KICKING OFF

PROCEDURAL ART

2021-2022

by Max Klostermann

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PROCEDURALLY GENERATED CONTENT

What does the term **procedural** mean?

- it refers to a process that computes a particular function
- **procedural** also refers to a method of generating data algorithmically as opposed to manually

In video games, game development and movie productions it is commonly used to

- create **large amounts** of **content automatically** (in editor and/or at runtime)
- make the content **creator's lives easier** through tooling and dedicated software
- make productions such as the **creation** of **vast virtual worlds manageable** in the first place

PROCEDURALLY GENERATED CONTENT

Typical fields of application:

- 2D / 3D ART
- generated levels
- placement of assets
- 3D meshes
- terrain / landscapes
- entire galaxies
- textures
- cityscapes / dungeons
- sound and music

PROCEDURALLY GENERATED CONTENT

FOR MOVIES

- Crowd & Fluid simulation, VFX, entire 3D worlds
  - Blade Runner 2049
  - Astro Kid
  - Game of Thrones

- meshes and textures all created and positioned procedurally

- all texturing done using the procedural power of substances

- procedural animation of crowds/horses & simulation of debris/dirt

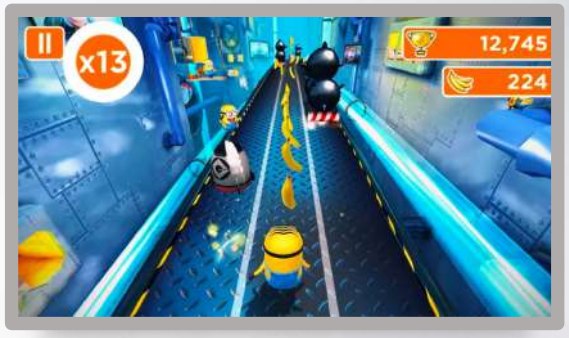
PROCEDURALLY GENERATED CONTENT

IN GAMES

- 2D/3D worlds, VFX, Assets, Animations, Tooling
  - Minecraft
  - Minion Rush
  - Marvel's Spider-Man

(and countless others…)

- levels randomly created by using a mathematical algorithm



- generates upcoming obstacles and level elements in runtime

- utilizes offline tooling in the engine's editor for designers & artists

PROCEDURALLY GENERATED CONTENT

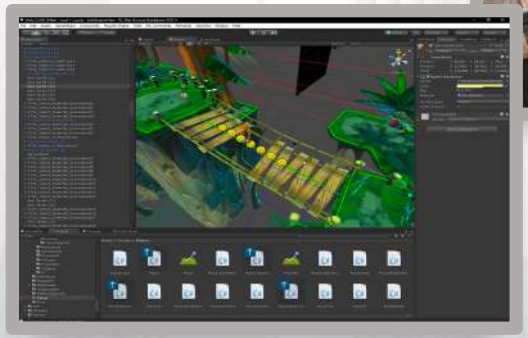
MAIN BENEFITS

- ✓ Production efficiency
- ✓ Infinite worlds & “possibilities”
- ✓ Adaptive content
- ✓ Automated systems
- ✓ Consistency

Offline authoring of Manhattan: Spider Man

Endless worlds: Elite II

Procedural narrative: Left 4 Dead 2



Adaptive bridges in Unity (Houdini)

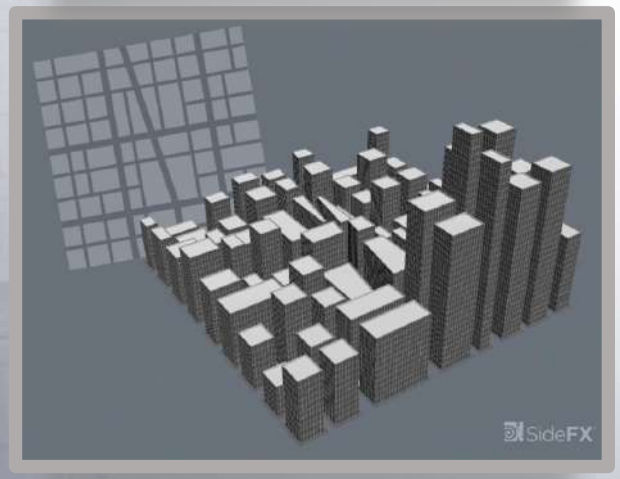
Consistent results for specific art direction

