AU LONDON 2019

Abstract ID : AULON598

Bridging Mechanical Software and BIM: A Pumped-Storage Hydroelectric Plant in Morocco

Description: The project consists of a pumped-storage hydroelectric plant in Morocco (project value: 284 million euro). The water stored in an uphill tank will be released into a 3-kilometer transfer line (penstock and galleries) and travel on a natural slope to a reservoir about 550 meters downhill. A 350 MW hydroelectric plant will be built along the penstock between the upper and lower reservoir. The reversible plant will generate electricity when operating in turbine mode and pump water from the lower to the upper reservoir in pumping mode. Thus the system will generate renewable energy on demand and can be switched between pump and turbine mode up to 20 times a day, depending on the amount of surplus electricity available or the needs of the Moroccan electricity grid. This class will focus on the plant and the project BIM challenges and goals. I will explain the different actors, their scope of work, their tools, and their different software packages. I will also explain how this new way of working was implemented even if no actor has completed a BIM project before. The main obstacles of the project, concerning digital transformation and interoperability will be highlighted and explained. The class will review all experiments that have been done to achieve 2 main goals: allow a good model integration in the design software despite their differences and produce correct 2D drawings. The class will show how Revit can integrate mechanical files made by Siemens NX through .sat files and Inventor, and the best practices and ways to integrate the models correctly. It will also show the reverse way how the mechanical software can integrate Revit files. It will present a workflow to integrate all models into Navisworks through Revit to be able to do classic 3D coordination. The presentation will conclude with the main benefits of working with 3D models instead of 2D information even though the workflow is longer and more complicated sometimes.

Presenters:
Philippe Testard
Andreas Marschall
Nabil Nougha

AUTODESK. UNIVERSITY

AU LONDON 2019

Philippe Testard - Andreas Marschall – Nabil Nougha

AULON598 - Bridging Mechanical Software and BIM

A Pumped - Storage Hydroelectric Plant in Morocco

AUTODESK. UNIVERSITY

Agenda

- Presenters and Companies
- The Project
- BIM Implementation
- Interoperability
- Wrap-Up

Presenters and Companies

- The Project
- BIM Implementation
- Interoperability
- Wrap-Up

About the Speakers

Testard Philippe – BIM Manager
Vinci Construction Grands Projets

Marschall Andreas – BIM Manager
Andritz Hydro

Nabil Nougha – DSS Enterprise
Customer Success Organization

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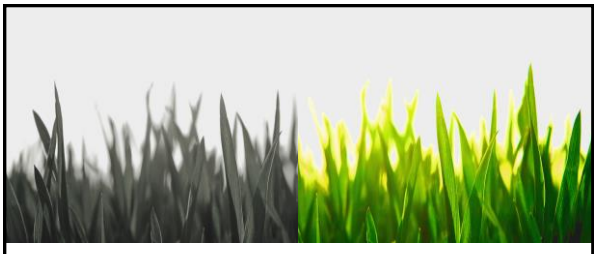


…the grass is **greener** on the **other side**…

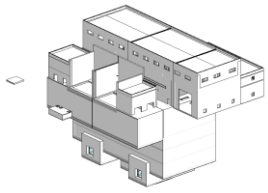
5

The grass is **greener** where **you water it**!

6

Civil

- Change of mindset (Sharing is Caring)
- Consideration of a lot of parameters instead of "Just 3D drawings"
- Increasing designer skills
- Formworks drawing the "french way"
- Precast/Rebars needs to be developed
- Sub-suppliers often not BIM compliant



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Andritz / Electromechanical

- Software, Software, Software!
- IFC classes not reflecting complete scope
- Silo mentality
- Concept design critical
- Long supply chain
- Cable routing not feasible in Revit
- O&M implementation
- Linking of external information
- Sub-suppliers often not BIM compliant

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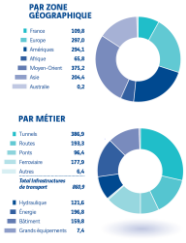
About Vinci

Key figures 2017 (including joint ventures)

- Revenue
  € 1,346.5 million
  (2018: € 1,060 million)
- Net income
  € 37.7 million = 2,8%
  (2018: € 34.8 million = 3,3%)
- Employees worldwide
  6,066 (January 31st 2019)
  391 expatriates
- Safety figures (January 31st 2019 12 months)
  Frequency rate 1,75
  Severity rate 0,07



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Company Situation - Vinci Construction Grands Projets

- **BIM Management experience:**
  - Santiago International Airport (Chile)
  - National Research Oncological Center (Kazakhstan)
  - Thames Tideway Tunnel (UK)
  - Etc, etc…
- **BIM Management department**
- **Structural office:**
  - Excellent in AutoCAD
  - Not experienced with Revit

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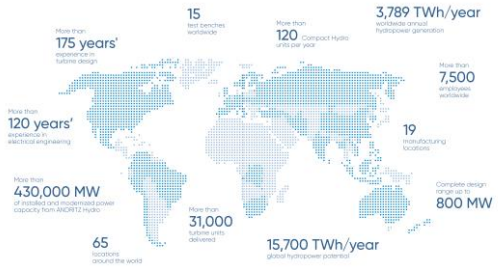
About Andritz



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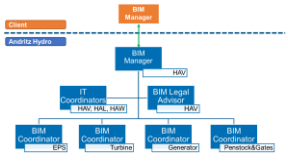
Company Situation – Andritz Hydro

- **BIM Experience**
  - Tender projects (Spain, Australia, China, UAE,…)
  - Rehab projects
  - Trainings and workshops
- **BIM Setup at Andritz Hydro**
  - Founded as R&D project end 2017
  - Internal standardization
  - COC BIM located in Vienna
  - BIM consulting and training
  - Support during tender stage (BEP/EIR)



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AUTODESK. Company Situation – Enterprise Priority Premium Support

24x7 for Severity 1

24x5 for Severity 2 & 3

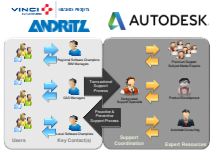
- 8 different support languages* (best effort), English is set as global language
- Around 170 Specialist working worldwidly

