

# CHALLENGES IN VIRTUAL APPEARANCE ASSESSMENT

TOTAL APPEARANCE CAPTURE

Dr. Marc Ellens  
SENIOR RESEARCH SCIENTIST | X-RITE

 x-rite PANTONE®



# DISCLAIMER

We may make statements regarding planned or future development efforts for our existing or new products and services.

These statements are not intended to be a promise or guarantee of future delivery of products, services or features but merely reflect our current plans, which may change. Purchasing decisions should not be made based upon reliance on these statements.

We assume no obligation to update these forward-looking statements to reflect events that occur or circumstances that exist or change after the date on which they were made.

# COMPANY INTRODUCTION: WHO WE ARE

Started **1958**

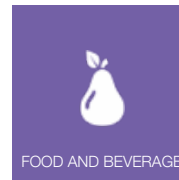
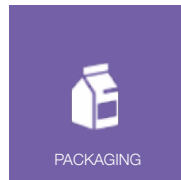
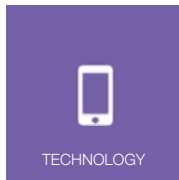
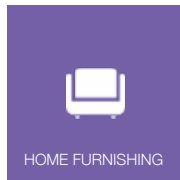
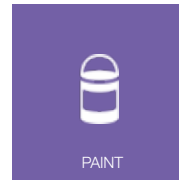
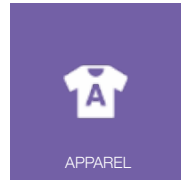
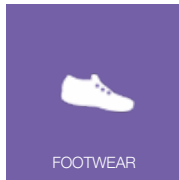
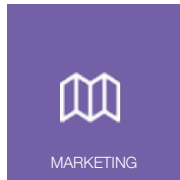
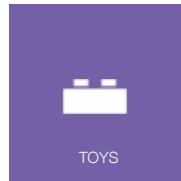
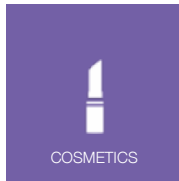
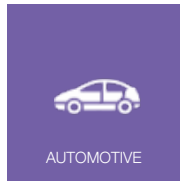
Public NASDAQ **1986**

Acquired by Danaher **2012**

## KEY CUSTOMERS

- Brand owners/designers
- Printers and converters
- Textile, plastics & industrial
- Retail photo, paint & cosmetics

WE DEFINE and MANAGE COLOR ACROSS THE SUPPLY CHAINS FOR ALL CONSUMER GOODS...



COLOR IS ONE OF THE TOP 3 ATTRIBUTES THAT INFORMS CONSUMERS' BUYING DECISIONS.

**\$1 Billion**

Market Size

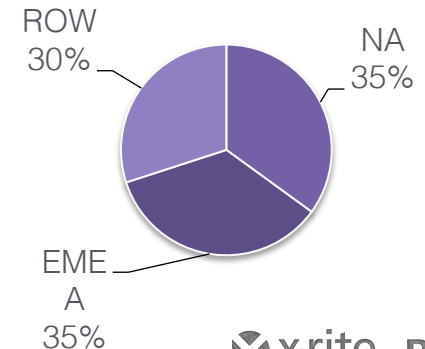
**4-6%**

Long Term Market Growth

**\*\$275 Million**

80% Equipment  
20% Software/Services

GEOGRAPHIC MIX (as % of 2012 sales)



