3DEXPERIENCE®

S9949: A new PBR Material serving Mobile, Web, Real-time Engines and Raytracing

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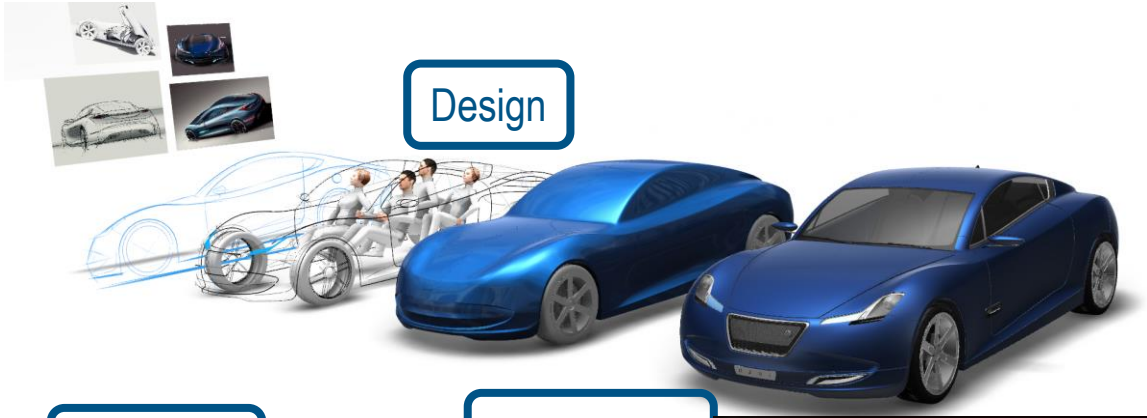
Pierre Maheut (Allegorithmic)
Jan Jordan (NVIDIA)

DASSAULT SYSTEMES | The 3DEXPERIENCE® Company

Motivation

Enterprise Visualization – Diverse Requirements

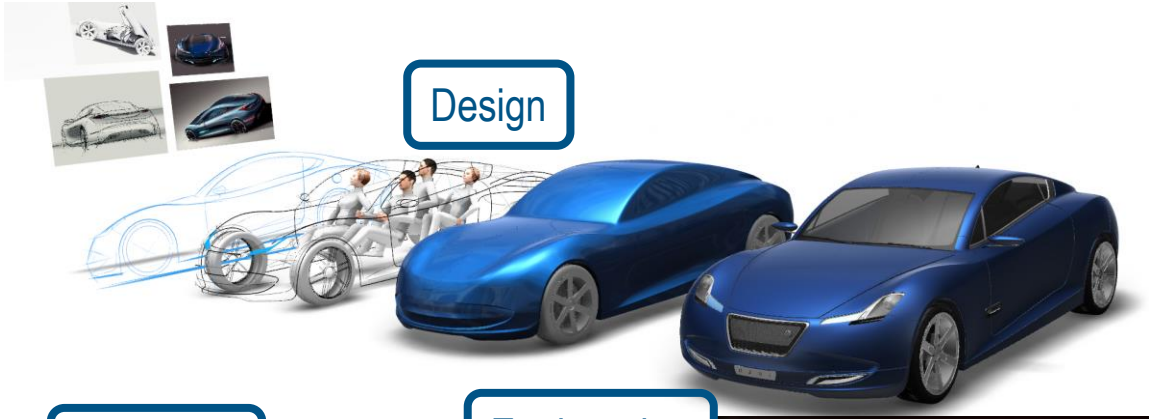


Marketing

Engineering

image courtesy of Opel

Enterprise Visualization – Diverse Requirements



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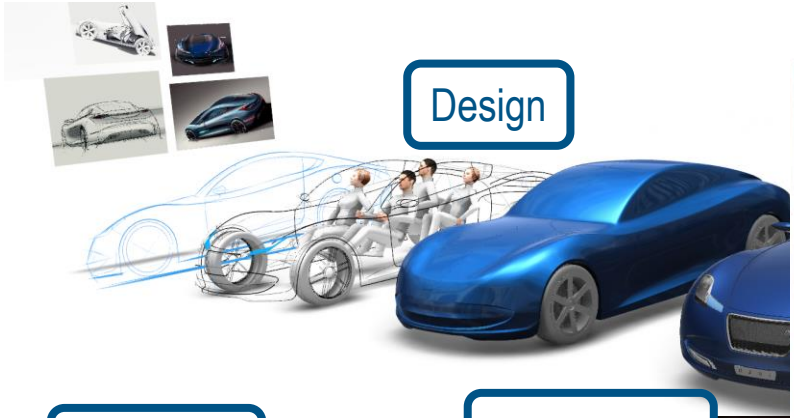
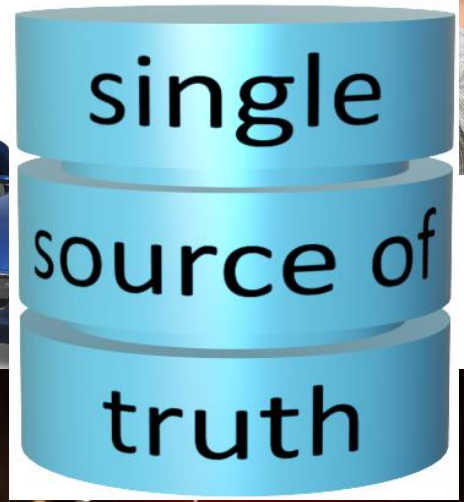
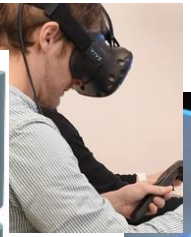
Enterprise Visualization – Diverse Requirements



Design



VR



Powerwall

AR

Mobile

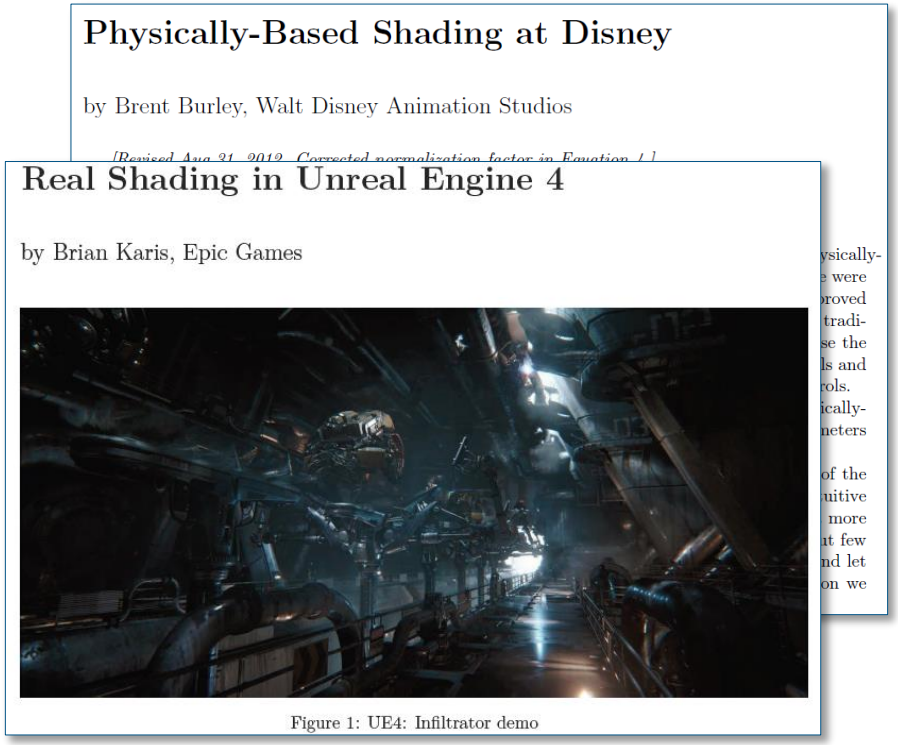
Marketing

Engineering

image courtesy of Opel

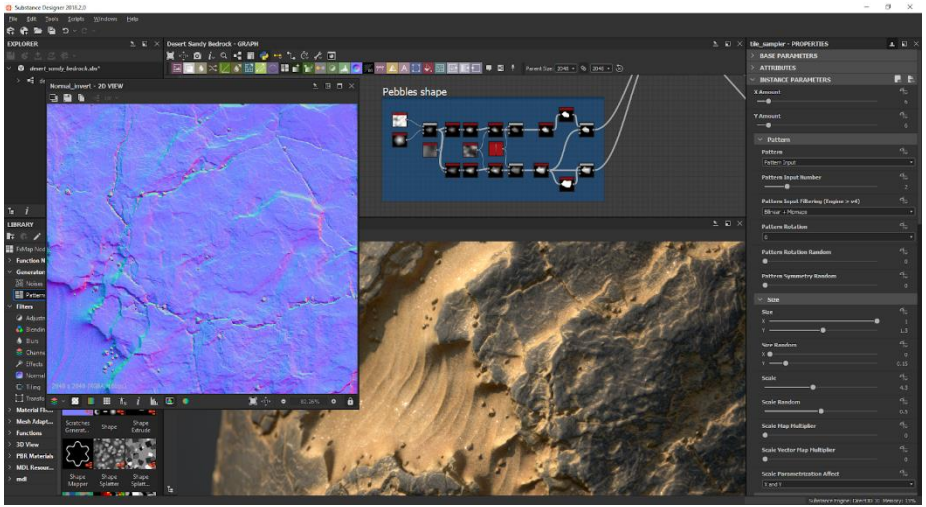
GGX PBR

- Different proposals
  - Disney Principled BRDF
  - Unreal 4 PBR Material
  - …
- Widely adopted
- Very performant
- Not all relevant effects covered



