CASE STUDIES FOR EVALUATING PHOTOSIMULATIONS FOR VISUAL IMPACT ASSESSMENT

Principle
Photosimulation resolution

Statement
The base-photograph and photosimulation should have high resolution and minimal compression.

Explanation
The Snellen eye-chart for "normal" vision tests our visual acuity or the spatial resolution of our visual processing system. It uses block letters that are 5 arc minutes high and composed of lines and gaps with a width of 1 arc minute. However, perception research has found that resolution acuity of a normal eye is 30 arc seconds. The horizontal angle of view of a photograph taken with a "normal" lens is approximately 40°. If the expectation is that our visual acuity is 1 arc minute then the photograph must have at least 2,400 horizontal pixels (i.e., 40° x 60'); if visual acuity is 30 arc seconds it must have at least 4,800 horizontal pixels.

In addition to matching human visual acuity, the pixels of a photograph must capture the detail as it exists in the view. Figure 1 shows a grid of squares representing the pixels of a digital camera sensor. Each pixel of a digital photograph can only be one color. The color of the wind turbine blade in the purple square will be white, but the color in the orange square will be light blue and may not be recognized as part of the turbine blade. The tower presents a problem — it is a full pixel wide but is split by the grid. The green squares represent the solution determined by the Nyquist-Shannon sampling theorem — to capture a desired resolution is sufficient to sample at twice that resolution. The green squares to the left and right will be recorded as blue and the ones in the center will be white, and the tower captured. The same rule would apply to the blade tip, the lower left quarter of the orange square would become white and the rest would be blue.

Taken together, applying the eye's visual acuity and the sampling theorem to a digital camera requires that a photograph taken with a "normal" lens have a horizontal resolution between 4,800 (2400 pixels sampled at 2x resolution) and 9,600 pixels (4800 pixels sampled at 2x resolution), which requires a 15.3 up to 61.0 megapixel digital camera.

These resolution issues also apply to printing. For instance, 300 dpi is referred as a "retinal display," where we no longer see the dots when held at a comfortable distance. If a photosimulation is to be printed 16 in wide on tabloid paper, that means that the image must have a minimum of 300 x 16 or 4,800 pixels. However, the pixels of the image and the printer will not match perfectly, so the Nyquist-Shannon sampling theorem suggest that the image be 9,600 pixels wide to fully print the information in the image. It is more complicated than this because printers do not print simple pixels and may use algorithms to sharpen edges or make other adjustments. However, the general principle still applies.

A further consideration is that cameras often save images as a JPEG file, a "lossy" compression format that reduces the file size of the image but reduces the image quality of the details in the process. All photographs should be saved as the highest quality JPEG file, or better yet as a RAW format file that is "lossless." Great care may be taken to prepare simulations to maintain a high quality image, but it is not unusual that the simulation will be made available to the public as a PDF document that has been significantly compressed using JPEG to facilitate download times.

Case Study. View of from The Rocks Estate

The Rocks Estate is a 1,400-acre property listed on the National Register of Historic Places. It is owned by the Society for the Protection on New Hampshire Forests which maintains an education center and trail system for visitors. A 345 kV transmission line on 75 ft lattice structures is proposed within an existing corridor. At a distance of less than half a mile, the existing structures on 43 ft wooden H-frames are easily overlooked, the new structures will be more visually prominent.

A selection cropped from the original photosimulation representing views from The Rocks Estate as prepared for the applicant's VIA is shown in Figure 2. The details of the lattice structures and conductor wire are clearly apparent in the full resolution, uncompressed image. However, the PDF version of the photosimulation made available to the public on the permitting agency's website is significantly degraded.

Discussion

VIA reviewers must always request the original base-photograph and photosimulation in order to evaluate visual effects. Information about the last applied JPEG compression is not part of the image metadata, however, there are online tools that will provide estimates.

As this case study demonstrates, the quality of a simulation can be degraded during the process of preparing them for distribution. This can be done by the VIA authors or developer when they submit their permit application, or it can be by the permitting agency when the files are compressed to make storage and downloading more manageable. The result may be unintentional, but reviewers must always be conscious of this possibility since it has a very significant effect on the apparent visual prominence of a project and can lead to a misunderstanding of potential visual impacts.

FIGURE 1. A camera sensor records an image as pixels — represented by the squares.