PROCEDURALLY GENERATED CONTENT

*"The **flexibility** and **control** provided by **procedural techniques** give the designer a platform for artistic **freedom** and **experimentation**. **New** visual **effects** and original **objects** can be **created** by experimenting **with parameter values** that exceed normal boundaries."*

- George Kelly, 2006

PROCEDURALLY GENERATED CONTENT



‘Runtime’ **VS** ‘Editor time’

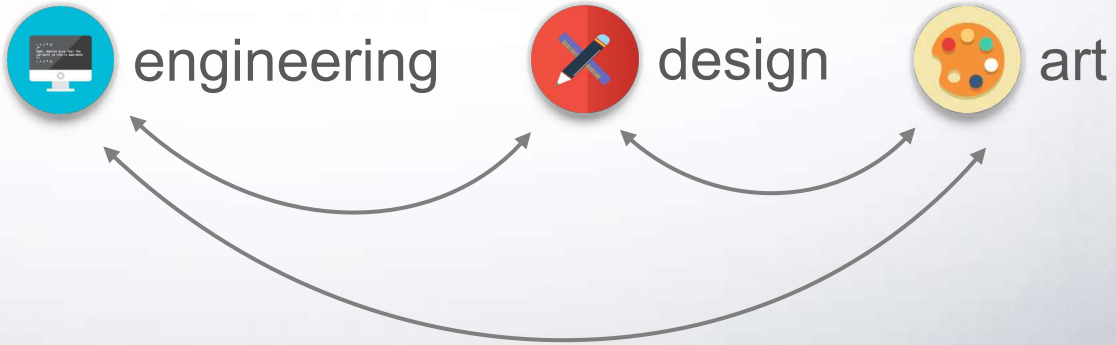
- Big difference for procedural pipelines and applications:
  - **Runtime** refers to content generated during ‘**gameplay**’
    - usually used in games to boost replayability
    - usage: diverse gameplay possibilities and endless variety
  - **“Editor time”** refers to content being authored **offline**
    - content not generated in real-time / at runtime
    - usage: rendering, VFX, workflow benefits through Tooling

The Assignment

PROCEDURAL CITY AREA

Create a three-dimensional, (at least partially) procedurally crafted, reimagined small city area in Unity, based on one of four available themes.

Each student gets to freely choose their own focus:

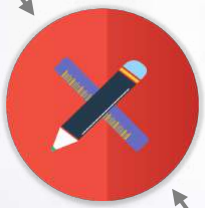


The Assignment

THERE ARE NO CMGT ROLES

Substances?, Meshes and Structure generation?, Post-Processing?, Shader Graph?, Modular Assets?, Optimization?

\+ ITERATIVE TESTING & RESEARCH!



Mesh generation?, Shader Graph?, Additional props?, Substances?, Post-Processing?, Tooling?, Optimization?

\+ ITERATIVE TESTING & RESEARCH!

Structure generation?, Modular Assets?, Shader Graph?, Tooling?, Additional props?, Scripting?

\+ ITERATIVE TESTING & RESEARCH!

The Assignment

FINAL HAND-IN(S)

Unity project – a scene with an (at least partially) procedurally generated city area (in editor or play mode)

Assets/Tools/Building blocks – can be C# scripts, shaders, substances, 3D meshes etc.

Research - a document including all relevant research (visual, technical, 5 pages max)

Video – a short video demonstrating the procedural capabilities/tooling etc.