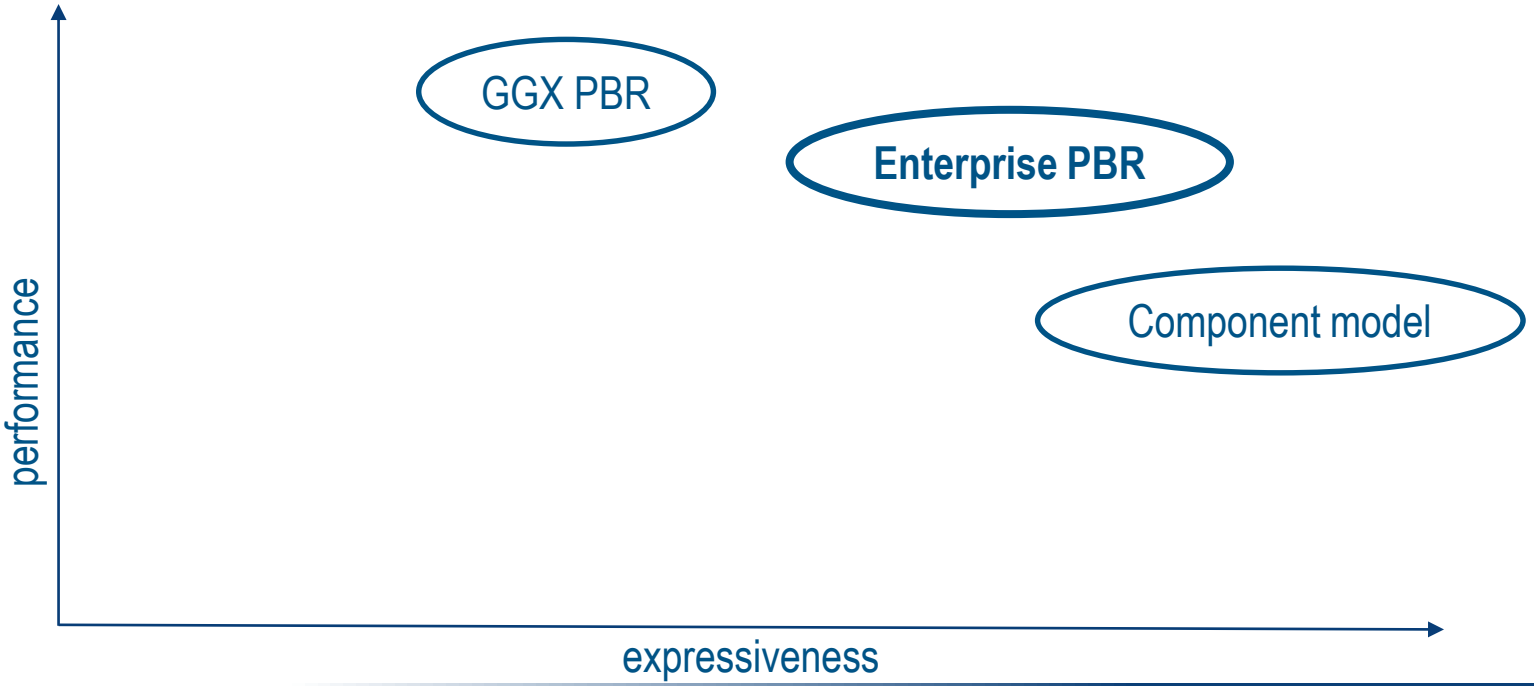
Component Models

- Many proposals
  - MDL (Material Definition Language)
  - OSL (Open Shading Language)
  - …
- Widely adopted
- Very expressive
- Hard to implement efficiently



New Proposal: Enterprise PBR

- Great expressiveness at great performance



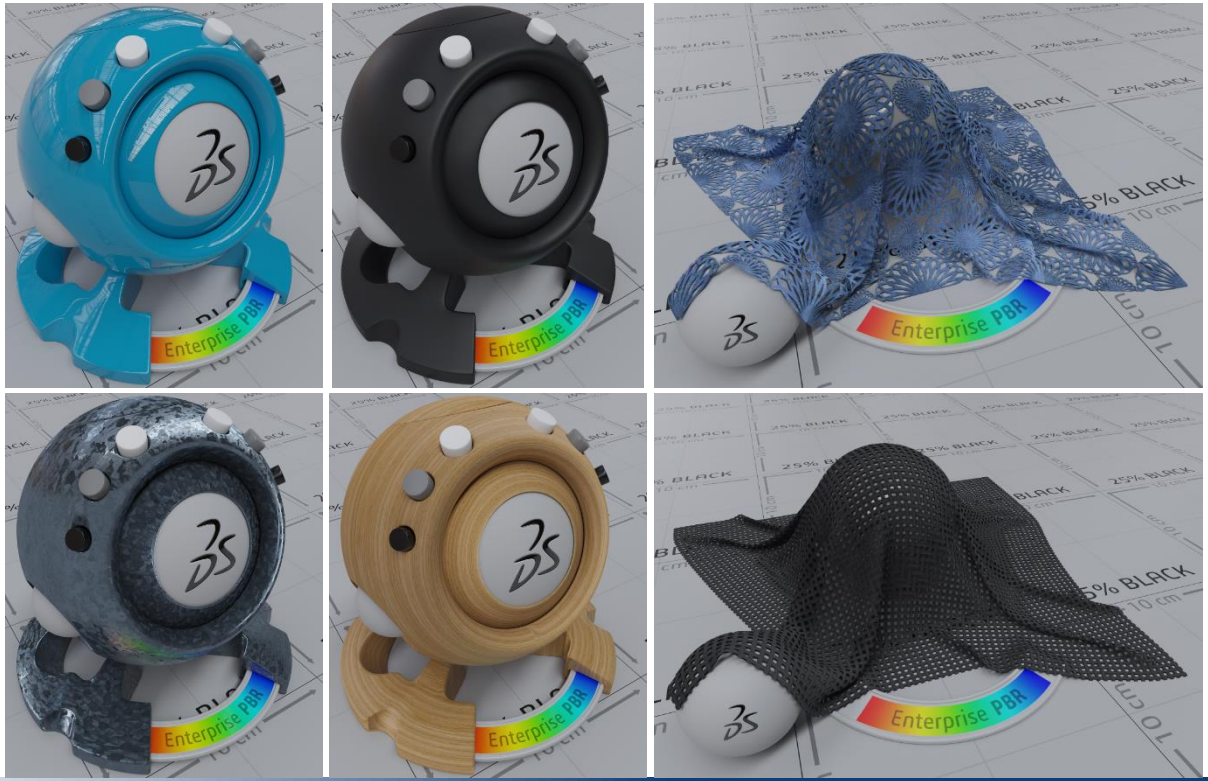
Proposed Appearance Model

Enterprise PBR

- Design Goals
  - Expressiveness – model most common materials
  - Performance – AR / VR / mobile
  - Ease of use – few intuitive parameters
  - Fitness for Global Illumination
- Inspired by existing GGX models

Enterprise PBR – Base Layer

- Albedo *
- Metallic *
- Roughness *
- Anisotropy *
- Normal Map *
- Transparency
- Cutout Opacity *
- Sheen *
- Specular *
- Specular Tint *
- **Not:** Sheen Tint



* Supported in popular GGX PBR

Enterprise PBR – Coating Layer

- Clearcoat *
- Clearcoat Roughness *

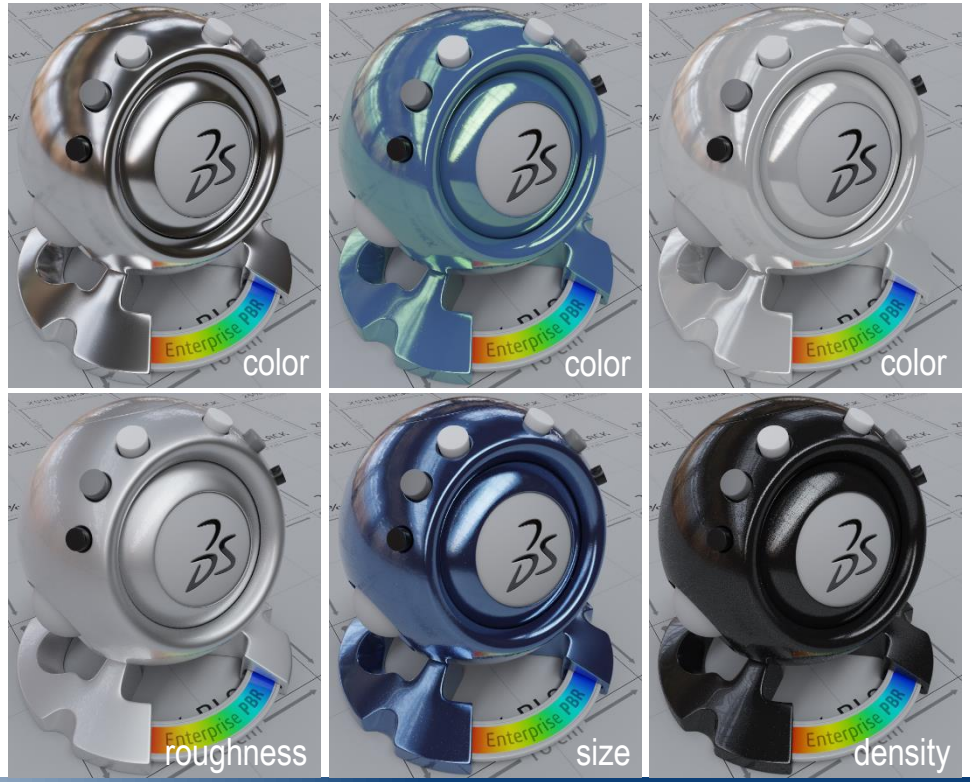
- **Not:**
  - Clearcoat IOR
  - Tinting
  - Thin Film

* Supported in popular GGX PBR

Enterprise PBR – Flakes Layer

- Flake Color
- Flake Density
- Flake Roughness
- Flake Size

- **Not:**
  - Differentiation Flip vs. Flop
  - Roughness of individual flakes

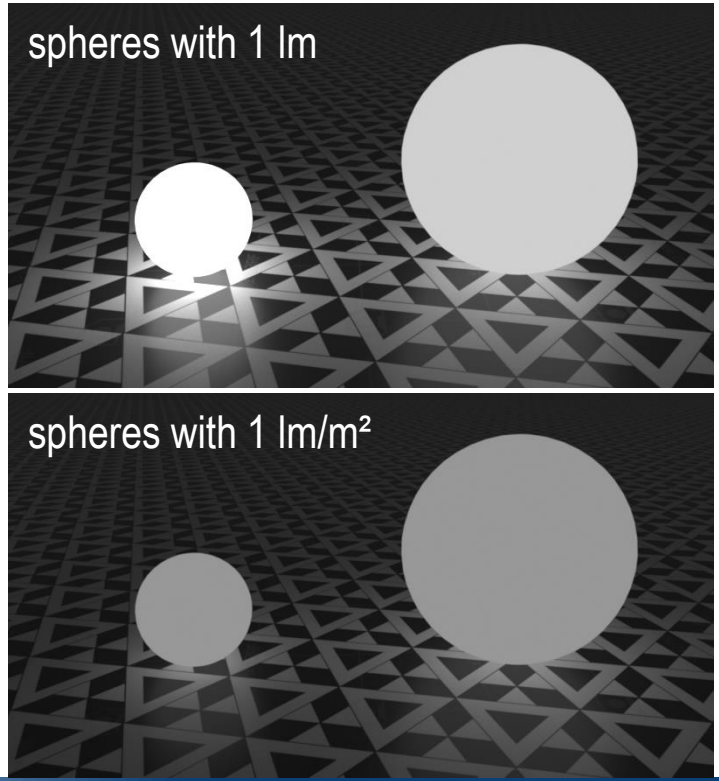


* Supported in popular GGX PBR

Enterprise PBR – Emission Layer

- Emission color * (normalized or not)
- Emission value (in lm/m² or lm)