* English, Spanish, French, Italian, German, Japanese, Korean, Chinese 13

AUTODESK. Company Situation – Autodesk

Enterprise Priority Support – Customer Success Organization

- Primary point of contact with Autodesk Support Services Organization
- Manage Proactive Services
- Expedite Support Requests
- Manages Escalations
- End-users Support Enablement & Optimization
- Drive Shared-Goals Planning & Follow-Up
- Ensure Continuous Alignment



EBA Contract

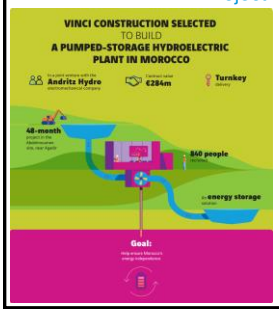
14

- Presenters and Companies

The Project

- BIM Implementation
- Interoperability
- Wrap-Up

Project Presentation



المكتب الوطني للكهرباء
Office National de l'Electricité

- **Client:**
  Office **N**ational de l'**E**lectricité et de l'**E**au Potable (**ONEE**)
- **Financing:**
  - 25 % African Bank of Development
  - 75 % European Investment Bank
- **Contract**:
  « Turnkey »

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Project Location

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Project Location

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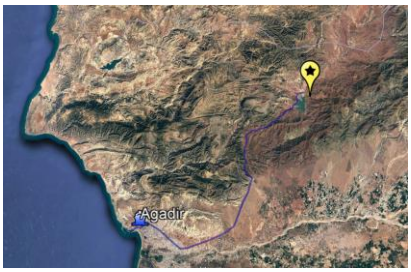
Project Location



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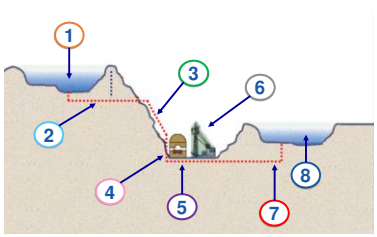
Project Location

20

Scope of Work



1. Upper Basin
2. Penstock Section 1
3. Penstock Section 2 (exposed)
4. Penstock Section 3
5. Powerstation
6. Switchyard
7. Penstock Section 4
8. Lower Basin

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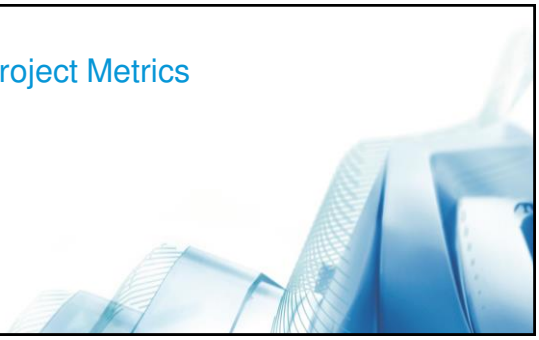
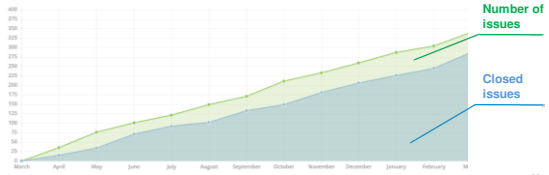
Project Metrics



Basic BIM Figures

- **Number of People Involved in BIM:**
  - VCGP Structural Office: **8**
  - VCGP Project Team: **~10** (currently)
  - Andritz: **~10**
  - MEP: **4**
  - Architectural: **2**



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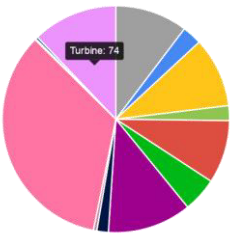
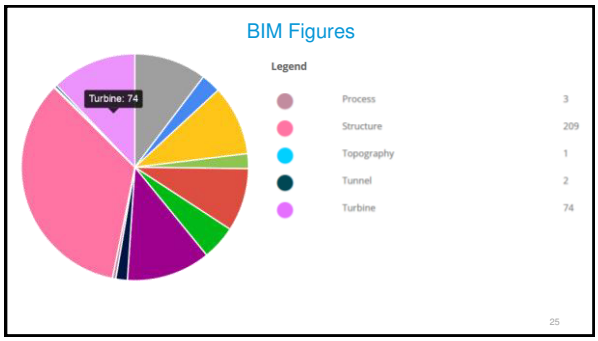
BIM Figures

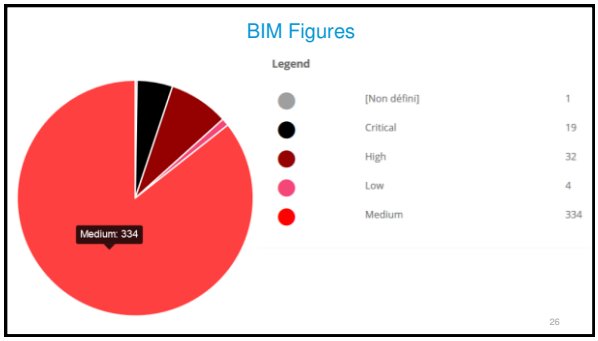


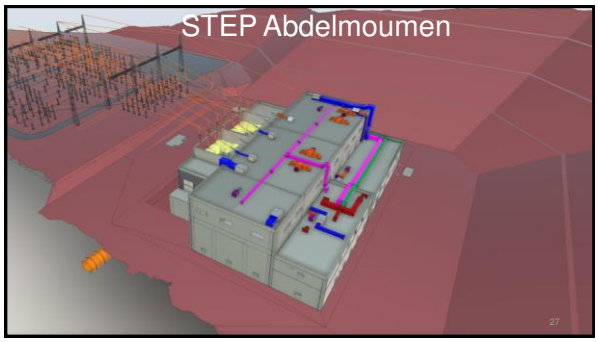
Legend

Architecture	63
BIM	17
Coordination	61
ELectric	13
EPS	55
Generator	30
HVAC	73
Penstock and Gate	10

24


BIM Figures
Legend
Turbine: 74
Process 3
Structure 209
Topography 1
Tunnel 2
Turbine 74
25


BIM Figures
Legend
Medium: 334
[Non défini] 1
Critical 19
High 32
Low 4
Medium 334
26


