

DOE R&D Workshop

NEW LIGHTING CONCEPTS

Steve Paolini – 4feb16



Outline

- Introduction
- Products
- Why go beyond RGB?
- What's next
- Summary



- Founded 2007 – Silicon Valley, CA
- Purpose – create any light for human consumption
 - Products/services to create/playback light
- Privately owned
- Current products:
 - Light Replicator (16 color light player)
 - Penta (5 color light player)
 - Light Recorder (spectrometer)
 - LumenScripts (content)
 - Recordings, created, composed digital data

Target Applications for Researchers

- Consumer/Home – daylight experience indoors, better circadian cycle
- Retail – make products more appealing
- Healthcare – faster healing, wake/sleep
- Workplace – increase productivity
- Sensors – time varying spectrum
- Movie, TV – outdoor scene or filter replication

Two ways of experiencing light

Illumination

- Look at people, objects
- Less saturated colors
- Changes slowly
- Low spatial density
- High spectral density
- CRI – important, RGBWA
- Collimated, Diffuse

- Electric lights, Daylight
 - RGB is NOT sufficient

Infotainment

- Look at the light
- Saturated colors
- Changes fast
- High spatial density
- Low spectral density
- CRI – don't care, RGB
- Collimated, Diffuse

- Computer Display, TV, Rock Concert
 - RGB is sufficient

The sky is a special case. It fits into both categories.

Next Generation Light Sources – now

- Remote on/off, dimming
- Fixed custom spectrum (non-blackbody)

- Warm-white, Cool-white “white tunable”
- RGB and beyond

Warm-white, Cool-white “white tunable”



Warm-white, Cool-white “white tunable”



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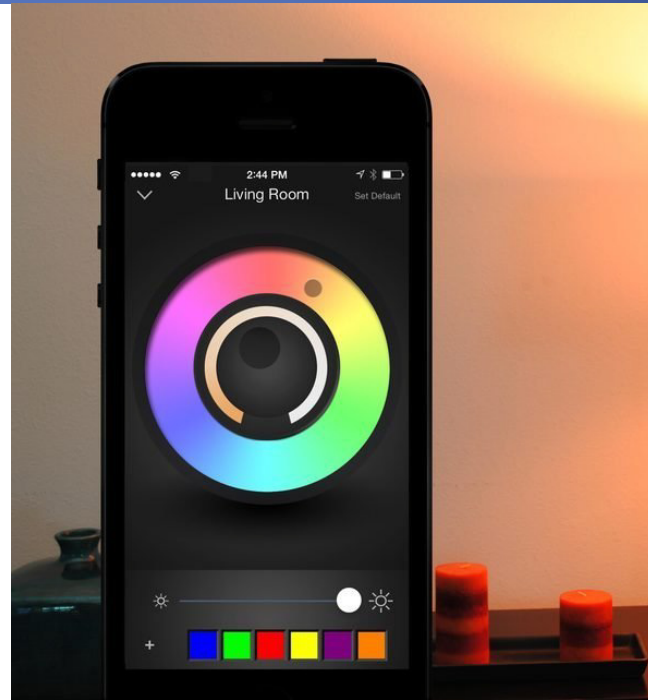
Beetle