The Assignment

JUDGEMENT DAY(S)

At the end of **week 9** (at the latest) you are going to:

- submit all 4 files to Blackboard
  - Unity project
    - Assets/Tools/Building blocks
      - Research document
        - Video

In **week 10** you will:

- showcase your work in a presentation of 15 minutes

DO‘s and DON‘Ts

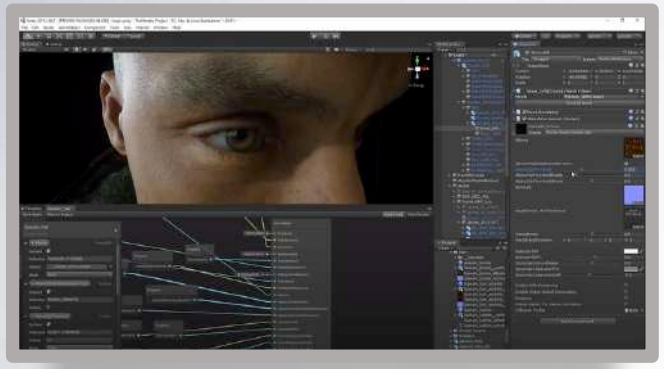
1. DO **NOT**:
   - focus on creating a first-person-walking simulator experience!

   DO:
   - capture the mood and essence of your chosen theme (a “**skyline impression**”)
2. DO **NOT**:
   - focus on a Unity build that enables procedural generation at **runtime** (at least not fully)!

   DO:
   - aim for providing tooling and utilize asset and building block generation in “**editor time**”
3. DO **NOT**:
   - use Unity’s built-in rendering pipeline (3D preset) since it doesn’t support Shader Graph

   DO:
   - use the **High Definition Render Pipeline (HDRP preset)** instead

Recommended setup



Unity's LTS version

- long-term stable build of Unity (LTS Releases)

High Definition Render Pipeline (HDRP)

- **high-fidelity** scriptable render pipeline targeting modern platforms
- high graphical standards utilizing physically based **lighting** (linear & HDR) and **shading** (optimized PBR shader)
  - does **support** Substances and exposed parameters "natively"

    (⇢ install the free 'Substance in Unity' plugin)
  - does **support** Shader Graph
  - ships with amazing looking and optimized **Post-Processing FX**

Methods from the industry

TECH DEMOS

Cityscape for FPS-RPG (2019)

