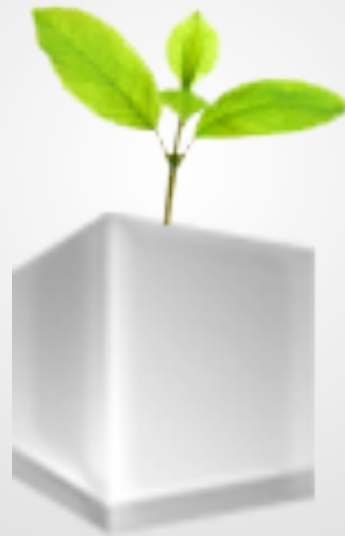


Procedural Generation

Natural Environments Out Of The Box



Master of Informatics

Term 2009/2010 – HAW Hamburg

Supervisor: Prof. Dr. –Ing. Andreas Meisel

Torben Wallbaum, B.Sc.

Contact: torben [,at '] redsparks.net



Chapter: Overview

- Explicit Graphics
- Procedural Graphics
- Natural Environments
- Techniques
- Use Cases and Examples
- Project and Future Work
- .KKrieger



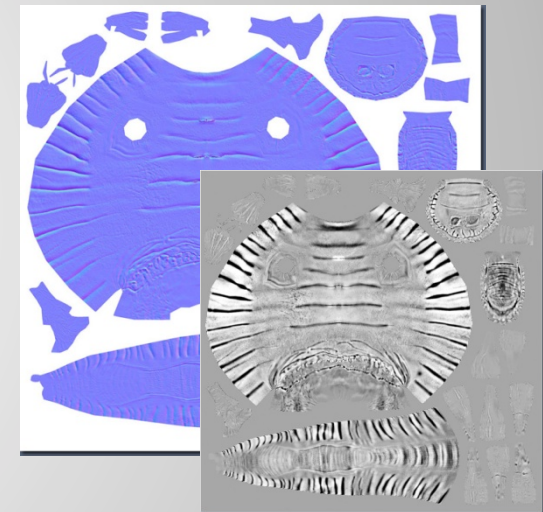
- What do you need for a modern 3D graphic?



Model



Textures



Maps



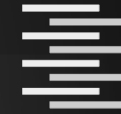
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Chapter: Explicit Graphics

Final Product



Making Of 'Nightmare Stalker'
by Chris Davis
www.3dtotal.com [12-08-09]



- The common approach:
 - Explicit specification of all elements
 - Very complex
 - Time-consuming
 - Large files





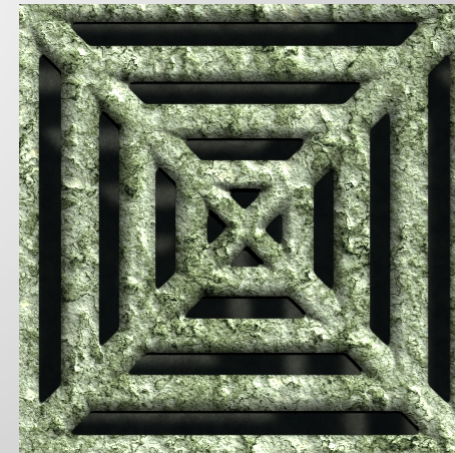
- Abstraction
- Parametric control
- Database amplification
- Application ranges include geometry, textures, animations, particle systems, etc.
- Flexibility



- Was originally introduced to produce textures
- Since 1985 the use of procedural techniques has been growing rapidly
- Since then it is an active field of research in computer science
- Low-cost programmable graphics hardware of today makes high-quality effects possible