Advanced
Tunable System

2700K–6500K CCT Control
Samjin Ultra System Compatible

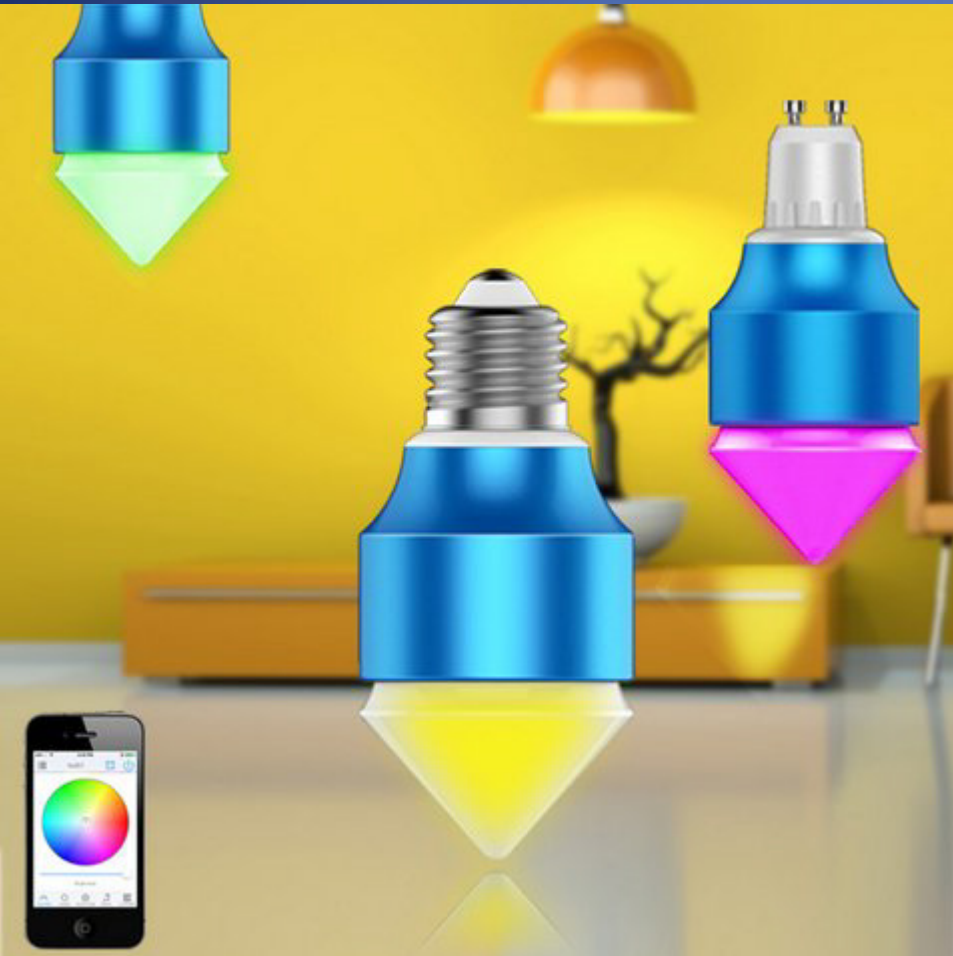


RGB and beyond



RGB and beyond

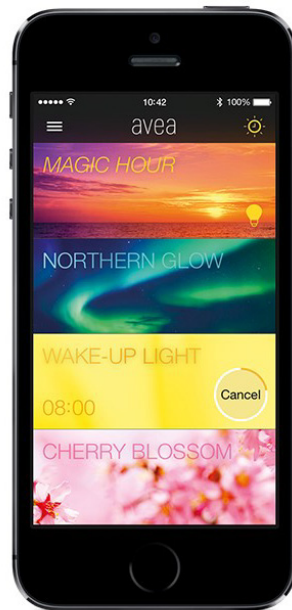
MarSwell® 450LM RGBW Bluetooth Smart LED



