

Visual Prominence as Perceived in Photographs and In-Situ

James Palmer¹, Robert Sullivan²

¹Scenic Quality Consultants, Burlington, VT/USA · palmer.jf@gmail.com

²Argonne National Laboratory, Lemont, IL/USA

Abstract: Current visual simulation guidelines for major developments in the UK recommend using base photographs taken with a 75 mm effective focal length (EFL). This recommendation is made in spite of the geometric laws of perspective. Nonetheless, there is some research comparing photographs to in-situ views supporting this guideline, though these studies do not attempt to explain why this enlargement is necessary. This paper compares the visual prominence of in-situ observations to judgement made viewing photosimulations and as-built photographs with 50 mm and 75 mm EFLs.

Keywords: Simulation, visual impact assessment, landscape perception

1 Introduction

In public hearings considering whether to permit proposed wind energy development, it is common to hear condemnations of the visual simulations as not accurately representing how the project will look. To address this problem THE HIGHLAND COUNCIL (2016) proposed replacing the standard of a 50 mm lens on a full-frame digital camera (as per Highland Council guidance in 2009) with a 75 mm effective focal length (EFL) for the preparation of photographic-based visualizations of wind energy development. The Council's current standards were issued in 2016 and include the following statements:

“These Standards were informed by extensive research and field-testing by officers and responded to growing demands for visual formats that were more representative, could be clearly and easily understood, were accessible to all parties and could be relied upon by planning officers, committee members and the public [...]” (THE HIGHLAND COUNCIL 2016)

“Changes and modifications are intended to clarify and improve the standards and are as follows: ... Images for visual impact assessment have been standardised to a focal length of 75 mm for both on-shore and off-shore wind farms.” (THE HIGHLAND COUNCIL 2016)

The documented empirical evidence supporting a standard that changes from a 50 mm to a 75 mm EFL is based on a study by HUNTER & LIVINGSTONE (2012). That study surveyed more than 300 participants at nine landscape viewpoints and asked them which of seven photographs taken with EFLs from 50 mm to 110 mm in 10 mm increments “provided the most realistic representation of the scale and distance to a specific focal point” (HUNTER & LIVINGSTONE 2012, 2). The survey results indicated that participants thought an EFL between 70 mm and 80 mm provided the most realistic representation. Based on the survey results, the authors recommended using a 75 mm EFL for wind energy project simulations. In addition, the study also recommended that images be printed on A3 paper and held at a “comfortable” (HUNTER & LIVINGSTONE 2012, 24). viewing distance, though the study did not investigate viewing distance and did not specify a particular distance or range of distances as

“comfortable” (ibid.). It also should be noted that these were ordinary countryside views, and they did not include wind turbines or other development normally associated with visual impacts.

A contemporaneous book by MACDONALD (2012), a photographer and architect, made the same recommendation that base photographs for single-frame visual simulations use a 75 mm EFL, which has subsequently been adopted by SCOTTISH NATURAL HERITAGE (2017) and more recently by the LANDSCAPE INSTITUTE (2019) for representing wind farms. Oddly, the LANDSCAPE INSTITUTE (2019) recognizes that a 50 mm EFL image printed at a size of 260 mm × 390 mm on A3 paper and held at 542 mm is “mathematically correct” (14), but states that when such an image is “held at comfortable arm’s length, the scale of the viewed image is smaller than reality” (ibid.).

PALMER et al. (2017) were unable to replicate HUNTER & LIVINGSTONE’S finding using similar landscape views. Their result indicated that the optimal EFL was slightly longer than 50 mm. In a second study, PALMER (2019) found that students held a simulation of off-shore wind energy development printed on a tabloid (approximately A3) sheet at 460 mm, or closer than the “mathematically correct” correct 594 mm. In other words, the viewing geometry should have made the turbines appear larger, not “smaller than reality.” These results suggest that additional research is necessary to understand how best to represent visual change and its impacts to the public and decision makers.

