3D PDF as an engineering deliverable for Hydro-Québec, an alternative to traditional 2D Drawings

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Annual Experience & TechniFair

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Agenda

- **Hydro-Québec & La Romaine project**
- **Anark Corporation**
- **HQ e-Signature historical information**
- **The 3D PDF Project**
- **3D MBD mockups used for 3D PDF**
- **Conversion recipe**
- **Workaround and limitations**
- **Anark Core server integration with SmarTeam**
- **3D PDF live demo**
- **Questions**

Hydro-Québec is a major supplier of electricity, relying on clean, renewable energy.

Hydro–Québec generates, transmits and distributes electricity. Its sole shareholder is the Québec government. It uses mainly renewable generating options, in particular large hydro, and supports the development of other technologies—such as wind energy and biomass. A responsible corporate citizen committed to sustainability, Hydro–Québec carries out construction projects to prepare for the future. It also conducts R&D in energy–related fields, including energy efficiency. The company has four divisions.

Hydro–Québec - Clean Energy

Power Generation Projects
Romaine Complex

Hydro Québec

Rivière Romaine

At a Glance	
Status:	**Under construction**
Region:	**Moyenne-Côte-Nord**
Type:	**Hydroelectric**
Owner:	**Hydro-Québec Production**
Project supervision:	**Hydro-Québec Équipement et services partagés**

Hydro-Québec Production obtained the necessary approvals to build a 1,550-MW hydroelectric complex on the Rivière Romaine, north of the municipality of Havre-Saint-Pierre on the north shore of the St. Lawrence. The complex will consist of four hydropower generating stations with average annual output of 8.0 TWh.

Construction of the Romaine-2 development began in 2009. Romaine-2 was commissioned in 2014 and the Romaine-1 development was commissioned in 2015. Work on the Romaine-3 and Romaine-4 developments, which will be operational in 2017 and 2020, respectively is underway.

The Romaine project will generate substantial economic spinoffs—approximately $3.5 billion for Québec as a whole and $1.3 billion for the Côte-Nord region, and create an average of 975 jobs each year while the project is being carried out.

Hydro-Québec is reiterating its commitment to sustainable development by focusing on renewable energy at the Romaine complex, which will help meet current needs without jeopardizing the energy supply of future generations.

Anark Corporation

Leading provider of MBE publishing and visual collaboration software and solutions to industry leaders since 2000.

Empowering 3D Model Based Enterprise revolution within Aerospace, Defense, Automotive, Energy, Industrial, Electronics, and Medical Equipment Sectors
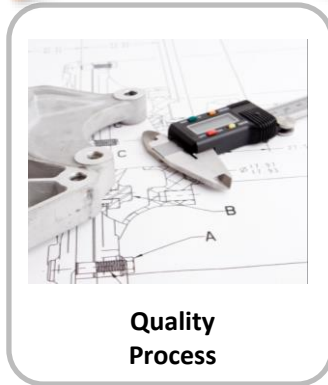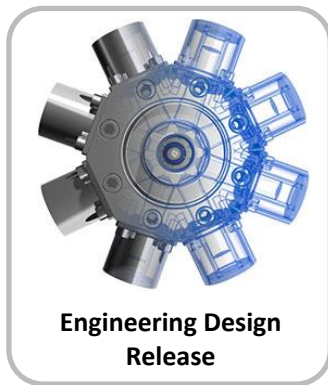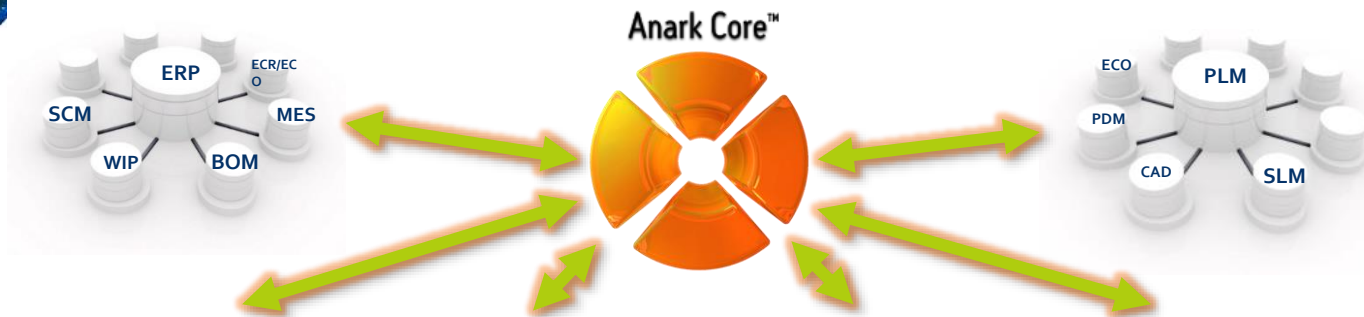
Profitable, growing company, with world-wide network of technology, integration, and channel partners

Anark Corporation HQ in Boulder, Colorado

- See Anark's Vender Solution Presentation
- Tuesday in the Nomeus Room from 11:45 to 12:35

- Session 5171: Powering the Digital Thread with Advanced Visual Collaboration and 3D MBE Publishing
- Stephen Collins, Anark Corporation Co-Founder and President

HQ e-signature historical information

- In 2013, we implemented a native CATIA file based e-signature process
- However, this process is quite complex to achieve and to consult :
  - » The p7m files are not intuitive and require a special software to decrypt and open
  - » Lengthy signature process (zip files, files list imported in drawing, p7m, Notarius, etc.)
  - » CATIA is mandatory to access the 3D models (node lock licensing, high end workstation, CATIA environment is required, etc.)
  - » Qualified CATIA operators are required to access the 3D models
  - » Can't easily be printed (screen shots) and the engineer's stamp is not visible on the printout
  - » A lot of end user support is required from Hydro-Quebec to maintain this e-signature process

Which explains the 3D PDF initiative for Romaine-4

3D PDF enables :

- CATIA conversion without loss of information

- Consult authenticated documents with minimal SW and HW (Acrobat Reader XI or later) and 3D knowledge

- Implements print capabilities (along with engineer's stamp)

- Measurements and comments are natively integrated in 3D PDF

- 3D PDF are natively managed by our project document management tools likewise any other engineering document