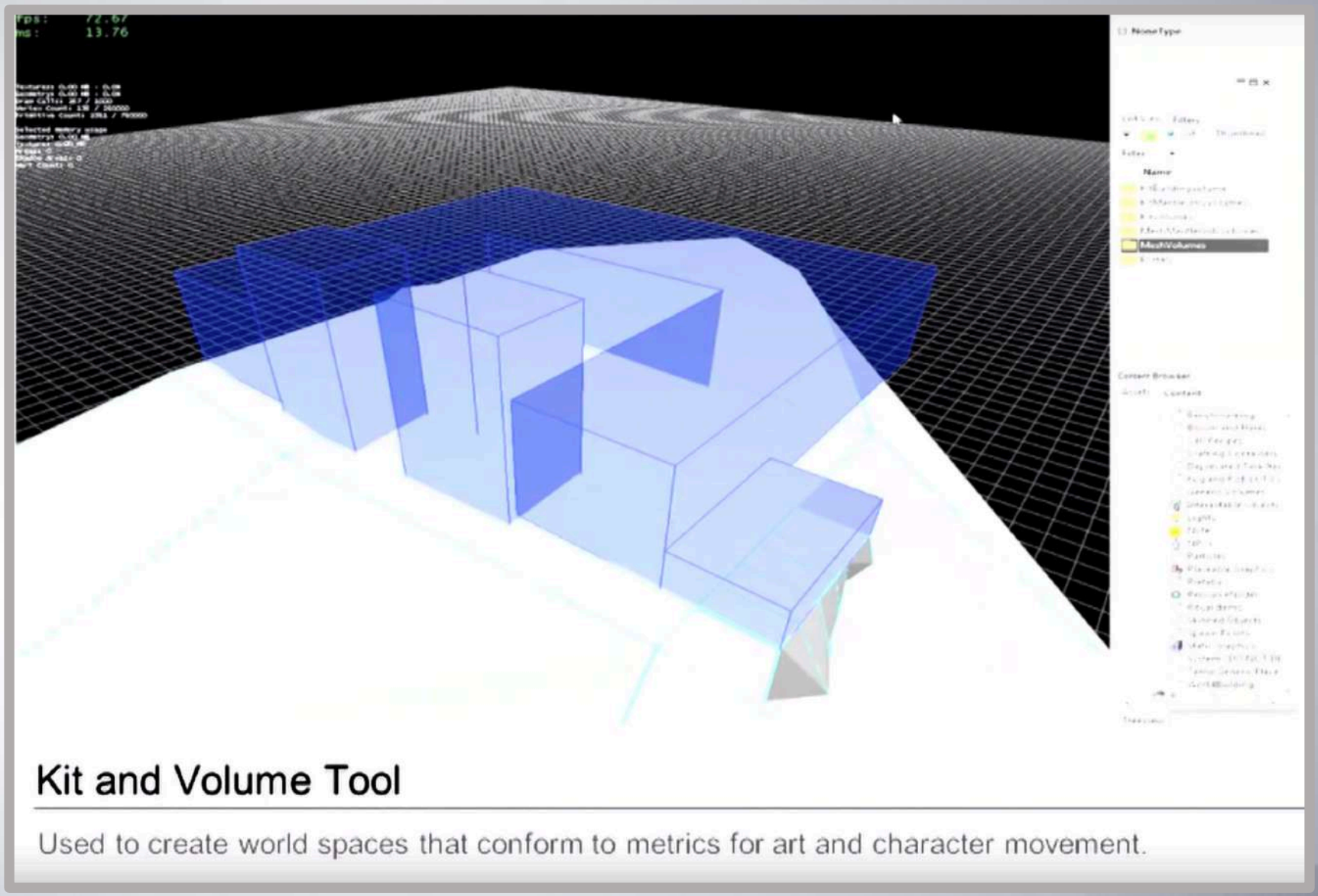
https://youtu.be/b5AIpncO_9I

Methods from the industry

TECH DEMOS

Cityscape for MMO (2013)

