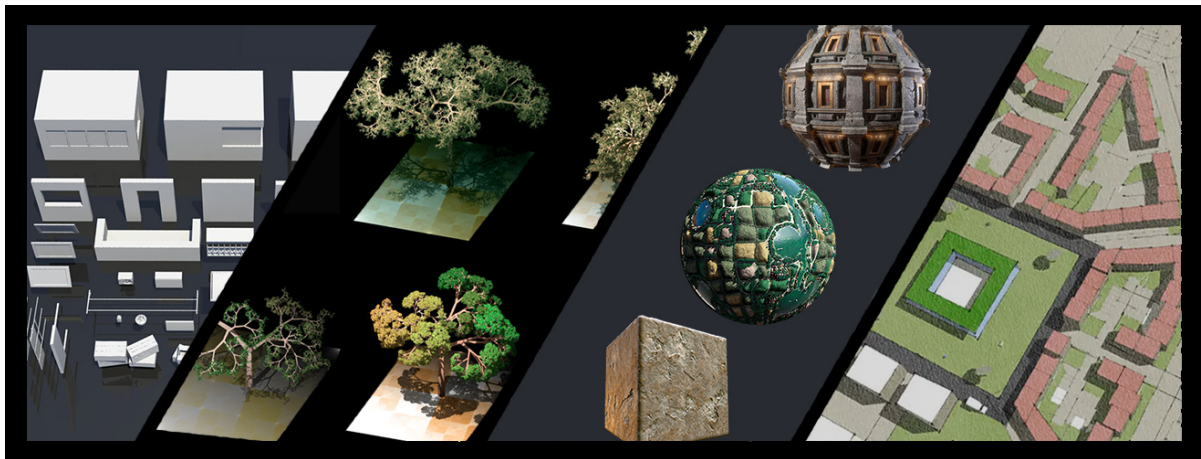


Procedural Art

Term 2.1

Course Manual study year 2021/2022

*Bachelor Creative Media and Game Technologies (CMGT)
School of Creative Technology*



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CMGT roles Artist | Designer | Engineer

1 General overview

Module Name	Procedural Art
Unit code	L.25875
Year and Term	2.3
CMGT roles	Artist, Designer and Engineer
Credits	3 ECTS
Lessons	Lectures: 5 * 1.5 = 7.5 hours. Labs: 5 * 2.5 = 12.5 hours. Q&A sessions: 5 * 1.75 hours = 8.75 hours
Study load	84 hours
Responsible lecturer	Max Klostermann (m.m.klostermann@saxion.nl)
Lesson structure	1.5 hours lectures, 2.5 hours labs, 1.75 hours Q&A sessions
Module summary	The student gains theoretical and practical knowledge about different means of generating procedural content, understands how procedural workflows can be utilized to create and enhance visual output, establishes a non-destructive pipeline, accelerates iterations and thus lowers the overall amount of production time in current and future projects. The product delivered is a procedurally crafted and reimagined small-scope city area produced by using suitable tools and workflows, presented in the game engine Unity.
Industry relevance	Procedural workflows are becoming more and more standard for both real-time software applications such as Game engines and offline-rendering tools utilized for Visual FX and CGI in the movie industry. Acquiring a basic understanding on how products and projects can be approached and enhanced procedurally is important in order to have a foundation for critical conversation and exchange with other professional fields related to Creative Media & Game Technologies.
Type of exam	Assessment (based on uploaded products)
Exam code	
CMGT Competencies	1. Technical research and analysis 2. Designing, prototyping and realizing 3. Testing and rolling out 5. Conceptualising 6. Designing
Required prior knowledge and skills / conditions for enrolment	Engineers: Unity Game Scripting. Recommended: Algorithms. Designers: Unity Game Scripting. Recommended: 3D Modeling. Artists: Unity 3D Art. Recommended: 3D Modeling.
Preparatory for	Project Show-Off and a multitude of other future projects

2 Why this module?

It is generally advisable for future projects that students obtain theoretical knowledge of procedural workflows in order to **generate digital content** in a **procedural manner as opposed to investing too much time into tedious and manual labour**. Understanding and being able to apply this knowledge is important for **establishing a pipeline** which **improves the workflow** and lowers the time it takes to author content for everyone involved **in the long run**. We teach this in the context of **small-scale assignment** using the game engine **Unity**, pre-existing- and self-made tools that enable all CMGT roles to create re-usable, adaptable and non-destructive procedural content with an **individual approach and focus**.