Flux Bluetooth Smart LED Light Bulb



RGB and beyond



RGB and beyond



RGB and beyond

 K E T R A™

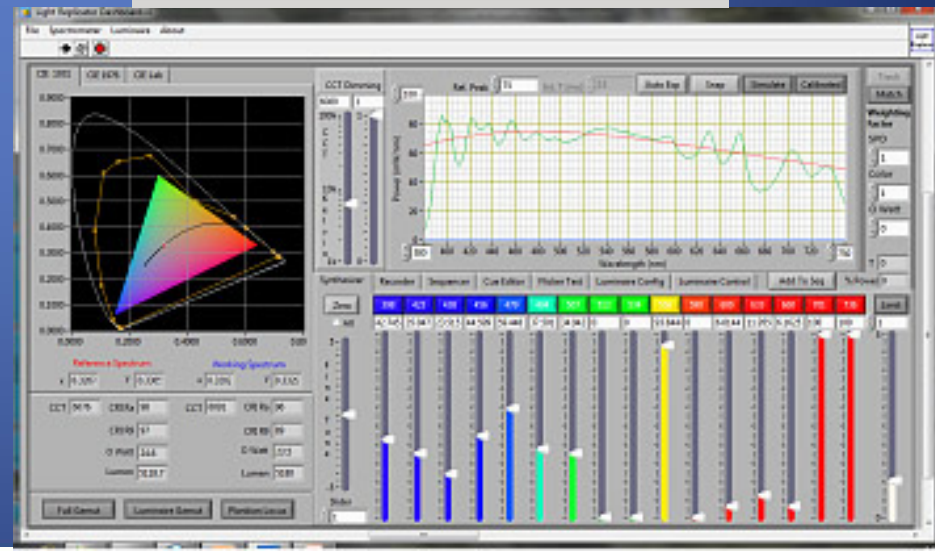
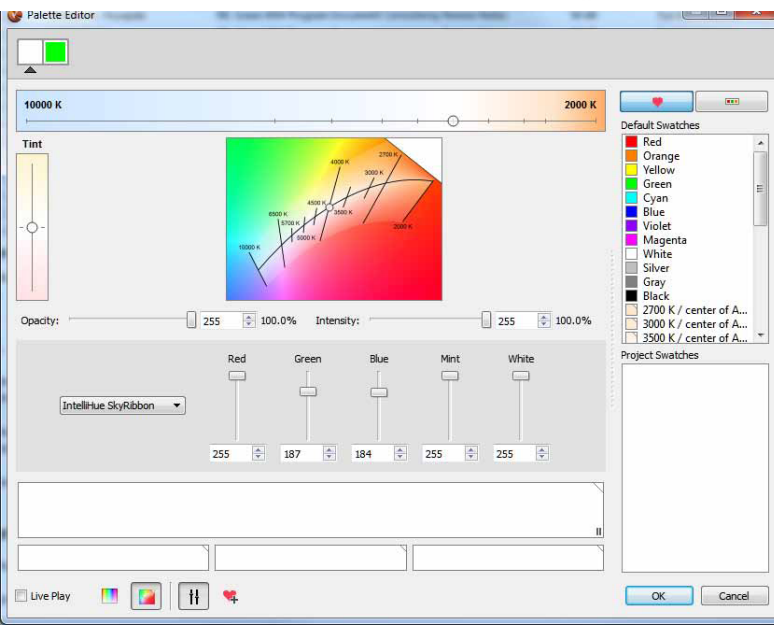
lumenetix®