STEP Abdelmoumen
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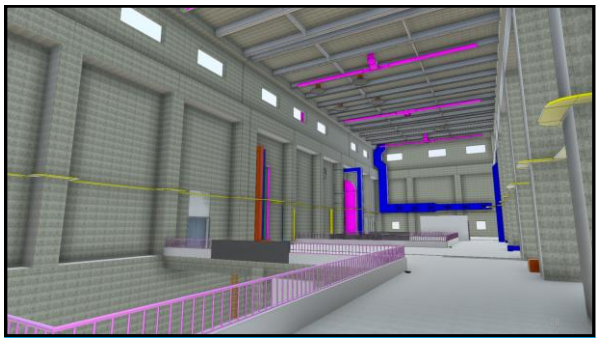
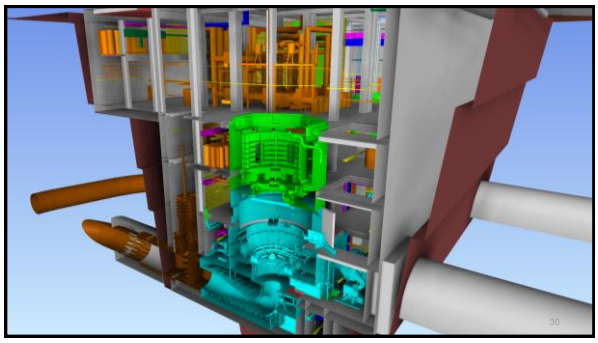
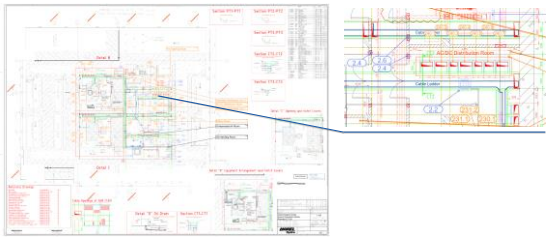




Why BIM?

3D Design is too Expensive…!



It's All About Planning!

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Office Locations/Global Collaborations

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Why Do BIM First?

- 2D Drawing Production
- Design Authoring
- Distant Coordination
- 3D Coordination

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Where Has BIM Been Used for?

- 2D Drawing Production
- Design Authoring
- Issue Tracking
- Distant Coordination
- 3D Coordination
- Quantity Take-off
- Communication
- Digital Transformation
- Training

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The Future of BIM?

- 2D Drawing Production
- Design Authoring
- Issue Tracking
- Augmented Reality
- Distant Coordination
- 3D Coordination
- Quantity Take-off
- Field Issue Tracking
- Communication
- Digital Transformation
- Training
- BIM Model Visualization

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What BIM 360 Has Been Designed for

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Main Challenges

How Did We Get There? Main Challenges

- Many Different Software Packages
- Information Exchange
- Software Limitations
- First BIM Project for a Lot of Actors

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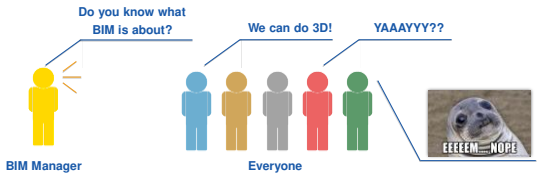
- Presenters and Companies
- The Project

BIM Implementation

- Interoperability
- Wrap-Up

BIM Implementation: Everyday Hurdles



A Lot of Communication / Explanations / Trainings Needed

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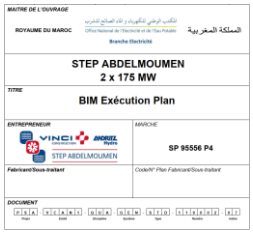
BIM Implementation



BIM Execution Plan (BEP)

- Coordination
- Responsibilities
- Shared Coordinates
- Guidelines
- Naming Conventions

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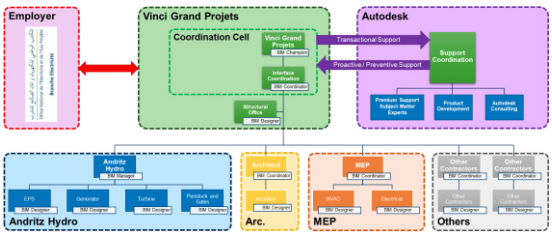
Coordination Team



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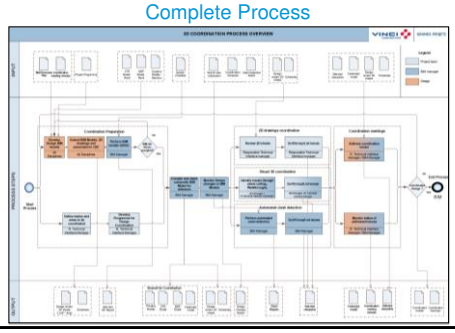
It's About the Quality!

Complete Process



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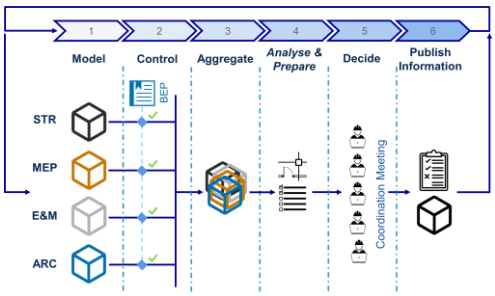
Simplified Process



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Quality Control

1. **Georeferencing:** Coordinates + Orientation
2. **Worksets**
3. **Name of Elements, Grids & Levels**
4. **Units**
5. **Correct Categories of Elements**
6. **Materials**
7. **Warnings**
8. **Project Browser**
9. **Exports**
10. **Links**

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Quality Control Checklist

SYSTEM MODELS			
Items to verify		Evaluation: Bad / No - Rejected / Good / Yes - Accepted	Remarks
General	Metric system	Yes	
	All items in English	Yes	Check all model for element types
	View organization (project browser)	Yes	Make difference between WIP AND DEVENABLES
	Project information	Yes	Refer to BIM Execution Plan for Naming Convention
	Project base point / Survey point	Yes	Reference base point and check all models to align in the same poi
	Purged (Y/N)	Yes	
	Detail level	Yes	Refer to BEP and LOD
Accuracy	Number of warnings	Yes	Check importance. Major warnings shall be resolved
Workset	Utilization of Worksets as defined in BIM implementation plan	Yes	Check if elements are in the correct workset
	Workset usages defined in BIM implementation plan	Yes	
Levelgrid	Naming quality	Yes	Check name convention
	Reference STR. (structural slab level) only		
Project Material	Detail level of graphic presentation	Yes	
	Purged all unused materials	Yes	Kick ids corrupted file, slowing performance, etc
Naviswork export	.nwc file format (Y/N)	Yes	
Family general	Utilization of proper family category for each design element	Yes	