In order to develop media products, both for the movie- and game industry, you need to have knowledge about the current technologies used in the field which will enable these new workflows. We use technologies and approaches to **let digital content be generated for us** - the developer and the user as well. It is important to understand what happens and how things happen in between: how content is authored procedurally, what its benefits are and why we should make use of it as developers of interactive content.

Students need to understand the foundations of procedural art and ask themselves questions like:

- What caused procedural pipelines in the industry to emerge and why?
- What are the possibilities and limitations of procedural workflows?
- When does a procedural workflow make sense and when does it not?
- What is the current state of procedural workflows in a professional pipeline?
- How will procedural workflows evolve and how is that potentially going to look like?

2.1 What happens in the labs and lectures?

In the **lectures** you will learn about theory, look at practical exercises and get inspiration for the subsequent labs you will be using to work on your own experiments and the assignment. The lectures are split-up and will both focus on different aspects – one being more **scripting focused** while the other will dive more deeply into **art-related contents**. These lectures are scheduled simultaneously. Students are **free to attend either lecture** each week. Since lectures will be conducted online, they will be **recorded** as well so that students are able to watch all lectures at a later time. Chances on missing out on information are greatly limited that way, which we consider a big plus.

In the **lab** class you will do **research**, work on **scene & asset creation, tooling, experiments** and occasionally small (optional) **lab assignments** by using the tools and processes necessary for finishing the city area scene. Make sure to check the **expertise of each lab teacher** in case you have a **specific question or problem** in a particular field of expertise the current lab teachers do not offer. This might mean that you need to find alternative ways of guidance, as in e-mailing, visiting other labs or joining the Q&A sessions scheduled for each Friday.

We will work a lot with **Unity**, an **IDE** of your choosing and a software package aimed towards a node-based, procedural workflow, namely **Substance 3D Designer** from Adobe. To get an understanding on how a procedural pipeline is set up, you will learn how to create and customize digital content on an intermediate level.

2.2 How does this module relate to other modules in the CMGT study program?

We expect that both engineers and designers followed the **Unity Scripting module**, so that you are able to work with the Unity game engine that we will use during both lectures and lab classes. Being able to apply knowledge obtained during the **Algorithms module** is a big plus. The artists are expected to have followed at least the **Unity3D Art module**. Knowledge and skills obtained during the previous **3D Modeling course** will be beneficial for both designers and artists. Besides that, this module teaches you the basics of acquiring a 'procedural mindset' which you can and will apply in future projects and work in general. It prepares for many of the following modules, be it a subsequent module or group project since procedural workflows are universally applicable to most digital projects.

3 What are you going to learn in this module (learning objectives)?

The student:

1. **acquires** a procedural **mindset** in being able to **create** digital content **non-destructively**.
2. **understands** the **structure** of **meshes** and procedural **materials**.
3. **understands** the **modular assets workflow** for procedural scene creation.
4. **is able to** generate **reusable** and highly **adaptable content** for a multitude of projects.
5. **knows** about different **physically based** (PBR) **materials, textures** and **shaders**.
6. **understands** methods and techniques for **optimizing** digital **content** for a **real-time** application.

4 Which resources do you need?

Any resources, recommendations, links to subsequent information and files will be conveyed during the lectures and made available on Blackboard afterwards. Furthermore, the student needs to obtain a free **Unity** license ([store.unity.com/ - plans-individual](https://store.unity.com/plans-individual)). We recommend using any **Unity LTS version (Long term stability)** and its render pipeline **HDRP** (High-Definition Render Pipeline) **template preset**. For creating procedural materials, students want to install a free student license from Adobe's node-based procedural flagship **Adobe Substance 3D Designer** (adobe.com/products/substance.html), **NOT Adobe Substance 3D Painter** since it exports bitmap textures only - the only **exception** for using **3D Painter** being the creation of additional prop textures (see rubrics). Next to this, please **include Microsoft Visual Studio** in your **Unity installation** (can also be done after the fact in your **Unity Hub: Installs -> Add components**, as this allows for code completion in Unity). Alternatively, please download and install an **IDE** of your choosing. **Microsoft Visual Studio** is recommended in any case (visualstudio.microsoft.com/). Additional Unity assets such as the '**Substance in Unity**' plugin can be downloaded from the Unity Asset Store for free (assetstore.unity.com/packages/tools/utilities/substance-in-unity-110555). Try whether they work with your installed Unity version (if it doesn't, ignore the substance implementation into Unity and showcase the procedural capabilities of your substances outside of the engine eventually).