In a study comparing post-construction panoramic and single-frame photographs of an on-shore and offshore windfarm taken at 50 mm, 75 mm and 90mm EFLs, TAKACS & GOULDEN (2019) obtained results similar to HUNTER & LIVINGSTONE (2012), i. e., 75 mm EFL photos were judged to best portray the wind farms. However, other studies have found the geometries of visual and pictorial space to be similar (ERKELENS 2018), and that a view is best represented by a photo taken with a 50 mm EFL lens printed to fill an A3 sheet of paper held at the appropriate viewing distance (BANKS et al. 2014).

In this paper we suggest a new direction for considering the conundrum of why photographic simulations are not representing the in-situ visual experience of proposed development accurately. Specifically, we consider in-situ ratings (from two viewpoints) of 18 transmission towers constituting the Dominion Power Surry-Skiffes Creek Wheelton Transmission Line Project (SSCW). The 500 kV SSCW transmission line crosses the James River in Virginia, USA. The four tallest structures near the center of the crossing were clearly visible from both viewpoints. Two of these structures measured 297 ft (90.5 m) high, and two were 277 ft (84.4 m) high. The in-situ ratings are compared to ratings of the photographic simulations from the SSCW project’s visual impact assessment (VIA) (STANTEC 2014). The in-situ ratings were also compared to ratings of photographs taken of the as-built project during the in-situ fieldwork, both using EFLs of 50 mm and 75 mm.

2 Methods

A team of seven visual resource and three natural resource professionals conducted fieldwork from July 23 to 25, 2019 in order to evaluate draft National Park Service (NPS) procedures to evaluate visual impacts. This evaluation involved observing and assessing the visual effects of the SSCW project, including the visual prominence of the constructed project from eight viewpoints using the scale in **Table 1**, which is adapted from SULLIVAN et al. (2014).

Table 1: Visual prominence scale

Level	Project Visibility
0	Not Visible
1	Visible only after extended, close viewing; otherwise not visible.
2	Visible when scanning in general direction of study subject; otherwise likely to be missed by casual observer.
3	Visible after brief glance in general direction of study subject and unlikely to be missed by casual observer.
4	Plainly visible, could not be missed by casual observer, but does not strongly attract visual attention, or dominate view because of apparent size, for views in general direction of study subject.
5	Strongly attracts visual attention of views in general direction of study subject. Attention may be drawn by strong contrast in form, line, color, or texture, luminance, or motion
6	Dominates view because study subject fills most of visual field for views in its general direction. Strong contrasts in form, line, color, texture, luminance, or motion may contribute to view dominance.

Two of the viewpoints evaluated in the field were selected for further evaluation: VP 09 is from a roadside pull-out with interpretive signage on the Colonial Parkway, which is a National Scenic Byway and All-American Road that is part of the Colonial National Historical Park. VP15 is a view from the entrance to the main house at Carter's Grove Plantation, which is a National Historic Landmark and is listed on the National Register of Historic Places. Both views are toward the four largest SSCW structures in the center of the river. The nearest visible structure is 3.5 mi (5.6 km) from VP09 and 1.8 mi (2.9 km) from VP15, as shown in Figure 1. An in-situ evaluation of these simulations determined that the scale of the structures was depicted accurately, though there were various other minor errors. The photographs of the as-built project taken during the fieldwork closely matched the viewpoints and views simulated in the VIA.

The VIA simulations were prepared by Truescape USA, Inc., using a 50 mm EFL; the as-built photos also used a 50 mm EFL. These images were cropped to a 75 mm EFL using a template and methods described by SCOTTISH NATURAL HERITAGE (2017).

All four images were printed on tabloid (11 x 17 in; 279 × 432 mm) premium color copy paper with a Xerox WorkCentre 7800 Series copier. A number identifying the condition for each image was printed in the left margin.

