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

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Motivation
Enterprise Visualization – Diverse Requirements

Design

Marketing

Engineering

Image courtesy of Opel
Enterprise Visualization – Diverse Requirements

Design
Marketing
Engineering

VR
Powerwall
AR
Mobile

Image courtesy of Opel
Enterprise Visualization – Diverse Requirements
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

- GGX PBR
- Enterprise PBR
- Component model
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

\[
C_r(v,l) = \frac{(1 - E_m(v \cdot n))(1 - E_m(1 \cdot n))}{\pi(1 - E_{m,avg})} \frac{F_{m,avg} E_{m,avg}}{1 - F_{m,avg}(1 - E_{m,avg})}
\]

- roughness = 0
- roughness = 1; no preservation
- roughness = 1; preservation
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
Ecosystem

Creating and Using Enterprise PBR
INTRODUCTION

WHO WE ARE
INTRODUCTION
METHODS TO GENERATE DIGITAL MATERIALS

TOTAL APPEARANCE CAPTURE
IS THE DIGITIZATION OF MATERIALS
WITH TRUE, FULL
APPEARANCE MEASUREMENT.

ARTISTIC PROCESSES
ARBITRARY RESULTS DEPENDING ON ARTISTIC SKILLS OF OPERATOR
TYPICALLY OPTIMISED FOR A SPECIFIC SCENE

TEXTURE SCANNER
PLAUSIBLE COLOR
DECLINING ACCURACY WITH
INCREASING MATERIAL COMPLEXITY

FULL APPEARANCE MEASUREMENT
PHYSICALLY CORRECT AS BASED ON MEASUREMENTS
HIGH ACCURACY EVEN FOR COMPLEX MATERIALS
SCENE INDEPENDENT

Accuracy
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.
AxF MATERIAL FORMATS
MEASURED MATERIALS

SVBRDF
- Ward
- GGX
- EP-GGX (Dassault Systems)
CarPaint (BTF/BRDF Hybrid)
Translucent Plastic
EP-GGX in AxF 1.7
DEFAULT SVBRDF MATERIAL MODEL

EP-GGX
AxF 1.7

GGX
AxF 1.5

Converted

Increasing Roughness

Measured
CAPTURE
THE TAC7 SCANNER

EDIT AND MANAGE
THE PANTORA DIGITAL MATERIAL HUB

VISUALIZE
THE VIRTUAL LIGHT BOOTH
THE INDUSTRY STANDARD FOR MATERIAL AUTHORING AND 3D TEXTURING
SUBSTANCE PARAMETRIC MATERIAL
A COMPREHENSIVE TOOLSET

SOFTWARE

SUBSTANCE DESIGNER

SUBSTANCE PAINTER

SUBSTANCE B2M

CONTENT

SUBSTANCE SOURCE
A COMPREHENSIVE TOOLSET

SOFTWARE

CONTENT
WINTER'S NEW ARRIVALS IN THE SUBSTANCE SOURCE WARDROBE!
MDL and Enterprise PBR bridging worlds

Jan Jordan
Software Product Manager MDL

March 18, GTC San Jose 2019
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:


[www.nvidia.com/mdl](http://www.nvidia.com/mdl)
MDL Materials: combinations of (X)DF

BSDF building blocks (subset)

- Diffuse Reflection
- Diffuse Transmission
- Glossy (various)

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...

**Fixed Material Model**
- Simple BSDF structure
- One texture per parameter

**MDL Material**
- Complex BSDF layering
- Complex procedurals
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

**MDL Material**
- Complex BSDF layering
- Complex procedurals

**Fixed Material Model**
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Distillation to Fixed Material Model

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**Distillation**

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Distillation to Fixed Material Model

**MDL Material**
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**Distillation**

**Fixed Material Model**
- Simple BSDF structure
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Diagram showing the process of distillation from MDL Material 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

Approximate render result: Some materials will look quite different
Distillation to Fixed Material Model

MDL Material
Complex BSDF layering
Complex procedural

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 3DEXPERIENCE Platform

- 3DEXPERIENCE 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