Night Photography

August 2013
Agenda

- Photography at different times of night
- Moon
- Stars
- Software and technology
- Tips, Tricks and Equipment
Blue Hour

- Blue Hour: “The period of twilight each morning and evening where there is neither full daylight nor complete darkness. The time is considered special because of the quality of the light at this time of day.”

35 minutes after sunset, sun about 7 degrees below horizon
Twilight

- Twilight: “the period between sunset and sunrise during which there is natural light provided by the upper atmosphere, which receives direct sunlight and scatters part of it towards the earth's surface”
Light After The Sun Sets

- Civil Twilight: Sun is 0 to 6 degrees below horizon
- Nautical Twilight: Sun is 6 to 12 degrees below horizon
- Astronomical Twilight: Sun is 12-18 degrees below horizon
- Night: Sun is more than 18 degrees below horizon
Blue Hour

- Some of the best “sunset” shots happen after most of the photographers have packed up their gear and gone home!

Top: 1 minute before sunset, sun on horizon
Bottom: 30 minutes after sunset, sun about 6 degrees below horizon
Blue Hour

- If conditions are right, clouds “light up” just after sunset

10 minutes after sunset, sun about 2 degrees below horizon
Blue Hour

- Clouds take on pink glow just after sunset

10 minutes after sunset, sun about 2 degrees below horizon
Blue Hour

- Twilight provides even, soft illumination...and the opportunity for longer exposures

15 minutes after sunset, sun about 3.5 degrees below horizon
ISO 100, F11, 2 seconds
Blue Hour

- Great time to shoot objects illuminated by artificial light: buildings, statues, monuments, etc.
- When light in sky is balanced by artificial light, the sky takes on a rich, saturated color, but not black

32 minutes after sunset, sun about 6 degrees below horizon
Blue Hour

- “Best” light for shooting artificially illuminated objects is usually when sun is about 4-8 degrees below horizon...at transition from civil to nautical twilight
- Exact time varies on lighting, location and time of year...but is about 20-40 minutes after sunset or before sunrise
Blue Hour

- Exposure times at twilight are usually between 1-20 seconds (ISO 100-400, F5.6-F11)...depends on light

38 minutes after sunset, sun about 7.5 degrees below horizon
ISO 200, F7.1, 8 Seconds
Blue Hour

- Look for balance between artificial and natural light
- Exposure times change rapidly...can change by one stop in just a few minutes

45 minutes after sunset, sun 9 degrees below horizon, moon (4%) 4 degrees above horizon
ISO 200, F7.1, 3 Seconds
Blue Hour

- After sunset and before sunrise, the horizon 180 degrees from sunset/sunrise takes on a soft, rosy light: “Alpenglow”

20 minutes after sunset, sun about 4 degrees below horizon
Blue Hour

- Alpenglow provides even, soft illumination with a warm color

15 minutes before sunrise, sun about 3.5 degrees below horizon
ISO 200, F22, 5 seconds
Blue Hour

- The Belt of Venus...is the Victorian-era name for an atmospheric phenomenon seen at sunrise and sunset. Shortly after sunset or shortly before sunrise, the observer is...surrounded by a pinkish glow...that extends roughly 10°–20° above the horizon.

5 minutes before sunrise, sun about 2 degrees below horizon
Blue Hour

- The light rose (pink) color is due to backscattering of reddened light from the rising or setting Sun...Often, the glow is separated from the horizon by a dark layer, the Earth's shadow or "dark segment". The light rose (pink) color is due to backscattering of reddened light from the rising or setting Sun. (http://en.wikipedia.org/wiki/Belt_of_Venus)

7 minutes before sunrise, sun about 2 degrees below horizon, moon about 7 degrees above horizon
Twilight

- After sun drops below about 7 or 8 degrees beneath horizon (about 45 minutes after sunset), skies start to become black

40 minutes after sunset, sun about 8 degrees below horizon
ISO 200, F8, 6 Seconds
Night