- **Not:**
  - Goniometric profile

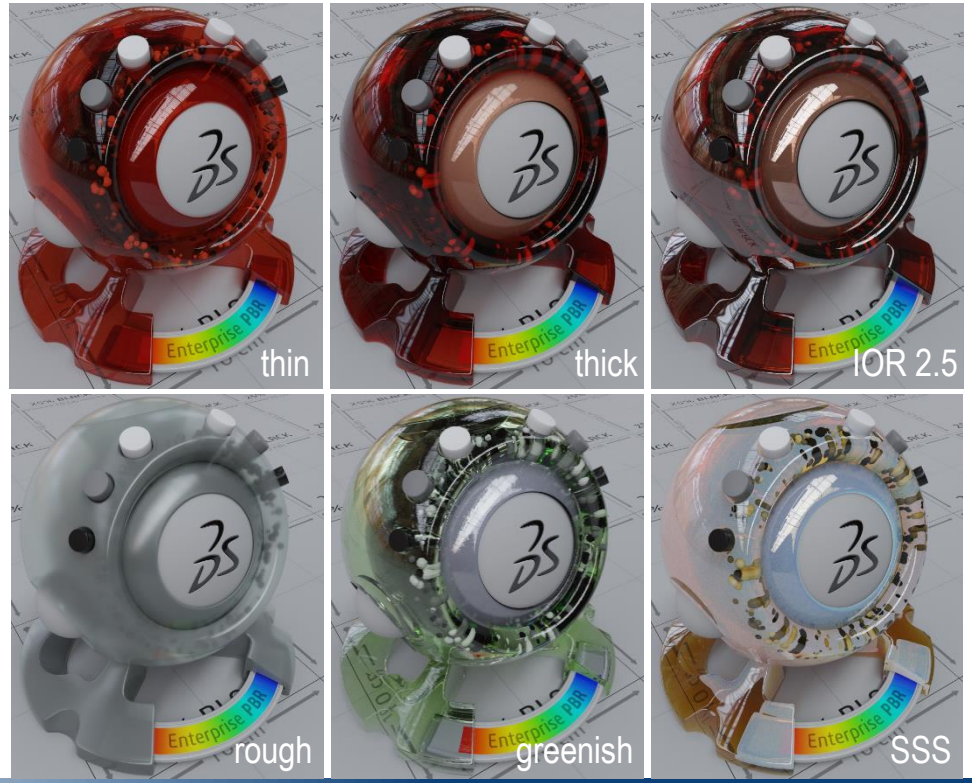


* Supported in popular GGX PBR

Enterprise PBR – Volume Layer

- Thin Walled
- IOR
- Attenuation Color
- Attenuation Distance
- Subsurface Color *

- **Not:**
  - Phase Function

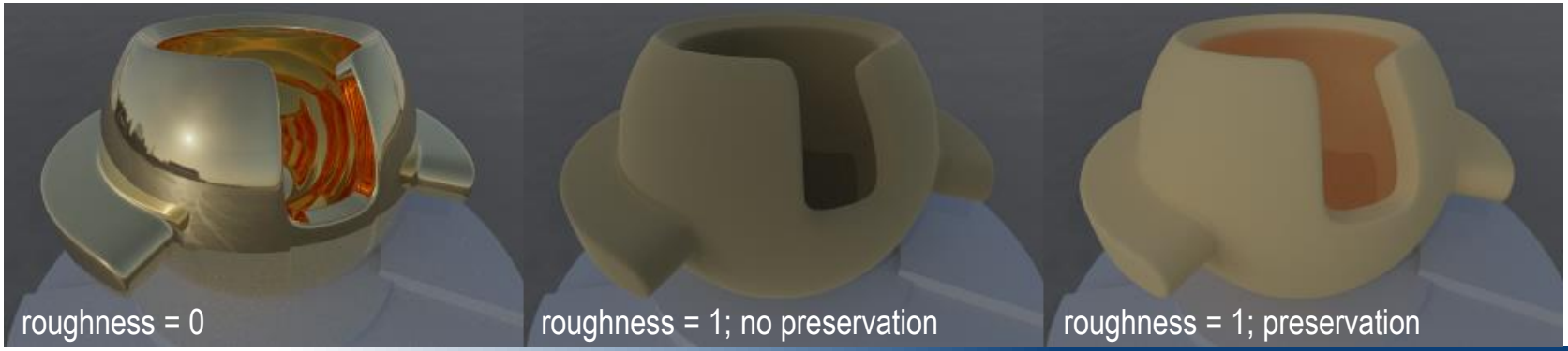


* Supported in popular GGX PBR

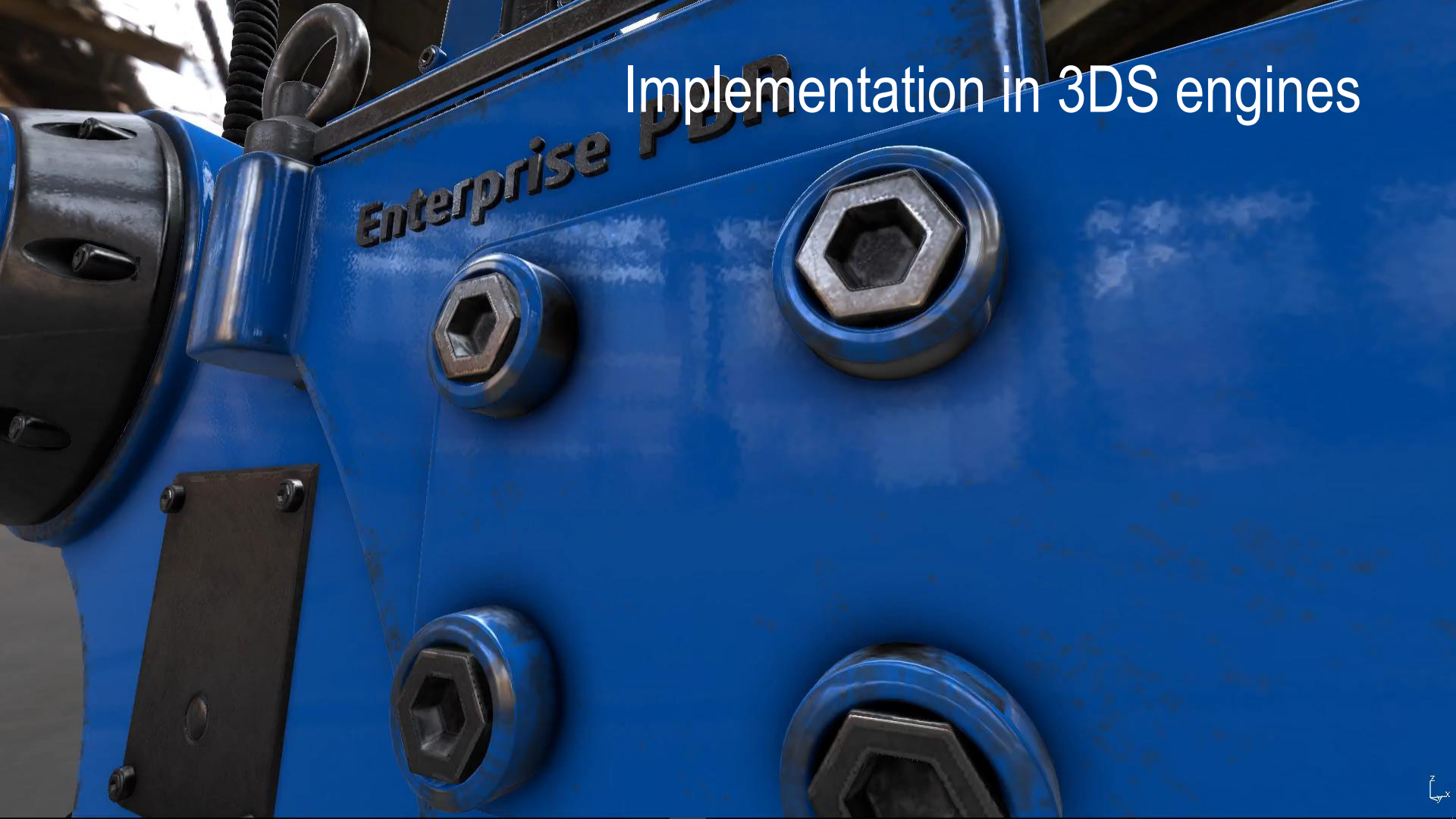
Energy Preservation

- Previous PBR models: energy conservation
- Enterprise PBR: also energy preservation / multi-scattering
- Solutions:
  - Lookup table
  - Approximation via closed formula

$$C_r(\mathbf{v},\mathbf{l}) = \underbrace{\frac{(1-E_m(\mathbf{v}\cdot\mathbf{n}))(1-E_m(\mathbf{l}\cdot\mathbf{n}))}{\pi(1-E_{m,avg})}}_{\text{Multiple scattering GGX}} \underbrace{\frac{{F_{m,avg}}^2 E_{m,avg}}{1-F_{m,avg}(1-E_{m,avg})}}_{\text{Multiple scattering Fresnel}}$$