5 What does the programme of this module look like?

On Blackboard you'll find the course content and a detailed course overview.

Week	Lecture/Lab	Topic(s)
1.4	Lecture	Combined Kick-Off for all CMGT students: Introduction and reveal of themes
1.4	Lab(s)	All lab classes: Getting started and research
1.5	Lecture(s)	Art-oriented lecture: Procedural materials primer Scripting-oriented lecture: Modular meshes and Shape grammars
1.5	Lab(s)	Art-oriented labs: (Optional) Material generation exercise and additional tips & tricks Scripting-oriented labs: Small (optional) exercise on Shape grammars & Marching squares
1.6	Lecture(s)	Art-oriented lecture: On Modular Assets and Substances in Unity Scripting-oriented lecture: Unity Editor Tooling
1.6	Lab(s)	Art-oriented labs: Modular Assets / Substances exercise (optional) Scripting-oriented labs: Small Tooling exercise (optional)
1.7	Lecture(s)	Art-oriented lecture: On shaders and how to utilize Shader-Graph Scripting-oriented lecture: Mesh Creation Basics
1.7	Lab(s)	All lab classes: Guided work on the assignment
1.8	Lecture(s)	Art-oriented lecture: Optimization techniques and tackling bottlenecks Scripting-oriented lecture: Advanced Mesh Creation
1.8	Lab(s)	All lab classes: Guided work on the assignment

6 How is this module assessed?

6.1 Assessment

The assessment encompasses the theory from the lectures, experiments conducted during the labs and the subsequent results in form of a final product. The assessment will be done based on a submission on Blackboard, a short presentation and the evaluation by the teachers involved.

There are two assessments:

- the first in week 1.9 where you need to submit the Unity project, the research document, assets, tools & building blocks and video before the presentation
- the second opportunity will be at the end of next term in week 2.9 (redo)

During the final assessment in week 1.10, each student will have to present their final product in a concise manner. A presentation template will be provided which includes slides that merely need to be filled with individual content made by the student and should cover all important aspects of the assignment.

Students will have 15 minutes in total to prepare and showcase their work in a presentation, followed by a set of questions asked by the assessors for another 5 minutes max. Please rehearse your presentation and come in as prepared as possible.

Furthermore, we will track your progress on a regular basis during the labs. Next to this, every Friday we will have open Q&A sessions for everyone who needs guidance and help.

See the rubric of the assessment on the last page.

6.2 Procedure

In order to be able/be allowed to participate in this course, you should enrol yourself for the course on Blackboard.

6.3 Criteria & Assessment form

The assignment is to create a reimagined small-scale city area from one of four pre-selected video game cities/areas. Students will work with the game engine Unity to author a three-dimensional, small, and procedurally crafted area of either a city block, a village or even a hamlet based on one of four predefined themes determined by the teachers. These available themes will be revealed during the first lecture and can be selected freely.

Deadline: The final submission needs to be handed in on Blackboard on Wednesday, the **20th of April 2022**, 23:59h at the latest.

All criteria of this assignment will be analysed and graded using rubrics. If the evaluation shows that certain criteria hasn't been met, those aspects will be graded with an insufficient. In order to pass the course, the score of your submission needs to be equal or higher than 9 points (see rubric below). In case there are any adjustments, it will be communicated through Blackboard in due time.