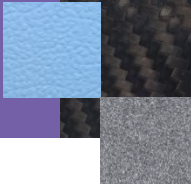
 **x-rite PANTONE®**



# COMPANY INTRODUCTION: OUR PRODUCTS



# WHAT IS APPEARANCE?



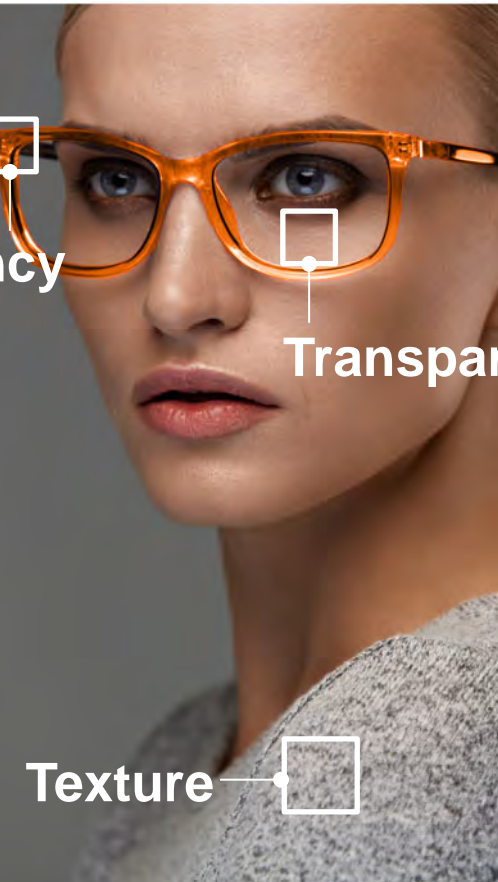
Color



Gloss



Translucency



Transparency



Texture

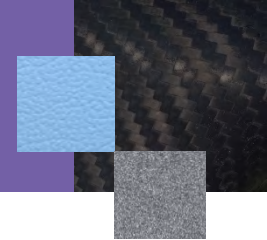


Complex Effects





# HOW WE PERCEIVE APPEARANCE



Material  
Geometry  
Micro-surface



Scene  
Illumination

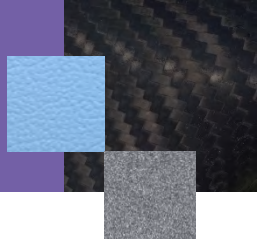


Context



Observer

# VIRTUAL ASSESSMENT: WHAT WE NEED TO GET RIGHT



Material  
Geometry  
Micro-surface

Scene  
Illumination

Context

Observer

Appearance Attributes  
Reproduction Fidelity

Color (temperature)  
Direction  
Distribution

- Lambertian
- Direct

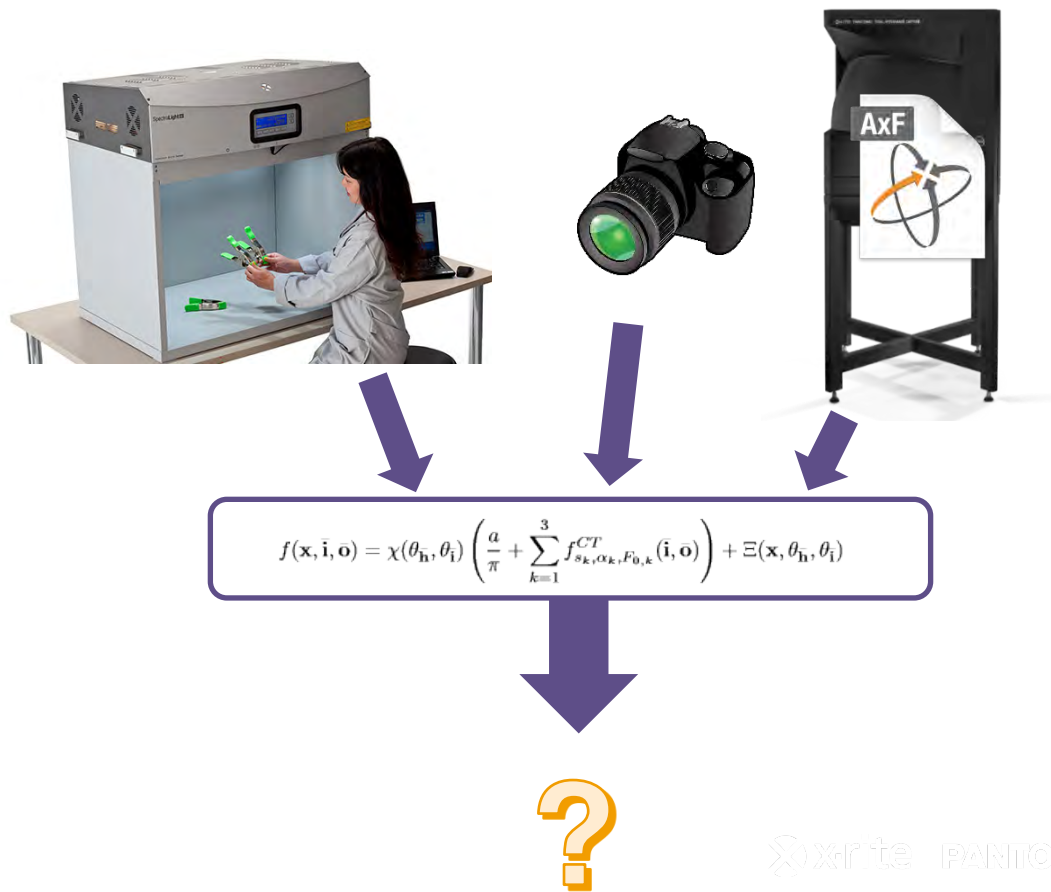
Intensity

Form / Shape  
Size / Scale  
Recognition  
Surround

Proximity  
Direction  
Control  
Monocular/Binocular

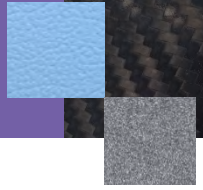
## Appearance Attributes

- Color
- Reproduction Fidelity
- Inspect
- Capture
- Measure
- Model
- Rendering





# VIRTUAL ASSESSMENT: LIGHTING



Color  
(temperature)

Distribution

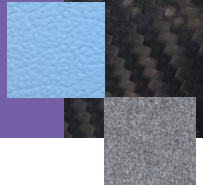
- Diffuse
- Spot

Direction

Intensity



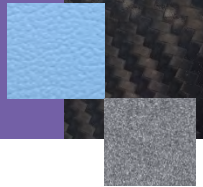
# VIRTUAL ASSESSMENT: CONTEXT



- Form / Shape
- Size / Scale
- Recognition / Semantics
- Surround



# VIRTUAL ASSESSMENT: OBSERVER



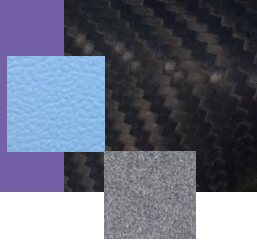
**The Norm: Compare to the screen in your office**