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Model Evaluation Sheet

Num	Objet	Remarques / Recommandations	Statut	Classe	Visuel
2.3	Unités	Ok	Conforme		
2.4	Paramètres Projet	Ok	Conforme		
2.5	Coordonnées et partage	Ok			
2.6	(Pts Extra, Pt Topo)	Ok			
2.8	Navigation / Manipulation	Ok			
3	ORGANISATION DU FICHIER				
3.1	Organisation Arborescence (Plans, Environnements bureau,...)		Non conforme	Mineur	
3.2	Organisation en Sous-Projets	Avons nous projet. Il est demandé d'organiser nous projets somoles tels : - FRA_Réseaux partagés et publics - FRA_Plans (DWG) - FRA_Liste (DWG) - FRA_Structure - FRA_Archi.rvt	Non conforme	Critique	
3.3	Organisation des feuilles (Plans, Environnements bureau,...)				
3.4	Légendes				
4	STRUCTURATION DU MODELE				
4.1	Modélisation	Différence entre modèle	Non conforme	Mineur	
4.2	Niveaux	Tous les niveaux ne "disque de bâtiments". Unités fonds canal et modèle à discuter. Niveau 0 Plan existe ?? Pas plus pas succès. Manque des vrai "Site" pour le gland Nivellement. Niveau non nécessaire	Non conforme	Mineur	
4.3	Zones de référence				
4.4	Points de référence	Eventuellement de plus de référence non nommés. UNRC ? Ne doit pas apparaître sur des plans	Non conforme	Mineur	
4.5	Types de Vues	ok	Conforme		
4.6	Types de Cotation	ok	Conforme		
5	ORGANISATION DE LA DONNEE				
5.1	Paramètres Partagés requis (Plans, Cotations, Boxes,...)	Faire un tri	Conforme		
5.3	Matériaux (Caractéristiques)	Matériau du voisinage et modèle géologique à mettre en paramètre partagé pour l'avoir en nomenclature et non en commentaire. Matériaux absent pour les hachures. Matériau courbe ?	Non conforme	Mineur	

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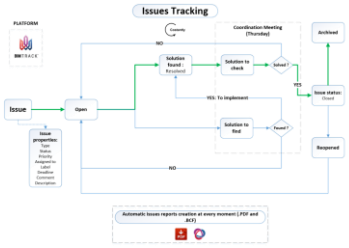
Issue Tracking Platform (BIMTrack®)



Goal:

- Create and follow-up issues
- Traceability of issues
- Coordination KPI's
- Live reporting
- Cloud based solution
- BCF server

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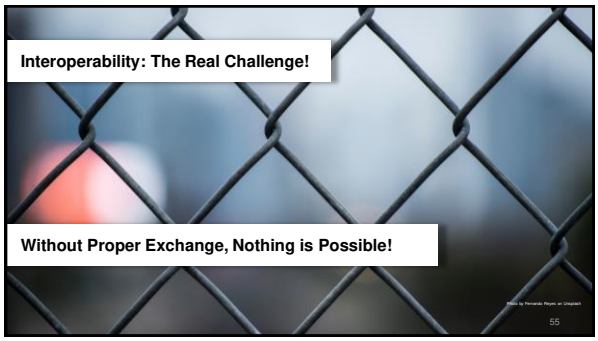
- Presenters and Companies
- The Project
- BIM Implementation

Interoperability

- Wrap-Up

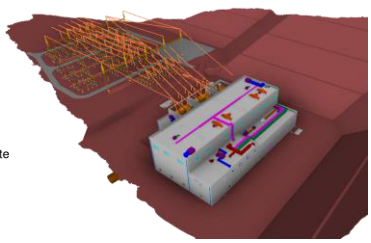


The Federated Model

Creating a Federated Model

Challenges:

- Software compatibility
- Geolocation
- Integration of Issue Management Platform
- File size
- Offline availability for site
- Viewing performance



Model Organisation

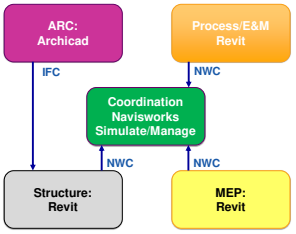
VGCP
Andritz
MEP
Architecture

Integration of Models from Andritz

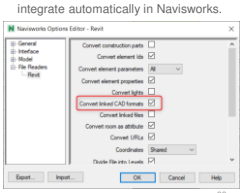
Challenge: Mechanical software not capable of geolocation, limited IFC functionality.

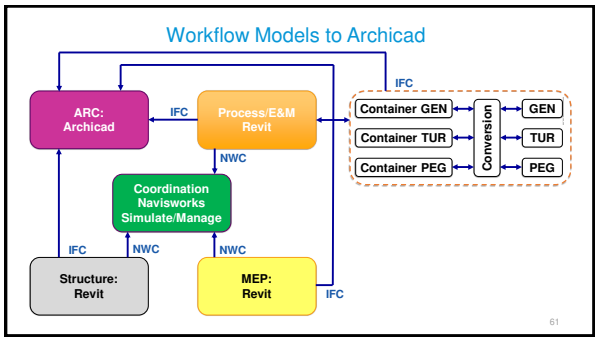
Structure			Denomination
Scope	Level 1	Model Package Name	Description
GEN	01	GEN-01	Generator (all components in the generator pit incl. brush holder bracket and slip ring cover)
GEN	02	GEN-02	Cutting water piping, required space: 2x piping appr. DN300
GEN	03	GEN-03	Oil piping for upper combined bearing incl. oil plant
GEN	04	GEN-04	Oil piping for lower guide bearing incl. oil plant
GEN	05	GEN-05	Carbon dust exhaust
GEN	06	GEN-06	Oil dust exhaust upper combined bearing
GEN	07	GEN-07	Oil dust exhaust lower guide bearing
GEN	08	GEN-08	Compressed air tank
GEN	09	GEN-09	Mobile lifting plant
GEN	10	GEN-10	Generator Openings
GEN	11	GEN-11	Generator Foundation
GEN	12	GEN-12	Generator Terminal Boxes
GEN	13	GEN-13	Generator Brake Piping
GEN	14	GEN-14	Openings Barrier Machine Hall Floor
GEN	15	GEN-15	Drainage Generator Pit
TUR	01	TUR-01	Spiral Case and Stay Ring
TUR	02	TUR-02	Draft Tube
TUR	03	TUR-03	Pit Liner
TUR	04	TUR-04	Hydraulic Governor and Accumulators
TUR	05	TUR-05	Turbine Speed Governor
TUR	06	TUR-06	Main Inlet Valve (MIV)
TUR	07	TUR-07	Foundation Modification Spiral Case
TUR	08	TUR-08	Foundation Modification Turbine Pit
TUR	09	TUR-09	Openings Level Generator Cover
TUR	10	TUR-10	Openings Level Generator Entrance
TUR	11	TUR-11	Openings Level Turbine Entrance
TUR	12	TUR-12	Openings Level Spiral Case
TUR	13	TUR-13	Openings Level Turbine Sump