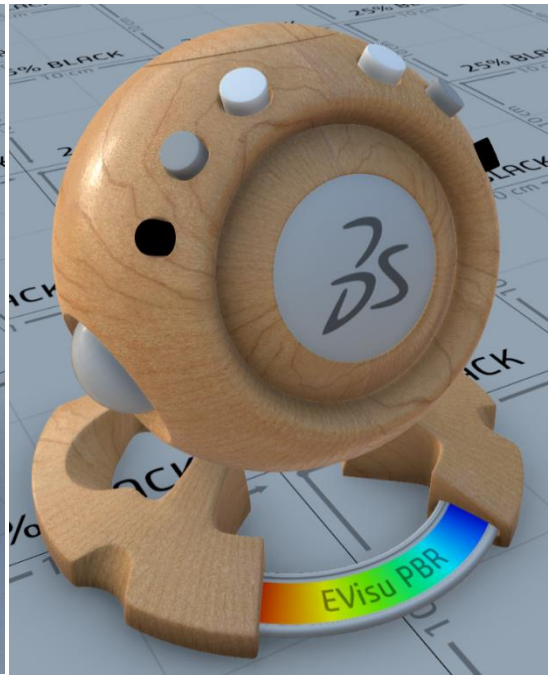


Implementation in 3DS engines



Consistency between Renderers

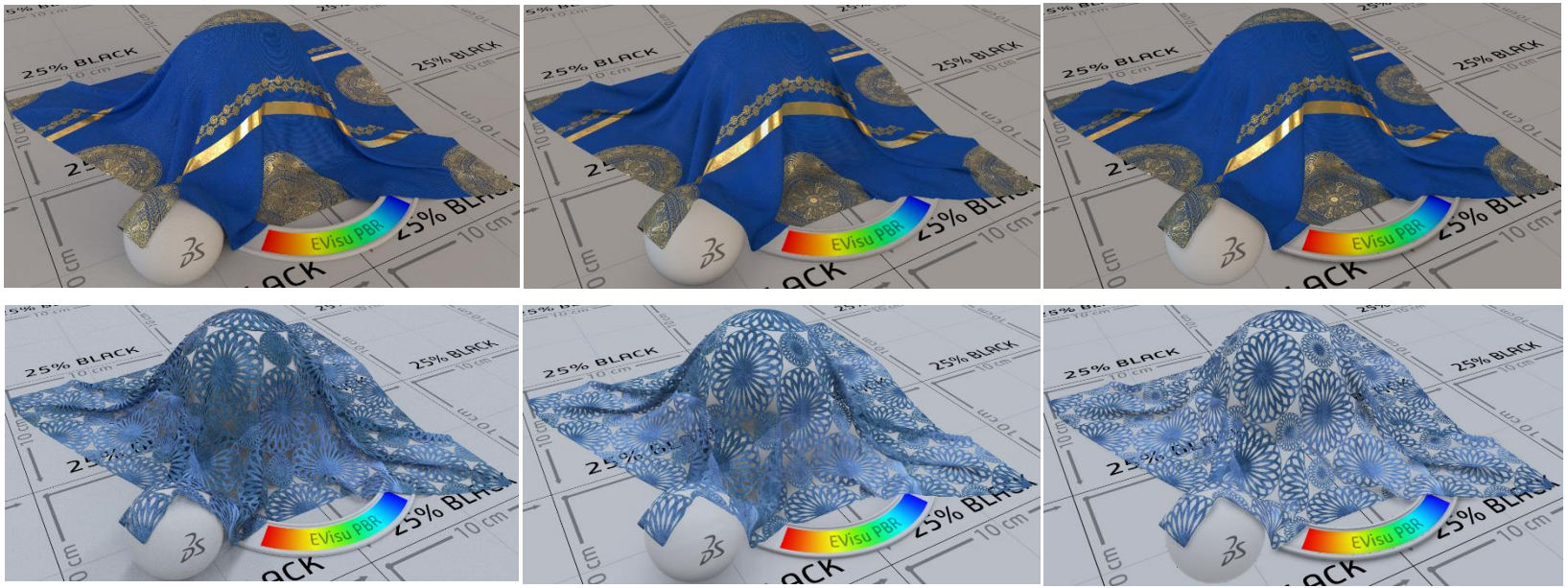
Path tracer



OpenGL 4.6

WebGL

Consistency between Renderers



Path tracer | OpenGL 4.6 | WebGL

Consistency in different Engines

Path tracer (GI) | OpenGL 4.6 (OGL) | WebGL (Web)

in collaboration with

COVIVIO

Consistency in different Engines (with baking)

in collaboration with
COVIVIO

Enterprise PBR – Github project

- Published on Github
  https://github.com/DassaultSystemes-Technology/EnterprisePBRShadingModel
  - ▷ Specification
  - ▷ User Guide
  - ▷ Images
  - ▷ Format Example (based on glTF 2.0)
- Target:
  Evolve into widely used standard

README.md

Enterprise PBR Shading Model

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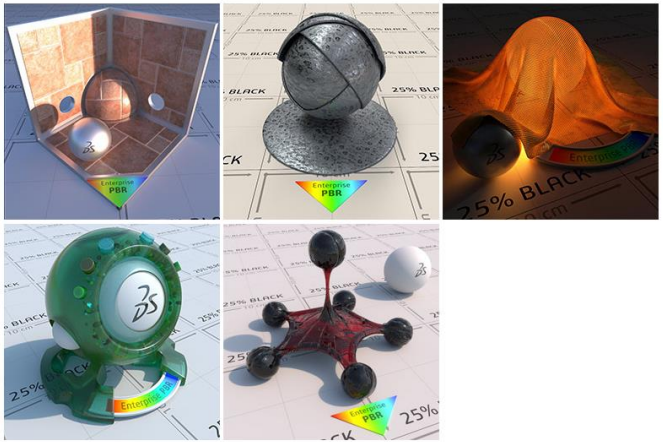
The Dassault Systèmes Enterprise PBR Shading Model (DSPBR) is an easy-to-use, renderer-independent PBR material for a large variety of industries and use-cases, ranging from high-performance VR applications to high-quality GI renderings.

- Specification
- User Guide

Raytraced Examples

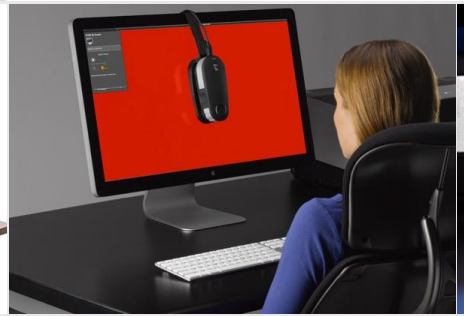


Ecosystem

Creating and Using Enterprise PBR

INTRODUCTION

WHO WE ARE



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INTRODUCTION

METHODS TO GENERATE DIGITAL MATERIALS

TOTAL APPEARANCE CAPTURE

IS THE DIGITIZATION OF MATERIALS

WITH TRUE, FULL

APPEARANCE MEASUREMENT.

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COMMUNICATE

THE APPEARANCE EXCHANGE FILE FORMAT

THE **AxF FILE** IS THE **DIGITAL TWIN OF A PHYSICAL MATERIAL SAMPLE** COMPRISING, FULL APPEARANCE MEASUREMENT INFORMATION PLUS METADATA.

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AxF MATERIAL FORMATS

MEASURED MATERIALS

- SVBRDF
  - Ward
  - GGX
  - EP-GGX (Dassault Systems)
- CarPaint (BTF/BRDF Hybrid)
- Translucent Plastic

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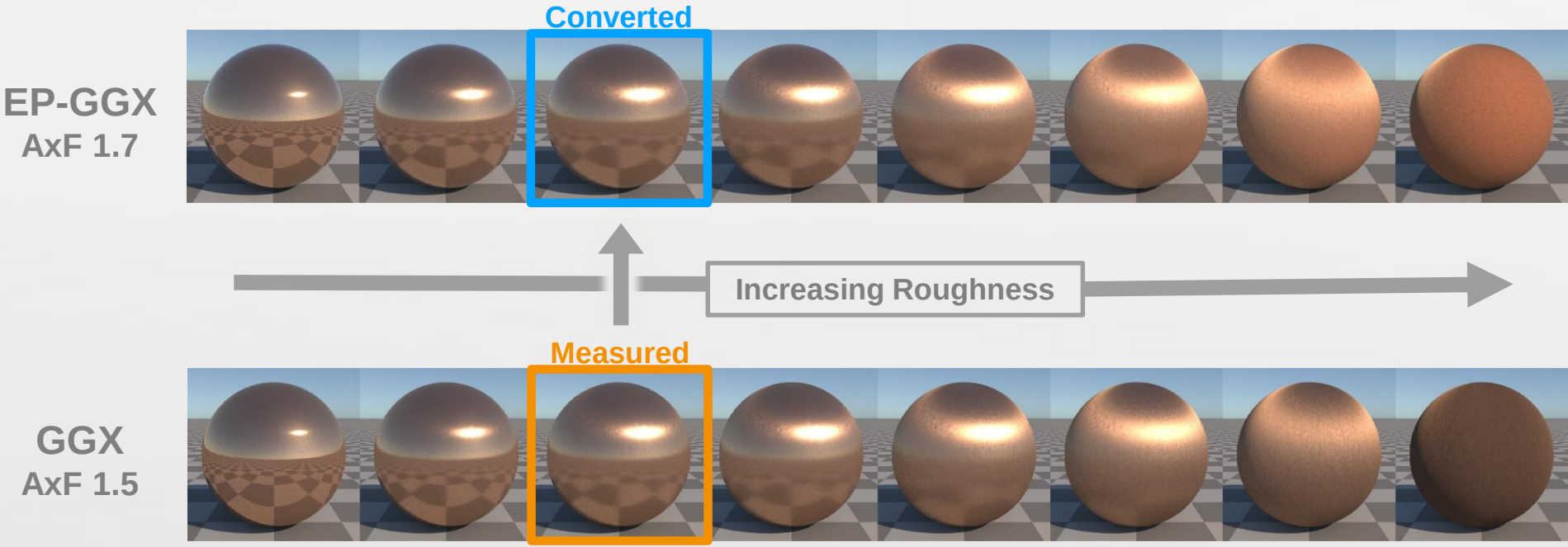
EP-GGX in AxF 1.7

