Computational Design for Civil Engineers

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Agenda

- What is Computational Design
- What is Dynamo
- Consulting Experience CivilConnection
- Dynamo For Civil 3D
- Use Cases
  - Rail
  - Roads
  - Land Development
- Next Steps
Computational Design
Design Intent with Sketching
Computational Design

\[ a = 4 \]
\[ b = 1 \]
\[ a - b = c \]
\[ F(a, b) \]
Computational Design

\[ a = \text{cube} \]

\[ b = \text{sphere} \]

\[ a \ominus b = \text{blocks} \]

\[ F(a, b) \]
Scripting

```python
# Create ReferenceArrayArrays
refarr = ReferenceArrayArray()

# Do some math to place points
z = 0
detail = 10
while (z <= detail):
    x = 0
    refptsarr = ReferencePointArray()
    while (x <= detail):
        y = (math.sin(x/3)*10) * (math.sin(z/10))
        z = z

    # Create Points that are appended to an array
    refptsarr.Append(doc.FamilyCreate.NewReferencePoint(XYZ(x, y, z)))

    # Increment x
    x = x+1

    # Increment z
    z = z + 1
```
Visual Programming

F(a, b)
Dynamo
Automation | The New Normal

Automation Is the Disruptor

- Visual interface to construct logic routines
Where can you find Dynamo

https://dynamobim.org/download/

- Advance Steel
- Alias
- Civil 3D
- FormIt
- Revit
- Sandbox
Iron Python | .NET Compatible

- Interpreted Programming Language (no need to compile)
- IronPython 2.7 installed with Dynamo
- .NET capabilities (e.g. Revit, Civil 3D, Navisworks, etc.)
Extend Dynamo with C#

- Zero Touch nodes
- Custom UI Nodes
- View Extensions
Dynamo = Visual Programming + Scripting

A color analogy

Set of predefined functionalities (Visual Prog.)

Simple language to define custom functionalities (DesignScript, Python)

Custom tools

Expand with 3rd parties modules (Packages, ZeroTouch, etc.)
Why Use Dynamo

- Complex Modeling | More
- Model Data Consistency | Better
- Automate Repetitive Tasks | Less Effort

Resources
- Dynamo BIM
- Dynamo Primer
- Dynamo Forum
- Autodesk Consulting Dynamo guide
- Autodesk University
Dynamo Workflows
Dynamo High-Level Workflows

- Select objects > Get properties > Write values to an external file
- Select objects > Read external input > Modify object properties
- Input data > Process data > Create or Update objects
Collaboration

- Tunnel design
- Tender phase
- Departments hierarchy
- Model elements ownership
- Amount of information
- Tools in use
CivilConnection

- Bidirectional flow of information between Civil 3D and Revit
- Toolkit to leverage computational design for infrastructures
- Complementary to InfraWorks Civil Structures workflows and for detailed design
- Open Source & customizable

- [Link to Customer Success Stories](#)
CivilConnection | Use Cases
Dynamo for Civil 3D
Development Timeline

September 2018
CRUX team develops a POC

October 2018
Consulting shared CivilConnection use cases with product team

November 2018
Dynamo for Civil 3D is announced at Autodesk University

December 2018
Nigel Peters and CRUX Team in China start development

February 2019
Dynamo for Civil 3D is launched on the Beta website

April 2019
Dynamo is available at product global launch

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How To Get Dynamo for Civil 3D

- Separate installer on Autodesk account
- New panel in the ribbon Manage > Visual Programming
- User Interface or "Headless" Command Line Interface
- Focus on transportation workflows
- Contains 9 sample workflows
Dynamo for AutoCAD

Diagram:
- **AutoCAD Document**
  - Blocks
    - Layers
    - Model Space
    - Paper Space
    - Line Types
  - Select Object
  - Object Types
  - Select by Type
  - Select by Layer

- **Object Model**
  - Block
  - Block Reference
  - Dynamic Blocks
  - Line
  - Text
  - MText
  - Polyline
  - Polyline3D
  - Face
  - Mesh
  - Solid
  - ...
Expand Automation Workflows

- For the workflows that are still missing in the nodes shipped in Dynamo use Python
- Create Python modules for AutoCAD and Civil 3D to be reused in Dynamo
- Leverage the full .NET API in a prototyping environment
- Look out on the Dynamo Package Manager for Civil 3D dedicated packages
- Create and share custom nodes for Civil 3D using C#
Sample Workflows

- Text + Circle Along Corridor Feature Line
- Corridor Counterfort Wall
- Split Corridor Solid
- Export Corridor Feature Lines
- Read/Write Subassembly Parameters
- Add Annotation Along Alignment
- Run Script Command To Change Layers
- Daylight Slope Patterns

- 01_Property Set Definitions to JSON
- 02_Create Property Set by JSON
- 03_Dump Property Set Values to CSV
- 04_Update Property Set Values by CSV
Rail
Rail | Concept Model & Section View
Rail | Concrete Ties
Rail | OCS Masts

1. Start
2. Place Block References from CSV
3. Get Baseline
4. Get Masts Location From CSV
5. Calculate Coordinate Systems
6. Calculate Location & Rotation
7. Insert Block References

Stations, Offset, Type

Corridor, Baseline

CSV
Rail | OCS Masts
Rail | OCS Cables
Roads
Road | Concept Model & Section View
Roads | Retaining Walls
Roads | Barriers

- Start
- Get Corridor Feature Lines
   - Corridor, Baseline, Point Code
- Calculate Posts Locations
  - Stations
- Place Guardrail Posts
  - Block Reference
- Create Guardrail Face
  - Location & Rotation follow feature lines
  - Solids
- End
Roads | Barriers
Site Development
Site Development | Ramps
Site Development | Stakeout Points

Create COGO points on surface

Start

Select arcs and lines on target layer

Select Tin Surface

Convert Parcels to Dynamo Polygons

Get closest point to polygon center

Project point on Tin Surface

Add COGO points

Python Script

Layer

Tin Surface
Site Development | Stakeout Points
Site Development | Review
Next Steps
Walk with us

- Download and install Dynamo for Civil 3D from your Autodesk account
- Visit Civil 3D Futures Portal to get the latest version and provide feedback
- Visit the Civil 3D section on the Dynamo forum here
  
  https://forum.dynamobim.com/c/civil3d

- Explore the use cases shipped with the product
- Start automating your workflows!
What’s Coming Next

- Feature Lines
- Full management of alignment and profile geometry
- Dynamo Player
- Localization versions of Dynamo
- Copy, transform and get extents of objects
- Positioning of blocks and block references
- Surfaces
- AutoCAD Dynamic Blocks
- Cogo Points
- MTexts
- Layer management
- Metadata in the dwg: Property Sets, XData and Block Attributes
- Civil objects Names and Descriptions