- Moonlight or artificial light are main sources of light at night
- In urban environments, artificial light predominates
Night

- Indirect light provides even illumination at night
Night

- Counterintuitive tip: look for subjects that aren't directly illuminated at night

Sun about 10 degrees below horizon
ISO 200, F8, 25 seconds
Night

- Almost impossible to avoid over-exposure of bright light sources
Night

- Clouds can reflect artificial light at night...white balance can be tricky, or offer artistic possibilities
Night

- In urban areas, clouds reflect artificial light and show unusual colors
Night

- A little artificial light can go a long way...scene is predominantly illuminated by three street lamps

90 minutes after sunset, sun about 18 degrees below horizon, moon (80% full) about 50 degrees above horizon.

Blended exposure: Exposure 1=ISO 400, F 7.1, 5 seconds, Exposure 2=ISO 400, F 7.1, 30 seconds
Night

- Motion of clouds and water becomes apparent with longer exposures at night
Night

- A little moonlight can go a long way...your eyes can't see colors at night, but your camera can!

Moon (96% full), 50 degrees above horizon, 4.5 hours after moonrise
ISO 800, F5.6, 60 seconds
Moon

- Great subject for night photography
- Great source of illumination for night photography

Full Moon Rising over Half Dome
10 minutes after sunset, sun about 2.5 degrees below horizon
Moon

- Provides some illumination even through thin clouds
Moon

- When moon is full, it rises at sunset, and sets at sunrise
- When moon is new, it sets at sunset, and rises at sunrise

Crescent Moon Setting over Bisti Badlands

30 minutes after sunset, sun about 7 degrees below horizon, moon about 7 degrees above horizon
Moon

- When moon is full, it is 180 degrees opposite sun at sunrise/sunset
- When moon is new, it is in same location as sun at sunrise/sunset

28 minutes after sunset, sun: 6 degrees below horizon, moon: 2 degrees above horizon
ISO 400, F8, 1.6 seconds
Moonlight

- A full moon provides about 18 or 19 stops less light than the sun
Moonlight

- Apart from exposure length, not too different from shooting with sunlight

Moon (90%) about 44 degrees above horizon
ISO 800, F5.6, 60 seconds
Moonlight

- Colors, contrast and white-balance can be tricky
- Scene is often illuminated by a combination of sources (moonlight, man-made light, light pollution)
- Shooting in “raw” format allows for easy color adjustment

Default camera settings
Color Temp: 5500K

Increased exposure by 0.5, reduced contrast, boosted shadows
Color Temp: 4800K

Color Temp: 4000K
Light Pollution

- Almost impossible to avoid anywhere near a city
  - Right side of picture: Gaithersburg/Germantown
  - Middle: Herndon/Reston
  - Left: Tysons Corner
Stars
Stars

- Shorter exposures show stars as points
- The shorter the focal length, the longer the exposure can be used before trails are visible

Moon (22% full), 7 degrees above horizon
ISO 3200, F2.8, 20 seconds
Stars

- The brighter the moon, the more stars are “washed out”, but moon provides illumination for ground
Stars

• Fewer stars are visible in urban areas, but some are still visible, and can be enhanced by careful image processing
Stars

• Some stars are still visible despite urban location and thin clouds

Moon (4 % full), 4 degrees above horizon
ISO 800, F4, 20 seconds
Stars

- Longer exposures show stars as “trails”
- Earth rotates 15 degrees per hour (360 degrees each day)
- Starlight provides faint, but visible illumination of ground
Stars

- The longer the lens, the longer the trails appear for any given exposure length
Stars

- Comparison of short (20 seconds) and long (4 minutes) exposures

ISO 3200, F2.8, 20 seconds

ISO 400, F3.2, 240 seconds
Stars

- As Earth spins on its axis, the stars appear to rotate around the visible celestial pole
Stars

- Stars rotating around the north celestial pole
Stars

- Panoramic image (more than 180 degree field of view), showing stars rotating around north celestial pole
Stars