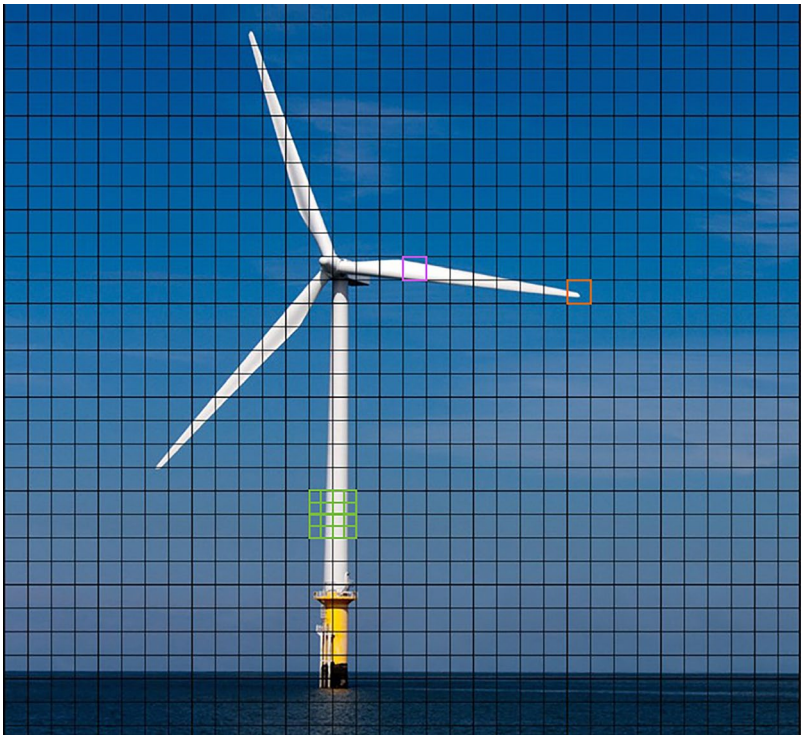
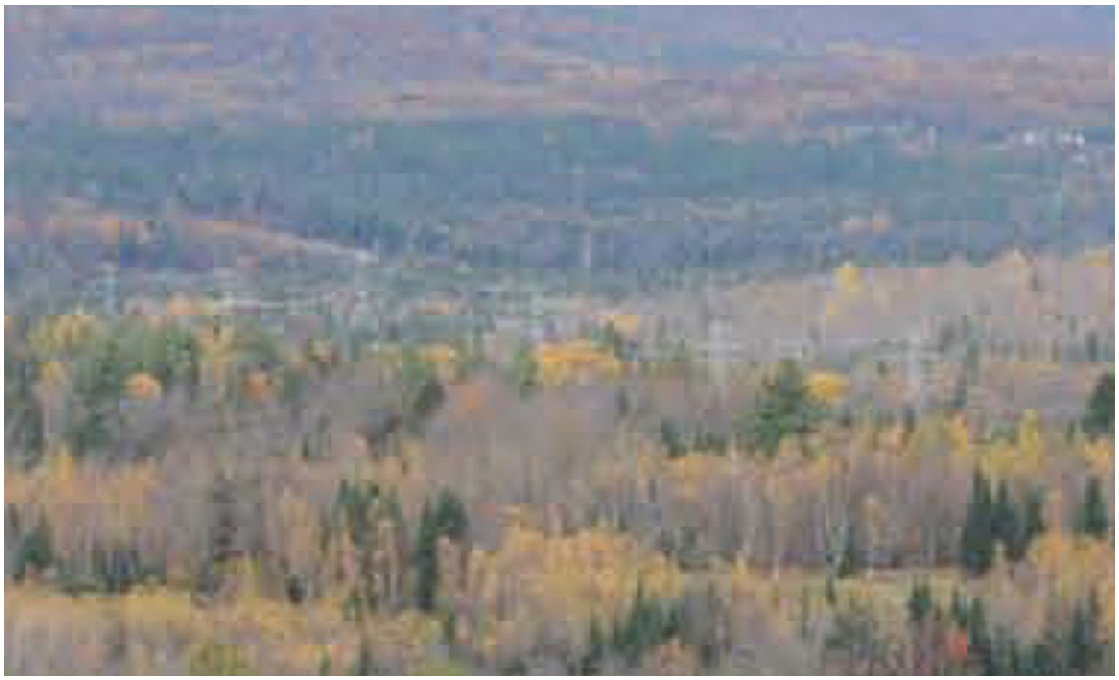


FIGURE 2. A cropped selection from the photosimulation at The Rocks Estate provided during discovery. This represents the full quality of the original photograph and simulation.



FIGURE 3. A cropped selection from The Rocks Estate photosimulation as it appeared in the VIA. The quality of the image is severely degraded from the original, as is quite apparent if one focuses on the conductor wires.



Statement of Limitations: The simulations presented here were entered into the public record as part of a permitting process. They were prepared to be printed on 11-by-17-inch paper. However, in the process of distribution as PDFs they may have been substantially compressed. The figures presented here were clipped from these PDFs, converted to high quality JPGs and their resolution reduced. The original photosimulation has been substantially changed and as presented here should be used only as learning material.

Source: The figures used in this case study are taken from materials submitted to the New Hampshire Site Evaluation Committee.