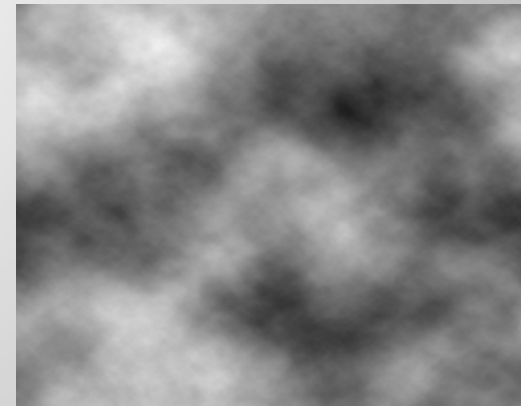
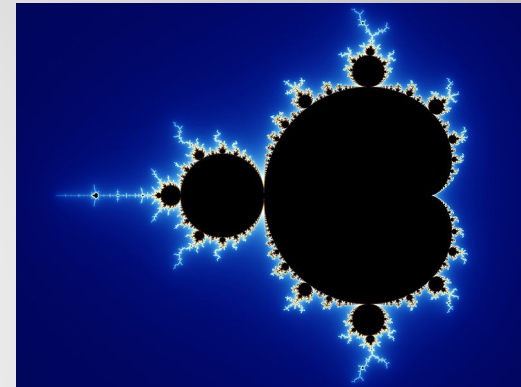
- Textures describe the appearance of a surface
- Can be divided into shading and texturing
- Generated synthetically, instead of scanning or painting a picture
- Does not qualify for all purposes



http://en.wikipedia.org/wiki/File:Procedural_Texture.jpg



- Different types of synthesis
 - Fractal (stochastic subdivision)
 - Shade trees
 - Noise
 - Statistical (reproduction)
 - Biochemical
 - Genetic (selection)
 - Etc.



<http://en.wikipedia.org>



- Pro
 - Extremely compact (kb instead of mb)
 - No fixed resolution
 - No fixed area (seams, repetition)
 - Generates a class of textures instead of a single one
- Con
 - Difficult to construct
 - Might be a surprise
 - Time versus space



Chapter: Procedural Graphics

Examples



Allegorithmic [12.12.2009]

<http://www.allegorithmic.com/?PAGE=GALLERY.illustrations>



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Chapter: Procedural Graphics

Examples



Allegorithmic [12.12.2009]

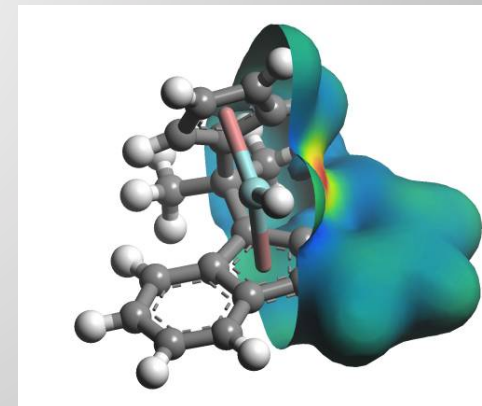
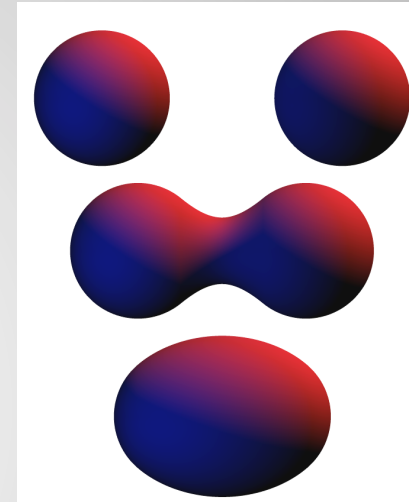
<http://www.allegorithmic.com/?PAGE=GALLERY.illustrations>



- Geometry is the foundation of 3D and 2D graphics
- Consists of faces, edges and vertices
- Procedural geometry is useful for repetitive and abstract structures



- „Multiplicative“ geometry
- Genetic
- Isosurfaces or MetaBalls
- L-Systems
- Fractals
- Particle Systems
- Etc.