Home araya⁵ Products iOS App



iOS  Bluetooth™ DMX  EcoSystem Enabled  VivacityControl Preso  CRESTRON

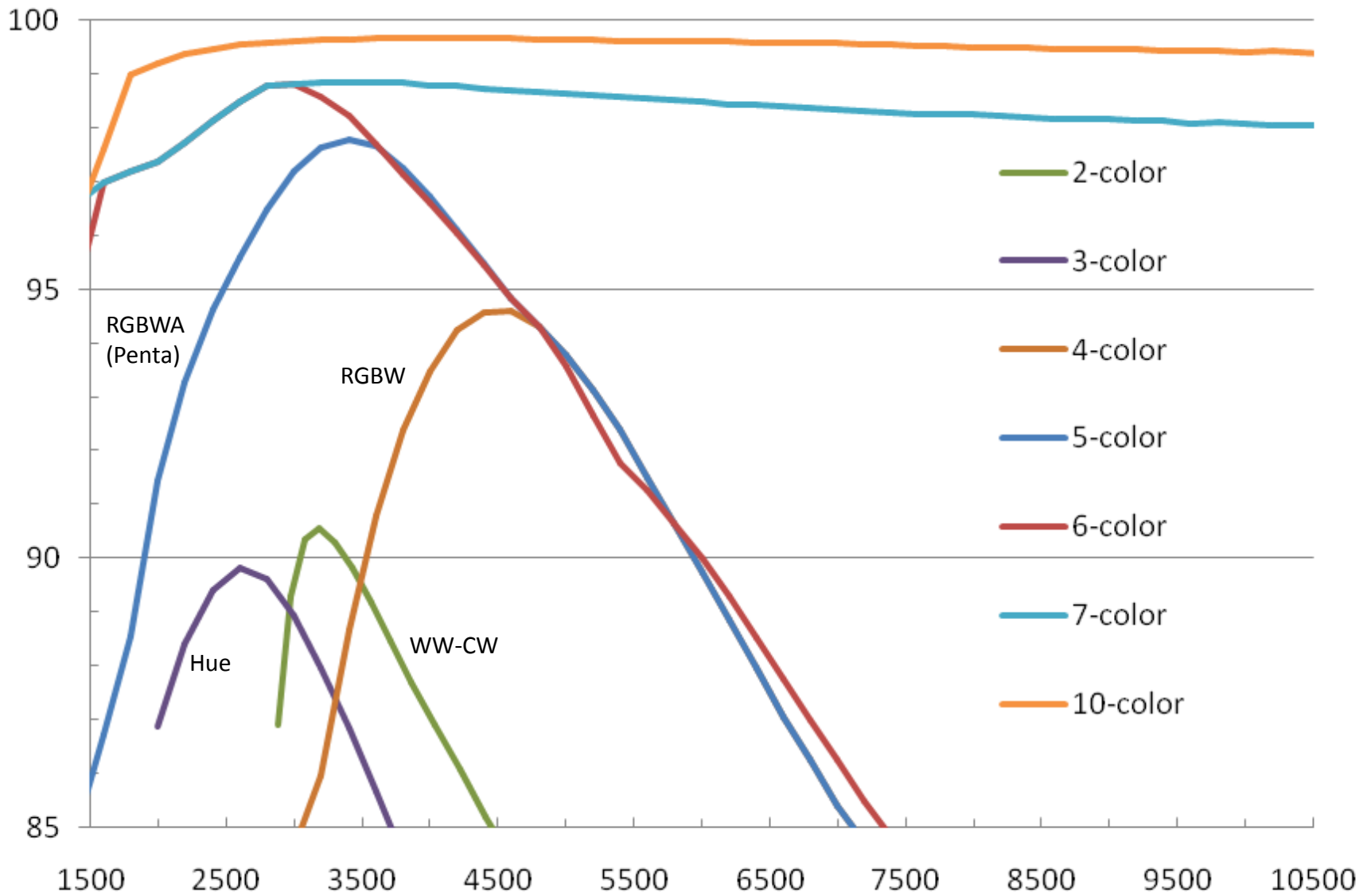
RGB and beyond



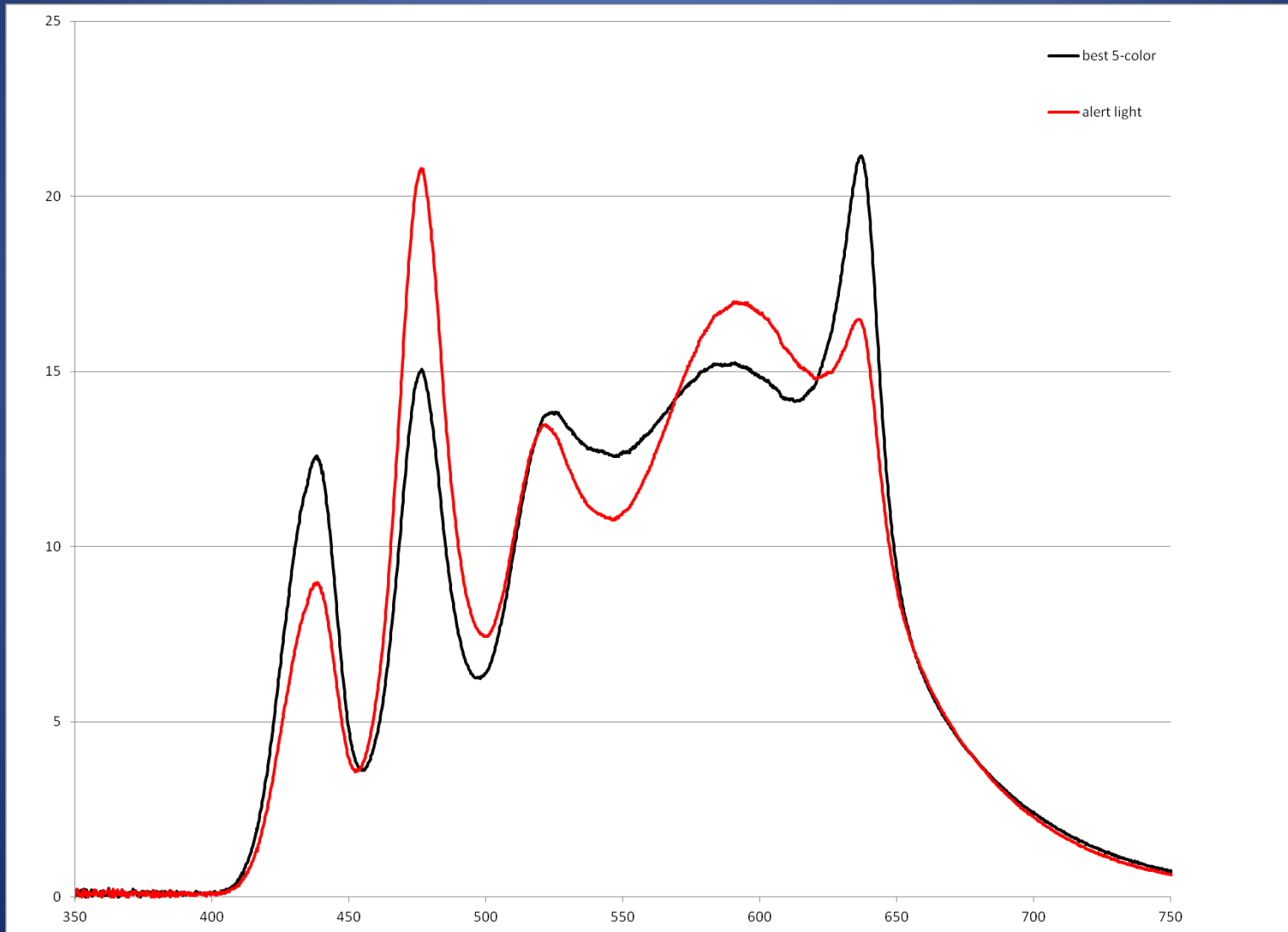
Why go beyond RGB

- Broader CCT range at higher color quality
- Multiple solutions for a given chromaticity
- Larger gamut area
- Tradeoff between efficacy and color quality

Multi-color – CQS vs. CCT



Multiple 4000K solutions – 5-color



What's Next – Light Players

- Illumination has many dimensions:
 - Intensity, spectrum, direction, beam angle, time
- A light player is to illumination as an MP3 player is to music.
- Record, Compose, Playback
- Some examples

Claude Monet – “Haystacks”

The series shows differences in perception of light across various times of day, seasons, and types of weather.

1890-1891 series [\[edit\]](#)



Grainstacks in the Sunlight, Morning Effect, 1890. Oil on canvas. Private collection.



Haystacks, (Midday), 1890-91, National Gallery of Australia



Wheatstacks (End of Summer), 1890-91. Oil on canvas. Art Institute of Chicago



Wheatstacks, 1890-91. Oil on canvas. Art Institute of Chicago.



Wheatstacks, Snow Effect, Morning, 1891. Oil on canvas. J. Paul Getty Museum



Haystacks at the End of Summer, Morning Effect, 1891. Oil on canvas. Musée d'Orsay, Paris, France.



Haystacks on a Foggy Morning, 1891. Oil on canvas. Private collection.



Haystack, Morning Snow Effect (Meule, Effet de Neige, le Matin), 1891. Oil on canvas. Museum of Fine Arts, Boston.



Grainstacks Snow Effect, (Meules, effet de neige), 1891. Oil on canvas. National Gallery of Scotland, Edinburgh, Scotland



Wheatstacks (Sunset, Snow Effect), 1890-91. Oil on canvas. Art Institute of Chicago.



Wheatstack (Snow Effect, Overcast day) (Meule, effet de neige, temps couvert), 1890-91. Oil on canvas. Art Institute of Chicago.



Wheatstack, 1890-91. Oil on canvas. Art Institute of Chicago.



Wheatstack (Thaw, Sunset), 1890-91. Oil on canvas. Art Institute of Chicago.