https://youtu.be/vxC8vX2zAgY?t=825

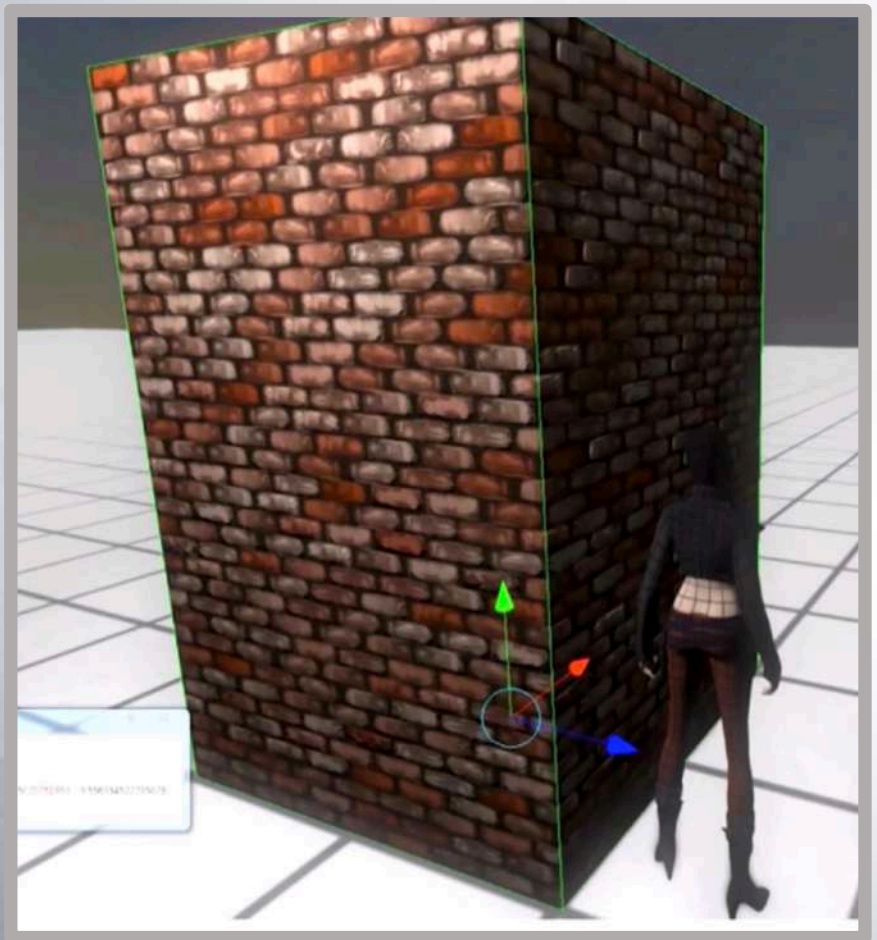


Kit and Volume Tool

Used to create world spaces that conform to metrics for art and character movement.

Getting your hands dirty!

HOW TO TEXTURE SMARTER



Goal: A simple PBR brick texture for a massive wall.

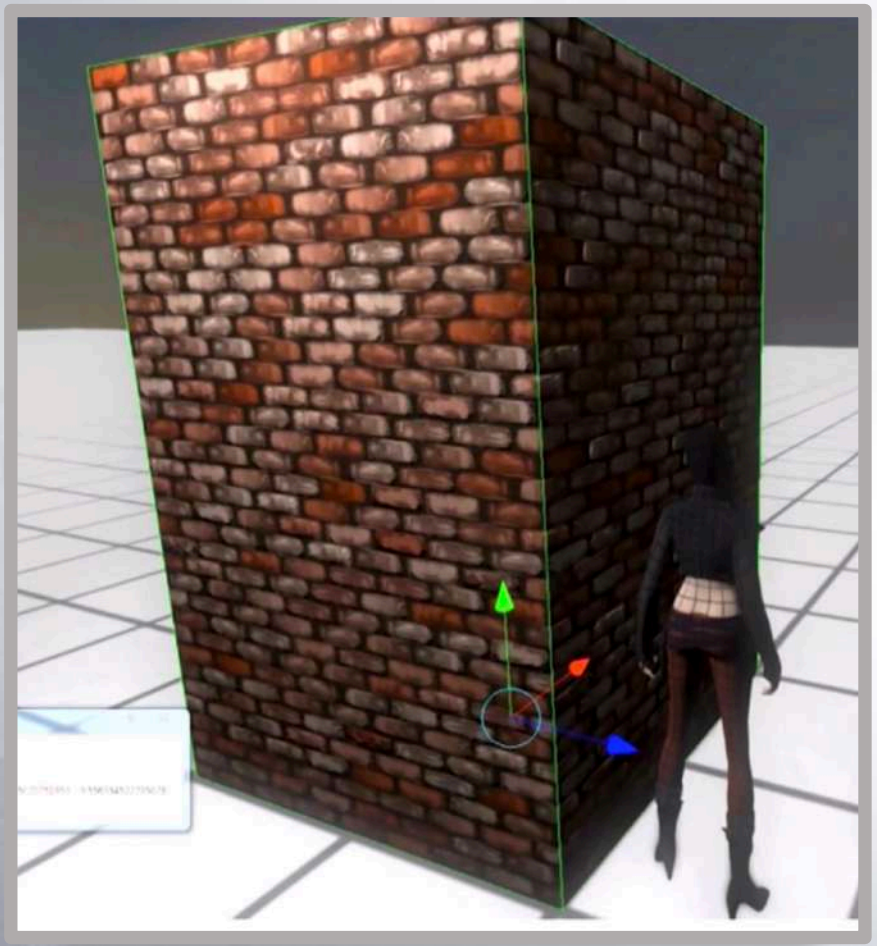
Specifications: A wall of glazed-headed Flemish bond with bricks of various shades.

Photoshop | Gimp | Paint.NET

- Three approaches:
  1. **Hand-made** bitmaps
     - Properties:
       - hand-drawn or kit-bashed (**time-consuming**)
       - different map types the shader demands need to be created and made tileable **manually**
       - **destructive** workflow
         - adaptable through **manual labour**

Getting your hands dirty!