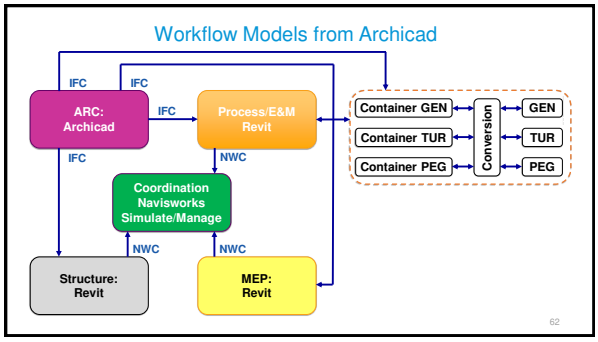
Workflow: Importing the Architectural Model in Navisworks

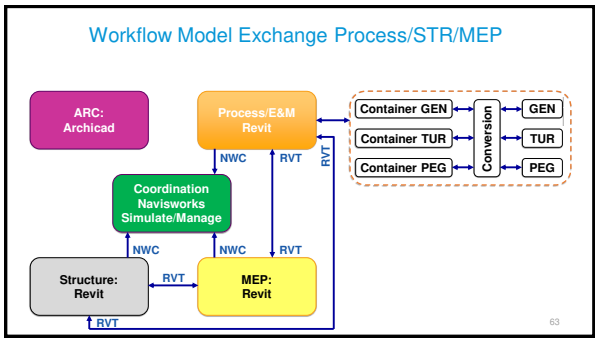


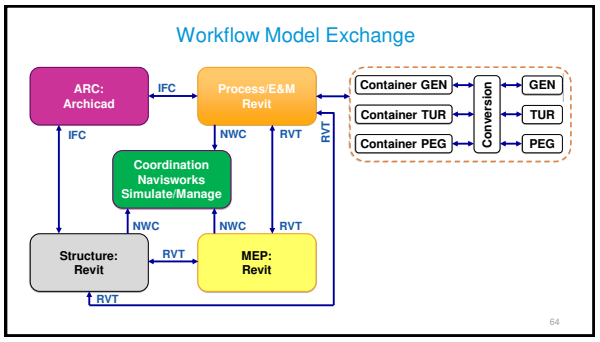
- **TIP:** use a georeferenced Revit file to export to NWC and integrate automatically in Navisworks.



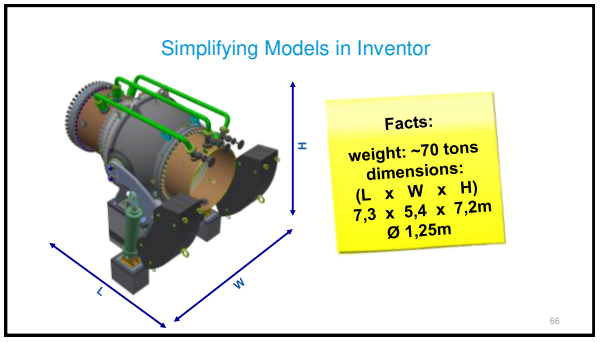

Workflow Models to Archicad
ARC:
Archicad
IFC
Process/E&M
Revit
IFC
Container GEN
Container TUR
Container PEG
Conversion
GEN
TUR
PEG
NWC
Coordination
Navisworks
Simulate/Manage
IFC
NWC
NWC
Structure:
Revit
MEP:
Revit
IFC
61


Workflow Models from Archicad
IFC
IFC
ARC:
Archicad
IFC
Process/E&M
Revit
Container GEN
Container TUR
Container PEG
Conversion
GEN
TUR
PEG
IFC
NWC
Coordination
Navisworks
Simulate/Manage
NWC
NWC
Structure:
Revit
MEP:
Revit
62

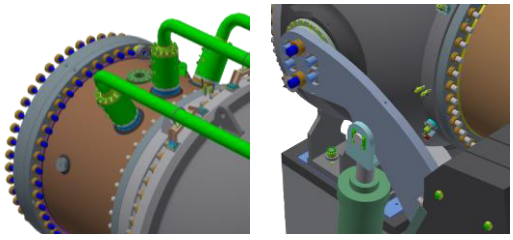

Workflow Model Exchange Process/STR/MEP
ARC:
Archicad
Process/E&M
Revit
Container GEN
Container TUR
Container PEG
Conversion
GEN
TUR
PEG
NWC
RVT
RVT
Coordination
Navisworks
Simulate/Manage
NWC
NWC
RVT
Structure:
Revit
RVT
MEP:
Revit
RVT
63


Workflow Model Exchange
ARC: Archicad
IFC
Process/E&M Revit
Container GEN
Container TUR
Container PEG
Conversion
GEN
TUR
PEG
IFC
NWC
RVT
RVT
Coordination Navisworks Simulate/Manage
NWC
NWC
RVT
Structure: Revit
RVT
MEP: Revit
RVT
64

Simplifying Models


Simplifying Models in Inventor
H
L
W
Facts:
weight: ~70 tons
dimensions:
(L x W x H)
7,3 x 5,4 x 7,2m
Ø 1,25m
66

Details to be Removed



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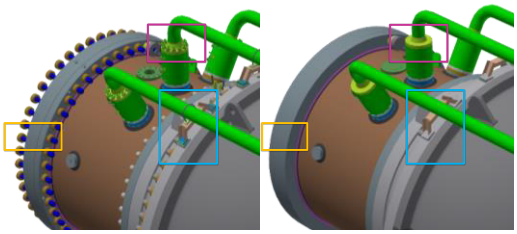
Visual Comparison



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Simplifying Models in Inventor

IMPORT .X_T IN INVENTOR

Import components to **assemblies** to be able to use **design views** and **level of detail** representations.