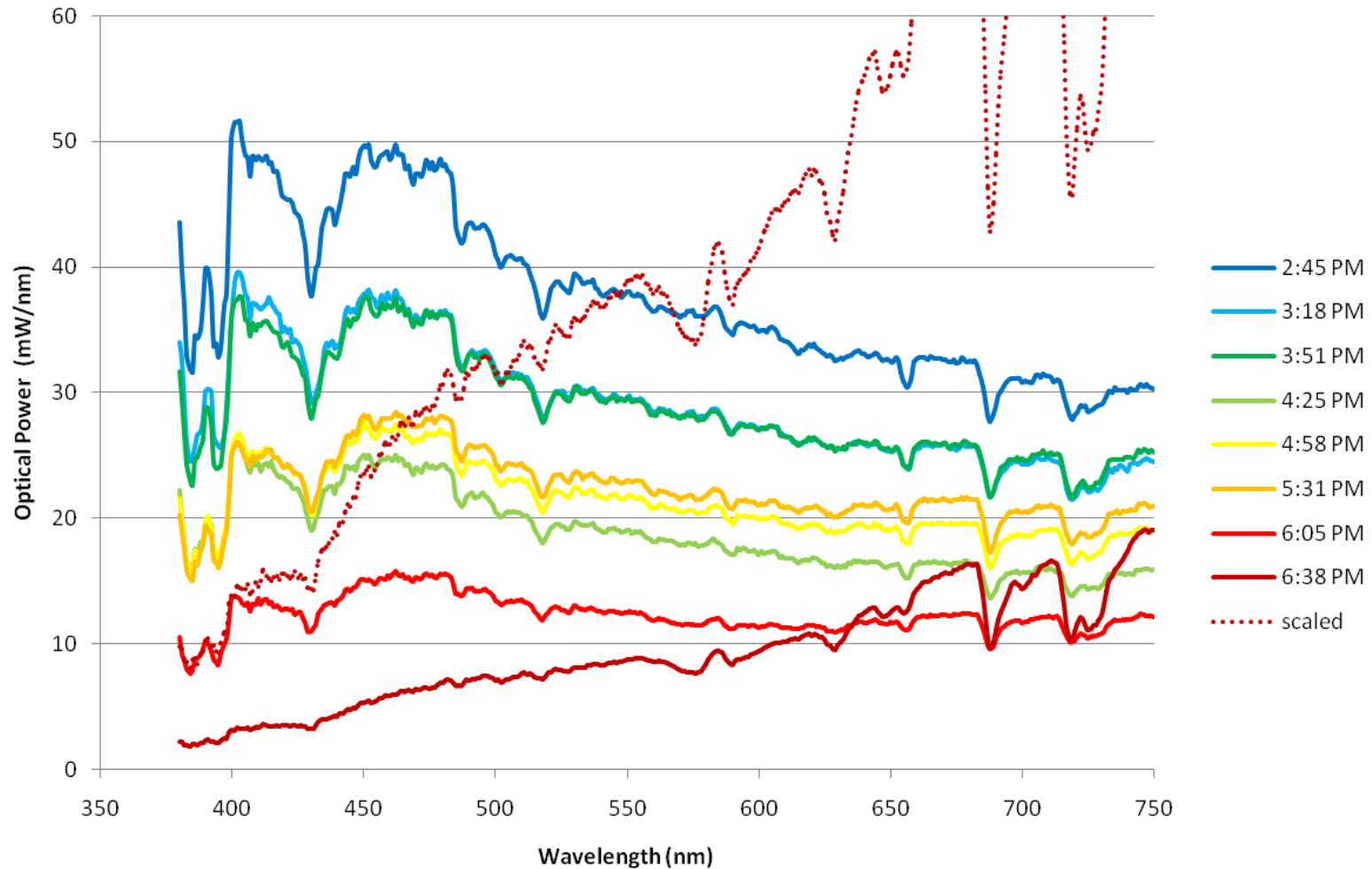
Wheatstack (Sun in the Mist), 1891. Oil on canvas. Minneapolis Institute of Arts.



Grainstacks. (Snow effects; sunlight), 1890-91. Oil on canvas. National Gallery of Scotland, Edinburgh, Scotland.