DEFAULT SVBRDF MATERIAL MODEL



CAPTURE
THE TAC7 SCANNER

DESIGN AWARD 2017

EDIT AND MANAGE
THE PANTORA DIGITAL MATERIAL HUB

VISUALIZE
THE VIRTUAL LIGHT BOOTH

DESIGN AWARD 2018

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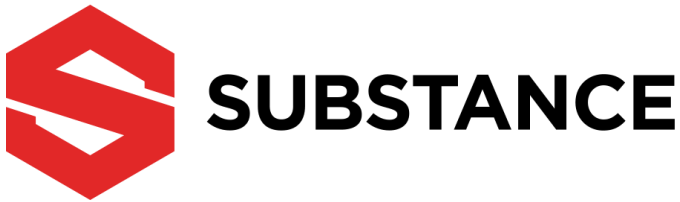
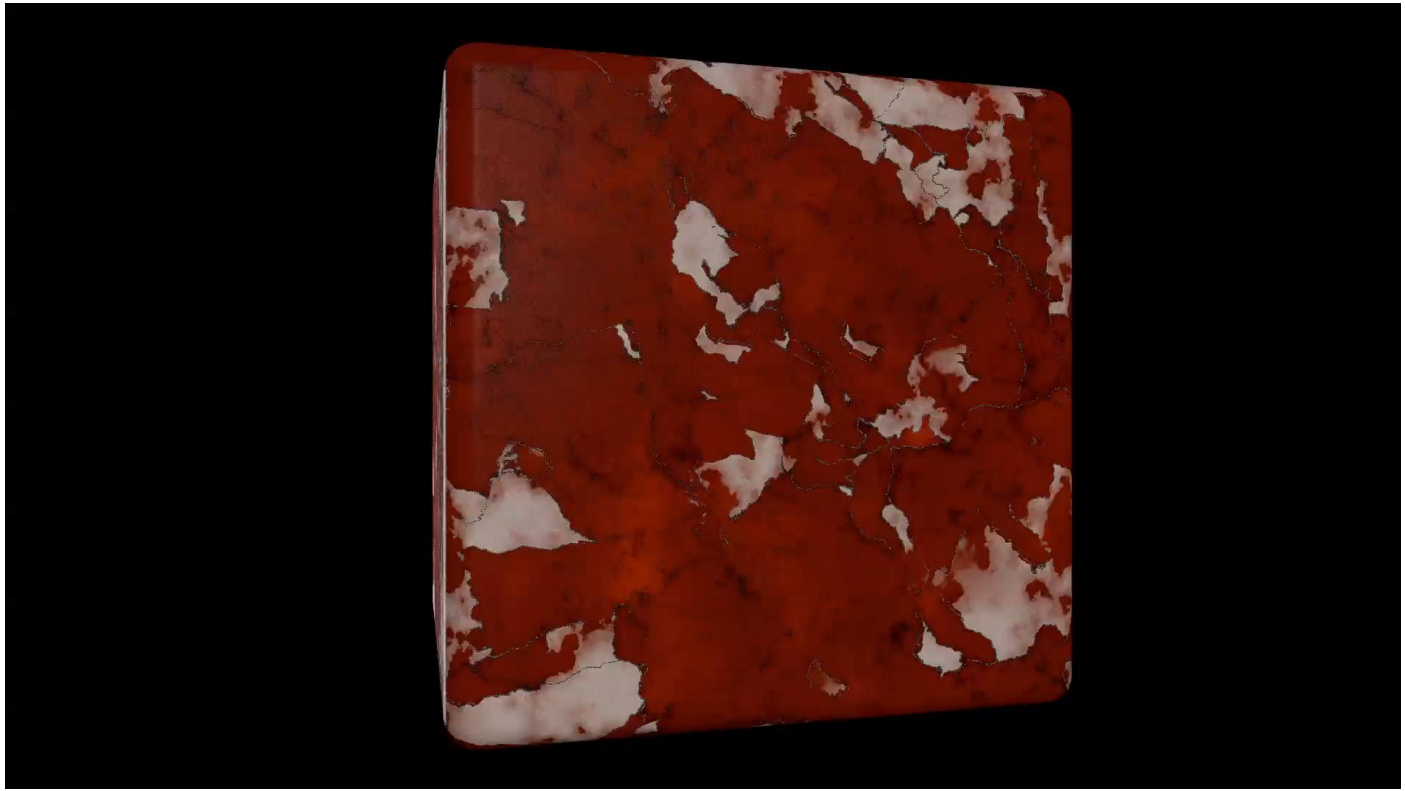