6.3.1 What do you have to hand in and how?

Deliverables (preconditions):

- A **Unity project** including a **Unity scene** that is at least partially procedurally generated (either in **editor**, or in **play mode** without compiling errors) and **represents a reimagined city area** based on **one** of the given **four themes**
- The created **assets, tools** and **building blocks** (can be Substances, C# scripts, Shaders, 3D meshes etc.)
- A **research document** based on your chosen theme, including visual research, additional research into relevant procedural techniques, potential use of external assets, contributions and sources (5 pages max)
- A short **video** demonstrating the procedural tooling/capabilities, and the resulting small-scape city area (including an overview of the research you've done; this should be an overview of your research document)
- Upload all files to the respective submission categories as .zip or .rar file
 - file size limit for Unity project: 1000 MB (1 GB)
 - file size limit for Tools & Building blocks: 500 MB
 - file size limit for Research document: 50 MB
 - file size limit for Video: 250 MB
- Name your files **FULLNAME_STUDENTNUMBER_CMGT-ROLE_THEME_'UNITYPROJECT'** or **'ASSETS&TOOLS&BB'** or **'RESEARCHDOC'** or **'VIDEO'** .zip/.rar respectively

Note: please do not include the Library, obj, Logs and .vs folders (and possibly .git folder) in your Unity project submission.

Important note about plagiarism: You may (and probably should) use the Handouts and Substances found on Blackboard as a starting point, and you may use free external assets (such as Kenney's modular meshes), as long as you clearly indicate what your own contribution is, as part of your research document. You will only be assessed and graded on your contribution. You may even use scripts/meshes/materials from other students under the same condition (see 'Rules for distribution' below for more additional information). Note that making a minor change to an asset from another student or from the internet, and presenting it as your own, is plagiarism. This will result in a 1 as a grade, and possibly additional measures. If you have shared your assets with other students and/or have used assets from someone, please also indicate this in your research document and credit their work, to avoid being the subject of these plagiarism measures.

Rules for distribution: The following notion is based on the official CMGT role you have signed up for in the beginning of the CMGT study course (you are free to choose what contents to create for this module regardless): As an artist you are not allowed to use assets from other artists in this module. As an engineer you are not allowed to reuse assets & code from other engineering students in this module. As a designer you are not allowed to use more than one art-related asset and one engineering-related asset from other students in this module. Note that the use of assets has to be mentioned and clarified in your research document as in, you give detailed information about the source and credit the original creator. If you are the original creator of an asset (scripts, art, substances etc.) you are allowed to share your asset with a maximum of 5 students that do not share the same CMGT role with you (artist/designer/engineer).

6.4 Redo

A second opportunity to submit the redo on Blackboard will be at the end of term 4 in week 4.10 on Sunday, the **3rd of July 2022**, 23:59h at the latest. A time, place and day for the **redo presentations** will be announced on Blackboard in a timely manner. They might be scheduled earlier than for week 4.9. Keep an eye out for the announcements for more information.

7 Who are the contact persons for this module?

Contact person	E-Mail	Expertise
Module coordinator		
Max Klostermann	m.m.klostermann@saxion.nl	Substances, Modular Assets, 3D Art/VFX, Optimization
Lecturers		
Mark Schipper	w.g.a.schipper@saxion.nl	Modular Assets, Substances, Shaders, Optimization, 3D Art/VFX
Luuk Waarbroek	l.waarbroek@saxion.nl	3D Art/VFX, Modular Assets, Optimization, Substances
Malik Nabil	m.m.nabil@saxion.nl	Modular Assets, Texturing, Optimization, 3D Art/VFX, Substances
Hans Wichman	j.c.wichman@saxion.nl	Unity Scripting, Algorithms, Debugging/Troubleshooting
Paul Bonsma	p.s.bonsma@saxion.nl	Unity Scripting, Algorithms, Mesh Generation, Code architecture

8 Rubric

Note: the rubrics are used to determine your grade and are visible in Blackboard under 'Grades and Feedback' --> 'View rubrics'.

Rubric - Procedural Art 2021/22
<p>Preconditions:</p> <ul style="list-style-type: none"> • A Unity project including a Unity scene that is at least partially procedurally generated (either in editor, or in play mode without compiling errors) and represents a reimagined city area based on a chosen theme (1 out of 4) • The created assets, tools and building blocks (can be C# scripts, shaders, 3D meshes, Substances etc.) • A research document based on your chosen theme, including visual research, additional research into relevant procedural techniques, potential use of external assets, contributions, and sources (5 pages max; the research document also contains a clear and truthful overview of what your own contributions are) • A short video demonstrating the procedural tooling/capabilities, and the resulting small-scale city area including an overview of the research document you've created <p>If you do not meet the preconditions, the submission will be graded with an insufficient. Plagiarism will result in a 1 and potentially also additional measures. The use of Substance Painter for authoring textures is also prohibited with one exception: the creation of textures for additional props (see category 5 in the rubric).</p>
<p>Grading: Divided into five categories, 25 scoring aspects (criteria) have been given (28 points possible in total). You can score 0, 0.5 or 1 points in each aspect (0 points = not satisfied, 0.5 points = satisfied on a basic or mediocre level, 1 point = satisfied completely) with three exceptions where a student is able to score 2 points max. for three particular aspects (optimization, materials/substances and tooling).</p> <p>Grade = 1 + #points/2 (with a maximum of 10). Note: you only need to score 17 points (1+17/2 = 9.5) in total for a 10 as your final grade.</p>