- Panoramic image (about 160 degree field of view), showing stars rotating around south celestial pole (below horizon)
Stars

- Choice of projection changes shape of star-trails, similar to wide angle lens “stretching” objects at the edge of the picture
Aurora

- Aurora Borealis ("Northern Lights") and Aurora Australis ("Southern Lights") are visible near polar regions.
- Intensity and colors vary; aurora moves slowly.
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- Intensity and colors vary; aurora moves slowly.
Aurora
Stars: Image Stacking

- Problem: Capturing star trails in urban areas is impossible with conventional photography because lights and light pollution makes it impossible to take a long enough exposure to capture the motion of the stars.

- Solution: “Image Stacking”
  - Capture multiple images in sequence using short exposures
  - Use software to “stack” these images into a single composite
  - Different stacking methods can produce different results
Stars: Image Stacking

- Single exposure (ISO 400, F5, 12 seconds) is exposed correctly for subject and sky. A longer exposure would overexpose.
- Stars are visible at full size:
Stars: Image Stacking

- Multiple images (all ISO 400, F5, 12 seconds) are taken in sequence, and stacked to create a composite image.
Stars: Image Stacking

- Image Stacking can be done using software that handles image layers, or a specialized program like Image Stacker.
- Image Stacker's “Brighten” blending mode picks the brightest pixel in each source image which allows star-trails to form, without overexposing the rest of the image.
Stars: Image Stacking

- One problem with stacking is the appearance of “gaps” in star trails corresponding to the time elapsed between images when photographing.

- Even a pause of a second may be long enough to reveal “gaps.”

A two second pause between images caused this stacked image to show “gaps.”
Stars: Star Tracer

- “Gaps” can be filled effectively using Star Tracer
- Star Tracer can be used to determine the trajectory of each star in the image, and fill in the gaps

Two second “gaps” in stacked image

“Gaps” filled by Star Tracer
Stars: Star Tracer

- You tell Star Tracer some information about your images, and draw a few “star lines” indicating the trajectory of some stars in your image.
Stars: Star Tracer

- “Optimizing” the project allows Star Tracer to determine the trajectory of all the stars in the image.
- Output image is created by “rotating” the image a number of times by a specified amount:
  - “Rotation” is a simplification of what actually happens to the image, but simulates the rotation of the earth.
- In this example, one 4 second rotation was enough to fill in the 2 second gap between trail segments.
Stars: Star Tracer

- Star Tracer isn't limited to just filling in short gaps
- Some cameras pause for a long time to perform noise-reduction between images, and the resulting stacked images show much larger gaps...these can also be filled

Fifteen second “gaps” in stacked image

“Gaps” filled by Star Tracer
Stars: Star Tracer

- In fact, once Star Tracer has calculated the trajectory of each star, it isn't limited to just filling in gaps...it can be used to “extend” the length of trails.

Eight 12 second exposures stacked to create a “synthetic 100 second” (approx) exposure

Star Tracer “rotates” the image by an amount of 90 seconds, five times

Trails extended by Star Tracer to create a “synthetic 9 minute” (approx) exposure
Stars: Star Tracer

- Star Tracer can't determine what is and isn't a star...by default it rotates the entire image. You can create a “mask” layer in the input image to prevent “non-star” areas from being rotated.

Using Photoshop to draw a mask on input image, prior to processing in Star Tracer.
Stars: Star Tracer

- Shooting panoramas at night takes time
- Five images (4 minutes each) combined into one image: 20 minutes of total image capture

Sun: 28 degrees below horizon, Moon (7%): 16 degrees below horizon
3 hours after sunset, 80 minutes after moonset
ISO 400, F4, 240 seconds
Stars: Star Tracer

- Panoramic image consisting of five images (4 minute exposures for each image): 20 minutes of total image capture

Sun: 28 degrees below horizon, Moon (7%): 16 degrees below horizon
3 hours after sunset, 80 minutes after moonset
ISO 400, F4, 240 seconds
Stars: Star Tracer

- Star Tracer used to extend trails
- Not sure there would have been enough night hours to create this panoramic image using conventional approach
Stars: Star Tracer

- Is it cheating? Does it matter?!
Things That Move in the Night

- Airplanes
  - Almost impossible to avoid in urban areas
  - Surprisingly difficult to avoid in remote areas
  - Airplane lights can be “removed” using photo editing software
  - Or...airplane lights can be the subject of the photograph!