SUPPRESS COMPONENTS

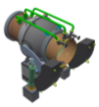
Manually suppress components that will not be selected automatically. Such as **welds**, handles of valves and **unnecessary big parts**.

SHRINKWRAP

Apply **automatic simplification** and **check content** of simplified component by clicking "preview" button.

EXPORT TO .SAT

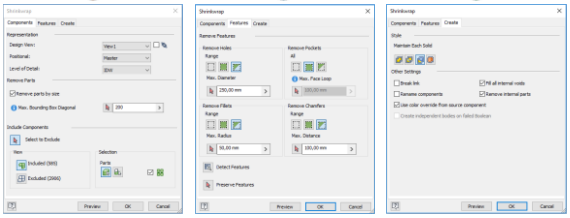
Save simplified part **and export** to .sat format.



69

Shrinkwrap it!

1 2 3



70

File Size Comparison

13%!

30 MB

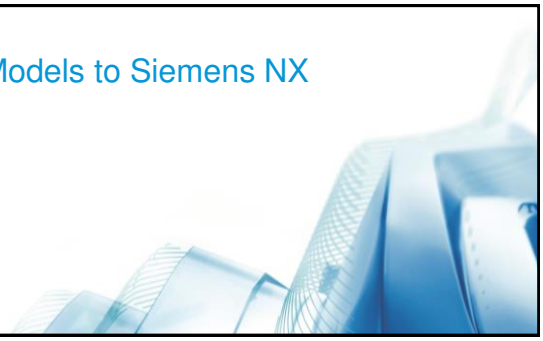
230 MB

Simplified Component

Original Version

71

Models to Siemens NX



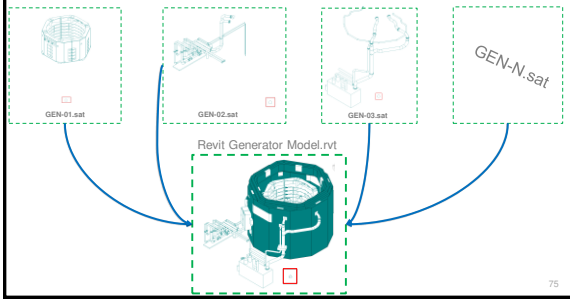
Bringing Back Information to Siemens NX

Open model in **Revit** → Export to **.sat** → **Open** .sat in **Inventor** and **export to JT** → **Import** .jt file in **Siemens NX** → **Save** imported model

73

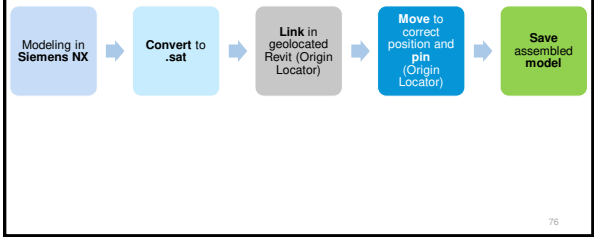
Linking Models

Andritz Model: PSA-VCAN7-GEN-ALT-MAQ-100003



75

Andritz Model: PSA-VCAN7-GEN-ALT-MAQ-100003



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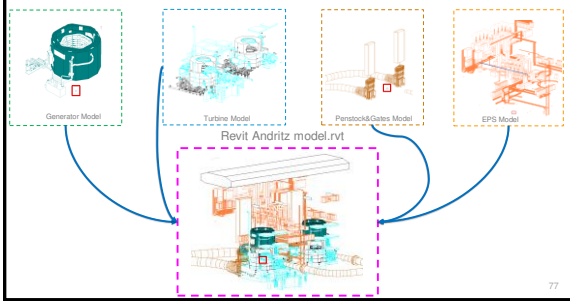
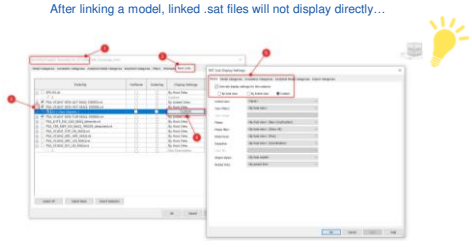
Andritz Models: Overview



77

Revit Tips and Tricks

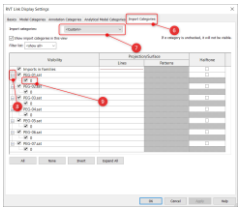
After linking a model, linked .sat files will not display directly…



78

Revit Tips and tricks

Tip: Create view templates to apply these parameters to all views.



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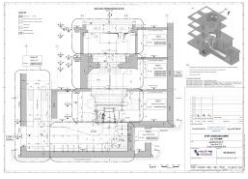
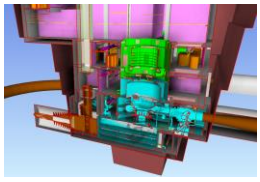
The Way to Wisdom…

2D Drawings Compared to BIM Models



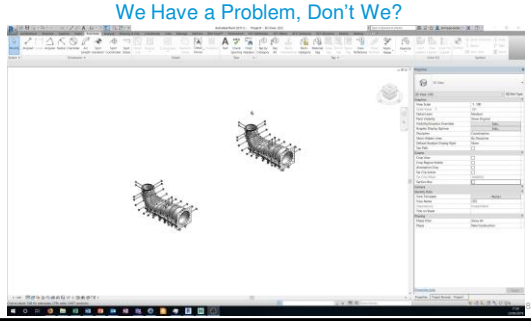
- On site = used during erection
- Dedicated purpose
- Contains limited amount of information



- Various use-cases (site, coordination,…)
- One model for all systems
- Covers all information (can be hard to find)

81

We Have a Problem, Don't We?