<http://en.wikipedia.org>



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Chapter: Procedural Graphics

Procedural Geometry



Procedural [13.12.2009]

<http://www.procedural.com/cityengine/pictures.html>



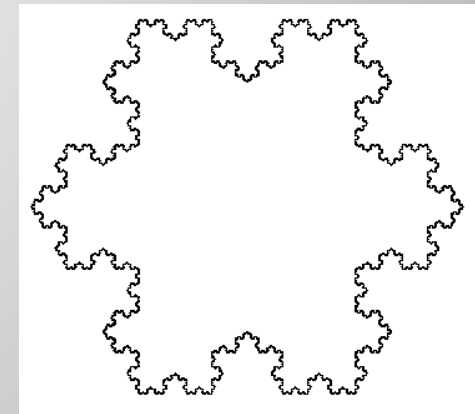
- **Virtually reproduce natural environments**
 - Single trees and other plants
 - Natural terrains
 - Entire landscapes like forrests and meadows
 - Etc.
- **Apply procedural / rule-based techniques**
 - L-Systems
 - Fractal
 - Noise
 - Etc.



Chapter: Techniques

Lindenmayer System

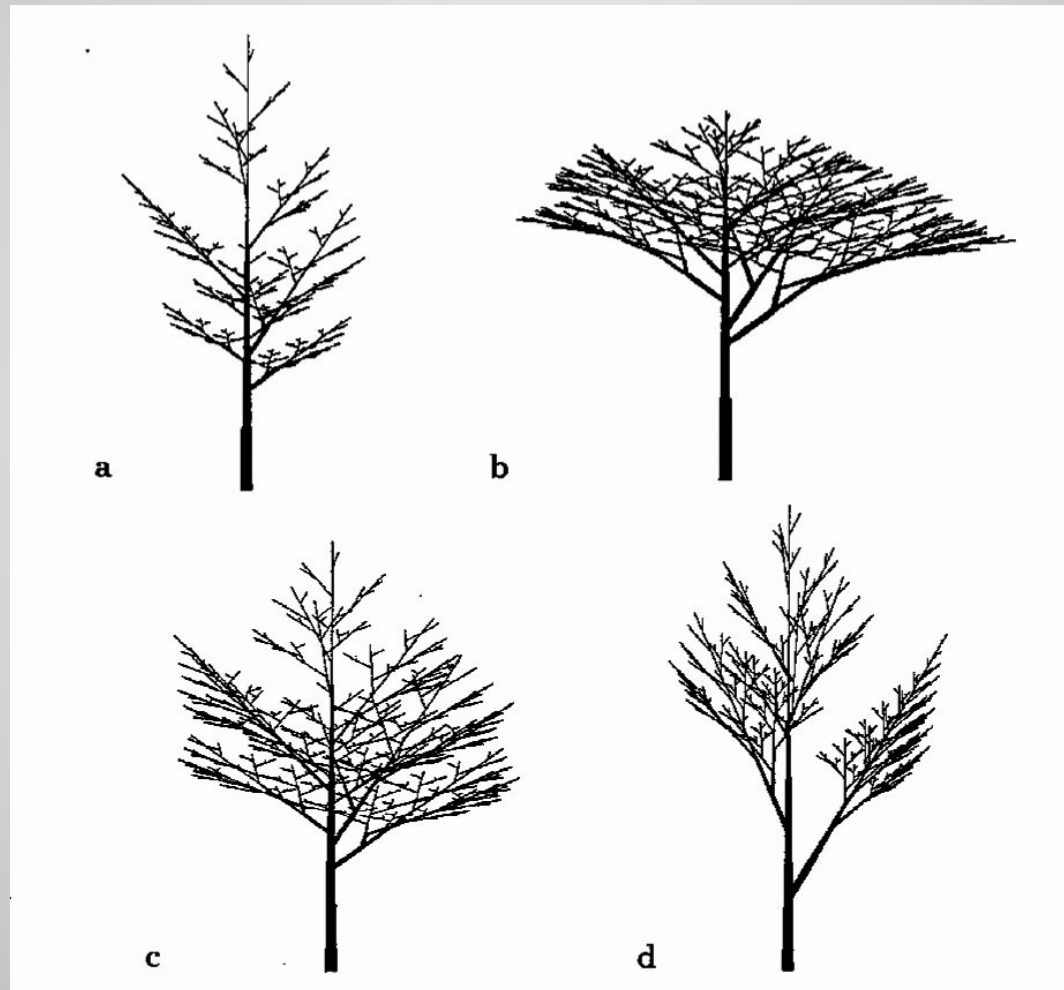
- Lindenmayer System -> replacement system
- $G = (V, \omega, P)$
 - V: alphabet
 - ω : not empty axiom
 - P: productions
- $\omega = F--F--F \mid P = \{(F \rightarrow F+F--F+F)\}$
- Turtle-Graphic