- Changes identification between two revisions

- Comply with the legal requirements of the Ordre des ingénieurs du Québec including electronic signature and long term archival requirements
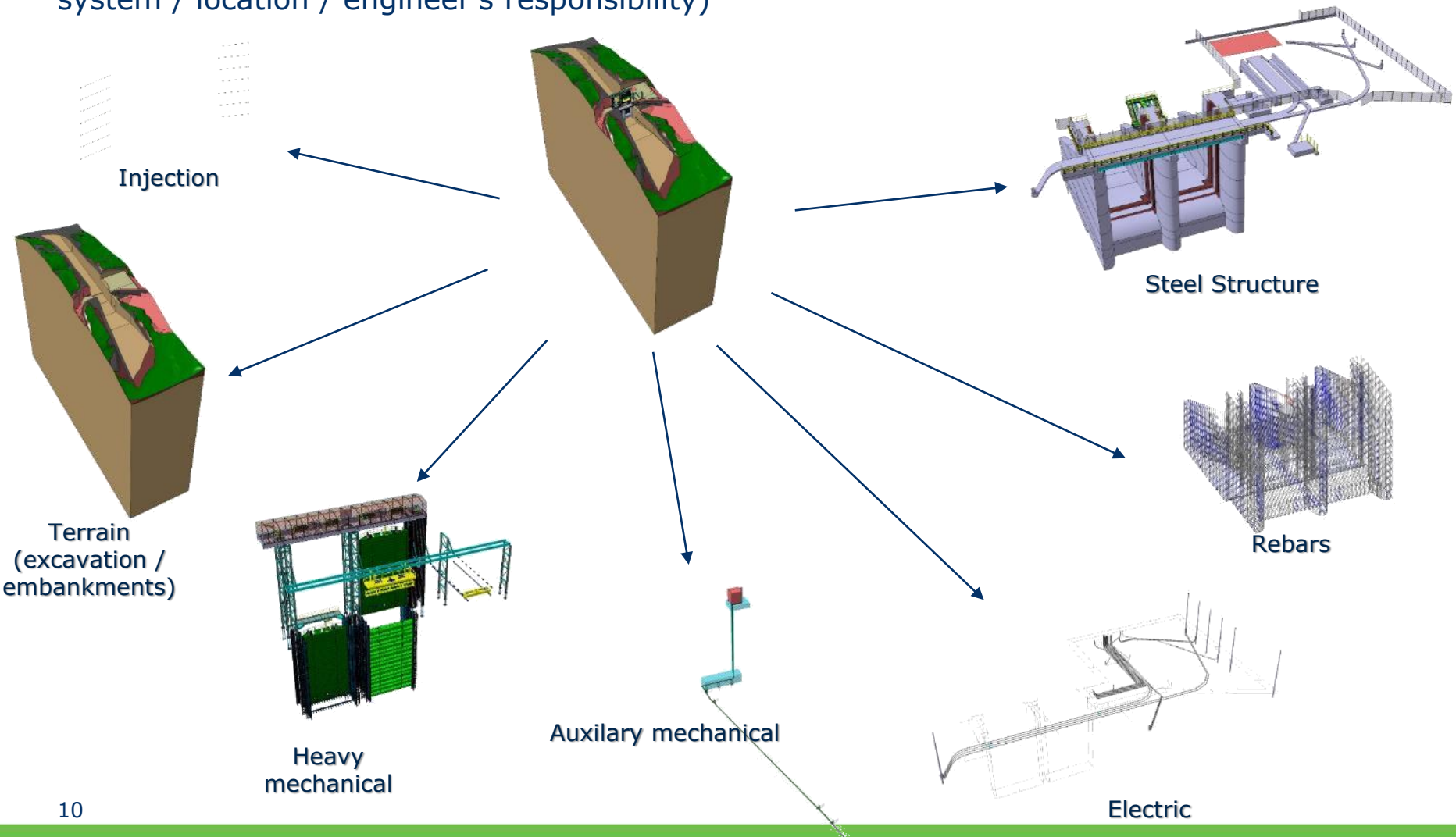
- Possible integration/automation with SmarTeam

3D PDF project story line

- First 3D PDF efforts started in 2013

- In 2014, we acquired a Anark Core Workstation licence with CATIA Advanced integration taking part of an early adopter program. The goal was to perform a proof of concept

- April 2015 : 3D PDF Project kickoff

- September 2015 : Meeting with Ordre des Ingénieurs du Québec

- November 2015 : First authenticated 3D PDF officially issued in a public request for quote

- December 2015 : Acquisition of Anark Core Server licence and official partnership with Anark

- October 2016 : First phase of Anark Core Server integration with SmarTeam
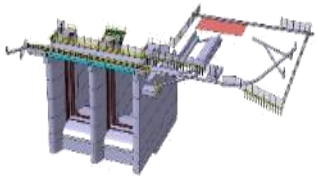
3D MBD mockups

- The overall model of each work is divided into several functional parts (by discipline / system / location / engineer's responsibility)

Injection

Steel Structure

Terrain (excavation / embankments)

Rebars

Heavy mechanical

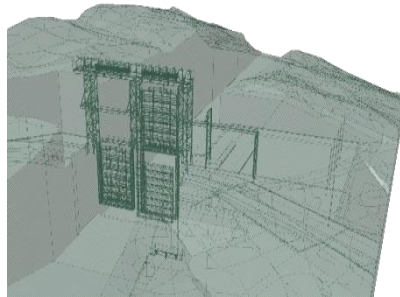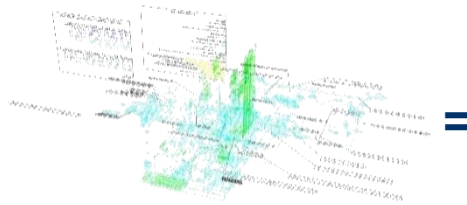Auxilary mechanical

Electric

3D MBD mockups

- Each **In Context** 3D mockup consists of :
  - Main design 3D model (showing engineer's scope of responsibility / discipline / system / location)
  - Surrounding 3D models which represent the **context** (reference)
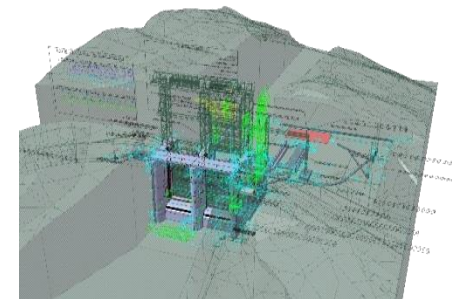 - Supplemental engineering information

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Main design 3D model (ex.: Steel structure)

Surrounding 3D **context** models (terrain, mechanical, electrical)

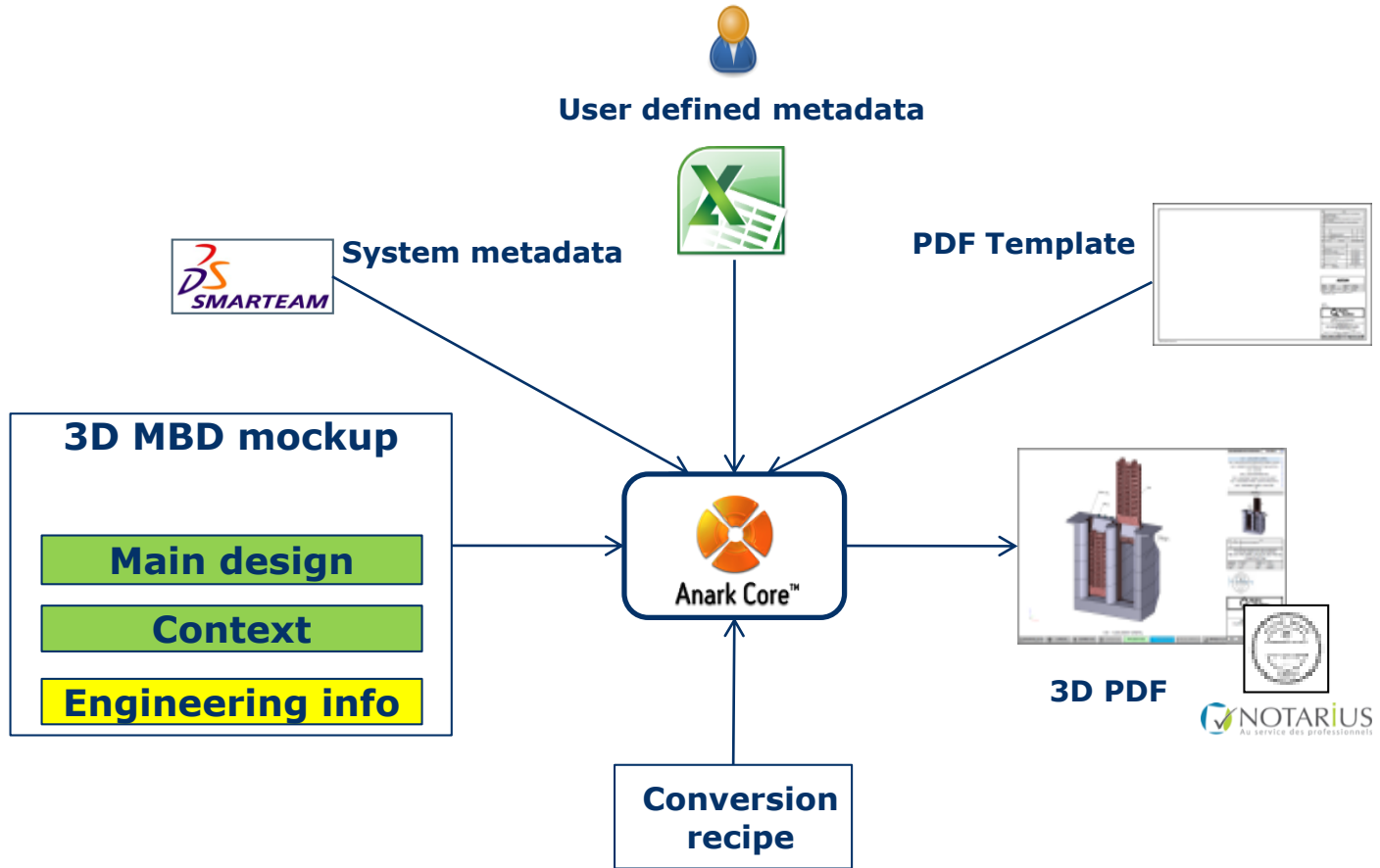**Engineering information** (notes, dimensions, etc.)