THE INDUSTRY STANDARD
FOR MATERIAL AUTHORING AND 3D TEXTURING

SUBSTANCE PARAMETRIC MATERIAL



A COMPREHENSIVE TOOLSET

SOFTWARE

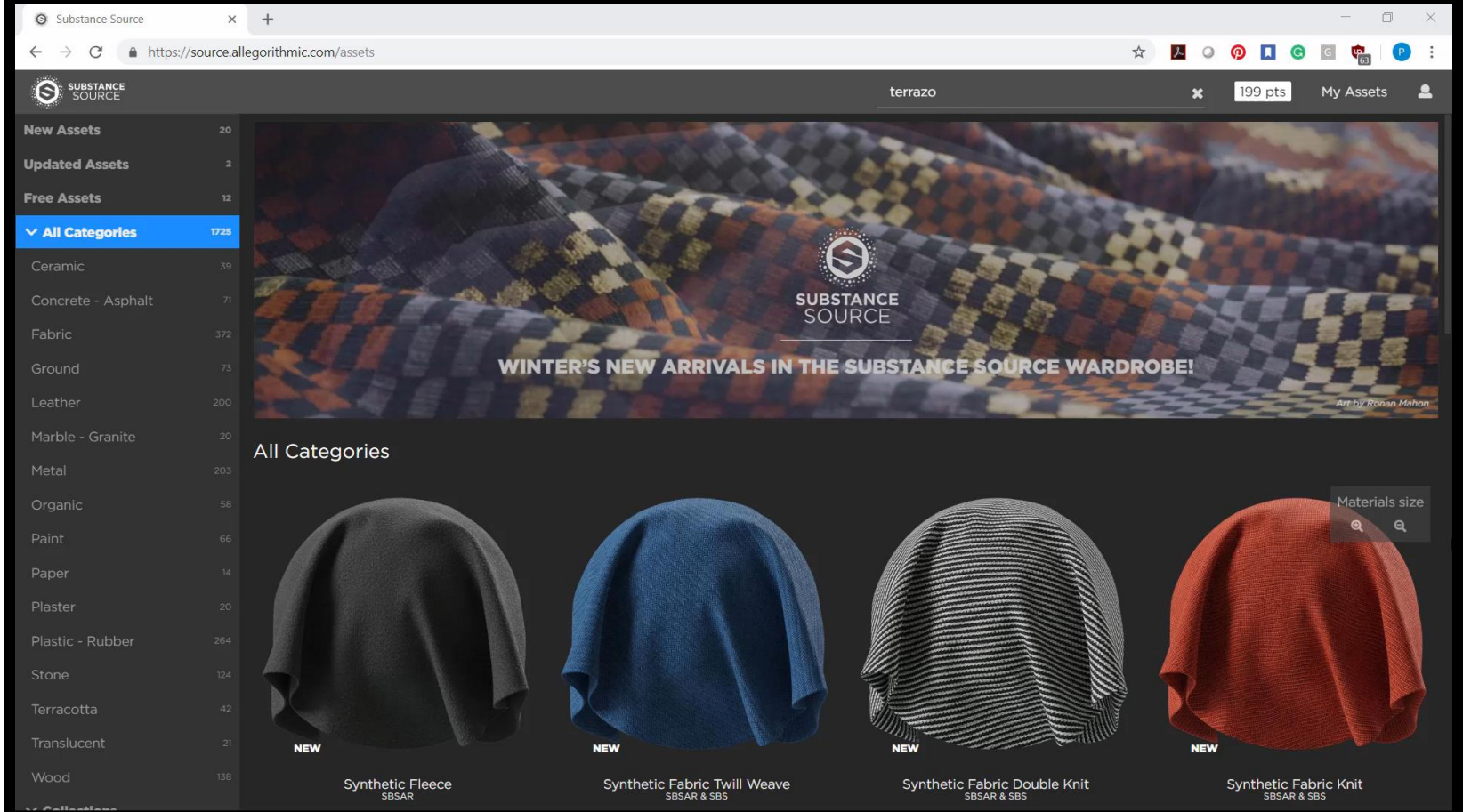
CONTENT

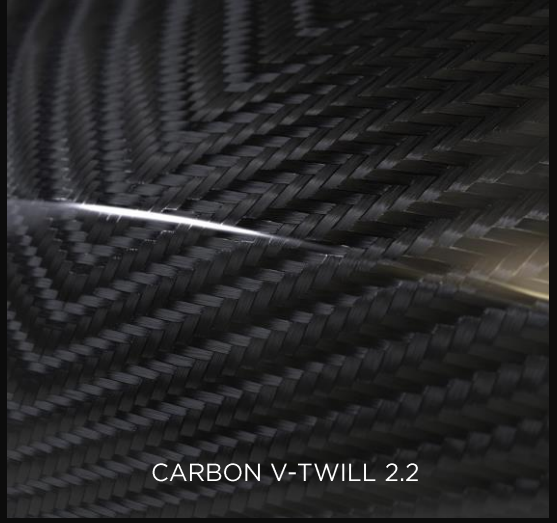
A COMPREHENSIVE TOOLSET

SOFTWARE

CONTENT

SUBSTANCE SOURCE

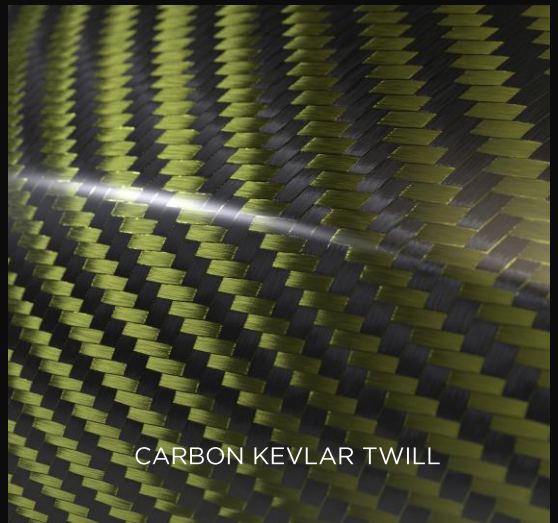



CARBON V-TWILL 2.2


CARBON V-TWILL 1.1


CARBON ANODIZED TWILL

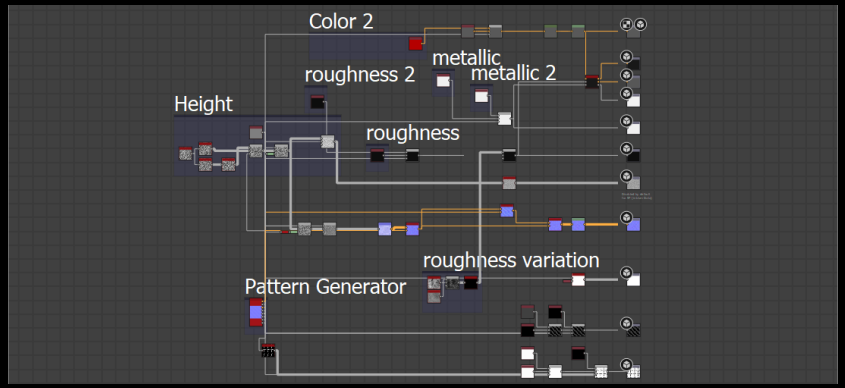

CARBON PLAIN

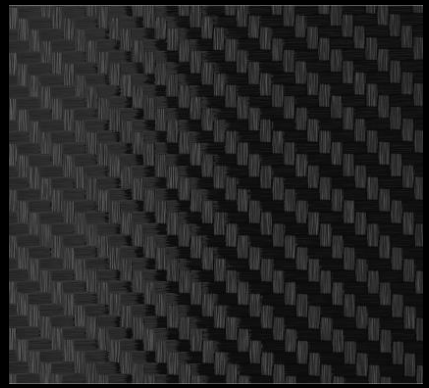

CARBON KEVLAR TWILL


CARBON ANODIZED TWILL 2.2

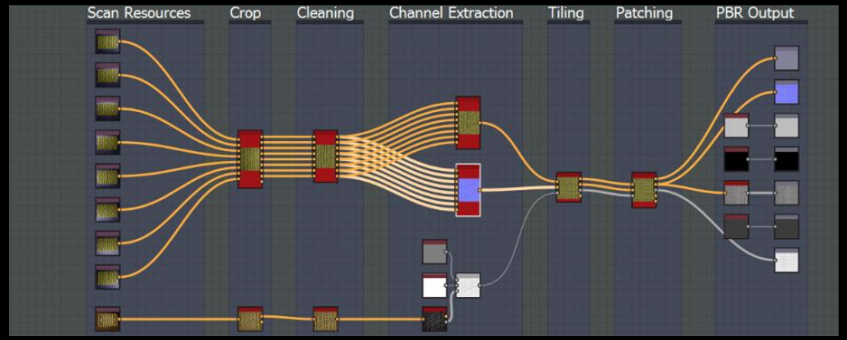
SUBSTANCE DESIGNER

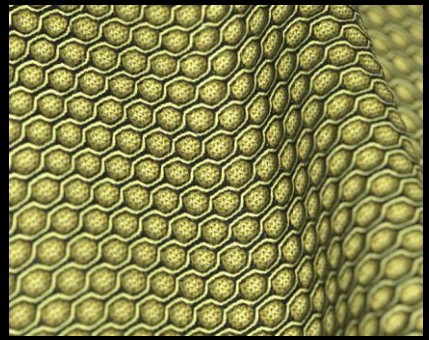
Procedural



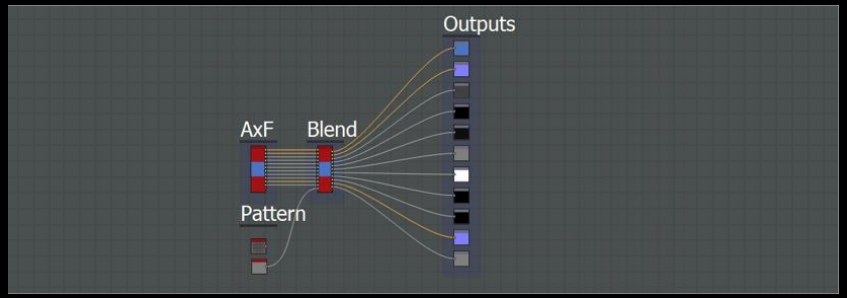


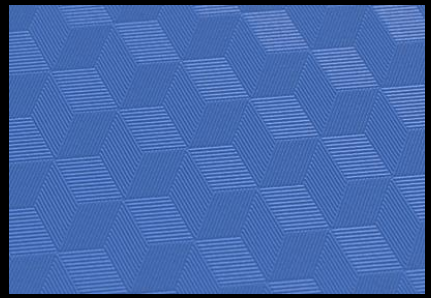
Scan Based

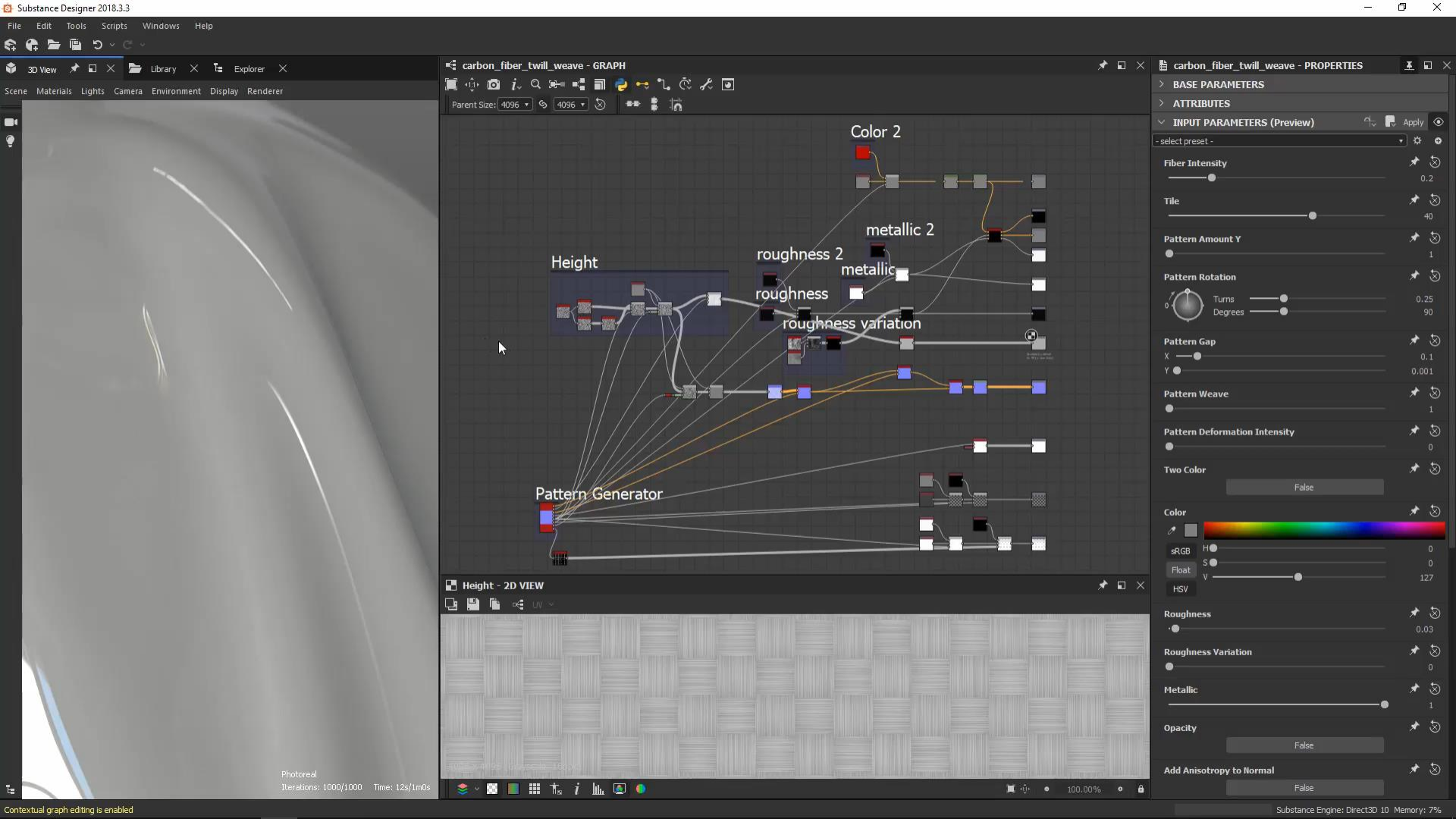




Hybrid






Substance Designer 2018.3.3
File
Edit
Tools
Scripts
Windows
Help
3D View
Library
Explorer
Scene
Materials
Lights
Camera
Environment
Display
Renderer
Photoreal
Iterations: 1000/1000
Time: 12s/1m0s
carbon_fiber_twill_weave - GRAPH
Parent Size: 4096
4096
Color 2
metallic 2
roughness 2
Height
metallic
roughness
roughness variation
Pattern Generator
Height - 2D VIEW
100.00%
carbon_fiber_twill_weave - PROPERTIES
BASE PARAMETERS
ATTRIBUTES
INPUT PARAMETERS (Preview)
Apply
- select preset -
Fiber Intensity
0.2
Tile
40
Pattern Amount Y
1
Pattern Rotation
Turns
0.25
Degrees
90
Pattern Gap
X
0.1
Y
0.001
Pattern Weave
1
Pattern Deformation Intensity
0
Two Color
False
Color
sRGB
Float
HSV
H
0
S
0
V
127
Roughness
0.03
Roughness Variation
0
Metallic
1
Opacity
False
Add Anisotropy to Normal
False
Contextual graph editing is enabled
Substance Engine: Direct3D 10
Memory: 7%

MDL and Enterprise PBR bridging worlds

Jan Jordan Software Product Manager MDL

March 18, GTC San Jose 2019

NVIDIA MDL

The **NVIDIA Material Definition Language (MDL)**

- is technology developed by NVIDIA
- to define **physically-based** materials
- for physically-based rendering solutions.
- Materials are defined by combining elemental building Blocks (BSDF)

More info:

S9346 Sharing Physically Based Materials between Renderers with MDL (https://on-demand-gtc.gputechconf.com/

www.nvidia.com/mdl

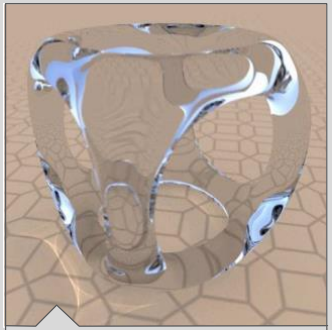
MDL Materials: combinations of (X)DF

BSDF building blocks (subset)

Diffuse Reflection

Diffuse Transmission

Glossy (various)



Spec. Refl.+Transm.