HOW TO TEXTURE SMARTER



Goal: A simple PBR brick texture for a massive wall.

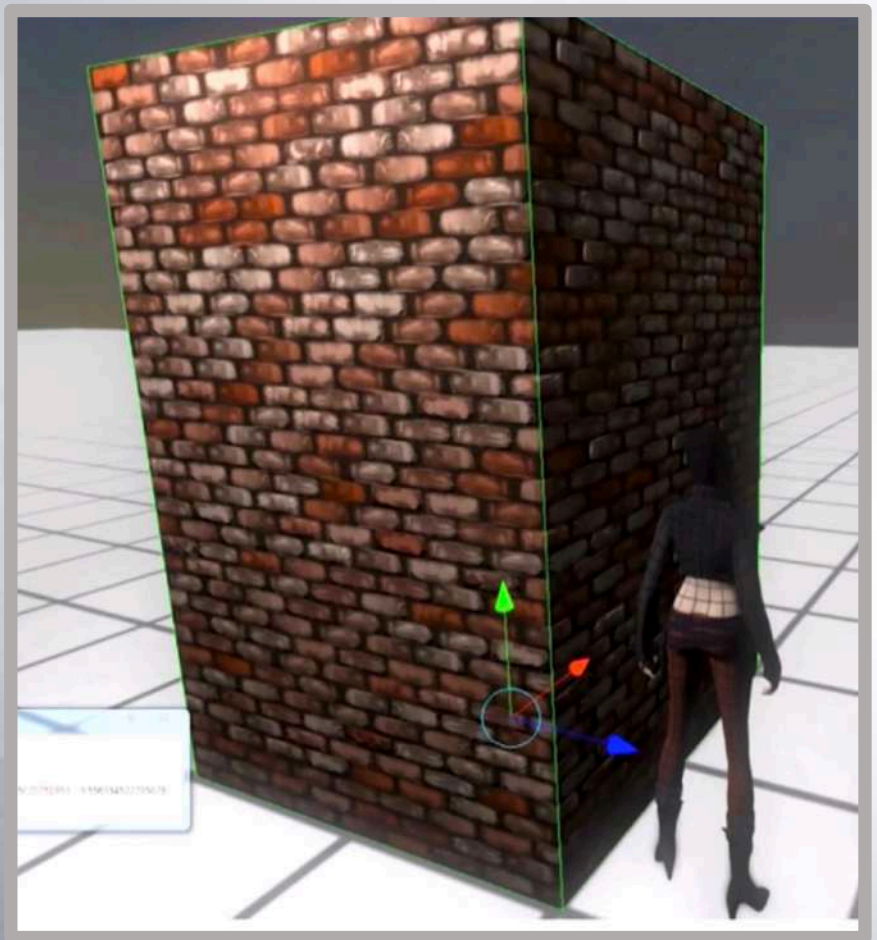
Specifications: A wall of glazed-headed Flemish bond with bricks of various shades.

Substance 3D Painter | Substance 3D Sampler | Quixel Suite

- Three approaches:
  2. **Procedurally** generated bitmaps
     - Properties:
       - generation through filters / masks (**time-saving**)
       - different map types the shader/material demands are generated **automatically** and / **or manually**
       - enables **tiling** but **only** on a **prop-basis**
         - **not optimal** for performance and control

Getting your hands dirty!

HOW TO TEXTURE SMARTER



Goal: A simple PBR brick texture for a massive wall.

Specifications: A wall of glazed-headed Flemish bond with bricks of various shades.

