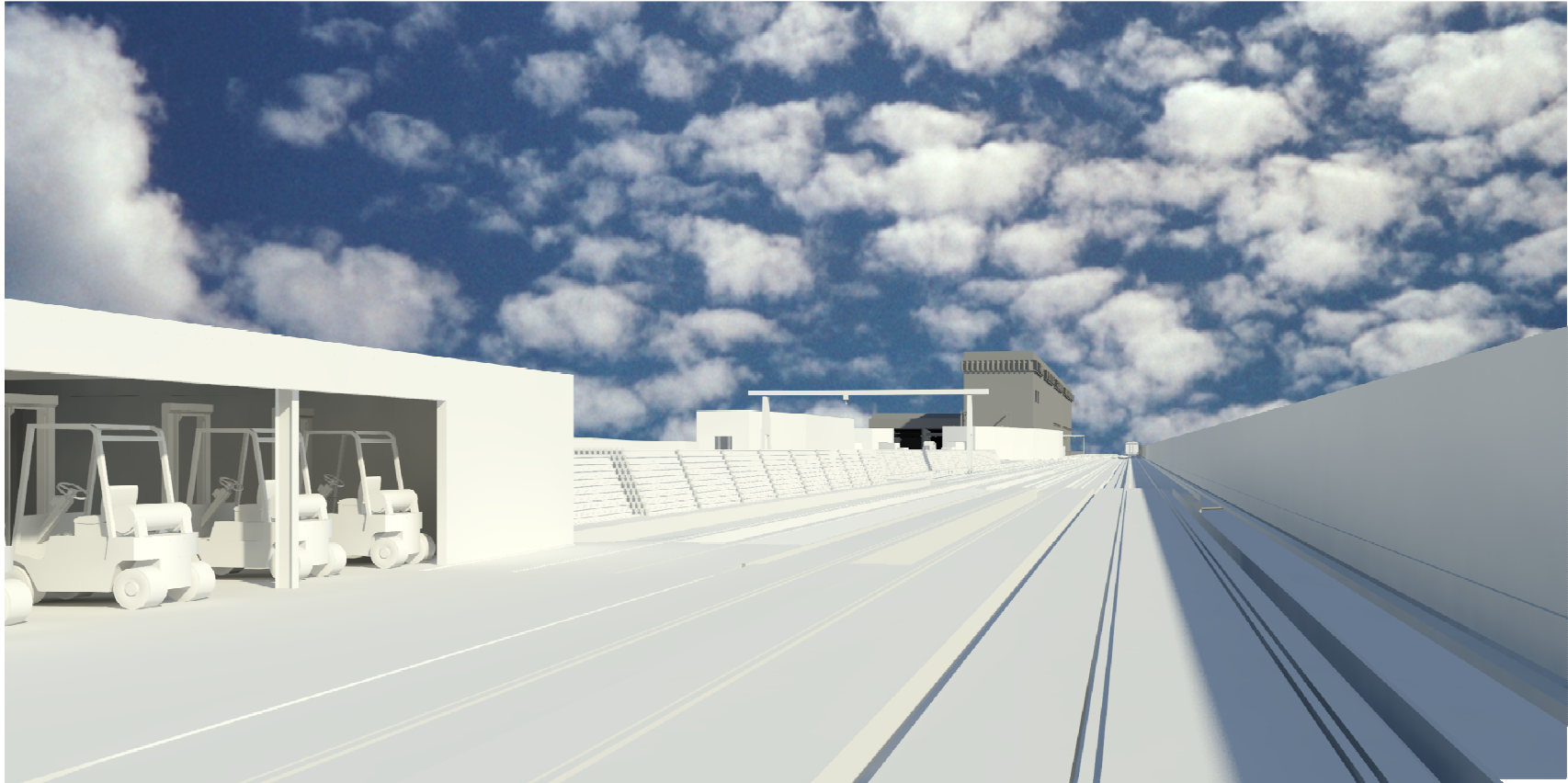
- Set BIM as a requirement in the contract
- Use of Revit and Civil 3D addon for interoperability