Ten participants used the visual prominence scale to rate the 8 images (VIA simulations and as-built photographs at two viewpoints with 50 mm and 75 mm EFL) at a workshop on October 27, 2019 during the Visual Resource Stewardship Conference. The workshop concerned using intercept surveys as part of a VIA, and the rating occurred prior to a discussion about the use and presentation of visual material during a survey. The eight images were distributed in random order to the group, who passed them around until everyone had rated all the images. Participants were told to view the images in a way that felt comfortable – sometimes this was held up at arm's length perpendicular to the line of sight, and other times participants were seated and the images viewed obliquely on a table surface. This instruction to view the images in a comfortable manner follows the recommendations of HUNTER & LIVINGSTON (2012) and MACDONALD (2012).



Fig. 1: 50 mm EFL lens photo of existing condition at VP15; red square shows 75 mm EFL

3 Results

The field team unanimously agreed that the in-situ ratings of visual prominence at both sites was level 5 – *Strongly attracts visual attention of views in general direction of study subject. Attention may be drawn by strong contrast in form, line, color, or texture, luminance, or motion.* The mean visual prominence ratings based on the simulations and as-built photographs with 50 mm and 75 mm EFL are given in **Table 2** and shown in Figure 2, which includes 90 % confidence interval error bars for comparison to the in-situ rating. An inspection of these error bars indicates that the visual prominence ratings of the simulations and as-built photographs with a 50 mm EFL are lower than observed in the field, but that with a 75 mm EFL they are similar or higher than what was observed in the field.

Table 2: Visual prominence ratings

VP	EFL	VIA Simulation				As-Built Photo			
		Mean	Std Dev	n	±90% CI	Mean	Std Dev	n	±90% CI
09	50	4.95	0.832	10	0.48	4.60	0.738	10	0.43
09	75	5.60	0.516	10	0.30	5.00	0.667	10	0.39
15	50	4.35	1.001	10	0.58	3.80	1.135	10	0.66
15	75	4.85	1.001	10	0.58	5.05	0.896	10	0.52

Note: Confidence intervals are calculated with two-tailed critical value of t , $df = n - 1$

Colonial Parkway

Carter’s Grove

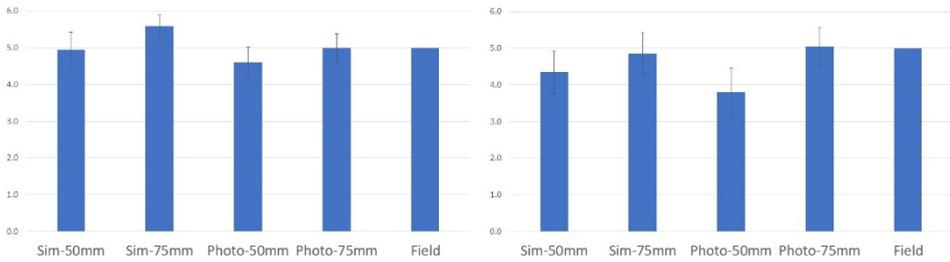


Fig. 2: Visual prominence ratings made in the field, of simulations and as-built photos using a 50 mm and 75 mm EFL lens with 90 % confidence intervals

Properly speaking, the error bars cannot be used to compare simulations to as-built photos, or 50 mm to 75 mm EFL because they are related images and not independent of each other (CUMMING et al. 2007). However, paired t-tests can be used for such comparisons. Table 3 compares the visual prominence ratings of the simulations to the as-built photographs for each EFL at each site. The results are mixed with two statistically significant results, but no clear pattern.

Table 3: Difference in visual prominence between simulations and as-built photos by EFL

VP	EFL	t	p
09	50 mm	1.172	0.271
09	75 mm	3.674	0.005
15	50 mm	2.538	0.032
15	75 mm	-0.6124	0.555

Note: $df = 9$

Table 4 compares the visual prominence ratings of the 50 mm and 75 mm EFLs. In this case it is clear that viewing simulations of photographs with a 75 mm EFL results in a statistically significant higher visual prominence rating than viewing simulations of photographs with a 50 mm EFL.