Substance 3D Designer Unity

- Three approaches:
  3. Procedural materials (Substances)
     - Properties:
       - texture generation through **nodes**
       - different map types the shader/material demands are generated **automatically** and made **tileable**
       - enables exposed parameters for **later** control
       - **non-destructive** and “natively“ **supported** by Unity

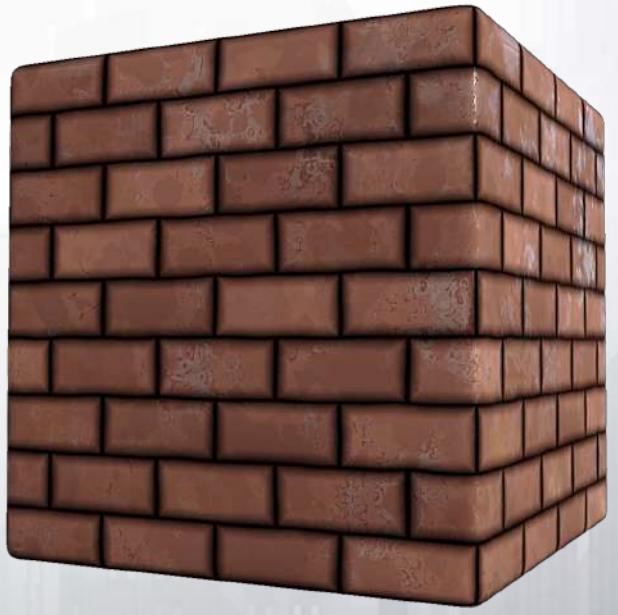
Getting your hands dirty!

EXERCISE

(you may follow along if you‘re extremely attentive)

Goal: A very simple brick **material** using

Substance 3D Designer



Methods from the industry

KEY CRITERIA

Realism --- Is the generated city area supposed to be a realistic depiction of a real city?

Your focus: make it as **believable** as you possibly can based on video game references!
A '**stylized**' version is **an option**; note: 'stylized' doesn't equal flat, low-poly and no details.

Scale --- Does the urban landscape create buildings/structures/a layout in the right scale?

Your focus: make it as **large as you want** without (too many visual) sacrifices!
Buildings = correct scale; the city **area size** = rather small (city area/village/hamlet even).

Variation --- Can the systems in use recreate the variation of buildings and infrastructure?

Your focus: create **Tooling (scripting)** for **Unity** that **does** the hard **work for you**.
We'll provide **hand-outs**, basic **scripts** to get started and **guidance** on how to pull it off.

Input --- What is the amount of variation one can expect from minimal input to best output?

Your focus: enable **options to** easily **adjust** the **look** of your city area!
e.g. Buildings = floors/scale/shape; **Textures** = exposed parameters using Substances.

Methods from the industry

KEY CRITERIA

Efficiency --- How long does generation take and how efficient are the algorithms used?

Your focus: make tooling work and make it run acceptable at runtime first.
City area generation at **editor time** is nice and gets rewarded too, though!

Control --- What is the amount of control & variation one can expect from using current tooling?

Your focus: regardless of your personal focus, make sure you **work non-destructively,** meaning: you can always make quick changes without time-consuming, manual work.

Real-time --- Can the urban landscape be viewed and generated in real-time?
Are there any optimization techniques applied to achieve a good performance?

Your focus: if you go for real-time / runtime, make sure to go into **optimization** as well.
There's going to be a **dedicated lecture** about optimization techniques!

Reveal of your options

THEMES

Every student gets to choose one theme based on four video game locations

The Emissary area of Los Santos
A luxury hotel chain area
(Grand Theft Auto V)

Morthal
A city in the North West
(The Elder Scrolls V: Skyrim)

Reveal of your options

THEMES

Every student gets to choose one theme based on four video game locations

Center of City 17
City in Eastern Europe
(Half-Life 2)

Downtown Night City
Futuristic Dystopian Megacity
(Cyberpunk 2077)

Reveal of your options

THEMES

Your city area/location should be a **reimagined** version of the original

The Emissary area of Los Santos

Morthal

Center of City 17

Downtown Night City

The **time of day** is up to you!