- Proximity
- Direction
- Control
- Monocular / Binocular





# VIRTUAL ASSESSMENT: OBSERVER

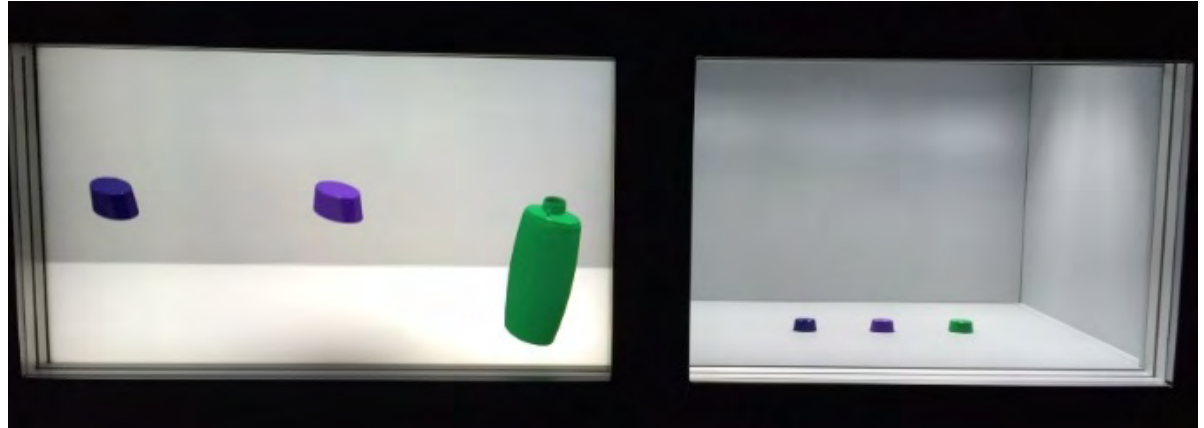


Proximity

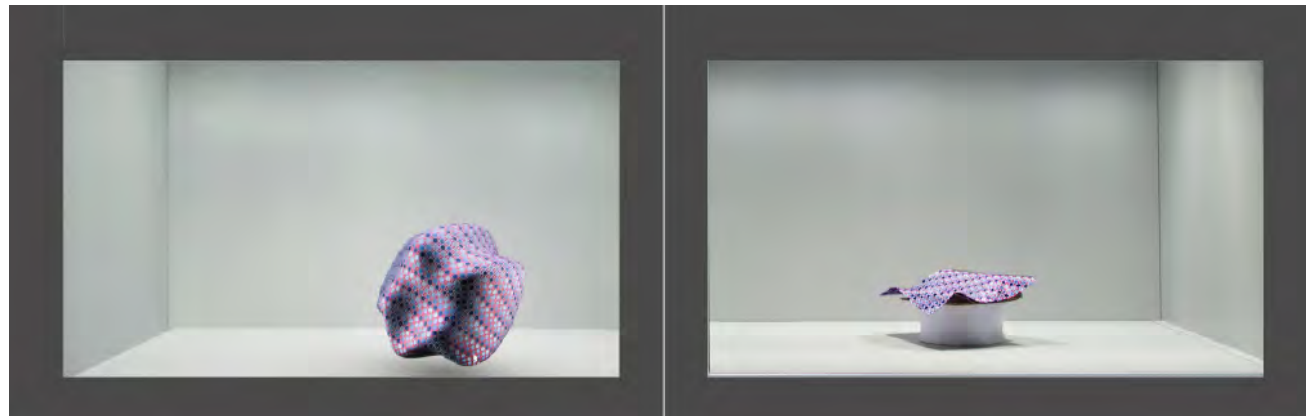
Direction

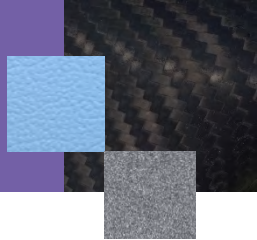
Control

Monocular /  
Binocular



VS





Proximity

Direction

Control

Monocular /  
Binocular

## Virtual Light Booth



# TOTAL APPEARANCE CAPTURE



# THE TOTAL APPEARANCE CAPTURE ECOSYSTEM

CAPTURE

COMMUNICATE

COMPARE

VISUALIZE



# CAPTURE | TAC7 SCANNER

- 4 industry-grade cameras
- 32 white LED point-light sources
- 8 spectral light sources
- Variable linear light scanner
- Backlight module
- Structured light projector
- Rotation stage to capture anisotropy



TAC brings virtual designs to life with digital material representations that are physically correct.

## Ward SVBRDF

- Diffuse map
- Specular color map
- Roughness map
- Normal map
- Clear coat normal map
- Surface orientation map
- Displacement (height) map
- Alpha map
- Fresnel map/value
- Index of refraction map/value

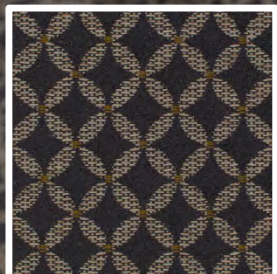
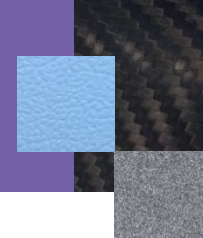
## Car Paint (CPA)

- BRDF with 3 lobes
- Color table
- Flake BTF
- Clear coat normal map
- Index of refraction map/value