Table 4: Difference in Visual Prominence between 50 mm and 75 mm EFL for Simulations and Photos

VP	Media	t	p
09	Simulation	-2.751	0.022
09	As-built Photo	-2.753	0.022
15	Simulation	-1.861	0.096
15	As-built Photo	-6228	0.000

Note: $df = 9$

4 Conclusions and Discussion

Though the sample sizes are small, there are clear trends from these results. First, the visual prominence ratings made in-situ are higher than for the ratings of the simulations and as-built photographs taken with the 50 mm EFL. However, with a 75 mm EFL this difference diminished to a level that is not statistically significant. While this finding is consistent with HUNTER & LIVINGSTON (2012), they made no attempt to explain their findings. MACDONALD (2012) accepts the relevance of perspective geometry to photography and acknowledges that the initial use of “separate (50 mm) single frame images [...] did give a reasonable representation of the landscape scale” (5). He believes the confusion and claims of misleading representation began with the practice of using digitally stitched panoramic simulations. The problem he identified is that “the viewing distance was not stated and when it was added to the burgeoning technical data, there was no explanation of what it was or how to apply it” (ibid.). Rather than address the problem he identified – simulations are not held perpendicular to the line of sight and at their picture plane distance – his “solution” was to magnifying the image to 150 % its original size.

4.1 What Is the “Problem” and What Is the Best “Solution”?

MACDONALD describes the problem of misinterpreting simulations this way:

“After carrying out observations on how the public viewed displayed images and environmental statements at public exhibitions, the main cause of the problem became clear. Because this viewing methodology was never explained or understood they were in effect, unwittingly viewing a misleading image which considerably reduced the potential visual impact, similar to the way the photographer had been misled by the panoramic images several years before. When questioned afterwards about the viewing distance, most people were completely unaware of it and those who glanced at the technical information considered it to be data for professionals only.” (MACDONALD 2012, 7)

It appears part of the “problem” is that the public does not read information about viewing photosimulations, understand its importance, or follow the instructions. Significantly, MACDONALD (2012) acknowledged that 50 mm EFL single-frame photosimulations “did give a reasonable representation of the landscape scale” (5) and that LANDSCAPE INSTITUTE (2019) recognizes they are “mathematically correct” (4). This suggests that it is critical when viewing simulations that viewing distance affects the perception of scale of objects in the simulation, that there is a correct viewing distance for the simulation, and it must be viewed from that distance to perceive scale accurately.

However, given the evidence that several studies have shown that viewers perceive 75 mm EFL images to most realistically depict the landscape and objects within the landscape, the issue may not simply be one of properly depicting scale. There may be other factors at play when judging the representational accuracy of simulations. Alternatively, the perception of scale may involve more than simply judging the apparent size of an object relative to its surroundings. Principles from ecological psychology may shed some light on these concerns.

4.2 Should Ecological Validity Be a Central Consideration for Visual Simulations Guidelines?

Ecological psychology rejects the dualism between an organism and the environment, asserting instead that characterization of the environment is only meaningful when mindful of the organism. We directly perceive information in the optic array from an object about what it affords us; as we move, the changing view provides information about the object's invariant properties. This recognition is central to GIBSON's (1979) ecological psychology.

However, as WILSON & GOLONKA (2013) observe:

“Pictures of objects do not afford the same things as the objects themselves. Interact with a coffee cup, and a picture of a coffee cup; they provide very different opportunities for interaction. You cannot drink out of a picture of a coffee cup; you cannot hold it by the handle because it has no handle!”