Research approach

WHAT, WHY AND HOW

1. **What** is research?
   - A careful and detailed **study** into a specific **problem** / **issue** / **concern** (scientific method)
2. **Why** should you do research?
   - You don’t know what you do not know (yet)
   - For this assignment, you have quite some freedom to develop your own approach and focus
     - What skills, tools and insights do you need to get for all chosen tasks?
3. **How** should you start?
   - Always start with asking a question! For your research document, being curious is enough
     - learn more about the different aspects and see what you are interested in doing
     - search for articles, videos and other sources on procedural generation of scenes & assets

ESSENTIAL ADVICE

- Look for **visual** inspiration and reference(!)
  - analyze original **concept art** in order to recreate the mood / impression of the theme
  - play the **games** to get a feeling for scale and variety (and feasibility)
  - build up a **visual library**, find recurring **patterns** and define **landmarks**
  - analyze 3D models and textures you can find online, e.g. **sketchfab.com**
  - search for **blueprints / floorplans** and **maps** of your chosen video game city
- Seek out articles, documentation and surveys for the **technical (art)** approach
  - some **keywords** are: Split- and Shape grammars, L-systems, Voronoi, Substances

ESSENTIAL ADVICE

- Search for advice on **best practices** from the professional field (GDC talks, tutorials)
- do **NOT** jump to production right away by skipping the research phase
  - no submission of research document (5 pages max) = preconditions not met = **redo**
- **read** the **cluster manual(!)** and the **assessment criteria(!!!)** carefully!
- What are your options, what seems interesting to me and what is feasible?

– *“Do I need to model a thousand buildings now?”* Answer: **no**. Research ‘modular assets’.

– *“Haha! I’m just gonna texture in Substance 3D Painter again!”* **No, you can’t.** Use Substance 3D Designer.

– *“Am I going to hand-place all building blocks?”* Answer: **no**. Look for Scripting solutions and Tooling.

You‘ll be fine.
The rubrics are your friend.

You only need 9 out of 28 points to pass.
You only need 17 points to score a 10 as your final grade.

Expertise, lectures & labs

EXPERTISE

ENGINEERING ASPECTS

Meshes & Structure Generation, Algorithms, Tooling, Code Architecture, Advanced Scripting, Optimization, Research

Paul Bonsma

Hans Wichman

DESIGN ASPECTS

Modular Assets, Materials (Substances), Shader Graph, Unity Scripting, Modeling, Optimization, Research

Mark Schipper

Max Klostermann

Luuk Waarbroek

ART ASPECTS

Modular Assets, Additional Props, Materials (Substances), Shader Graph, Post-Processing, Optimization, Modeling, Research

Max Klostermann

Mark Schipper

Malik Nabil

Expertise, lectures & labs

LECTURE SETUP

- All scheduled lectures for all classes are **2 in 1's** (from now on)
  - every week there will be **two lectures** at the same time
  - you get to **choose** which lecture to attend each week
    - 1 **scripting-oriented** lecture each week (Paul Bonsma or Hans Wichman)
    - 1 **art-oriented lecture** each week (Mark Schipper or Max Klostermann)
  - all lectures are scheduled simultaneously, **BUT**
    - we are going to **record** all of them, obviously
    - **watch** them **so** you **don't miss out** on anything

Expertise, lectures & labs

LAB SETUP

- All scheduled labs will be **guided work** hours
  - most labs will offer small (**optional**) assignments and tutorials
  - if you have a burning **question** that **can't be answered** by your lab teacher(s)
    - look up the **expertise** of each **teacher**
      - join **their lab**
      - ask questions via **mail** (and pray for an answer!)
      - go to the **Q&A session** (every **Friday –** all teachers available)!
      - **Tip**: start early so that you do have questions on a Friday

Things you can do today!

FIRST THINGS FIRST

- **Read. The. Cluster. Manual.** (…there's something in there about sharing assets… wait, what?)
- **Choose** a **theme you** can see yourself **love** doing & working on
- Start with **visual research**, play the games, **absorb** the **mood** and initial impressions
- **Optional**:
  - Get your hands dirty with **first** "baby"**-steps** in
    - Scripting and Tooling or
    - Substance Designer or Unity
    - Visual FX (Post-Processing) in Unity

REFERENCE LIST

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Resources

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THAT‘S ALL!

NOW, RELAX A BIT!

IT‘S GONNA BE ALRIGHT.

*Not an actual human being.
But this is what actually happens,
when you don‘t finish your meal, kids.

See you soon!