Changing Daylight Example

SPD Snapshots of Daylight Over 4-Hour Period



Portable Spectrometer for Light Recording

Removable Aluminum case that secures Spectrometer

Bluetooth Technology for remote measurements

Defuser light entry for easy measurements

WiFi
Lightweight handheld device with Wifi to transfer data

Free APP to analyse many types of data including Spectrum. Continuous measuring compatible

Calibrated with NIST traceable light source

Comes packaged with iPad touch 5

ASENSE™

Pod 11:02 AM

Back Continuous Reset All

Measure delay 1 min

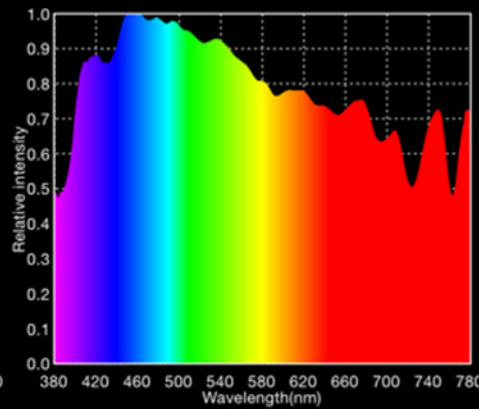
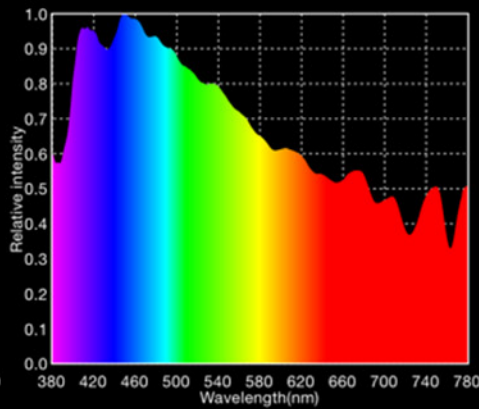
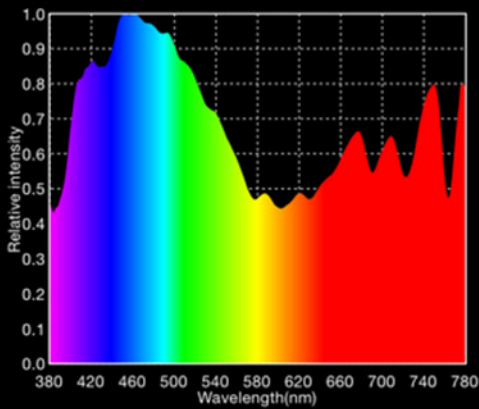
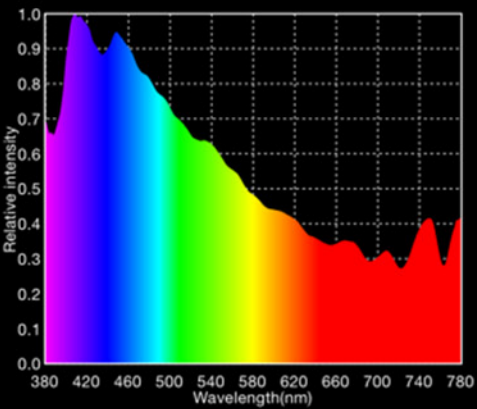
Total Times - 5 +

Select Parameter(s)

