Computational modeling linear structures with Civil 3D, Revit & Dynamo CivilConnection Package

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Michel Beliën
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Parametric Design
Civil 3D (BIM) specialist
Royal HaskoningDHV in the World
Consultancy, Engineering & Project Management

Workforce of 6,500 in more than 150 countries
One of the top independently owned engineering companies
Audience?

Engineers
ICT
Management
Applications; Civil 3D, Revit, Dynamo

Attendees
- Australia
- Brazil
- Canada
- China
- Colombia
- Czech Republic
- Ecuador
- Finland
- France
- Germany
- Italy
- Japan
- Malaysia
- Netherlands
- Russian Federation
- Singapore
- Sweden
- United Arab Emirates
- United Kingdom
- United States
IR. JACOB VAN BRUGGEN (BRIDGES), THE MAASTUNNEL DESIGNER
Ir. J.P. As a civil engineer, van Bruggen was the designer of the Maas tunnel. The engineer from Groningen came to work in 1924 at the age of 28 in the Public Works department where he quickly made a career. In 1927 he was already personally involved in the improvement of the old Willemsbrug.

NEVER USED TECHNIQUES
In 1937 he was appointed chief of the Tunnel Department of the Municipal Technical Service Rotterdam. Thanks to its technical competence, but especially his dare to use techniques never used before, the tunnel could be made. He thereby resisted the power of the Government, which initially saw nothing in its tunnel design. They preferred a high bridge there.
Tender Design | Civil 3D

Tender Design North

Tender Design South
Tender Design | Civil 3D Access Ramps
Tunnel – half deepened

- **Reinforced** underwater concrete with screwed-combi piles
- **Temporary** sheet piles without anchors
- Without structural floor
- Fillings (Variable)
- Emergency tube
- 89 Segments x 25m (2,225 Km)

Access Ramps

- Underwater concrete with screwed-combi piles
- **Permanent** Sheet piles with anchors
- **Structural Floor**
- Fillings (Variable)
- Central emergency reservation
- **Cladding walls**
- 16 + 13 Segments (North = 400m+ South = 325m)
Project BIM Execution Plan (BEP)

- Model agreements:
  - Design should be done in 3D!
  - All Structures with Revit
  - Revit Project Manual

- Model Division & Components:
  - North & South
  - Construction pit
  - Access Ramp
  - Specials

- Classification
  - Assembly Code
  - Location properties
    - Segment Numbers
    - Main Road (Left, Right)
    - Side (In- or ex- terroir)
Access ramps “Complex”?

- Horizontal & vertical Alignment
- Acceleration lanes
- Structural floor, variable sloped fillings (cross fall)
- Non re-inforced underwater concrete with screwed-combi piles
  - Maximum distance; 2 directions
- Facing wall (0-20°)
- Capping Beam + Sound wall
- Barriers, Guiderails
- Central Emergency reservation
- Tunnel Portal (parabola)
How to create “simple” a 3D Model with “complex geometry” and the available data
Project approach Final Design

• Continuity Tender Model
• Digital Engineering
  o Parametric
  o Scripting
  o Applications
    ▪ Civil 3D
    ▪ Revit
    ▪ Dynamo
  • CivilConnection Package

Brainstorm session
Challenge

Civil 3D start till end

Revit from scratch

Civil 3D – Dynamo - Revit

CivilConnection
Workflow

- MX (Road Design)
- Design Parameters
- Design Changes

- Civil 3D
- Dynamo (CivilConnection)
- Revit (Structural Design)

- Document management
  - Vault
  - BIM 360
Civil 3D vs. Revit Model

**Civil 3D:**
- Linear *curved*
- Corridor; Segments per 25m

**Revit:**
- Straight segments (construction fase)
- Discrete objects; Elements 2.5 or 5m
“If you always do what you always did, you will always get what you always got”

- ALBERT EINSTEIN
CivilConnection?

- Dynamo Package (Open source May 2019) [https://github.com/Autodesk/civilconnection](https://github.com/Autodesk/civilconnection)
- Real time connection Civil 3D ↔ Revit
- Uses Civil 3D corridor feature lines as reference
- Improve collaboration, coordination and quality
- Reduce & manage design updates, avoiding manual rework
Dynamo nodes Examples

- CivilApplication
- Corridor
- Featureline
Dynamo nodes Examples

- RevitUtils
Back to Basics
Civil 3D basics

- **Alignment** - Horizontal Alignement
- **Profile** - Vertical Alignement
- **Assembly** - Basic section profile

*Corridor – 3D model*
Revit basics

- 3D parametric object-based design
- Revise instantly
- Single File Database
Dynamo basics

- Visual Programming
- Direct link with the software (Civil 3D, Revit)

No magic skills needed. Can be useful though!
CivilConnection | Prepare Civil 3D
Naming convention – subassembly points