+

Recursive layering and mixing of DF

Fresnel Layer
Custom Curve Layer
Measured Curve Layer

Complex example

www.mdlhandbook.com

4 anisotropic glossy highlights + translucency

MDL vs. Enterprise PBR

When to use MDL

-if your users often have exotic requirements for materials

-if you want to give users choice about material interfaces and features

-if flexibility in content creation is key

When to use Ubershaders

-if your users are ok with you choosing a material interface for them

-if you need performance guarantees (VR, Games)

-if most work is using a similar set of materials

Bridging worlds: going there…

Implementing Ubershaders in MDL

Fixed Material Model

- Simple BSDF structure
- One texture per parameter

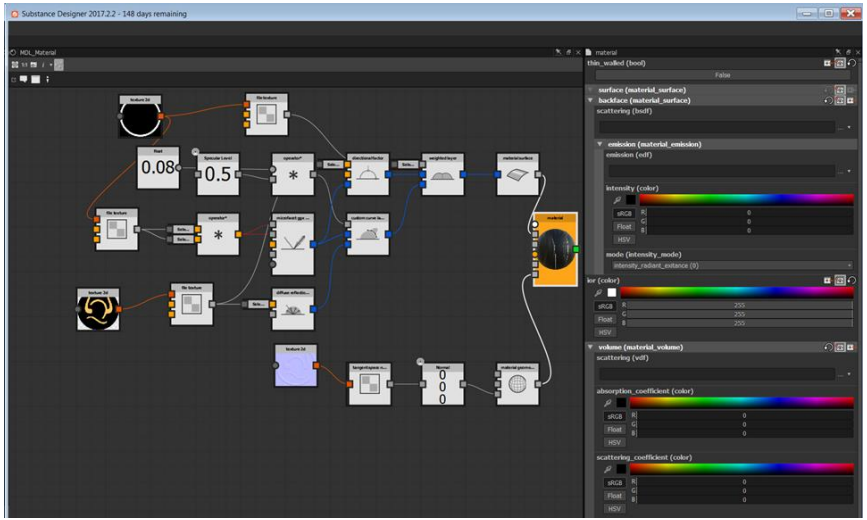
Implementation

MDL Material

- Complex BSDF layering
- Complex procedurals

MDL is powerful enough to implement common physically based Ubershaders.

Sharing of content is reduced to sharing of parameter values and textures.



Bridging worlds: …and coming back

Distillation to Fixed Material Model

Distillation to Fixed Material Model

MDL Material

Complex BSDF layering

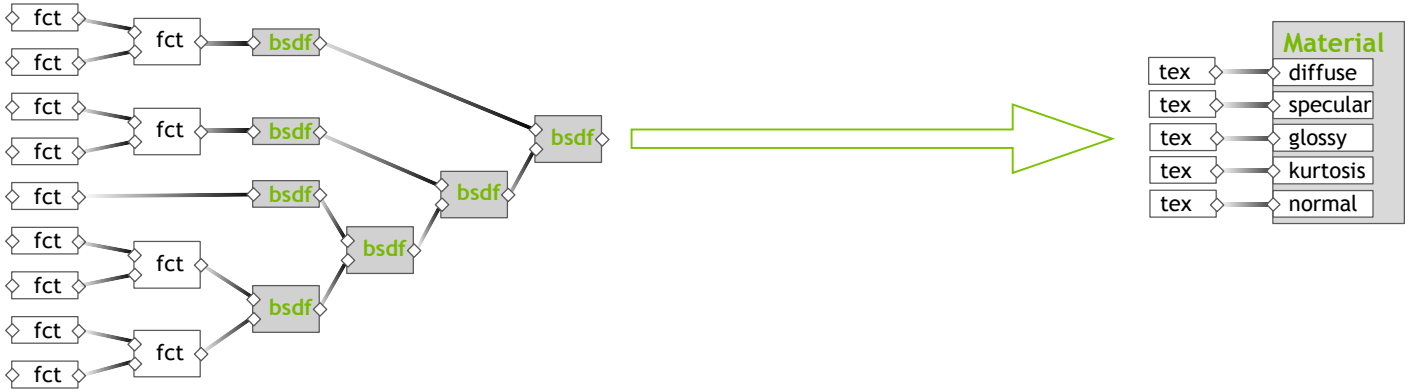
Complex procedurals

Distillation

Fixed Material Model

Simple BSDF structure

One texture per parameter



Distillation to Fixed Material Model

MDL Material

Complex BSDF layering

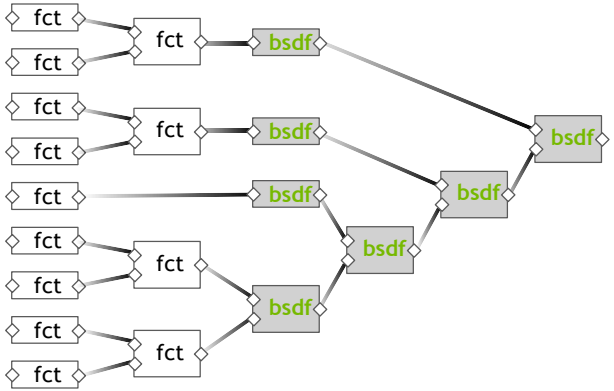
Complex procedurals

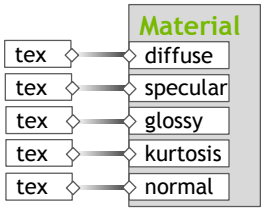
Distillation

Fixed Material Model

Simple BSDF structure

One texture per parameter





Approximate render result: Some materials will look quite different

Distillation to Fixed Material Model

MDL Material

Complex BSDF layering

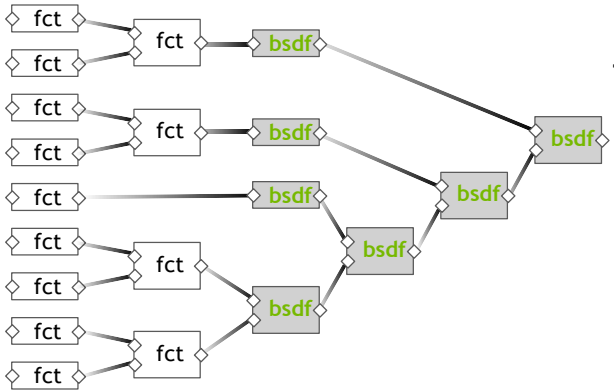
Complex procedurals

Distillation

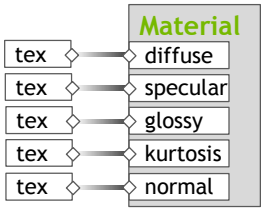
Fixed Material Model

Simple BSDF structure

One texture per parameter



Fast projection of material instances: Realtime editing



Approximate render result: Some materials will look quite different

MDL Distilling

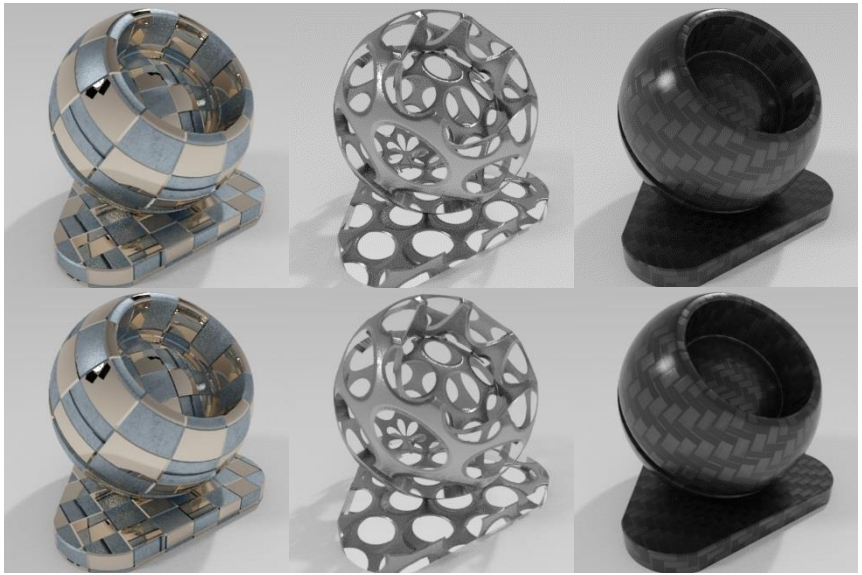
Released as part of Iray/MDL SDK

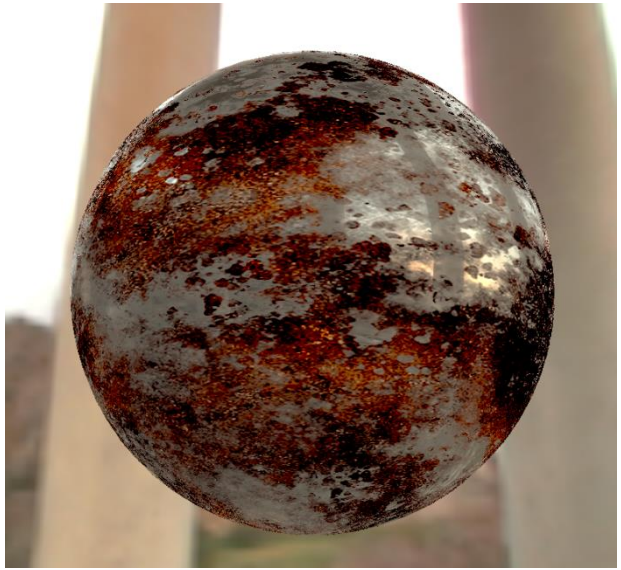
Multiple distilling targets (diffuse only, diffuse_glossy, UE4)