3D MBD mockup **« In Context »**

Predefined views (*Captures*)
- Point of view
- Filtered geometry
- Filtered annotations
- Section cut (as needed)
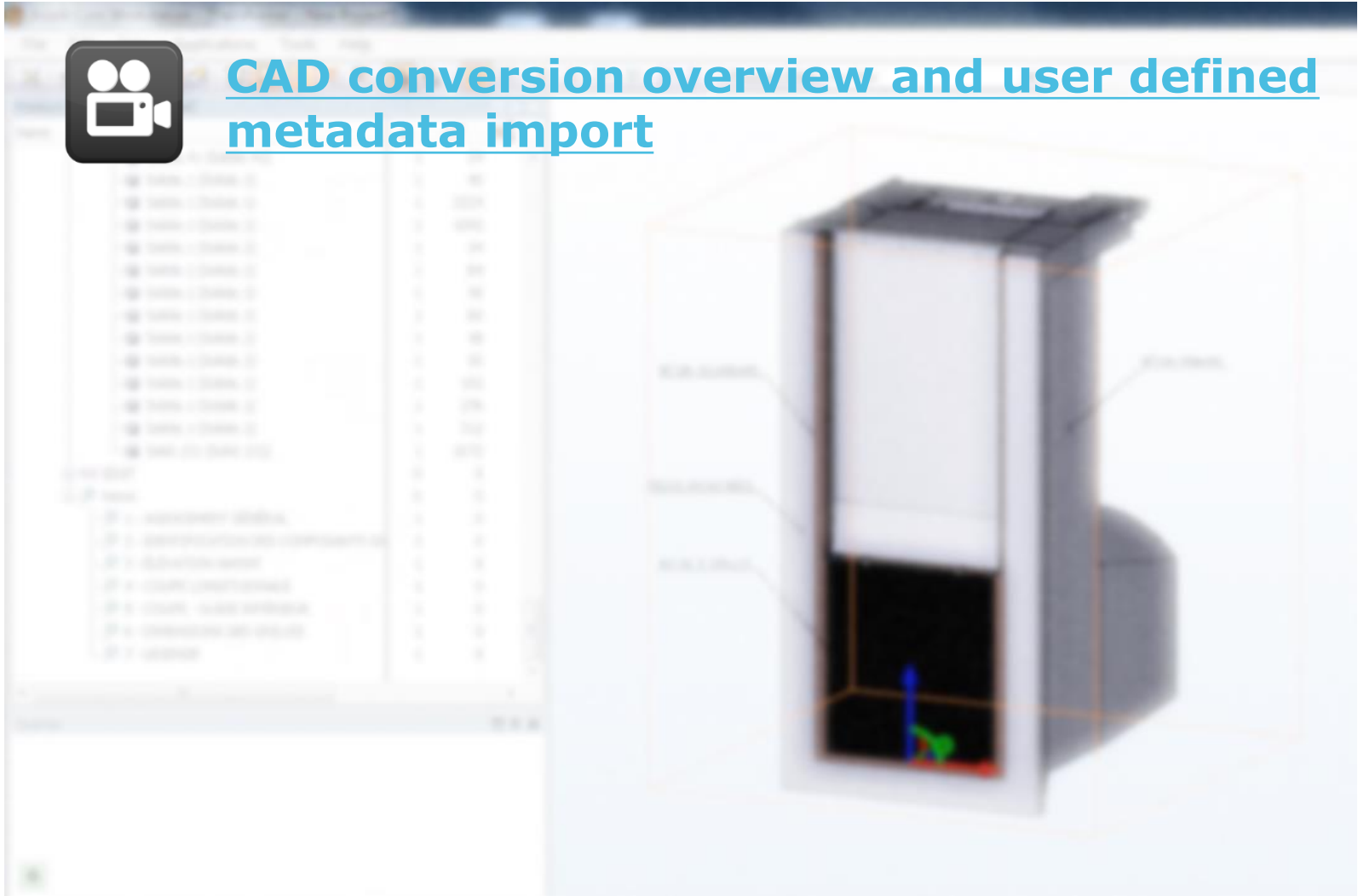
3D PDF creation and signature process

User defined metadata

System metadata

PDF Template

3D MBD mockup

- **Main design**
- **Context**
- **Engineering info**

Anark Core™

3D PDF

Conversion recipe
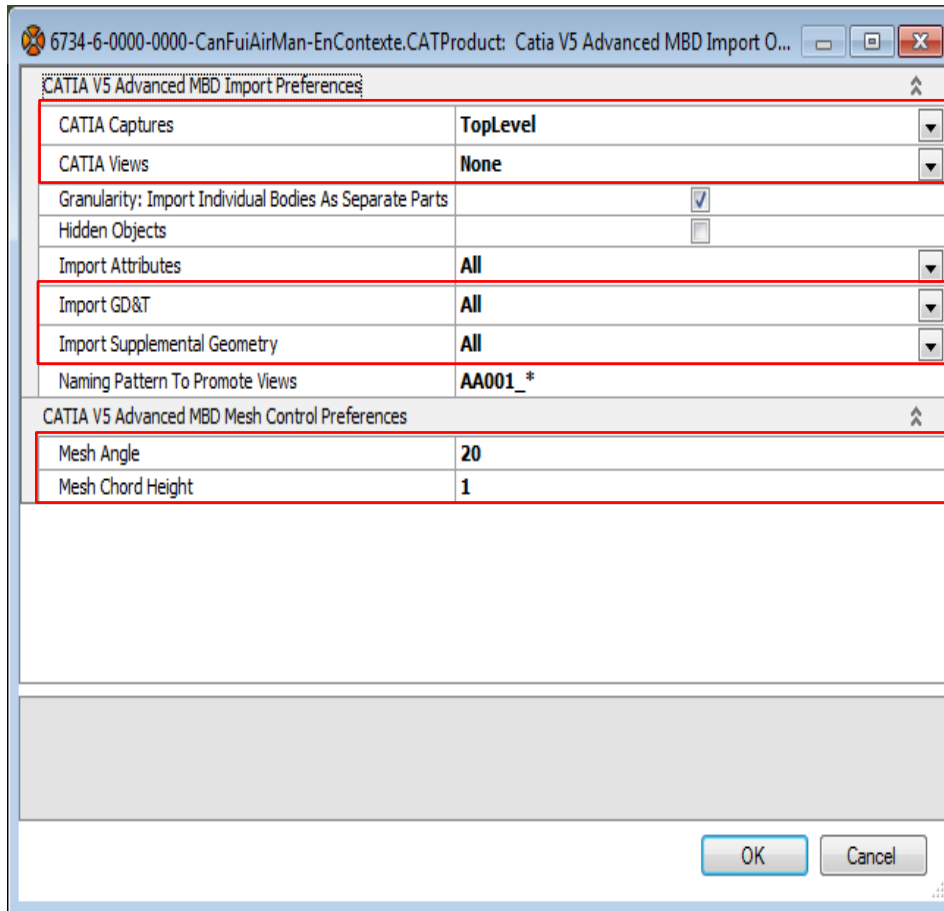
Conversion recipe

CAD conversion overview and user defined metadata import

Conversion recipe – CATIA V5 Advanced MBD import

Only top level captures can be imported

Control over annotations and wireframe geometry

Precision level can be defined here

- **A proper precision level needs to be defined because unlike in a CATIA session, it cannot be changed after conversion.**