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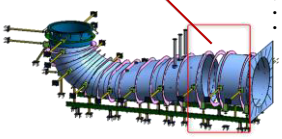
1. Inserting in Generic Families or Mass Families: Process

Create a new metric **generic model** template → Insert .sat

84

1. Inserting in Generic or Mass Families

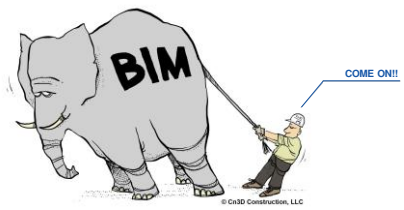


Advantages	Disadvantages
• Native Revit file • View plan sectioning • Upper plan sectioning • Section plan sectioning	• **Missing geometry** • No automatic placement in models • Requires family management • Generic families (filter to handle visibility of elements needed)

** Case 14274218*

85

After Months of Research…



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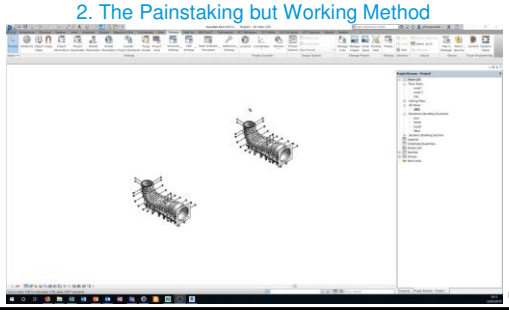
2. The Painstaking but Working Method

Load container file with linked .sat files → **Export 3D dwg** file from a **3D view** containing **elements to be included**. → **Create** a new **generic model** family → **Insert 3D dwg « origin to origin »** → **Load family** into the model → **Adjust view** settings and create templates and worksets

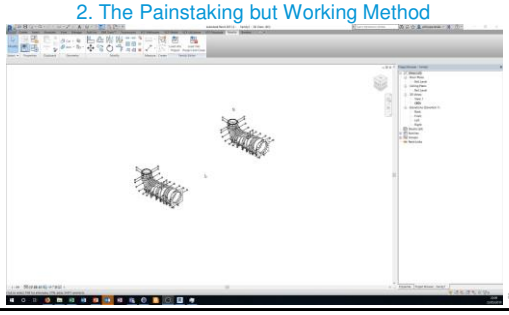
87

2. The Painstaking but Working Method



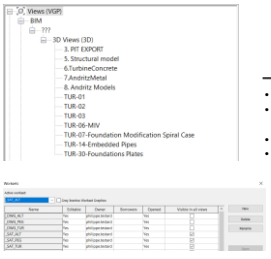
88

2. The Painstaking but Working Method



89

2. The Painstaking but Working Method



Advantages	Disadvantages
• View plan sectioning • Section plan sectioning • Upper plan sectioning • No more missing Elements	• File extremely heavy and slow • Exporting may crash the computers • Requires huge model organization • No automatic placement in models Very time consuming

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3. Create In-Place Generic Models and Link the .sat File!

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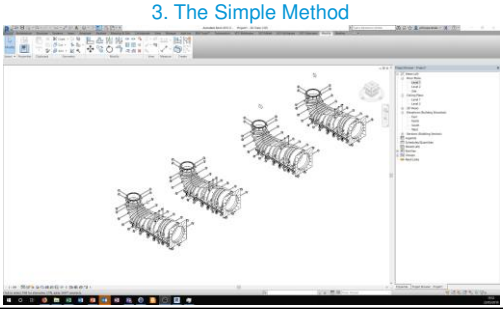
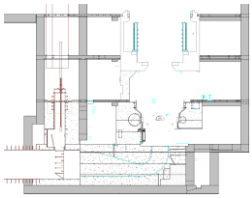
3. The Simple Method



93

3. The Simple Method



Advantages	Disadvantages
• View plan sectioning • Upper plan sectioning • Section plan sectioning • Automatic placement for others actors	• Limited classification (no mechanical equipment for example) • In-place models

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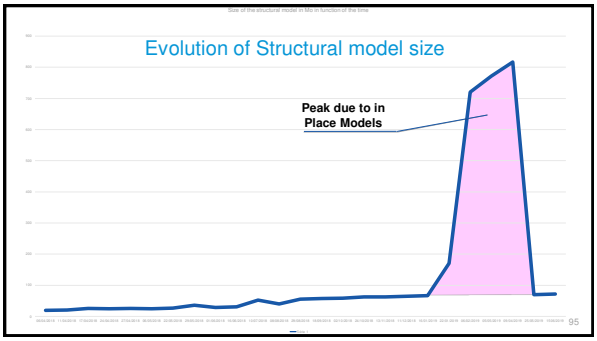
Evolution of Structural model size



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Contribution of Autodesk EPS