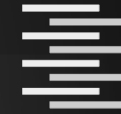




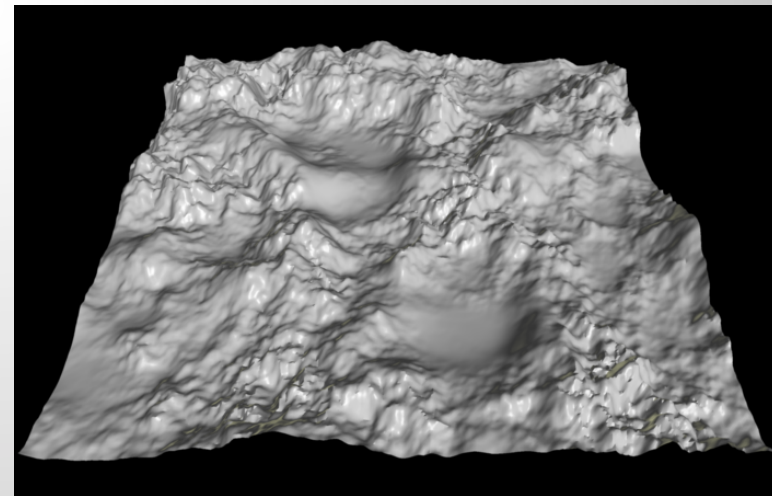
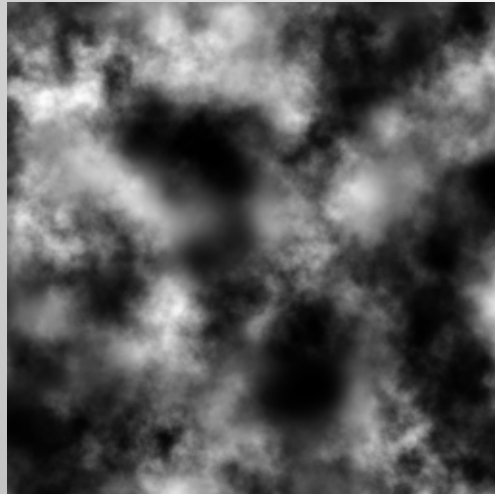
Chapter: Techniques

Lindenmayer System





- Generating terrains through fractals and noise
- Simple:
 - Noise could be a HeightMap (Perlin Noise)



<http://en.wikipedia.org/wiki/Heightmap>



- Architecture
- Town and country planning
- Movie industry
 - Special effects
 - Environment
 - Animation movies (Shrek, etc.)
- Game industry
 - Landscapes for games
 - Almost a whole game?



Chapter: Examples

How does it look like

Welcome to SPORE™





Chapter: Examples

How does it look like

- Terragen 2 by Planetside Software
- Generation of landscapes
- CityEngine
- Modelling of 3D cities with parameters