Conversion recipe – Closer look on product structure tree

**3D geometry, GD&T and views are visible in the Product Structure**

Number of polygons

Name	
☐ 🖳 Root	2228112
☐ 🖳 6734-6-0000-0000-CanFuiAirMan-EnContexte (6734-6-0000-0000-CanFuiAirMan-EnContexte)	2228112
⊞ 🖳 CON-Canal de fuite air de manoeuvre centrale (6734-6-0000-0000-CanFuiAirMan)	397928
☐ 🖳 Habillage (6734-6-0000-0000-CanFuiAirMan-HAB)	6248
⊞ 🖳 Canal de Fuite - Habillage - Excavation (6734-6-0000-0000-CanFuiAirMan-HAB-Geo)	27
⊞ 🖳 6734-6-0000-0000-HAB-LimiteExcRoc-R4-01-01 (6734-6-0000-0000-HAB-LimiteExcRoc-R4-01-01)	4113
⊞ 🖳 6734-6-0000-0000-HAB-LimiteExcCanFui-R4-01-01.1 (6734-6-0000-0000-HAB-LimiteExcCanFui-R4-01-01)	1760
⊞ 🖳 Localisation des Coupes_TR (6734-6-0000-0000-CanFui-Localisation-des-Coupes)	16
☐ 🖳 Éléments de Référence_TR (6734-6-0000-0000-CenRER-Reference-Ech1-1000)	298
⋯ 🔘 Positionnement - NE PAS MODIFIER (Positionnement - NE PAS MODIFIER)	274
⋯ 🔘 Positionnement - NE PAS MODIFIER (Positionnement - NE PAS MODIFIER)	22
⋯ 🔘 NIVEAU DE LA MER_TR (NIVEAU DE LA MER_TR)	2
⊞ 🔲 GD&T	0
☐ 🔲 Supplemental Geometry	0
⬛ Frontière.NIVEAU DE LA MER	0
⬛ Base_Est-Ouest_GRF	0
⬛ Base_Nord-Sud_GRF	0
⬛ Segments_Est-Ouest_GRF	0
⬛ Segments_Nord-Sud_GRF	0
⊞ 🖳 Éléments d'implantation_TR (6734-6-0000-0000-CenRER-Implantation-Ech1-1000)	34
⊞ 🖳 Contexte (6734-6-0000-0000-CanFuiAirMan-Contexte)	1823936
⊞ 🔲 GD&T	0
☐ 🔘 Views	0
⋯ 🔘 1 - AGENCEMENT GÉNÉRAL	0
⋯ 🔘 2 - IDENTIFICATION DES COMPOSANTS SIGNÉS ET SCELLÉS	0
⋯ 🔘 3 - ÉLÉMENTS DE RÉFÉRENCE ET D'IMPLANTATION	0
⋯ 🔘 4 - PIÈCES JOINTES ET DESSINS	0
⋯ 🔘 5 - LÉGENDE	0
⋯ 🔘 6 - LOCALISATION DES VUES	0

Views matching CATIA captures

Conversion recipe – Tessellation
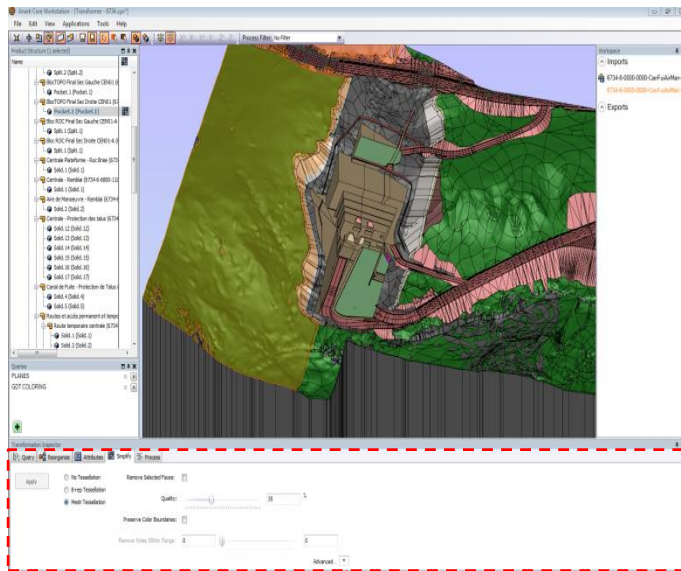
Tessellation @ 35%

Without tessellation

Transformation Inspector

Query | Reorganize | Attributes | **Simplify** | Process

Apply

- ○ No Tessellation
- ○ B-rep Tessellation
- ● Mesh Tessellation

Remove Selected Faces: ☐

Quality: ————●———— 35 %

Preserve Color Boundaries: ☐

Remove Holes Within Range: 0 —●———————— 0
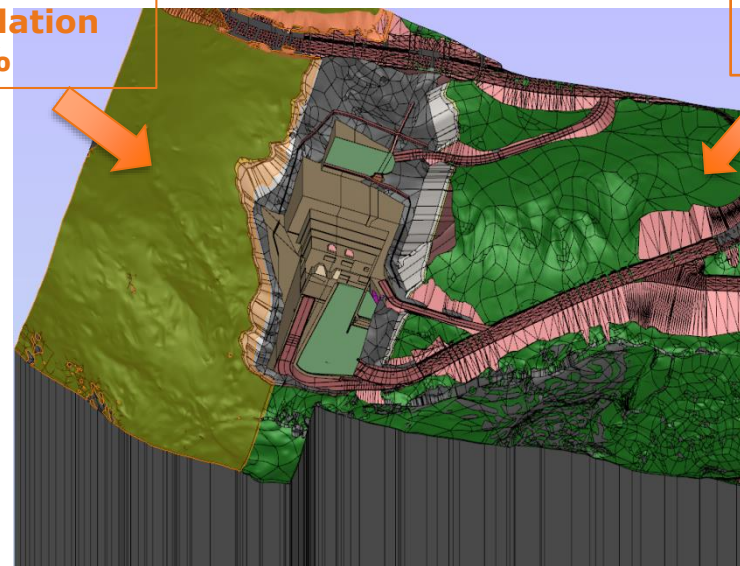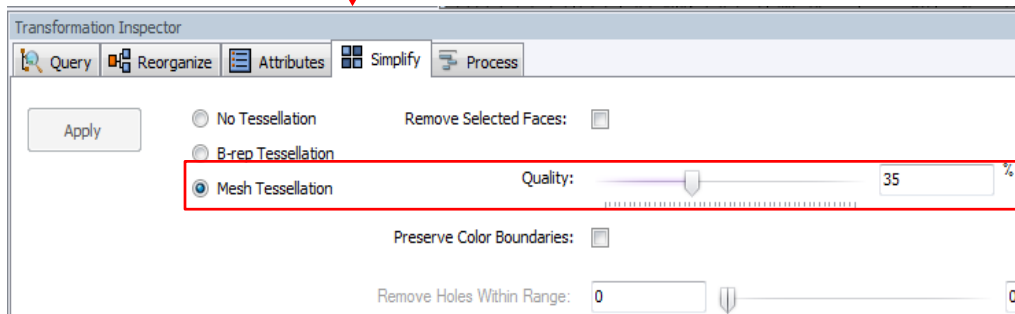
ADVANTAGES:

- **Removes smooth edges on terrain**
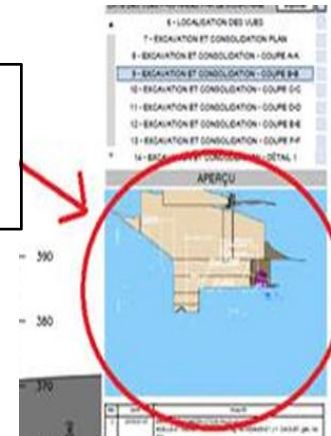- **Reduces file size (less polygons)**

Conversion recipe – Query engine

The query engine enables conditional modification. We use it mainly for :