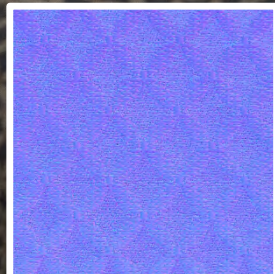




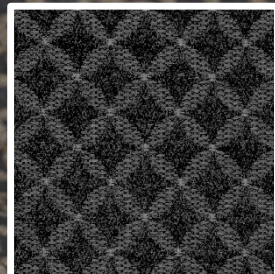
# CAPTURE | TAC7 EXAMPLE



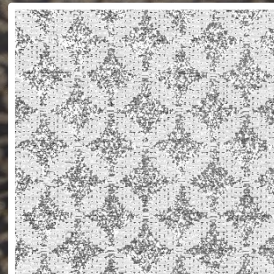
DIFFUSE ALBEDO MAP



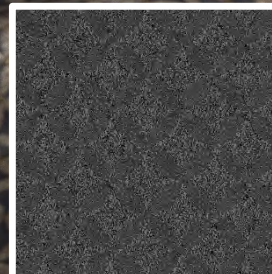
NORMAL MAP



ROUGHNESS MAP



SPECULAR MAP

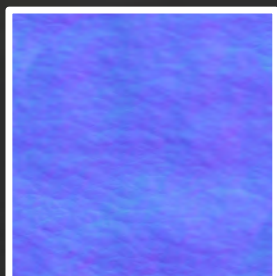
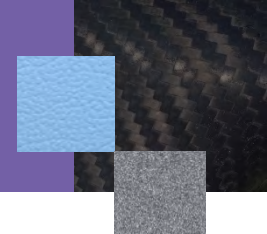