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Chapter: Examples

How does it look like



Terragen 2 [12.12.2009]
<http://www.planetside.co.uk/gallery/f/tg2>



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Chapter: Examples

How does it look like



Terragen 2 [12.12.2009]
<http://www.planetside.co.uk/gallery/f/tg2>



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Chapter: Examples

How does it look like



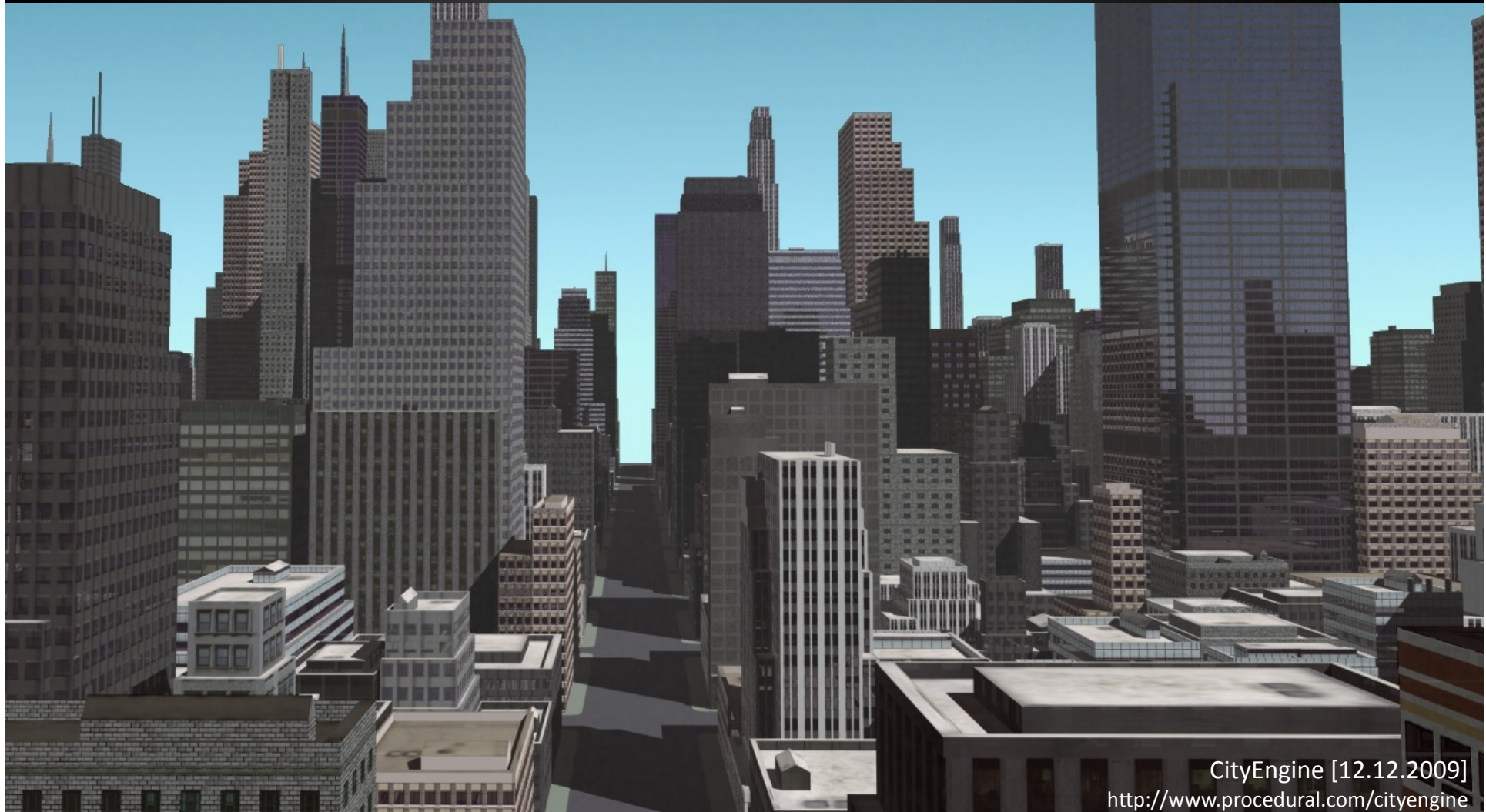
Terragen 2 [12.12.2009]
<http://www.planetside.co.uk/gallery/f/tg2>



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Chapter: Examples

How does it look like



CityEngine [12.12.2009]
<http://www.procedural.com/cityengine>



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Chapter: Examples

How does it look like



CityEngine [12.12.2009]
<http://www.procedural.com/cityengine>



Chapter: Project

Plans for the upcoming Projects

- Learn more about the subject of procedural graphics
- Try and compare different techniques
- Concentrate on natural environments
 - Interaction within the environment
 - Weather
 - Artificial ageing
 - Animation
 - [Programmable Graphics Hardware]