- **Remove unusused planes**
- **Change annotation color to black**
- **Apply tesselation on terrain**
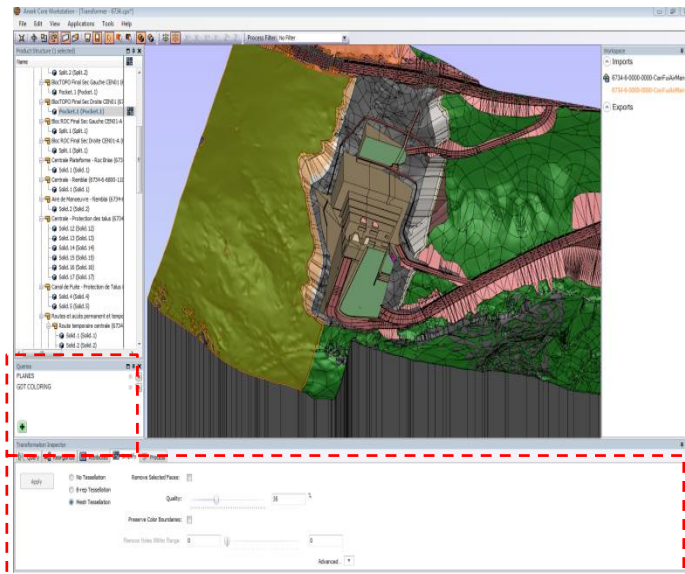
Changing the colors with this method enables better 3D PDF previews

Transformation Inspector

| | Query | Reorganize | Attributes | Simplify | Process |

Apply	AND/OR	RELATIONSHIP	TYPE	ATTRIBUTE	NOT	COMPARISON	SEARCH VALUE
		(	GD&T	Color		Equals	254, 254, 255
	or (		GD&T	Color		Equals	255, 255, 255
	or (		GD&T	Name		Contains	Nord
	or (		GD&T	Color		Equals	0, 0, 0
	or (		GD&T	Color		Equals	0, 255, 255

Conversion recipe – User defined metadata

	A	B
1	VERSION_GABARIT	2.00.2
2	LOGOAECOM	VRAI
3	PDF_POUR_SIGNATURE	VRAI
4	DIRECTION_HQ	
5	REMARQUE	PRÉLIMINAIRE
6	INSTALLATION	CENTRALE de la ROMAINE-4
7	TITRE_1	CANAL DE FUITE ET AIRE DE MANOEUVRE
8	TITRE_2	EXCAVATION ET CONSOLIDATION
9	DESCRIPTION_1	PLAN, COUPES ET DÉTAILS
10	DESCRIPTION_2	
11	MODELEUR	C. PRADO
12	VERIFIE_CAO	G. QUIRION/C. BOUTHOT
13	PREPARE	T. ADADI
14	VERIFIE	J.Y. DAOUST
15	REQUISITION_DE_TRAVAIL	QT717
16	DATE	2016-03-24
17	NO_INSTALLATION	6734
18	NO_CLASSE	70307
19	NO_SERIE	001
20	NO_FEUILLE	00
21	NO_REVISION	C
22	NO_EMETTEUR	OY
23	NO_FORMAT	9
24	NO_ETAPE	01
25	NO_UNITE_REQUERANTE	SM
26	NO_PLANCHE	
27	DATEREV	2016-07-07
28	FINALITEREV	ÉMIS POUR CONSTRUCTION R4-01-01 SCELLÉ ET SIGNÉ PAR: T. ADADI, ing. No 5029005 ET J.Y. DAOUST, géo. No 334
29	REFERENCE_CATIA	6734-6-0000-0000-CanFuiAirMan-EnContexte
30	ID_SMARTEAM_REV	CATPRD-00052757 REV F
31		

CARTOUCHE / NOTES / REFERENCES / REVISIONS

This Excel file is filled by the end user. It contains user defined metadata. During conversion, this excel file is translated to an xml file and the values are associated to text fields or use by the template's Java script to enable specific behaviors (enabling supplier logo, enabling signature fields...)
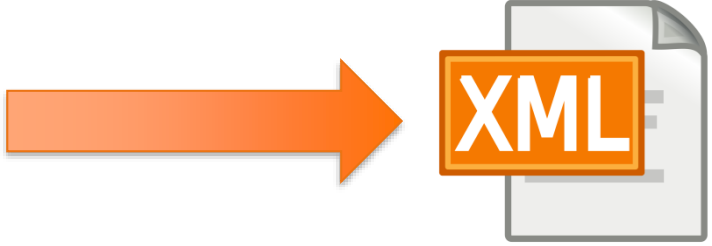
Workaround and limitations

- **Dark background vs white background** → We have to change the color of light color objects such as texts and wireframe (axis lines…) to black.

- **Wireframe line types** → A suffix is manually added to the CATIA objects. The suffix is catch by Java script to colorize the lines. Also, we have created CATIA power copies that mimics line types.

- **Transparency** → Not translated during conversion. We use a suffix that is catch by Java script to activate transparency in 3D PDF.

- **2nd section plane** → Also not supported in CATIA. We add a « white screen » plane with a suffix. Java script changes the rendering for this specific objet so it appears white.

- **Change identification** → Blue color is used for wireframe geometry and annotations, driven by suffix applied on CATIA objects.