	Criteria	Not satisfied	Basic / mediocre	Satisfied completely
1. Theme-based Research (4 pts) You analyse several methods of procedural content creation to explore potential solutions and research visual reference.	A clear description of architectural elements is given.	0	0.5	1
	A clear description of the city shape is given (roads, neighbourhoods, terrain elements, top-down-structure).	0	0.5	1
	A clear description of materials is given (necessary amount, state of material, material properties).	0	0.5	1
	New procedural techniques or tools have been researched and described ("new" = not treated in detail during the lectures).	0	0.5	1
2. Meshes, UV and Structure Generation (10 pts) You are able to create mesh structures procedurally and / or make use of modular assets to design buildings with real-time optimization in mind.	A wide range of shapes is created procedurally from a smaller range of building blocks.	0	0.5	1
	Meshes are created or modified procedurally (e.g. lathe, extrude, warp).	0	0.5	1
	The resulting structures match the visual research.	0	0.5	1
	Meshes (modules) are created that fit the style.	0	0.5	1
	A consistent scale for size and placement of buildings and other structures has been established.	0	0.5	1
	There is a lot of recognizable variety in the buildings (i.e. not "bowls of oatmeal" style variety).	0	0.5	1
	Mesh modules are UV'd to enable tiling.	0	0.5	1
	Procedural meshes are textured without extreme artefacts, e.g. stretching, stitches (this can be done with procedural UVs or by shaders).	0	0.5	1
3. Materials, Shaders and Textures (6 pts) You apply procedurally generated physically based materials and texture types to mesh-based structures in a procedural manner.	Optimizations have been done for real-time efficiency (think: LOD groups, draw call optimization, careful observing poly counts, mesh welding).	0	1	2
	An appropriate amount of believable looking High-Quality PBR materials (substances) have been created behave realistically and are efficient in performance.	0	1	2
	A suitable amount of texture variety has been produced that match the visual style and are used in the scene to capture important characteristics & details of the chosen theme.	0	0.5	1
	Good choices have been made regarding texel density and texture sizes.	0	0.5	1
	All textures have the proper scale (as applied in the scene onto their respective surfaces).	0	0.5	1
	Custom shaders are used and enhance the scenery (as in boosting the visual fidelity, e.g. motion, water, raindrops done through Shader Graph or code).	0	0.5	1

4. Customizability and Control (5 pts) You can showcase complex and diverse content creation by means of providing control and tooling methods.	There is custom (Unity editor) tooling for fast scene creation (e.g. building placement, road drawing).	0	1	2
	Buildings can be customized after generation.	0	0.5	1
	Building parameters can be controlled before generation (e.g. different neighbourhoods have different building styles).	0	0.5	1
	Materials can be customized (exposed parameters right inside of Unity).	0	0.5	1
5. Look and Feel (3 pts) You are able to provide polished visual results by creating a plausible, re-imagined adaptation of the chosen theme.	Additional props and an appropriate amount of city-specific characteristics were added to increase detail and realism.	0	0.5	1
	Appropriate lighting and Post Processing / VFX have been applied to enhance visual fidelity.	0	0.5	1
	The overall look matches the chosen theme.	0	0.5	1
<p style="text-align: right;">Total amount: 1+ ____ /2</p> <p style="text-align: right;">Grade: ____</p>				

Points under Total amount (pre-calculation)					
≤ 8.5 points = Insufficient (1 - 5)	9 – 10.5 points = Sufficient (6)	11 – 12.5 points = Decent (7)	13 – 14.5 points = Good (8)	15 – 16.5 points = Great (9)	≥ 17 points = Excellent (10)