GLSL rendering sample using Distilling and baking

MDL

UE4





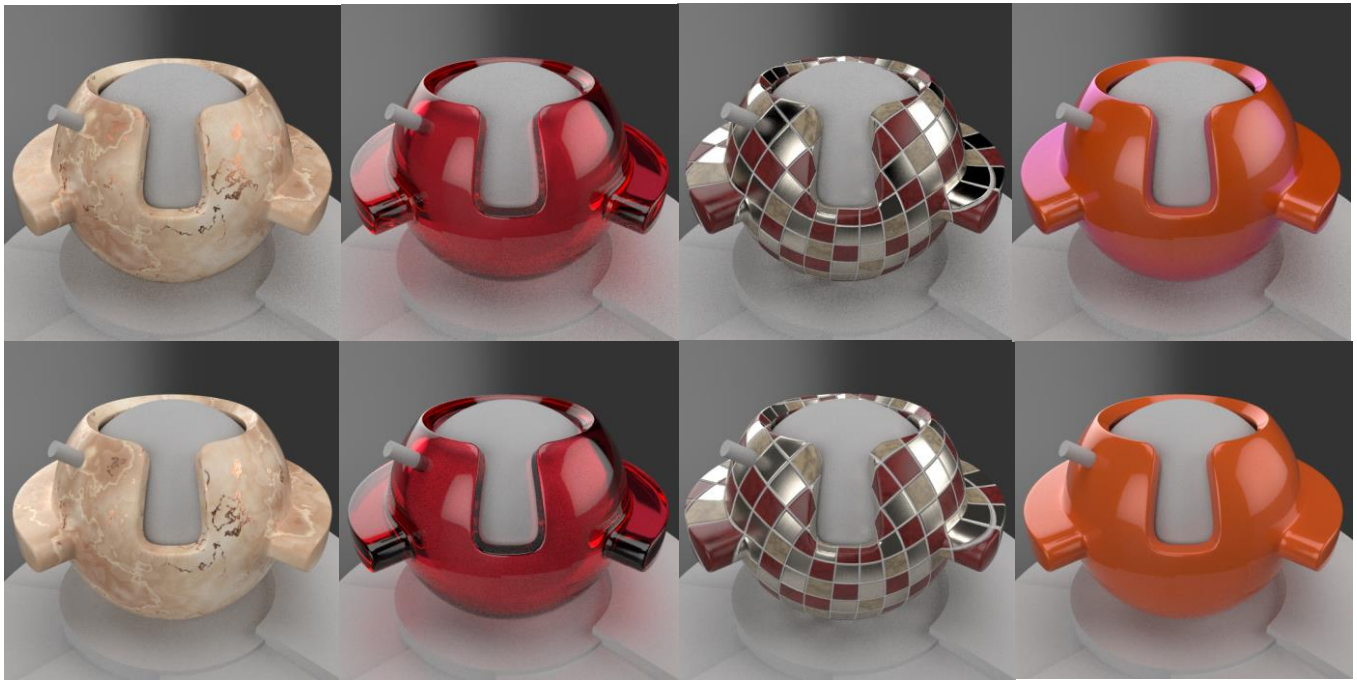
MDL Distilling

Released as part of Iray/MDL SDK

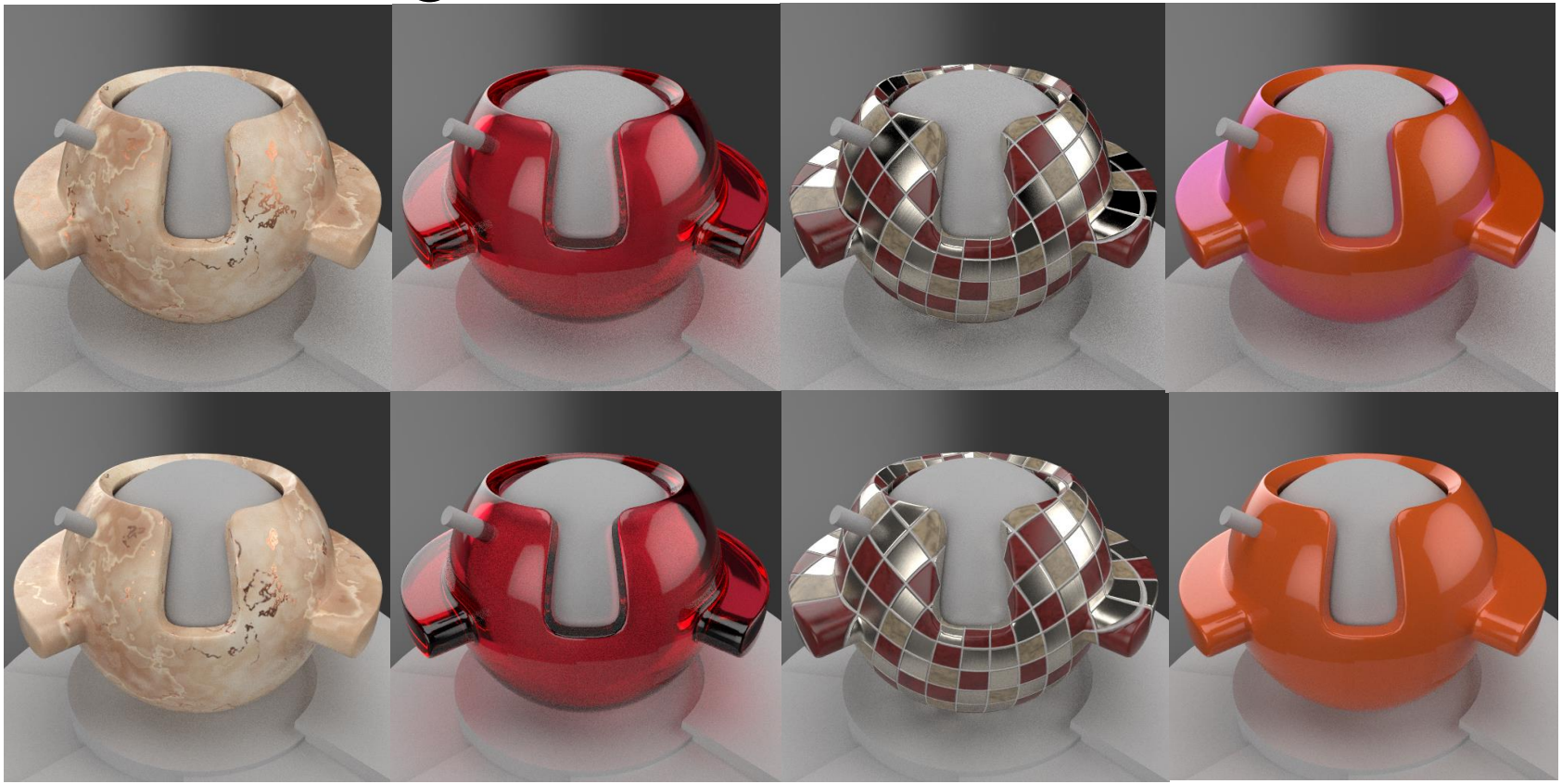
New with MDL SDK 2019: transmissive_pbr (Enterprise PBR semantic)

Original:
Iray MDL

Projection:
Stellar Physically
Correct with
Enterprise PBR

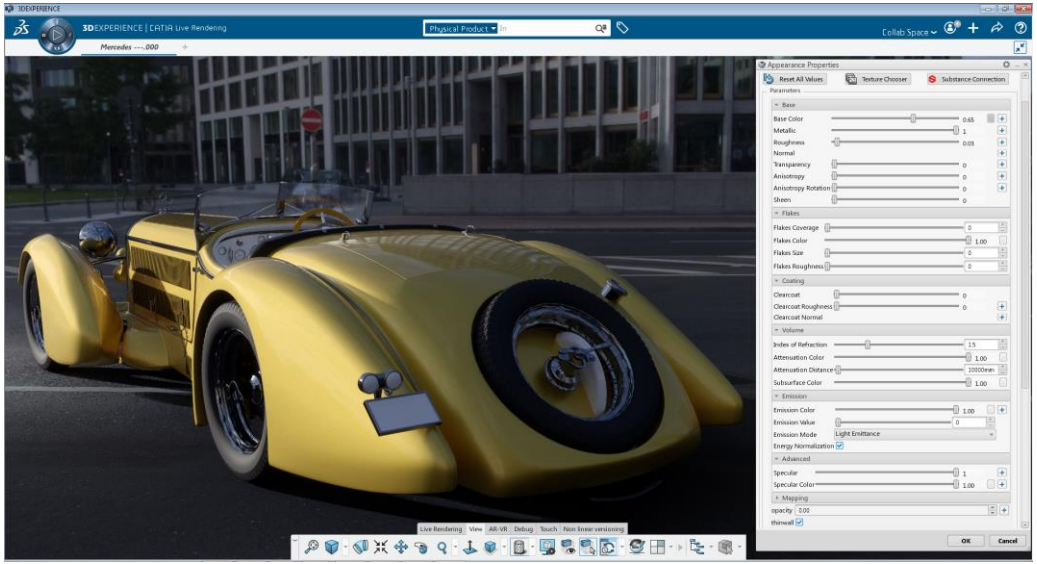


MDL Distilling



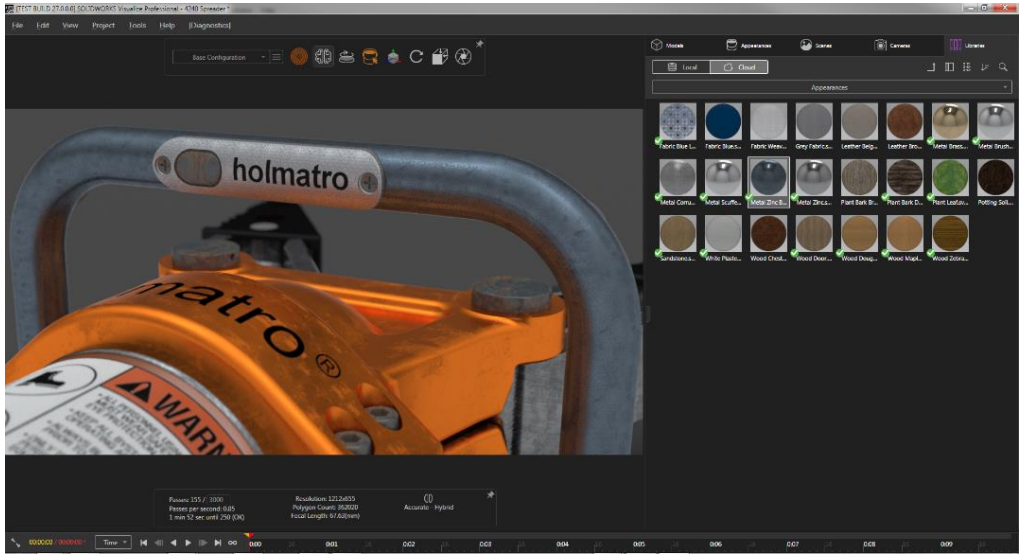
Enterprise PBR in **3D**EXPERIENCE Platform

- **3D**EXPERIENCE platform
  - BUSINESS EXPERIENCE platform
  - “Framework” for 3DS apps
  - Support Substance archives
  - Predefined content roles
- Enterprise PBR enables
  - High fidelity appearance representations
  - Lossless import



Enterprise PBR in SOLIDWORKS Visualize

- SOLIDWORKS Visualize
  - Quick and easy creation of professional, photo-quality images, animations & other interactive 3D content
- Enterprise PBR enables
  - High fidelity appearance representations
  - Lossless im-/export



Enterprise PBR in 3DEXCITE DELTAGEN Suite

- 3DEXCITE DELTAGEN
  - Bring CAD-Data to life
    - Real-time 3D rendering
    - Interactive Storytelling
    - Immersive marketing
- Enterprise PBR enables
  - High fidelity appearance representations
  - Lossless im-/export

Questions & Answers