Line types
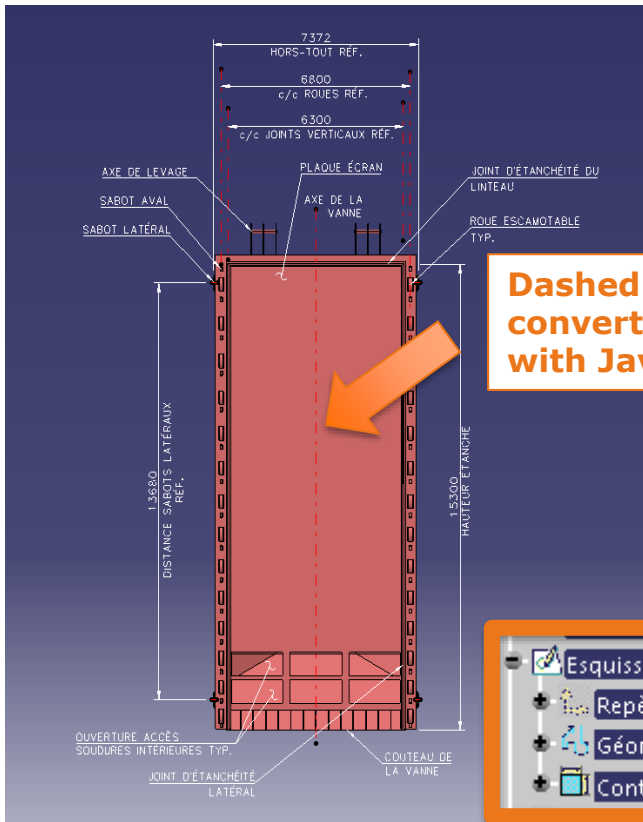
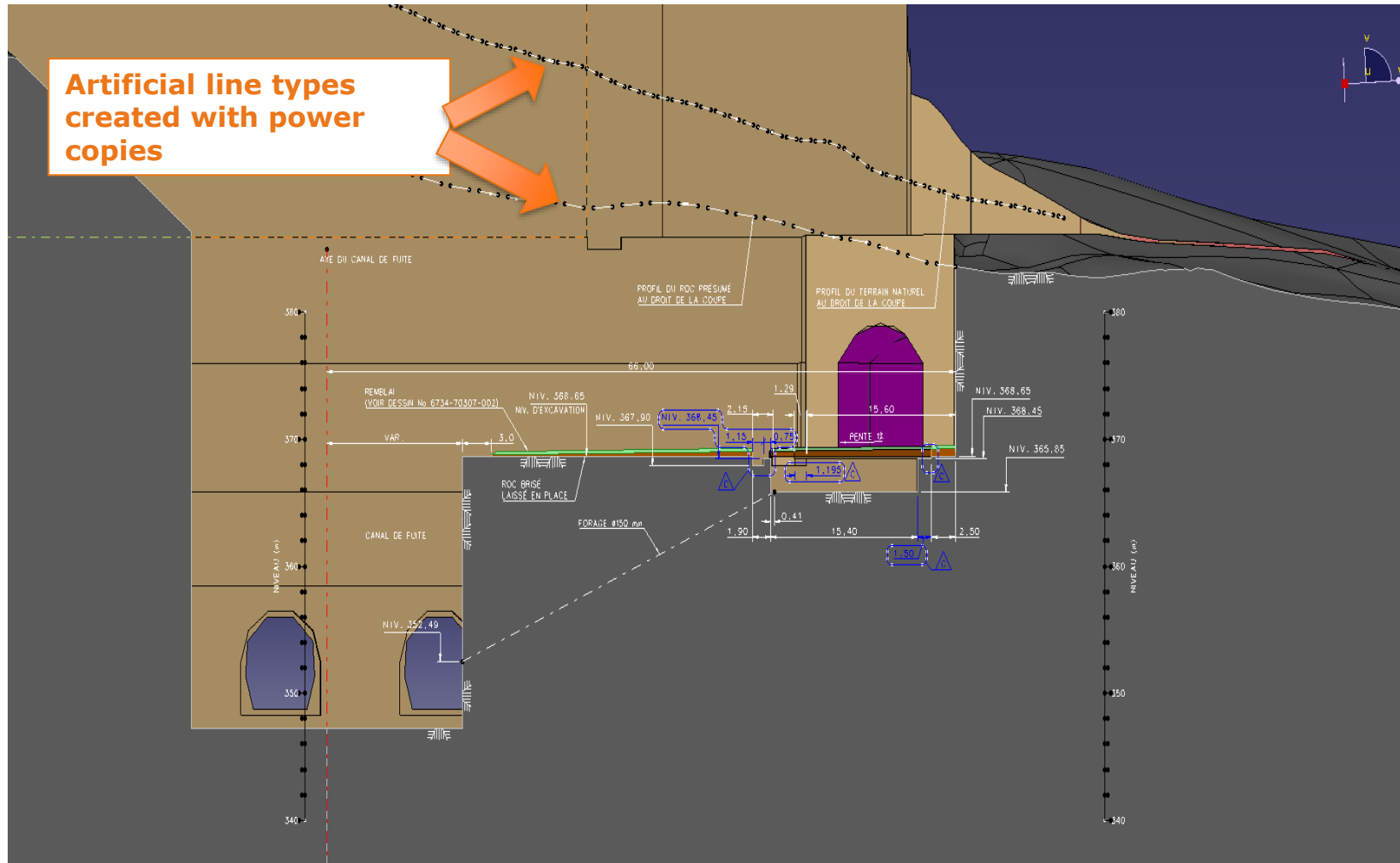**Dashed axis lines in CATIA are converted to solid red lines in 3D PDF with Java Script**
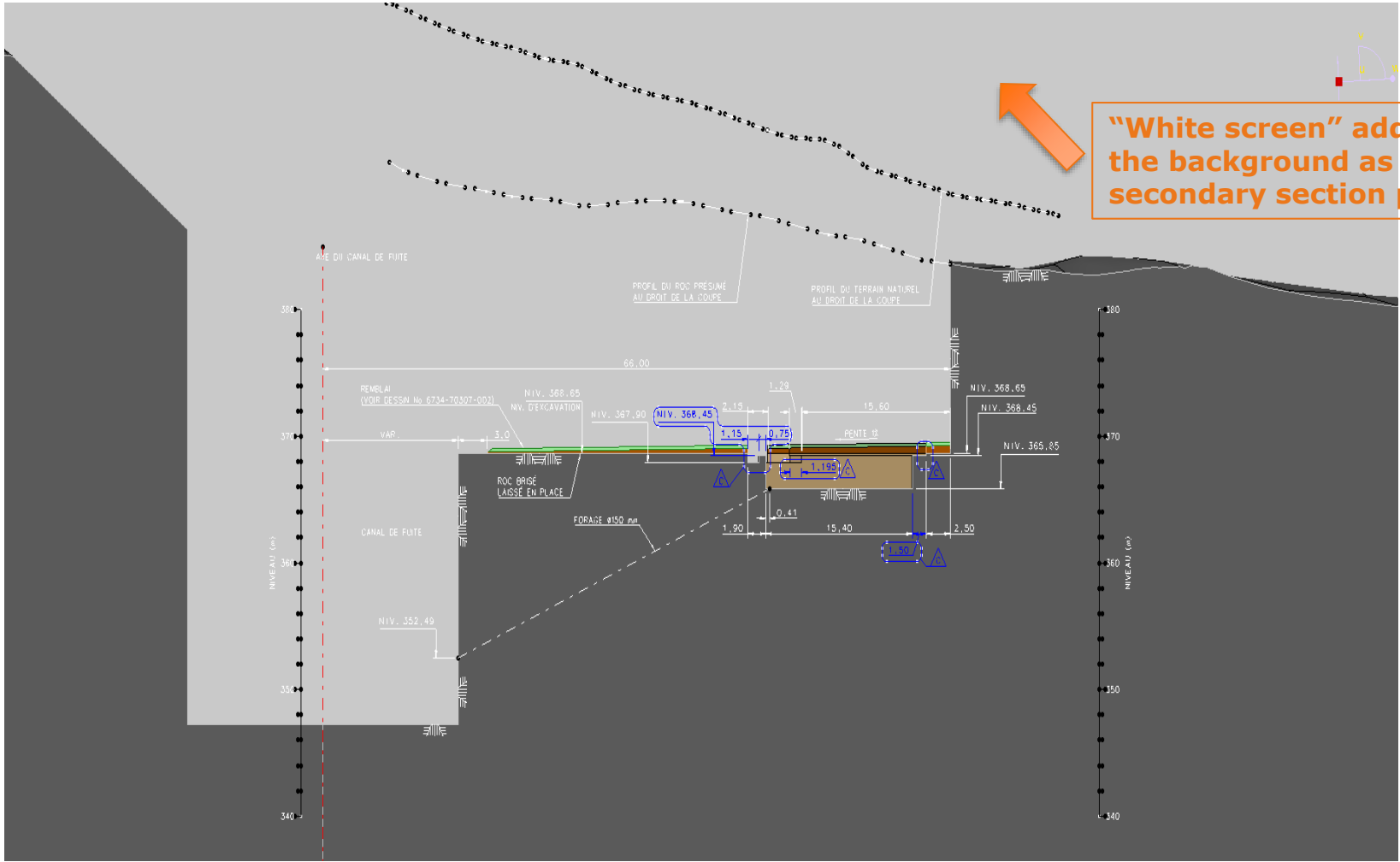
Suffix added to CATIA instance names
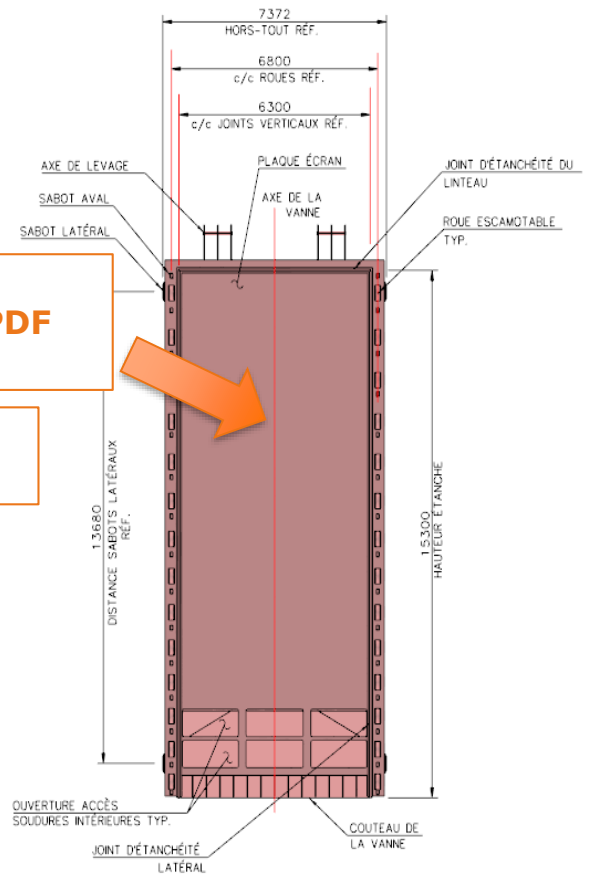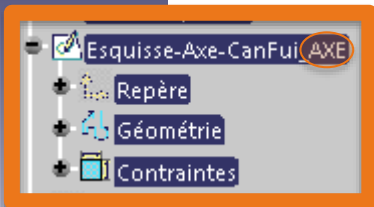
Line types and section planes
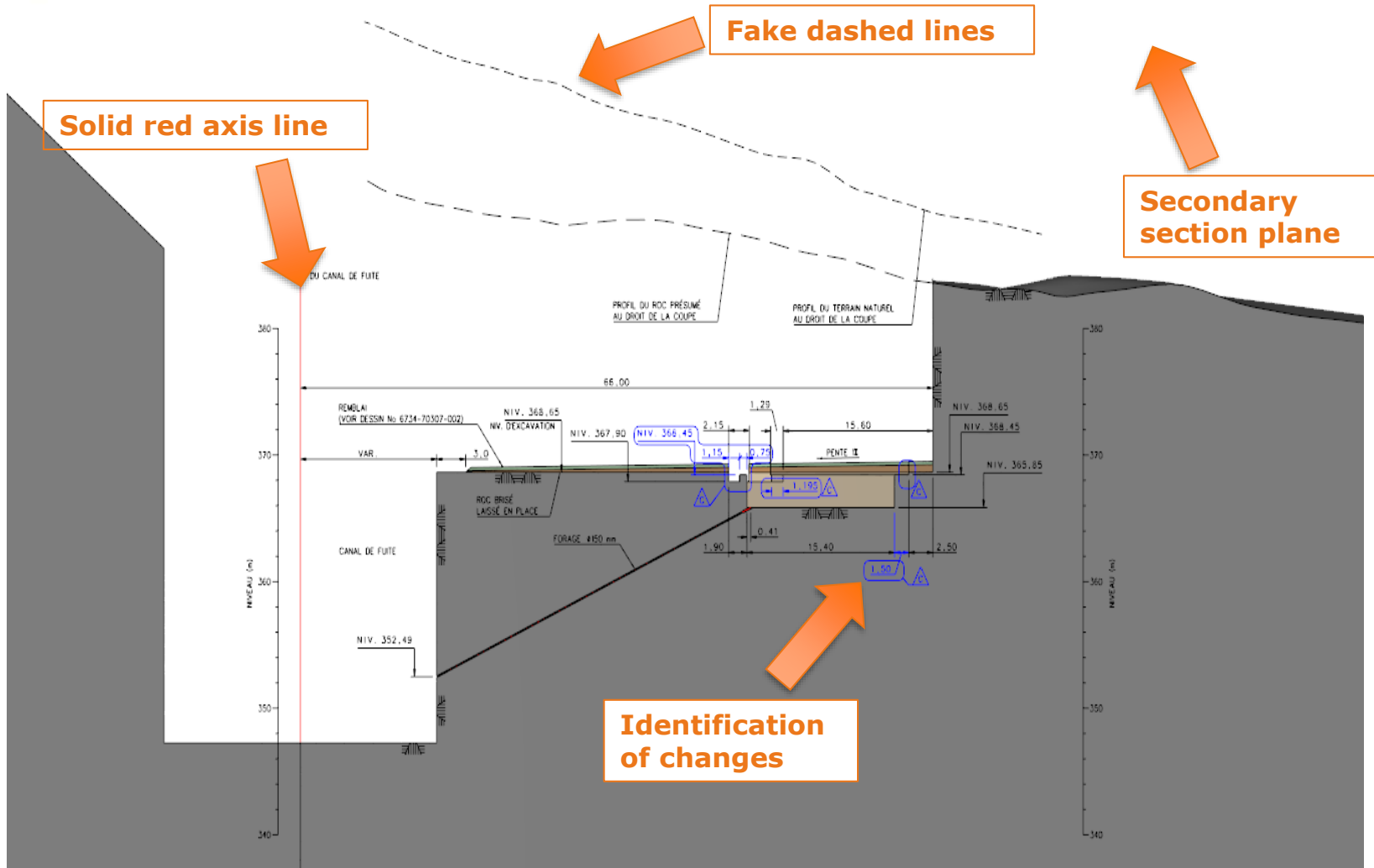

