ArcGIS Pro and CityEngine

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Procedural Modeling Provides a Flexible 3D Design Environment Supporting a Rapid and Repeatable Process

Steps
- Author Rules (or use Library)
- Generate Multiple Design Scenarios
- Evaluate Alternatives

Particularly When Projects Require Many Iterations
Procedural Modeling is Intelligent
Rule Based Database

- Interactive
- Multiple Views
  - Realistic Display
  - 3D Thematic Rendering
- Performance Reporting
  - Driven by Attributes
  - Visualized Dynamically

Design

Infiltration Rate

3-D Zoning
When to use ArcGIS Pro?
When to use CityEngine?
<table>
<thead>
<tr>
<th>Feature</th>
<th>ArcGIS Pro</th>
<th>CityEngine</th>
</tr>
</thead>
<tbody>
<tr>
<td>“2D to 3D” procedural engine</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Interactive design tools</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Dynamic reports, handles, local edits,...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rule authoring</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Dynamic 3D streets &amp; blocks</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

→ Continuous improvements & focus on visual rule authoring (with Portal/Online contents)
## 3D Data Types

<table>
<thead>
<tr>
<th>Feature</th>
<th>ArcGIS Pro</th>
<th>CityEngine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidar / reconstruction</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>BIM import</td>
<td>Partly</td>
<td>Partly</td>
</tr>
<tr>
<td>Multipatch editing</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3D export (Unity, etc)</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

→ CE for advanced 3D models (materials, instances...); CE focus on CAD/BIM to WebGIS workflows
# 3D Visualization

<table>
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<tr>
<th>Feature</th>
<th>ArcGIS Pro</th>
<th>CityEngine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scales</td>
<td>All (global &amp; local)</td>
<td>Up to city scale (local only)</td>
</tr>
<tr>
<td>Rendering</td>
<td>Streaming, adaptive</td>
<td>In-memory only</td>
</tr>
<tr>
<td>Animation</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>AR/VR</td>
<td>No</td>
<td>R&amp;D</td>
</tr>
</tbody>
</table>

→ Focus in CE on preview; Pro, Earth & WSV are our real-time visualization environments
“LegoScript”

parameterized instructions + Legos
Shapes = Scope and Geometry
Shape Operations

modify scope and geometry
Rule = Sequence of Shape Operations

```
Envelope -->
case scope.sx*scope.sz > 6000:
    15%: split(y){ '0.9 : Tower
        | ~3  : s('0.8,'1,
        | ~1  : s('0.6,'1,
    15%: split(y){ 'rand68 : Tower
        | ~rand(0.5,1.5): s
        | ~1            : s
    15%: split(y){ 'rand48 : Tower
        | ~1            : s('ran
else: Tower
else: Tower
```
Procedural Model/Symbol
= Rules (CGA) + Assets on Shapes
Demonstration

Procedural in CE

Demonstration
Authoring CGA for RPKs, tips

Assets
All will be included → beware the ‘random’ use of textures and models
Has a huge impact on file size → consider multiple / focused RPKs

Using Tags / Annotations
Define input geometry: @InPoint, @InLine, @InPolygon, @InPointCloud, @InMesh

Parameters (ie: the ‘attr’ definition)
Use it as much as needed… but no more
Use a good name → shown on the UI
Match to data model → auto-connect matching names
Set Ranges: @Range (v1, v2)
Provide ‘type’ information → @Distance, @Percent, @Angle

Protect the CGA (as needed)
If your rule is something you sell, or has IP, then protect it
Creating procedural 3D content in ArcGIS Pro

- There are two options:
  - FeaturesFromCityEngineRules GP tool
  - Procedural symbols

- Both options use CityEngine rule packages (*.rpk) to create 3D content
  - Rules are authored in CityEngine
  - The rules can NOT be edited or authored in ArcGIS Pro
What is a rule package?

- Rule package is a compressed file containing:
  - the compiled CityEngine rule
  - any assets (dae, obj, jpg, png etc.) used by the rule
  - optionally also the source CGA rule file
Sharing and consuming rule packages

- Share as rule package
  - Within your organization
  - Item on Portal
  - Item on AGOL

- Consume in:
  - ArcGIS 10.5
  - ArcGIS Pro
  - 3rd party 3D apps
    - CityEngine SDK
  - Maya
  - ArcScene 10.2
  - 3rd party 3D apps
    - CityEngine SDK
Rule Packages on ArcGIS Online

- Item type on ArcGIS Online
- Living Atlas
- ArcGIS Marketplace - planned for future releases
Supported geometry types

- **Polygon**
  - CGA start rule should be marked with `@InPolygon` annotation

- **Multipatch**
  - CGA start rule should be marked with `@InMesh` annotation

- **Point**
  - CGA start rule should be marked with `@InPoint` annotation
Supported geometry types

- CGA example for a rule that expects polygon geometry as input:

```plaintext
@StartRule @InPolygon
Lot --> extrude(HEIGHT) Bldg
Bldg --> color(1,0,0) RedBldg.
```

- **Lot** is the start rule. It is where shape generation starts

- **@StartRule** – is the CGA annotation that identifies the “start rule” (Lot in the example)

- **@InPolygon** – is the CGA annotation that specifies the expected input geometry
Do I need to write CityEngine rules?

• Sure, if you want to...
  - You will have to learn CityEngine scripting/CGA
  - Might take some effort initially but the advantage is that you will be able to write your own custom rules for generating 3D content (and it is a lot of fun)

• But you do not have to
  - Search for RPKs shared on www.arcgis.com
  - For procedural symbols: look at the symbols available in Procedural Symbols style
Features From CityEngine Rules

- Input can be polygon, multipatch or point
- Output is a multipatch feature class
- Can optionally:
  - generate reports
  - export leaf shapes
    - if start rule has @Out (granularity=separatedShapes) annotation
Procedural symbols

- Applied to polygon, multipatch or point feature layers
- Define custom attribute mappings
- Save symbols to style
Procedural in Pro

Demonstration
Take away

Rule packages are “LegoScript”

parameterized instructions + Legos

They can be used across the platform to make and inform 3D data

- Search for RPKs on AGOL & Living Atlas
- Get a free trial version of CityEngine at: http://www.esri.com/cityengine
- Have a look at the forum: geonet.esri.com → search for CGA
3D Island
@ Esri Showcase
Please take our Survey
Your feedback allows us to help maintain high standards and to help presenters

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Find the session you want to review

Scroll down to the bottom of the session

Answer survey questions and submit
Questions?

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