ANISOTROPIC ROTATION



DETAILED FABRICS

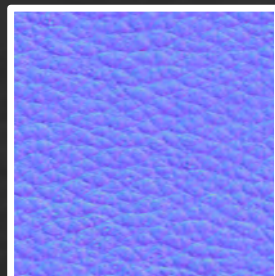
# CAPTURE | TAC7 EXAMPLE



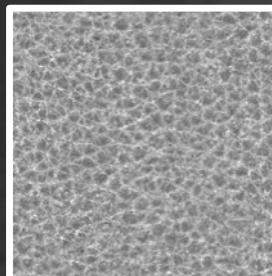
CLEAR COAT NORMAL MAP



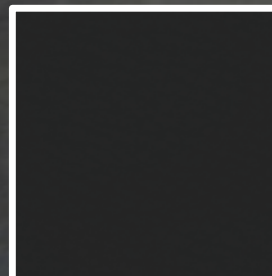
DIFFUSE ALBEDO MAP



NORMAL MAP



ROUGHNESS MAP



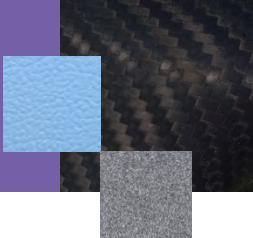
SPECULAR COLOR MAP



COATED LEATHER



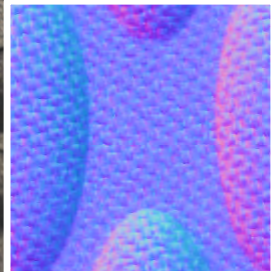
# CAPTURE | TAC7 EXAMPLE



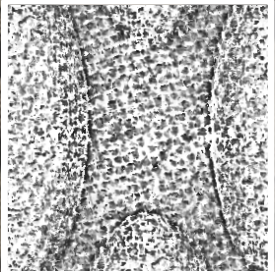
DISPLACEMENT MAP



DIFFUSE ALBEDO MAP



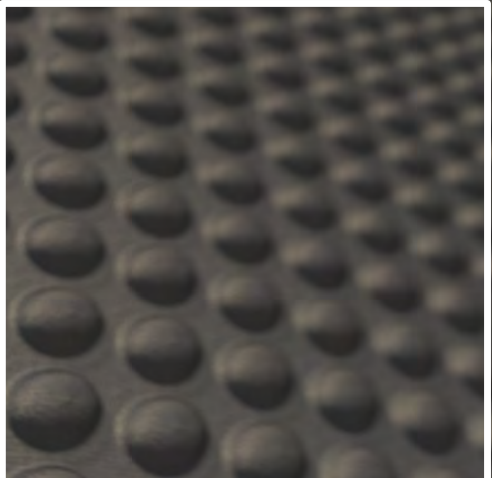
NORMAL MAP



ROUGHNESS MAP



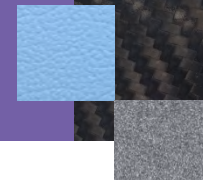
SPECULAR COLOR MAP



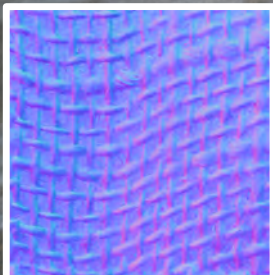
THERMOFORM TEXTILE



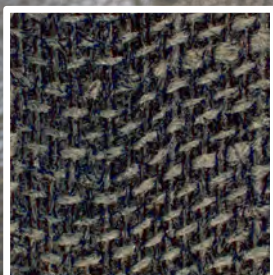
# CAPTURE | TAC7 EXAMPLE



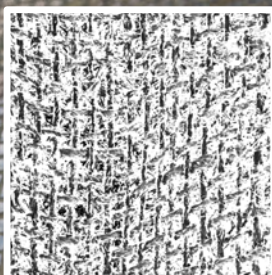
DIFFUSE ALBEDO MAP



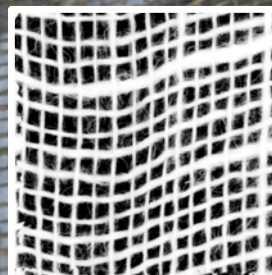
NORMAL MAP



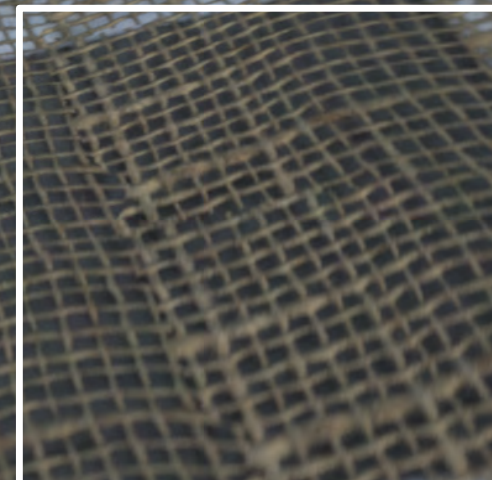
SPECULAR COLOR MAP



ROUGHNESS MAP

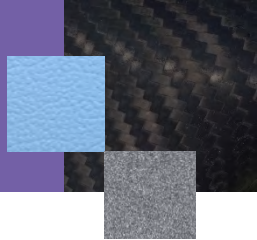


ALPHA MAP



LINEN FABRIC

# TOTAL APPEARANCE CAPTURE ECOSYSTEM



Visit us at

<https://www.xrite.com/categories/appearance/total-appearance-capture-ecosystem>

for videos and further information

# COMPARE | VIRTUAL LIGHT BOOTH

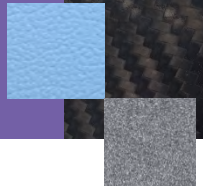
Accurately compare digital and physical materials in an immersive mixed reality environment.

- D65 (Daylight) LED Spot Lighting