# Coordination Model & Design Reviews

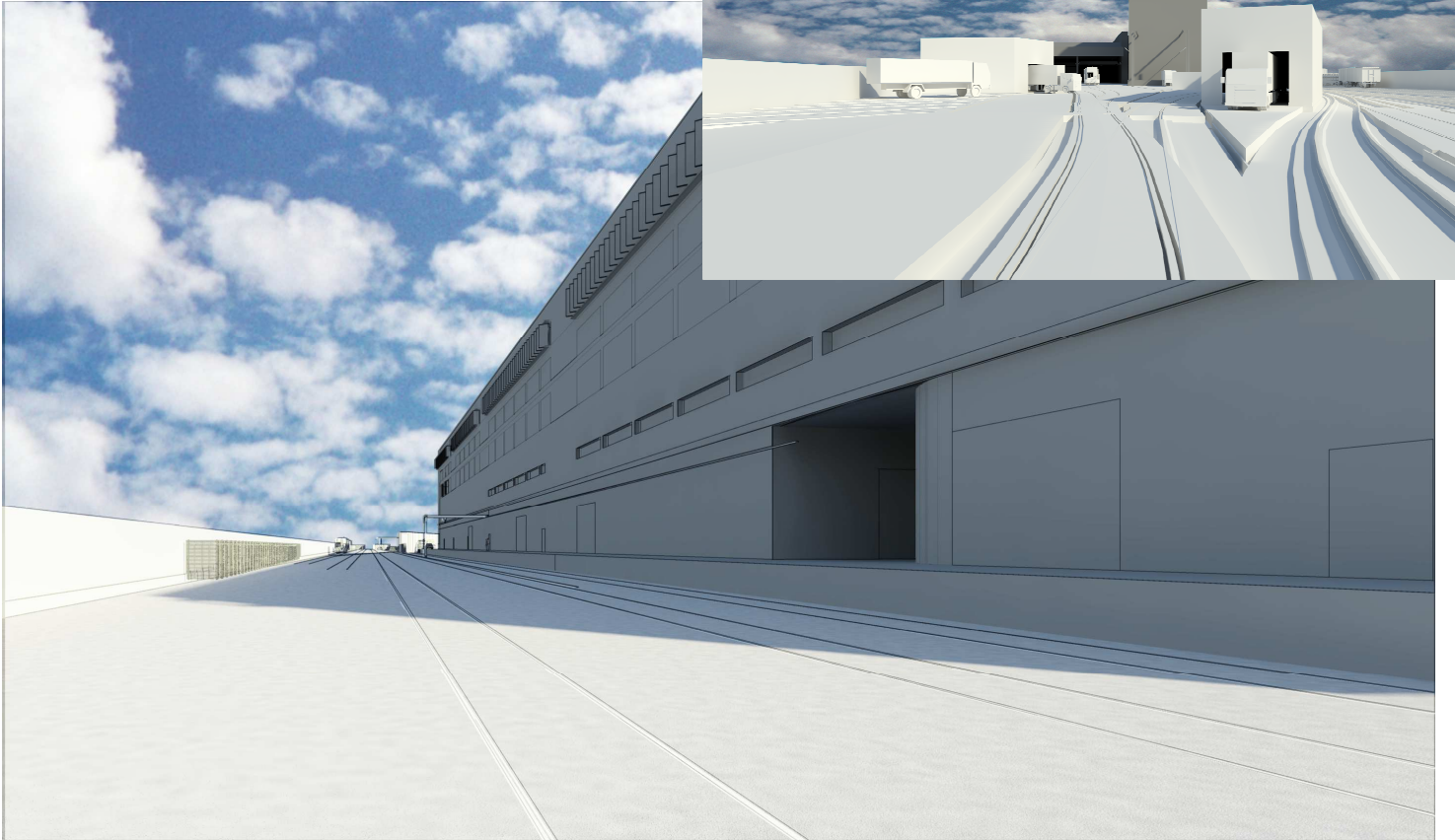
# Visualisation tools



# Images



# Images





# Automated Clash detection

Conflicts

file:///U:/FR01T14865%20MOE%20SM1%20Vtry/400ProdConception/400-01b%20AVP%20Inf-b/400-01b-003%20Infra/civil3D/SM1%20Vtry/03\_Rapports/analyse%20existant/reseau%20EP-EU.html