Chapter: .KKrieger

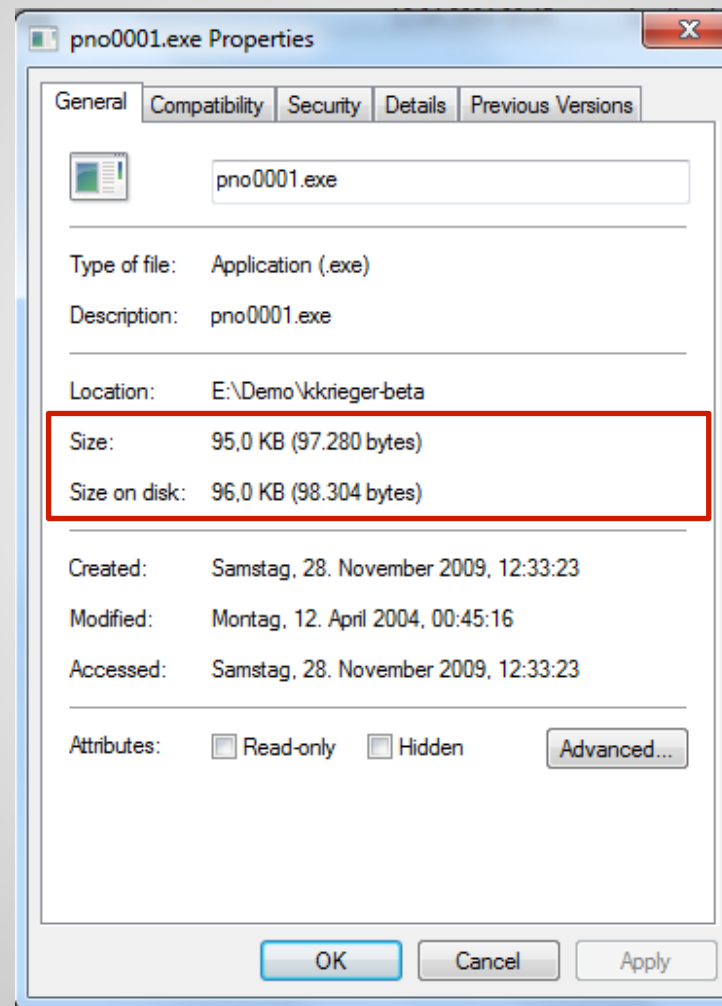
- Developement by .theprodukt
 - Was part of „Farbrausch“ (German Demo Group)
 - Egoshooter intensely uses procedural techniques
 - Guess the file size 😊



.KKrieger Demo



Chapter: .KKrieger





Chapter: Literature

LITERATURE

- **[DEUS03]**: DEUSSEN, OLIVER PROF. DR.: Computer-generierte Pflanzen: Technik und Design digitaler Pflanzenwelten, Springer-Verlag 2003
- **[EBER03]**: EBERT, DAVID S. / MUSGRAVE, F. KENTON / PEACHEY, DARWYN / PERLIN, KEN, WORLEY, STEVEN: Texturing & Modeling: A Procedural Approach, Morgan Kaufmann 2003

FURTHER READING

- **[O'NEIL01]**: O'NEIL SEAN: A Real-Time Procedural Universe, Gamasutra Article (4 Parts): http://www.gamasutra.com/view/feature/3098/a_realtime_procedural_universe_.php
- **[DEUS04]**: DEUSSEN, OLIVER PROF. DR. / EBERT, DAVID S. / FEDKIW, RON / MUSGRAVE, F. KENTON / PRUSINKIEWICZ, PRZEMYSLAW / ROBLE DOUG / STAM JOS / TESSENDORF JERRY: The Elements of Nature – Interactive and Realistic Techniques, SIGGRAPH 2004 – Course 31



**Thank you for your
attention!**