- D65 (Daylight) Tungsten Halogen Diffuse Lighting
- i1Pro 2 Ambient Light Monitoring
- Face-tracking
- Synchronized Rotation Stage
- Regional Angle-dependent Display Profiling
- Custom Scene Development
- Closed-loop Display Calibration
- Adjustable Height

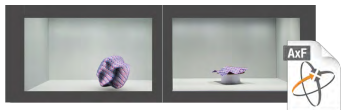




# VISUAL ASSESSMENT: EVOLUTIONARY COMPARISON

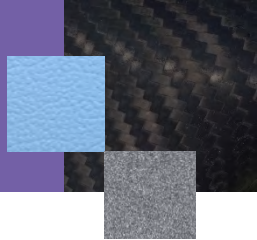


Attributes    Reproduction    Direction    Light Color    Distribution    Intensity    Shape    Scale    Recognition    Surround    Proximity    Obs. Dir.    Control    Mode



\*Gary Meyer, Hua-Tzu Fan, Christopher Seubert, Curtis Evey, Jan Meseth, Ryan Schnackenberg, "Visual comparison testing of automotive paint simulation", Proc. SPIE 9398, Measuring, Modeling, and Reproducing Material Appearance 2015, 93980M (13 March 2015), used by permission.

# THINGS WE SHOULD TALK ABOUT



- **Virtual / Augmented Reality**
- **Auto-stereoscopic Enhancements**
- **Remote Assessment**
- **Automated Assessment**
- **Model Standardization**
- **Scene Standardization**

A close-up photograph of a car's interior, focusing on the center console and leather seats. The center console is light-colored with a gear shifter and handbrake. The leather seats are dark with a pebbled texture. A blue semi-transparent rectangle is overlaid on the left side of the image, containing the text "QUESTIONS?".

**QUESTIONS?**