Streaks left by airplanes flying through scene
Things That Move in the Night

- Meteors (Shooting Stars)
  - Usually show as streaks with gradual start/end
  - Can move in any direction
  - Can happen any time of year, but most frequently during meteor “showers”

- Moon
  - Appears elongated in exposures longer than a few seconds
Things That Move in the Night

- Satellites
  - Usually show as bright streaks
  - Are illuminated by sun below horizon, and are only visible in hours near sunrise and sunset
  - Are very predictable!

International Space Station
70 minutes after sunset, sun about 12 degrees below horizon
ISO 400, F5.6, 90 seconds
Tips and Techniques: Exposure

- Determining correct exposure is much easier with digital than film: instant feedback and no reciprocity failure.
- Use a high ISO setting (e.g. ISO 3200 or ISO 6400) and short exposure to take test shot(s), review image(s), then adjust ISO and exposure length to desired setting.
- Exposure remains constant if ISO is doubled and exposure is halved.

<table>
<thead>
<tr>
<th>ISO</th>
<th>Exposure (seconds)</th>
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<tbody>
<tr>
<td>100</td>
<td>240</td>
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<tr>
<td>200</td>
<td>120</td>
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<tr>
<td>400</td>
<td>60</td>
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<td>800</td>
<td>30</td>
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<td>1600</td>
<td>15</td>
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<tr>
<td>3200</td>
<td>8</td>
</tr>
<tr>
<td>6400</td>
<td>4</td>
</tr>
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Tips and Techniques: Exposure

Exposure (shutter/aperture/ISO) is a complicated tradeoff

<table>
<thead>
<tr>
<th>Longer exposures</th>
<th>Shorter exposures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moon becomes elongated</td>
<td>Moon is rendered as round</td>
</tr>
<tr>
<td>Creates Star Trails</td>
<td>Renders stars as points</td>
</tr>
<tr>
<td>More planes</td>
<td>Fewer planes</td>
</tr>
<tr>
<td>More meteors/satellites</td>
<td>Fewer meteors/satellites</td>
</tr>
<tr>
<td>Allows for lower ISO</td>
<td>Requires higher ISO</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low ISO</th>
<th>High ISO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fewer stars appear in image</td>
<td>More stars appear in image</td>
</tr>
<tr>
<td>Creates Star Trails</td>
<td>Renders stars as points</td>
</tr>
<tr>
<td>Less noise</td>
<td>More noise</td>
</tr>
<tr>
<td>Typically requires larger aperture</td>
<td>Typically allows for smaller aperture</td>
</tr>
<tr>
<td>Typically requires longer exposure</td>
<td>Typically requires shorter exposure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Larger Aperture</th>
<th>Smaller Aperture</th>
</tr>
</thead>
<tbody>
<tr>
<td>More light...more stars</td>
<td>Less light...less stars</td>
</tr>
<tr>
<td>Shorter exposure</td>
<td>Longer exposure</td>
</tr>
<tr>
<td>More vignetting</td>
<td>Less vignetting</td>
</tr>
<tr>
<td>Softer image</td>
<td>Sharper image</td>
</tr>
<tr>
<td>Less depth of field</td>
<td>More depth of field</td>
</tr>
</tbody>
</table>
Tips and Techniques: Exposure

- “Light Painting” with a flashlight can be used to illuminate portions of a scene.
Tips and Techniques: Exposure

- Exposure blending can be used to balance exposure of bright and dim objects in “contrasty” scenes
- Can be used to blend two images taken with different exposures
- Can be used to blend one raw image processed differently (once for shadows, once for highlights)
- I use TuFuse and/or TuFuse Pro for Exposure blending:
Tips and Techniques: Exposure

- One raw file, processed into two images (once for sky, once for statue), and then combined using TuFuse into a single image.