Artificial line types created with power copies

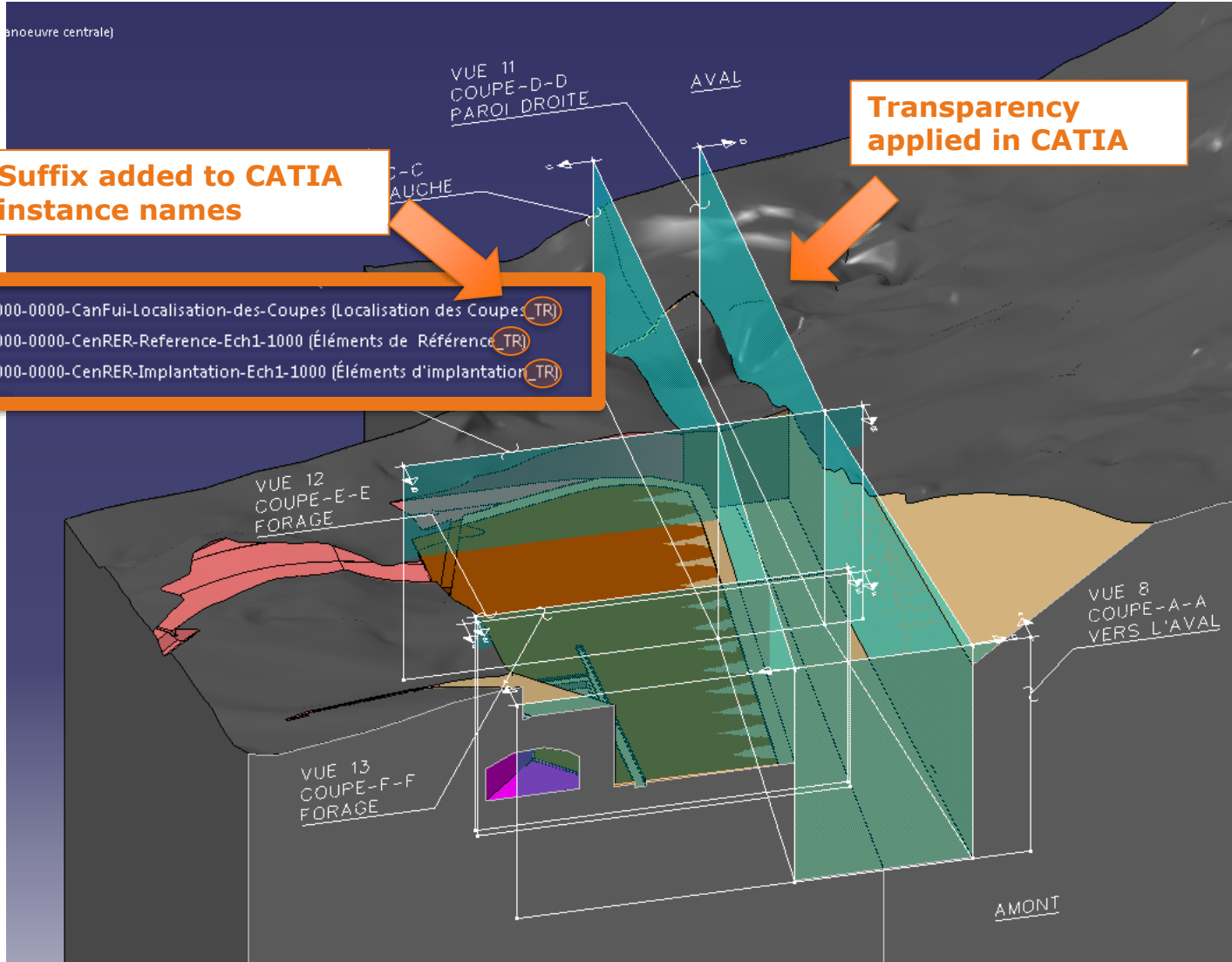"White screen" added to the background as a secondary section plane