CCT	✓
CRI	✓
COS	✓
Illuminance	✓
CIE1931	✓
CIE1976	✓
Ap	✓

Next



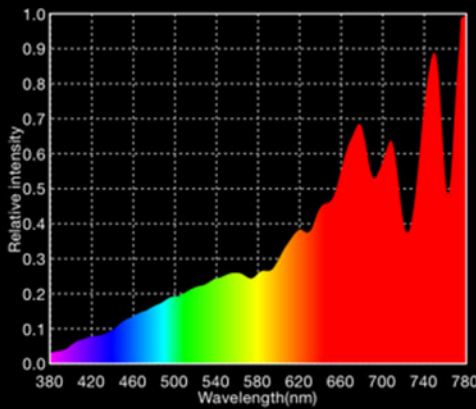
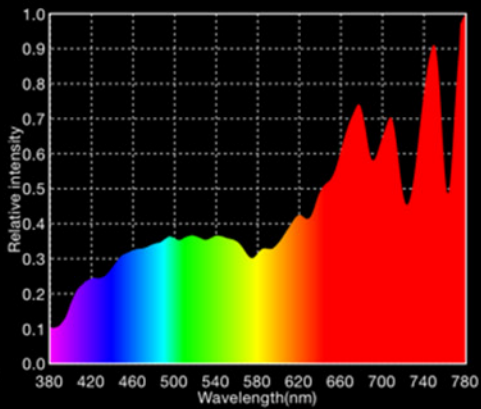
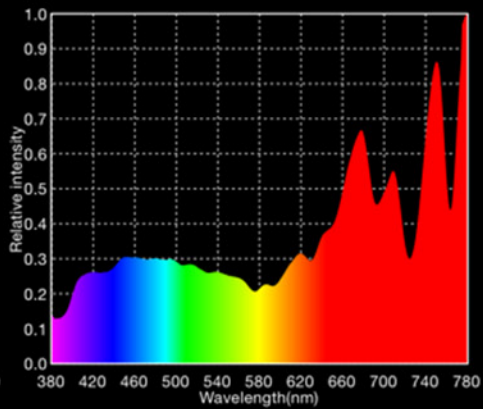
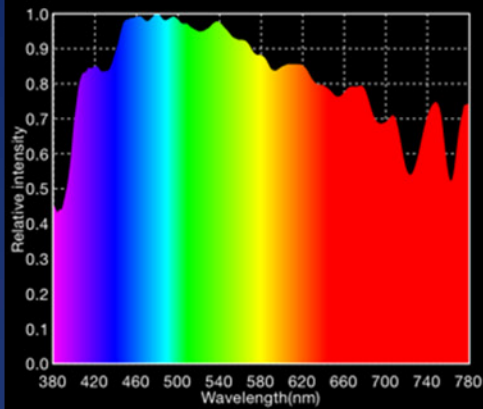


2015/08/12 02:30:12
 CCT 11745 K
 CRI(Ra) 97
 Illuminance 6007 lux
 CIE1976 u' 0.1848
 CIE1976 v' 0.4347
 Duv 0.0036

2015/08/12 08:48:27
 CCT 10688 K
 CRI(Ra) 94
 Illuminance 232 lux
 CIE1976 u' 0.1823
 CIE1976 v' 0.4415
 Duv 0.0077

2015/08/12 09:04:35
 CCT 8224 K
 CRI(Ra) 98
 Illuminance 5789 lux
 CIE1976 u' 0.1913
 CIE1976 v' 0.4528
 Duv 0.0031

2015/08/06 05:54:16
 CCT 6542 K
 CRI(Ra) 99
 Illuminance 3961 lux
 CIE1976 u' 0.1983
 CIE1976 v' 0.4672
 Duv 0.0024



2015/08/11 11:59:07
 CCT 6049 K
 CRI(Ra) 99
 Illuminance 25354 lux
 CIE1976 u' 0.2012
 CIE1976 v' 0.4728
 Duv 0.0023

2015/08/11 09:01:59
 CCT 5349 K
 CRI(Ra) 77
 Illuminance 189 lux
 CIE1976 u' 0.2182
 CIE1976 v' 0.4656
 Duv -0.0138

2015/08/08 08:47:05
 CCT 4540 K
 CRI(Ra) 85
 Illuminance 995 lux
 CIE1976 u' 0.2204
 CIE1976 v' 0.4856
 Duv -0.0056

2015/08/08 08:26:06
 CCT 3113 K
 CRI(Ra) 88
 Illuminance 6279 lux
 CIE1976 u' 0.2480
 CIE1976 v' 0.5144
 Duv -0.0034

Summary

- Products have moved beyond fixed CCT.
- Control interfaces are often complex.
- Light Players provide a simpler solution.
- Daylight provides a useful roadmap.
- The blackbody locus is a convenience.
- Clock, calendar time are key elements.
- Regular advancements on all fronts continue.



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Thank You