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<th>material</th>
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<th>positie h</th>
<th>l/r</th>
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<td>asfalt</td>
<td>asphalt</td>
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<td>links</td>
<td>l</td>
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<td>beton</td>
<td>concrete</td>
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<td>wall</td>
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<td>underwaterconcrete (UWC)</td>
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<td>grind</td>
<td>gravel</td>
<td></td>
<td>rechts bij center</td>
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</table>
Feature Lines created from Pointcodes

Subassembly basics
- PointCodes
- LinkCodes
- ShapeCodes
Adding point to the Subassembly

- Via Subassembly Composer

- Via Stock Subassemblies
Adding points to the Corridor

1. Edit... Code Set Style used for the Corridor
2. Import the Codes from your Subassembly
Corridor ready for Dynamo

- Corridor:
  - Get Codes
  - Get Featurelines
  - Rebuild
Subassembly Composer

- One Subassembly for the Ramp
- Input based on stations
- Formulas for several thickness / purposes
Subassembly Composer
Formulas + input different thickness Underwater Concrete
Solids export

1. Select Corridor → Extract Corridor Solids (ribbon)

2. Use <[Codes]> for your Layer Name Template

3. Make sure the shape you need has a color

4. Only select the solids you need
Solids export

- Use a template that contains your materials
- Materials are added to layers via *Material Attachment Options* ("MATERIALATTACH")
Revit “IFC” Visibility (PD)

- Shared Parameters created CivilConnection
  - CodeName
  - RegionName
- Filters
  - Overrides
Revit “IFC” Preliminary Design

Dynamo script
- Export IFC from C3D
- Link IFC
- Update IFC

Note!
IFC model ≠ Revit model

Reference model
Phased Revit model elements
- Piles
- Sheet piles + anchors
- Floor, etc…/

Figure 6: Setup and Update an IFC link
Capping Beam (start point Pit!)

- Structural Framing
- Featureline code
- Variabele distance edge asphalt
- Slope ramp (determine horizontal distance cladding wall)
- Dimensions elements
  - Capping beam (1000x1200) → 1100x1200
  - Barriers
  - Cladding wall (angle 0-20° 40m)
- Tolerances
Floors (MultiShapePoints; Multiple Featurelines)

- **Generic Model Adaptive (4points)**
  - Concrete structural floor
  - Plinth along sheet piles
  - Filling
  - Gravel
  - Underwater concrete (Basic)
Piles

- Structural Columns
- Lateral and longitudinal Center to Center distance?
  - Excel Structural engineer (6 parameters)
  - Calculated segment length 50m (2 segments 25m)
- Top off Pile, bottom underwater concrete (sloped)
Dynamo & Python

- Floors cut with sheet piles
Construction pit (4 per side)
Access ramp
Coding Revit elements (per segments)

- Assembly Code
- Location marks 1 & 2
Assign Featurelines

- Assign Revit elements to C3D feature lines

RevitUtils.AssignFeatureline

- element
- featureline

RevitUtils.UpdateObjects

- civilDocument
- elements
- normalized

Data

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Parts By Component
Scripted elements Pit North

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Scripted elements access ramp North
Specials : Tunnel Portal

- Blades variable height + joint detail
- Sound wall (parabola)
- Ending
  - Emergency exit door
  - Fire resistant cladding
  - Rounded walls
Miscellaneous Specials

- Pump room
- Emergency barrier area
- Emergency Transit (CADO)
Advantages CivilConnection

- Best of 2 worlds C3D (Linear) & Revit (discrete objects)
- Civil 3D corridor model long useable during design
  - Alignment changes
  - Feature lines
  - Codenames (subassembly)
- Linear C3D object bi-directional connected with Revit model
- Revit objects are coordinated and dynamic connected with Civil 3D
- Revit objects (solids) can be convert to C3D
Focus areas CivilConnection

• Dynamo knowledge
• Clean Civil 3D model (Dynamo is consequent, roundups !)
• Reading Corridor Codes names, “slow” {188 x (16+89+13)= 22,184}
• Not yet many project experience.
• C3D, IFC and Revit in same directorystructuur!
  o Vault, not with Revit Collaboration
  o BIM 360, (also for Civil 3D 2020)
  o IFC possible with Desktop connector
Current situation North
Current situation South
Learning Objectives

- Creating a Civil 3D model with the subassembly composer that is ready for applying with the CivilConnection Package for Dynamo
- Use dynamo to read your Civil 3D model
- Build your Revit Model based on the Civil 3D model and information
- Use the power of Civil 3D and Revit together
Skills Needed

Main skills

Software skills

Revit Engineer

Civil 3D Engineer
If you want to go fast
Go alone!

If you want to go far
Go together!
Thank you

Infrastructure
It’s all about connections

Royal HaskoningDHV
Enhancing Society Together

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