Line types - result in 3D PDF

Transparency – in CATIA
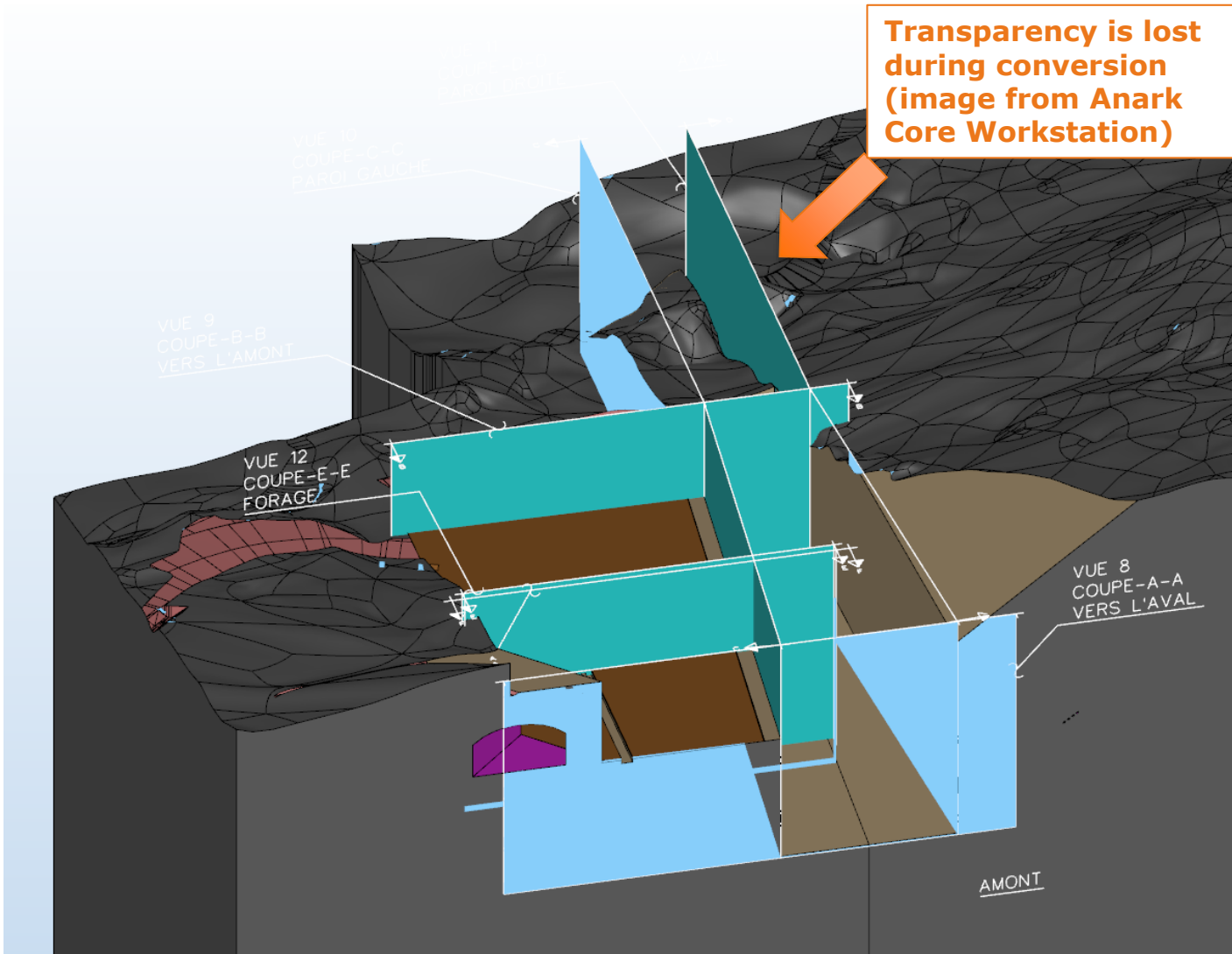

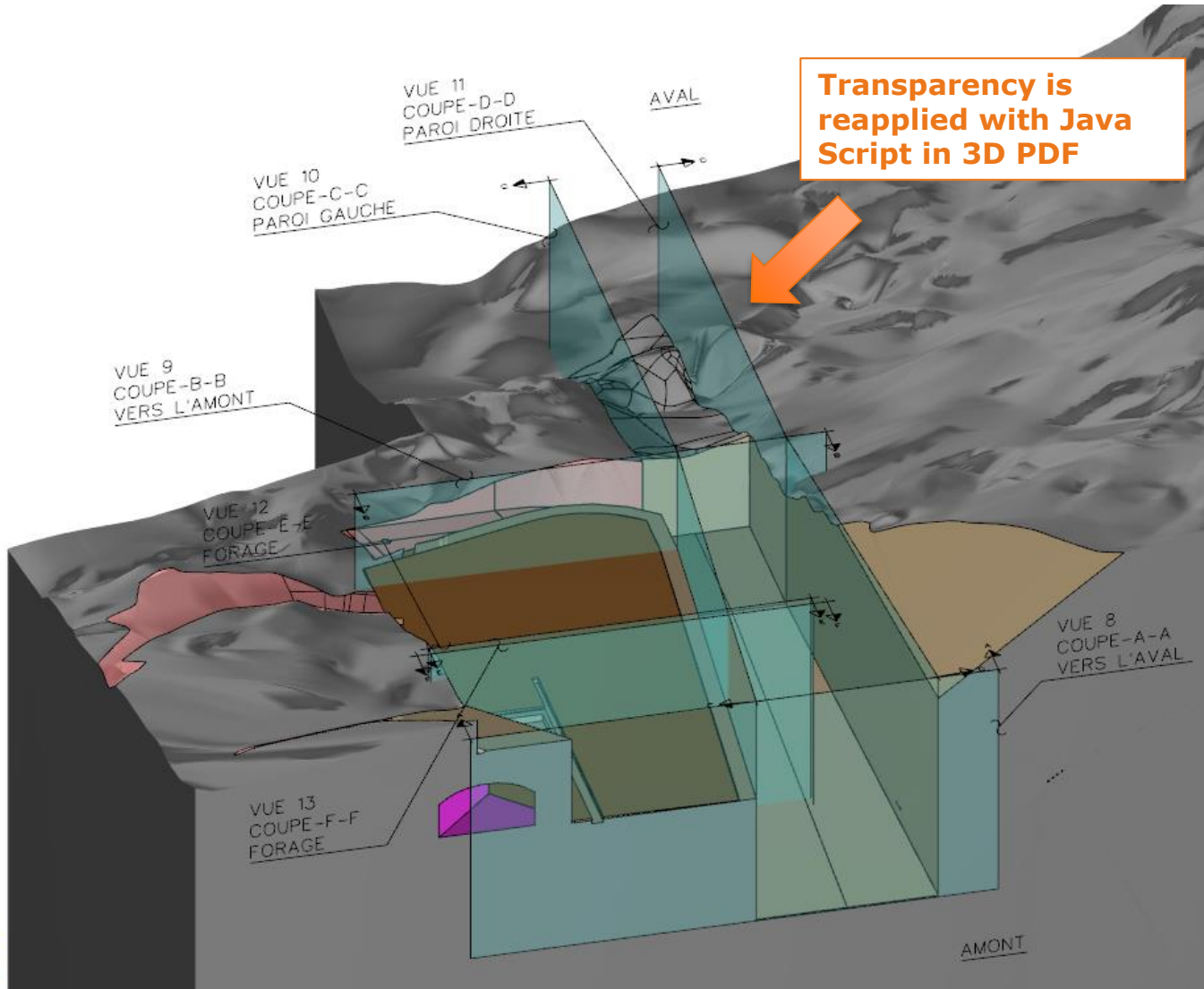**Suffix added to CATIA instance names**

Transparency applied in CATIA

Transparency – in ANARK Core Workstation

Transparency is lost during conversion (image from Anark Core Workstation)

Transparency – reapplied in 3D PDF

Transparency is reapplied with Java Script in 3D PDF

3D PDF Automation with Anark Core Server and ENOVIA SmarTeam

© Hydro-Québec

Ease of use - Methodology

- **33 pages documents**

- **Self-verification of 3D PDF prerequisites**

- **Less support given compared to the CATIA file based e-signature process.**

Post-mortem

- 2D Paradigm : A lot of the 3D captures are made to look exactly like 2D views (as they would appear on a 2D drawing)

- Lots of efforts required to implement the various workarounds, reduce the benefits

- Printing is much more important than anticipated

- Better acceptance and applies better to mechanical discipline

- Lots of improvements happened over a short period (1 year)

- Total conversion time improvement from 2 hours to 15-20 minutes

- No more manual intervention which often lead to conversion errors and extra validation time

- PDF paper size : it makes a difference

- Like any conversion process, it is not perfect