Computer Aided Design of Functional Geometry in Lighting

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Outline

- Overview on the Geometry Family
- Procedural Surfaces
- Concept Macrofocal Objects
- Free Form Surface Design
- Conclusion
“road map” of geometry family

Geometry Family

Elements
- Curve Arc
- Surface Patch
- Macrofocal Object

Surfaces
- Profile Curve
- Profile Surface
- Procedural Surface
- [Grid of] FF Surface

Application
- Reflector and Lens
Profile curve = sequence of arcs

- free form spread arcs
- Parabola, ellipse, hyperbola arcs

Procedural Surface
Prism curves

- Prism structure
- Total Internal Reflection (TIR) prism

Procedural Surface
Procedural operation

Procedural Surface  = Profile curve[s] + Operation

- rotation
- extrusion
- variable rotation
- sweep
- swing
Potentials of swept surfaces

Convex, concave, wave structure

rectangle beam

cross beam

Procedural Surface
Advantage of swung surface

Simple rotation surface shows a center peak
Swung surface creates a wide light plateau

Procedural Surface
Styling feature

Procedural Surface

drilled pillows

segments

pillows

waves
Macrofocal Concept

- For extended light source
- Not only one focal point
- Focal point migrates around source

Macrofocal Object
Feature of Macrofocal Objects

Assembly
- Several emitter surfaces
- A ray file
- A set of shield objects

Behavior
- Creates a convex hull of light image
- Identifies 2 extreme (edge) rays

Macrofocal Object

A set of 5 LED disks
Macrofocal Examples

H4 bulb

Source geometry

H4 filament images

Source images with convex hull
Macrofocal object with ray set

Paraboloid with side-emitter LED

LED images

LED contour
Cutoff lines with MF objects

Use edge rays to create the cutoff line

Macrofocal Object
Free form reflector

Automotive application

- Low beam
- High beam
- Fog lamp
- Signal lamp
Calculation skeleton

“fish bone” row of curves
• spine curve defines the major spread behavior
• orthogonal MF curves keep beam shape i.e. cutoff line

FF Surface Design
**Headlamp reflector**

**Lighting design parameter**
- Reflector segment grid
- Spread angles per segment
- Cutoff lines: upper, lower, curved

**FF Surface Design**
- Type of light source
- Housing/bezel geometry
Quick concept check

based on a few parameter

- Light function type
- Type of light source
- Raw size; height/width
- Outer spread angle
- Housing/bezel geometry

FF Surface Design
Free form lens

Automotive application
• LED headlamps
• Projector headlamps
• Compensation of ray deviations
• New design feature
Free form lens design concept

3 approaches

- outer free form surface with fix inner surface or source in solid media
- inner free form surface with fix outer surface with
- Free form surface on inner and outer side

FF Surface Design
Free form lens for cutoff beam

- Vertical sharp cutoff line
- Horizontal spread
FF lens for projector

FF lens creates an extra light spread

FF Surface Design
**Compensation of ray deviation**

The "neutral" surface
- Compensates the ray deviation
- Has a variable thickness

**Analysis**
- Checkerboard images
- Deviation diagrams
- Thickness map

**FF Surface Design**
Conclusion

“Simple” procedural surface
• Used for several lighting function

Free Form surfaces
• For more complex function

design by function
not by parameter