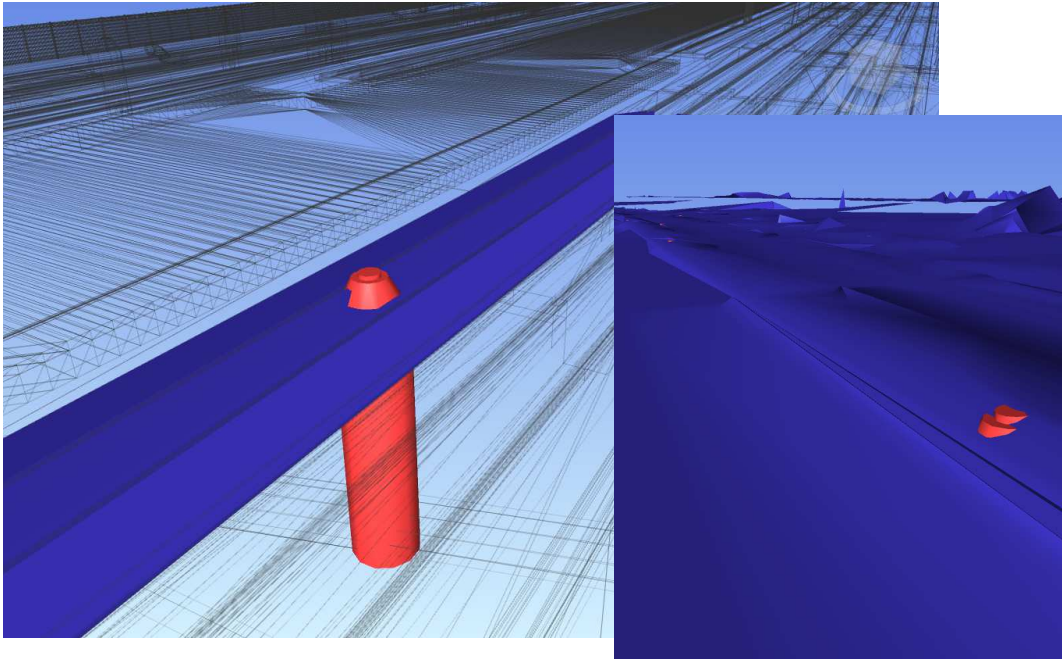
**Autodesk Navisworks** Rapport de conflits

Tolérance	Conflits	Nouveau	Actif	Vérifié	Approuvé	Résolu	Type	Etat
0.001m	8	8	0	0	0	0	Dur	Ancien

Image	Nom de conflit	Etat	Distance	Description	Date de recherche	Point de conflit	Élément 1				Élément 2			
							ID d'élément	Calque	Élément Nom	Élément Type	ID d'élément	Calque	Élément Nom	Élément Type
	Conflit1	Nouveau	-0.300	Dur	2016/3/11 13:26.49	x:1656581.604, y:8175065.524, z:30.550	Identificateur d'entité: 31C3A	RSX_Légende_Réseau Eaux Pluviales DSEA	Structure - (43)	Structure	Identificateur d'entité: 32D71	RSX_Légende_Réseau Eaux Usées DSEA	Structure - (129)	Structure
	Conflit2	Nouveau	-0.199	Dur	2016/3/11 13:26.49	x:1656582.560, y:8175057.690, z:30.622	Identificateur d'entité: 31C4B	RSX_Légende_Réseau Eaux Pluviales DSEA	Structure - (44)	Structure	Identificateur d'entité: 32D75	RSX_Légende_Réseau Eaux Usées DSEA	Canalisation - (116)	Canalisation
	Conflit3	Nouveau	-0.189	Dur	2016/3/11 13:26.49	x:1656581.760, y:8175065.854, z:35.022	Identificateur d'entité: 31C3A	RSX_Légende_Réseau Eaux Pluviales DSEA	Structure - (43)	Structure	Identificateur d'entité: 31EC8	RSX_Légende_Réseau Eaux Usées DSEA	Structure - (75)	Structure
	Conflit4	Nouveau	-0.178	Dur	2016/3/11 13:26.49	x:1656707.944, y:8175111.762, z:-0.210	Identificateur d'entité: 37BBF	RSX_Légende_Réseau Eaux Pluviales DSEA	Canalisation - (177)	Canalisation	Identificateur d'entité: 37BB7	RSX_Légende_Réseau Eaux Usées DSEA	Structure - (201)	Structure
	Conflit5	Nouveau	-0.174	Dur	2016/3/11 13:26.49	x:1656580.364, y:8175097.386, z:34.860	Identificateur d'entité: 31C29	RSX_Légende_Réseau Eaux Pluviales DSEA	Structure - (42)	Structure	Identificateur d'entité: 31EB7	RSX_Légende_Réseau Eaux Usées DSEA	Structure - (74)	Structure
	Conflit6	Nouveau	-0.163	Dur	2016/3/11 13:26.49	x:1656578.154, y:8175128.352, z:34.857	Identificateur d'entité: 31C18	RSX_Légende_Réseau Eaux Pluviales DSEA	Structure - (41)	Structure	Identificateur d'entité: 31EA6	RSX_Légende_Réseau Eaux Usées DSEA	Structure - (73)	Structure
	Conflit7	Nouveau	-0.011	Dur	2016/3/11 13:26.49	x:1656708.272, y:8175112.369, z:0.085	Identificateur d'entité: 37BBF	RSX_Légende_Réseau Eaux Pluviales DSEA	Canalisation - (177)	Canalisation	Identificateur d'entité: 37BB9	RSX_Légende_Réseau Eaux Usées DSEA	Canalisation - (175)	Canalisation
	Conflit8	Nouveau	-0.002	Dur	2016/3/11 13:26.49	x:1656583.285, y:8175056.304, z:34.940	Identificateur d'entité: 31C4B	RSX_Légende_Réseau Eaux Pluviales DSEA	Structure - (44)	Structure	Identificateur d'entité: 32D73	RSX_Légende_Réseau Eaux Usées DSEA	Structure - (130)	Structure