Raw file processed to retain detail in statue

Raw file processed to show sky color and stars

“Exposure blended” combination of two files
Tips and Techniques: Focus

- Auto focus can give inaccurate results in low light.
- In low light, look for a light source at (or close to) the desired focus distance (e.g. moon, distant street light, etc.).
- Manual focus, in conjunction with live view (particularly with a camera that allows for a magnified image) can be useful.
- A laser pointer with live view and manual focus can be used to perform accurate focus in totally dark situations.
Planning

- Photographer's Ephemeris
Planning

- Heavens Above: Shows position of satellites
- Website (http://www.heavens-above.com) and Android app
Planning

- Many smart-phone apps (e.g. LunaSolCal)
Planning

- Canadian Meteorological Center: http://www.weatheroffice.gc.ca/astro/index_e.html
Equipment

- **Tripod**
  - Very few possibilities for night photography without one!

- **Cameras**
  - Most DSLRs have a “bulb” mode allowing unlimited exposures
  - Most digicams are limited to maximum exposures of under 30 seconds
  - Modern DSLRs produce usable images at very high ISOs (e.g. ISO 3200)
  - Shooting in RAW format allows for processing after capture

- **Lenses**
  - Variety of focal lengths can be used
  - Look for lenses that perform well at wide apertures. Vignetting and distortion can be easily fixed with software, but blurry corners cannot. Be willing to compromise...no lens is perfect wide open.
Tripod

- Night photography without a tripod!

30 second exposure through the window of a moving vehicle at night
Equipment

• Cable Releases/Remote
  - Allows triggering of camera shutter without touching/moving camera
  - Allows shutter to be locked open in bulb mode for exposures longer than 30 seconds

• Intervalometers/Timer Remote Controllers
  - Can be programmed to shoot a specified number of exposures in sequence, with a specified exposure length, a specified delay between shots, and a delay before starting
  - Costs vary wildly despite the fact they all do pretty much the same thing (Canon=$150, Generic=$15)
Equipment

- **Laser Pointer**
  - Useful for assisting in focusing

- **Flashlight**
  - Small, low-power key-chain type flashlights are useful for setting up, looking in bag, etc.
  - Higher power flashlights are useful for navigation and “light painting”

- **Timer/watch**
  - Useful for timing long exposures without an intervalomter

- **Compass**
  - Useful for estimating position of sun/moon at different times of day

- **Patience!**
RAW Converters

• Shooting in RAW format allows you to correct:
  - White Balance
  - Vignetting
  - Distortion
  - Noise Reduction

• Not all converters perform equally well
  - Some offer better vignetting correction
  - Some automatically detect and remove noise and “hot pixels”
RAW Converters

- Canon Digital Photo Professional vs Adobe Camera Raw
- Adobe Camera Raw “automagically” removes hot pixels
Conclusion

- Don't put the camera away just because the sun isn't up!
Links and More Reading

- Software
  - Image Stacker: http://www.tawbaware.com/imgstack.htm
  - PTAssembler: http://www.tawbaware.com/ptassembler.htm

- Photographs
  - Gallery: http://www.tawbaware.com/maxlyons
  - Catalog: http://www.tawbaware.com/maxlyons/cgi-bin/imgdb.pl
  - Large Prints: http://www.maxlyons.net

- Discussion Forum: http://www.tawbaware.com/forum2/

- This presentation: http://www.tawbaware.com/maxlyons/max_lyons_night_photography.pdf

- Contact: maxlyons@tawbaware.com
C&O Canal at Night
14th Street Bridges
Washington Monument