A photograph is a frozen moment in the visual experience of a landscape – literally a “snapshot” of some portion of the information available in the optic array. However, it does not represent motion of objects in the scene, or our motion in the landscape over time; these are critical to understanding affordances. Because photomontage simulations do not depict object or viewer motion, they may affect people's perception of distance within the image, and either directly or indirectly affect visual prominence. MACDONALD (2012) recognizes that “our ability to assess distance within the 3D world which surrounds us would in turn give us a sense of scale and this would become even more apparent as we move through the landscape, because more distant objects appear to move more slowly” (3). Because photosimulations do not allow for viewer movement, they may also affect viewers' ability to judge distance and therefore scale. SULLIVAN et al. (2012) found that wind turbine blade motion contributed significantly to visual prominence of wind turbines at distances of up to 15 mi (24 km); others have identified wind turbine blade as a significant attractor of visual attention and a factor that increases perceived visual contrast from wind facilities (BISHOP & MILLER 2007).

Furthermore, the accuracy of the photographic record of physical properties such as color, texture, and sharpness may suffer from less than optimal camera and printer settings that affect contrast and resolution (detail) of the image. This is not simply an issue of viewing the photographs from the wrong viewing distance. Landscape photos are often less sharp and show less contrast than is observed in the field (SULLIVAN et al. 2012). SCOTTISH NATURAL HERITAGE (2006) suggests the camera's inability to replicate the full contrast range visible to the human eye is a “key limitation of photographs in replicating the human experience.”

Humans judge distance to objects in the landscape in part by assessing the effects of *atmospheric perspective*, the decrease in contrast between an object and its background as distance increases. As distance increases, the colors of the object become less distinct and shift toward the background color, usually blue or gray. Atmospheric perspective is an important cue for an observer to determine relative distance of objects in the landscape. The loss of sharpness and lower contrast of photographs relative to in-situ viewing may exaggerate the effects of atmospheric perspective, thus may affect the perception of scale and distance to objects in the landscape, making them appear farther away than they actually are.

Our experience observing the SSCW structures is more understandable when considered from the ecological perspective. The photographic portrayals of the impacting structures do not have the vividness or vitality that is observed in-situ. There is too little contrast between

the transmission structures and the sky. It is difficult to understand the full scale of the structures from a static view; this problem is enhanced because the structures are unusually large and beyond what is normal experienced in that landscape.

We believe that these factors may be a primary source of public dissatisfaction with photographic visualizations. If this is the case, then enlarging the depicted impacting structures in simulations to make them more prominent may be an inappropriate way to compensate for the weaknesses of photographic media. We suggest that additional research is needed to tease apart the causes for why photographic visualizations are not representing in-situ impressions. In particular, we suggest investigating whether virtual or augmented reality displays that incorporate motion provide a better representation of the information available from the landscape's optic array. In conducting these investigations, it is critical that they include in-situ observations as the standard for comparison.

These issues and others affecting the accuracy of visual simulations are discussed by Sullivan in Apostol et al. (2017). The number and complexity of the issues involved might lead to the conclusion that evaluation of visual impacts represented in technically accurate photosimulations should be primarily the responsibility of trained visual impact assessment professionals. The basis for this conclusion would rest on the assumption that the public's assessment of photosimulations should be discounted, until it has been demonstrated that they are able to properly interpret and observe the requirements for proper viewing distance as well as understanding the limitations of photography-based simulations discussed here and elsewhere.

Alternatively, VIAs could be required to contain a clear description of how to properly view photosimulations so that they are seen as geometrically accurate portrayals, and to explain the reasoning for this need. The VIA could also be required to discuss the inherent limitations of photosimulations in accurately simulating the in-situ visual experience. Presentation of this information would be particularly important at public meetings and other stakeholder engagement activities where the simulations would be presented.

Finally, we feel it should become standard practice that the photosimulations are peer reviewed for technical accuracy and proper presentation instructions and related information. If they are found inadequate by peer review, the simulations should be removed from the record and the permitting process stopped until corrected.