# Clash Detection Navisworks & AutoCAD Civil 3D

- Defined from C3D layers



Clash Detective

Analyse 1

Dernière exécution : jeudi 10 novembre 2016 13:27:44  
Conflicts - Total : 108 (Ouverts : 108 Fermés : 0)

Nom	Etat	Conflicts	Nouv...	Actif	Vérifié	Approuvé	Résolu
Analyse 1	Terminé	108	108	0	0	0	0
Analyse 2	Ancien	1	1	0	0	0	0

Ajouter un test Réinitialiser tout Compacter tout Supprimer tout Tout mettre à jour

Règles Sélectionner Résultats Rapport

Nom	Etat	Niveau	Interse...	Trouvé	Approuv...	Approuvé	Descripti...	Affecté à	Distance
Conflict1	Nouveau	A2-1(-6...	13:27:44 10-11-2016	Dur					-0.085 m
Conflict2	Nouveau	A2-1(-5...	13:27:44 10-11-2016	Dur					-0.060 m
Conflict3	Nouveau	A2-1(-6...	13:27:44 10-11-2016	Dur					-0.058 m
Conflict4	Nouveau	A2-1(-7...	13:27:44 10-11-2016	Dur					-0.055 m
Conflict5	Nouveau	A2-1(-7...	13:27:44 10-11-2016	Dur					-0.055 m
Conflict6	Nouveau	A2-1(-4...	13:27:44 10-11-2016	Dur					-0.055 m
Conflict7	Nouveau	A2-1(-4...	13:27:44 10-11-2016	Dur					-0.053 m
Conflict8	Nouveau	A2-1(-6...	13:27:44 10-11-2016	Dur					-0.052 m
Conflict9	Nouveau	A2-1(-7...	13:27:44 10-11-2016	Dur					-0.052 m
Conflict10	Nouveau	A2-1(-7...	13:27:44 10-11-2016	Dur					-0.052 m
Conflict11	Nouveau	A2-1(-4...	13:27:44 10-11-2016	Dur					-0.051 m
Conflict12	Nouveau	A2-1(-8...	13:27:44 10-11-2016	Dur					-0.048 m
Conflict13	Nouveau	NGF00 (-...	13:27:44 10-11-2016	Dur					-0.046 m
Conflict14	Nouveau	A2-1(-7...	13:27:44 10-11-2016	Dur					-0.044 m
Conflict15	Nouveau	A2-1(-7...	13:27:44 10-11-2016	Dur					-0.043 m
Conflict16	Nouveau	A2-1(-4...	13:27:44 10-11-2016	Dur					-0.042 m
Conflict17	Nouveau	A2-1(-6...	13:27:44 10-11-2016	Dur					-0.039 m
Conflict18	Nouveau	A2-1(-2...	13:27:44 10-11-2016	Dur					-0.036 m
Conflict19	Nouveau	A2-1(-3...	13:27:44 10-11-2016	Dur					-0.035 m