Help Summary from Autodesk Premium Support

	Case #	Subject	Case Category	Comment	Defect #
1	14474[illegible]	Nesting files .sat	Intersys	Limitation - enhancement request to ideatation	No
2	14470[illegible]	Unable to print A3 correctly	Printing	Solved	No
3	14475040	Aligner des labels	Annotation	Limitation - enhancement request to ideatation	No
4	14[illegible]	Export DWG en cassant les elements pas Workset	Intersys	Workaround found by philippe	No
5	14[illegible]	Ensure coupe sur plan	Annotation	Solved	No
6	14[illegible]	Probleme affichage zoom	Annotation	Solved	No
7	14[illegible]	Affichage des décalages	Annotation	Solved	No
8	14474897	Sortie de dalles Revit	Annotation	Limitation - enhancement request to ideatation	No
9	14476[illegible]	Question alignage ne fonctionnait pas toujours	Revit Core	Limitation - Workaround provided by Dev	REVIT-126169
10	14[illegible]	Epaisseur des murs	Revit Core	Enhancement request - As designed	No
11	14[illegible]	Gestion des impacts Revit	Line Rep/Revit Core	Enhancement request - As designed	No
12	14[illegible]	Mauvaise jonction des éléments	Line Rep/Revit Core	Solved	No
13	14[illegible]	Ligne symbolique de rotation	Annotation	Solved	No
14	14[illegible]	Etiquette de dalle	Annotation	Solved	No
15	14[illegible]	Symbole d'annotation trèfle en coupe	Annotation	Limitation	No
16	14[illegible]	Vides de lignes ne sortent pas correctement	Annex representation	Solved	No
17	14[illegible]	Masquer parties du quadrillage ponctuellement à une vue	Graphical	Workaround: hide a portion of a grid	No
18	14[illegible]	Lignes n'apparaissent pas	Annex representation	Enhancement request - As designed	No
19	14[illegible]	DWG Hl'enhancer for Revit 2018	Intersys	Issue has been reported to Plugin Development Team	No
20	14[illegible]	Problème trait parasite famille réservation face based	Line representation	Enhancement request - As designed	No
21	14[illegible]	Affichage réservation	Line representation	Enhancement request - As designed	No
22	14[illegible]	Problème d'impression PDF Revit	Printing	Fix Planned for 2021	REVIT-[illegible]
23	14[illegible]	Lines disappear when printing in PDF	Printing	Fix Planned for 2021	REVIT-143120
24	14[illegible]	Duplication trafic elevation et cote	Annotation	Fix Planned for 2020	REVIT-137726
25	14[illegible]	Important error while copying some annotation or mirroring them	Annotation	Fix planned for 2021	REVIT-142598
26	14[illegible]	Import dwg 2019	Intersys	Solved with 2018.2.1	REVIT-134197
27	14[illegible]	Impossibility to cut a family from an autocad file into a structural view too	Revit Core	Not reproducible	No
28	14[illegible]	Non compréhension de l'affichage des éléments	Annex representation	Seth's Workaround	No
29	14[illegible]	Refranchissement PLan	Revit Core	On hold (not reoccuring again)	No
30	14[illegible]	Affichage des escaliers en plancher haut	Line Rep/Revit Core	Logged for Revit 2020	REVIT-[illegible]
31	14[illegible]	Impression en wireframe ne fonctionnant pas correctement ?	Printing	As Designed	REVIT-[illegible]
32	1522[illegible]	Export DWG issues with special elements	Intersys	Ongoing resolution through potential Fix Plan	REVIT-[illegible]
33	1513[illegible]	Sectioning behavior different between collegueues	Line Rep/Revit Core	Solved	No
34	1530[illegible]	Scinder les coordonnées GPS ou dans le système Lambert	Revit Core	Solution found by Philippe	No

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EPS Services Metrics
Around 40 Treated Cases with VCGP

13	8	9	6
DIRECT SOLUTION	CONVERTED TO ENHANCEMENT REQUESTS	ESCALATION CONFIRMED BY DEVELOPMENT TEAM	FIXES PLANNED
13 direct solutions provided within the existing feature or through a simple workaround	8 cases redirected to idea station for future enhancement of Revit in such used cases	9 escalation to development team confirmed, including with or without fixes planned	6 corrections planned for the project release of Revit and other to latest ones (2019, 20, 21)

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Used Software

AUTODESK® INVENTOR®

PLM Software SIEMENS NX

NAVISWORKS

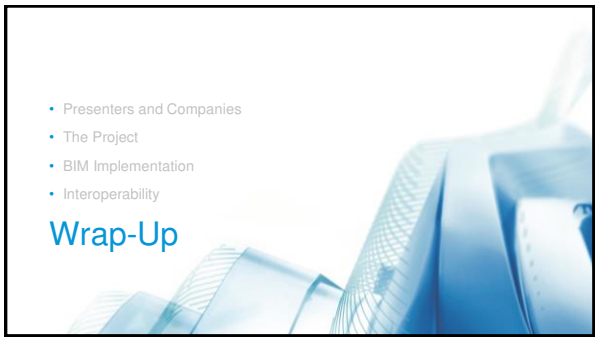
AUTODESK REVIT

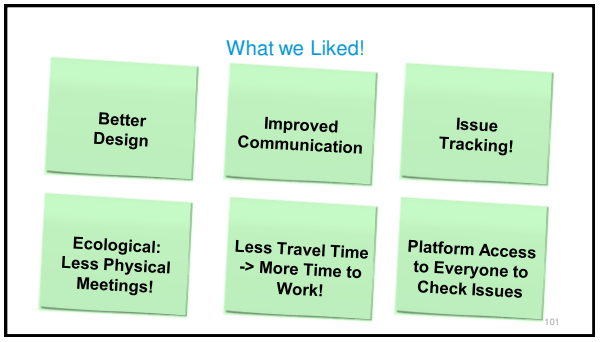
ARCHICAD

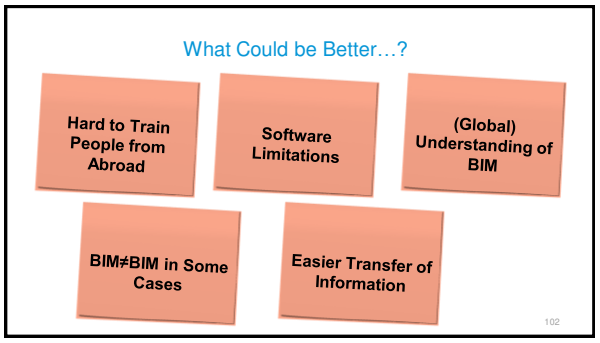
eproject

BIMTRACK

99


• Presenters and Companies
• The Project
• BIM Implementation
• Interoperability
Wrap-Up


What we Liked!
Better Design
Improved Communication
Issue Tracking!
Ecological: Less Physical Meetings!
Less Travel Time -> More Time to Work!
Platform Access to Everyone to Check Issues
101


What Could be Better…?
Hard to Train People from Abroad
Software Limitations
(Global) Understanding of BIM
BIM≠BIM in Some Cases
Easier Transfer of Information
102

What Do We Need to be Successful?

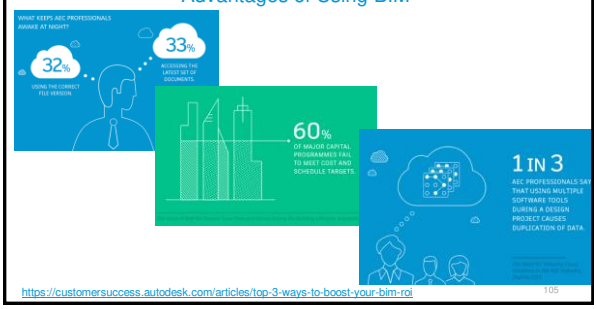
- Time, Energy and Proper Funding
- A Technical BIM Champion!
- Support from the Management!
- Supporting Partners

103

Next Step on Similar Projects:
→ Using BIM 360 Design Solution

104

Advantages of Using BIM



https://customersuccess.autodesk.com/articles/top-3-ways-to-boost-your-bim-roi

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Let's **water** the **grass** **together**!

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Questions ?

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