References

- APOSTOL, D., PALMER, J., PASQUALETTI, M., SMARDON, R. & SULLIVAN, R. (Eds.) (2017), *The Renewable Energy Landscape*. London: Routledge.
<https://doi.org/10.4324/9781315618463>.
- BANKS, M. S., COOPER, E. M. & PIAZZA, E. A. (2014), Camera focal length and the perception of pictures. *Ecological Psychology*, 26 (1-2), 30-46.
- BISHOP, I.D. & MILLER, D. R. (2007), Visual Assessment of Off-shore Wind Turbines: The Influence of Distance, Contrast, Movement and Social Variables. *Renewable Energy*, 32, 814-831.
- CUMMING, G., FIDLER, F. & VAUX, D. L. (2007), Error bars in experimental biology. *The Journal of Cell Biology*, 177 (1), 7-11.

- ERKELENS, C. J. (2018), Multiple photographs of a perspective scene reveal the principles of picture perception. *Vision*, 2, 26. doi:10.3390/vision2030026.
- GIBSON, J. J. (1979), *The Ecological Approach to Visual Perception*. Houghton Mifflin Co., Boston, US.
- HUNTER, P. D. & LIVINGSTONE, D. F. (2012) The effect of focal length on perception of scale and depth in landscape photographs. Implications for visualization standards for wind energy developments. Final report to The Highland Council. Sterling University, Sterling, UK.
- LANDSCAPE INSTITUTE (2019), *Visual Representation of Development Proposals*. Landscape Institute, London, UK. <https://www.landscapeinstitute.org/visualisation/> (03.03.2020).
- MACDONALD, A. (2012), *Wind farm Visualization: Perspective or Perception?* Whittles Publishing, Dunbeath, UK.
- PALMER, J. F. (2019), The Best Paper Format and Viewing Distance to Represent the Scope and Scale of Visual Impacts. *Journal of Digital Landscape Architecture*, 4-2019, 142-151.
- PALMER, J. F., VANDERHEYDEN, V., ALVES, G. & SISMANI, G. (2017), Best focal length to represent a landscape view using a single-frame photograph. *Journal of Digital Landscape Architecture*, 2-2017, 236-243. doi:10.14627/537629024.
- SCOTTISH NATURAL HERITAGE (2006), *Visual Representations of Windfarms: Good practice guidance*. Scottish Natural Heritage, Inverness, UK.
- SCOTTISH NATURAL HERITAGE (2017), *Visual Representation of Wind Farms: good practice guidance (version 2.2)*. Scottish Natural Heritage, Inverness, UK.
- STANTEC (2014), *Visual Effects Assessment for the Proposed Dominion Virginia Power Surry to Skiffes Creek 500 Kv Transmission Line Project*. Stantec, Glen Allen, VA.
- SULLIVAN, R. G., KIRCHLER, L. B., LAHTI, T., ROCHÉ, S., BECKMAN, K., CANTWELL, B. & RICHMOND, P. D. (2012), Wind turbine visibility and visual impact threshold distances in western landscapes. Conference Proceedings of the 37th Annual NAEP Conference. May Portland, OR.
- SULLIVAN, R. G., ABPLANALP, J. M., LAHTI, S., BECKMAN, K. J., CANTWELL, B. L. & RICHMOND, P. (2014), Electric transmission visibility and visual contrast threshold distances in western landscapes. Conference Proceedings of the 39th Annual NAEP Conference. April 7 – 10, 2014, St. Petersburg, FL.
- TAKACS, B. & GOULDEN, M. C. (2019), Accuracy of wind farm visualizations: The effect of focal length on perceived accuracy. *Environmental Impact Assessment Review*, 76, 1-9.
- THE HIGHLAND COUNCIL (2016), *Visualisation Standards for Wind Energy Developments*. The Highland Council, Inverness, UK.
- WILSON & GOLONKA (2013), The affordances of objects and pictures of those objects. February 28, 2013. <https://psychsciencenotes.blogspot.com/2013/02/the-affordances-of-objects-and-pictures.html> (03.03.2020).