Mise en surbrillance

Élément 1 Élément 2

Utiliser la couleur de l'état

☒ Mettre en surbrillance tous les conflits

Isolation

☒ Griser les autres éléments Masquer les autres éléments

☒ Gradation transparente

☒ Auto-révélation

Point de vue

Mise à jour automatique

☒ Animer les transitions

Point de conflit

Simulation

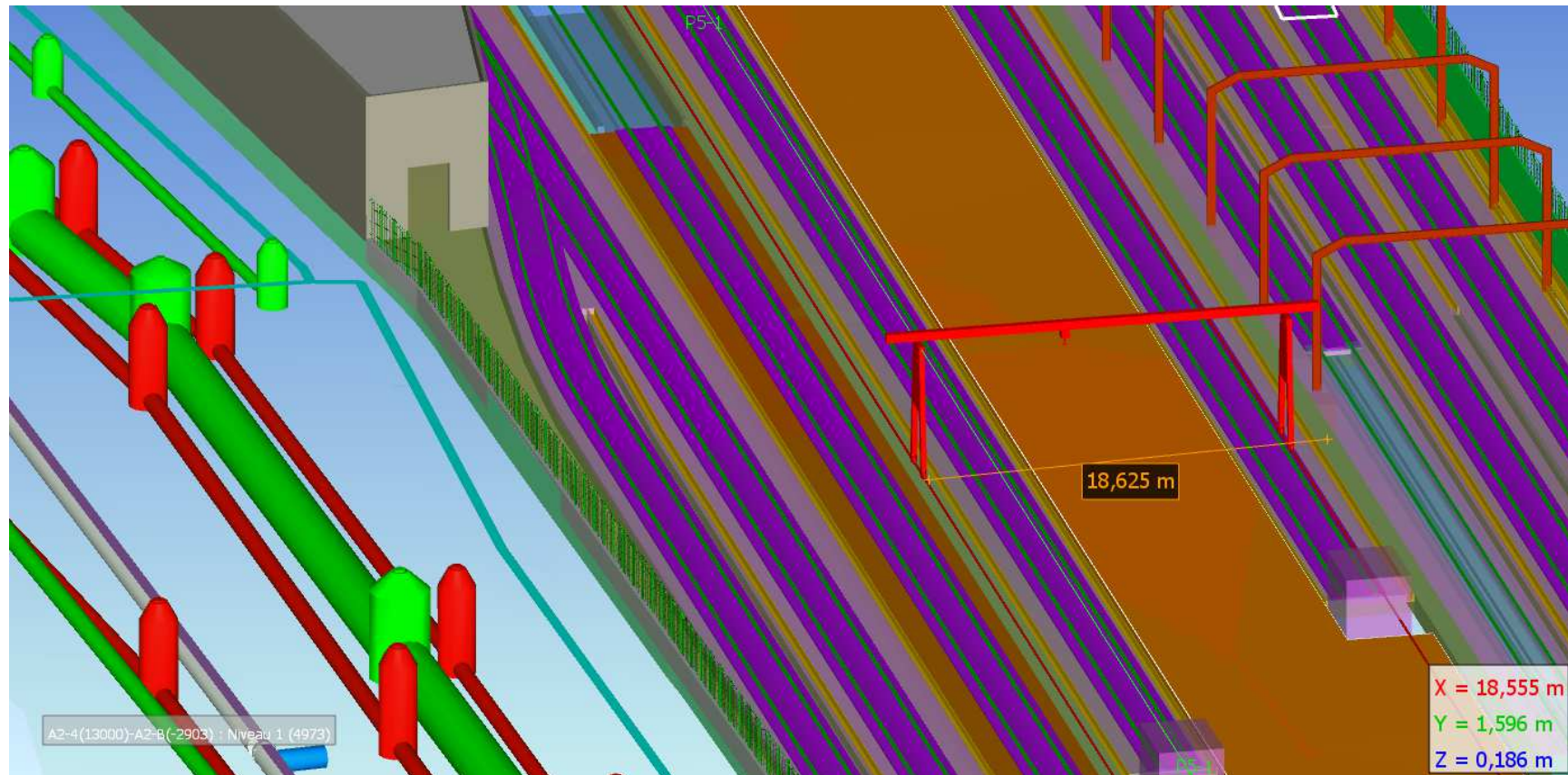
☒ Afficher la simulation

Afficher dans le contexte

Tout Vue



# Manual Design Reviews



# Lesson Learnt

- Data management
  - Specification of the model
  - Layer convention & folder structure
  - Data shortcut
- Possibility to model objects using different tools
- Additional non-BIM modelling
- Use of Navisworks for QTO & 3D Coordination
- Set BIM as a requirement in the contract
- Use of Revit and Civil 3D addon for interoperability
- Reduce number of automated clash detected, do not run clash detection on the entire project

# How did I do?

- Your class feedback is critical. Fill out a **class survey** now.
- Use the AU mobile app or fill out a class survey online.
- Give feedback after each session.
- AU speakers will get feedback in real-time.
- **Your feedback results in better classes and a better AU experience.**





# More Questions? Visit the AU Answer Bar

- Seek answers to all of your technical product questions by visiting the **Answer Bar**.
- Open daily from **8am-6pm Tuesday** and **Wednesday**; **8am-4:30pm Thursday**.
- Located outside **Hall C, Level 2**.
- Meet Autodesk developers, testers, & support engineers ready to help with your most challenging technical questions.





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