

**Quantifying the Visual Effects of Wind Farms;  
A Theoretical Process in an Evolving Australian Visual Landscape.**

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**Dissertation for Doctorate of Philosophy**

**School of Architecture, Landscape Architecture and Urban Design  
University of Adelaide  
2009**

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21st June 2009

## ACKNOWLEDGMENTS

During the experience of my candidature I have seen, touched, smelt and been immersed in landscapes. From the physical landscapes of Scotland, Newcastle upon Tyne, Germany, wind farms in Victoria and South Australia to the 'office' at Adelaide University, these places have all left an imprint for better or worse on the timeline which is this dissertation. However, I have become aware that the experience does not end; it is a means to opening up new horizons and further research questions which I may well endeavor to tackle in the future.

I like to refer to the roller coaster as a metaphor to the emotional and character defining experience during my candidature. There have been times of seldom boredom, loneliness and a lack of motivation. Conversely there have been moments of brightness when milestones are completed and certain theoretical topics mesh together cohesively. These periods of achievement, be they minor, helped to sustain motivation and drive needed to strive for the ultimate goal of producing this dissertation.

Friends and colleagues have come and gone within the Department of Architecture, Landscape Architecture and Urban Design at Adelaide University, with numerous acquaintances being made for future engagement. The relationships and conversational debate have been influential in defining and motivating this dissertation.

The longevity of the quest for a PhD is also paramount to the investment, stress, admiration and gratitude that were endured during the process. There are many people that have been involved who need to be rightfully thanked for their contributions.

I acknowledge with sincere gratitude the support of many individuals over the 5 years in preparing this dissertation and I apologize if I have forgotten to mention specific names. However I would like to thank in particular;

My family, Pia my wife, parents Bruce and Chris, sisters Nicole and Jodie as well as my extended family; grandma, aunties,

uncles and family in law for their understanding and motivational support.

My supervisors, Associate Professor Dr David Jones, Department of Architecture Landscape Architecture and Urban Design, for his directional support and Dr Andrew Lothian for his theoretical review and friendship throughout the process.

My professional practice mentor and friend Warwick Keates, for his critical thought and time spent listening to me flesh out ideas. Your help has been invaluable.

Maggie Roe & Claire Haggett, University of Newcastle (UK) and the Landscape Research Group, for their support and assistance whilst I was exploring concepts in the United Kingdom and Europe.

Ian Roberts (Adelaide University), for his technical assistance preparing online internet surveys.

Participants in the internet slide rating.

Finally, my friends and colleagues for their understanding and support.

## ABSTRACT

Renewable energy production takes on many forms; wind farms and their turbines are but one. Turbines are a unique dynamic infrastructure within the landscape, which signifies a change in social attitude towards sustainable developments. The clarity and simplicity of the turbines' function (wind blows, blades turn, turbine spins and electrical power is generated) enforces the benign qualities that wind farms possess. However there are implications associated with the compatibility of turbines to landscape visual character and conservation.

The environmental impacts associated with wind turbines include noise, shadow flicker, bird strikes and electromagnetic interference with radio and television signals. However, research suggests the major issue facing planning and development approval is on a social level, with visual pollution being the dominant public criticism.

Wind farms must be located where consistent strong winds permeate to generate maximum efficiency. The efficiency of output is dependent on clear exposure to the prevailing wind, which normally implies ridgelines and escarpments which are both visually dominant topographical locations. The Australian Wind Energy Association (AUSWEA) has

established guidelines confirming that smooth hilltops are the most preferred topography for airflow, free from obstructions. In contrast, locations with excessive turbulence will cause fatigue to the rotor blades, consequently shortening the life span of the turbine.

Hence the conspicuous siting of wind farms brings to the forefront a dilemma of conflicting values; safe and renewable energy development versus scenic preservation.

The aim of a visual assessment methodology is to gain validity, reliability, utility and sensitivity, and be quantifiable and justifiable in a court of law. The methodological model needs to ascertain an objective clarification of landscape values, which also reflects community preferences.

The current two models used to assess the visual impacts of wind farm developments are the subjective (Psychophysical Model) and the objective (Formal Aesthetic Model). These two models are similar in their intent of quantifying the quality of the landscape; however they differ in their theoretical methodologies and interpretations to landscape perception. The objective paradigm regards the visual quality to be

inherent in the physical landscape, whereas the subjective realm distinguishes the landscape to be interpreted as a product of the mind— in what Meinig termed, “in the eye of the beholder”.

The objective paradigm of visual assessment, (namely Expert, Professional, Formal Aesthetic or Visual Management System (VMS) models) is to consider the landscape to have aesthetic qualities, which are intrinsic. The fundamental approach to this model of thinking is that a professional consultant (Landscape Architect, Environmental Planner) who has been formally trained in landscape perception assesses in a detailed discussion the physical impacts with respect to the interrelationship of topography, vegetation, forms, lines and landscape patterning.

Visual envelopes, Global Positioning Systems (GPS), Geographic Information Systems (GIS), 3D simulations, mapping and photomontage are some of the tools and language used in this process. The positive aspects of this model are that it is useful in evaluating physical changes to the landscape and spatial configurations of landscape modification. The accumulated results of landscape classification can be cartographically mapped representing the visual effect. The foremost advantage of this model is the ease and minimal cost associated with its application. These attributes are all positives in delineating a legible and cohesive value for landscape impact.

The fundamental failure of the objectivist approach lies ironically in its intrinsic subjectivity, a sole practitioner interprets the landscape; hence there is a belief that the landscape possesses normative aesthetic values. Where the model gains in utility it is deficient in validity and sensitivity. The lack of sensitivity paradoxically lies in the limited classification categories of landscape quality. There is also some question as to whether landscape architects would agree with each other in their assessments. Furthermore it is contentious as to whether an association between these assessments and public preference can be established.

The subjective realm of assessment (Psychophysical model) is an objective evaluation of subjective public perceptions. It is commonly conducted in the form of a survey. The principle is to measure the impacts of scenic beauty for potential wind farm locations before development and visual representations of the completed project. It is a field of psychology developed by Gustav Fechner (1801-87) that deals with establishing quantitative relationships between physical features, environmental stimuli and human perception values. Relationships are determined through an empirical process providing statistical data, which represents the preferences of the community; consequently it is justifiable in a court of law.

To provide a framework for visual assessment which encompasses an analysis of people's perceptions of the landscape and a quantified evaluation of the landscape visual change, a new approach is required.

This thesis will seek to develop a framework which integrates both approaches into a new theoretical paradigm which evaluates the amenity of the landscape through the eyes of the beholder, but interprets the visual change as an inherent quality. Using two separate methodologies in a parallel process, the results can be spatially referenced in GIS, providing tools for illustrative cartographic analysis of visual impact.

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## ABBREVIATIONS

**AAPT:** Average Annual Daily Traffic

**ACNT:** Australian Council of National Trust

**AR:** Augmented Reality

**ASL:** Above Sea Level

**AUSWEA:** Australian Wind Energy Association

**BLM:** Bureau of Land Management

**CAD:** Computer Aided Design

**CASA:** Civil Aviation Safety Authority

**CAVE:** CAVE Automatic Virtual Environment

**DAC:** Development Assessment Commission

**DEM:** Digital Elevation Model

**DTM:** Digital Terrain Model

**EES:** Environmental Effects Statement

**EIA:** Environmental Impact Assessment

**EIS:** Environmental Impact Statement

**EPA:** Environmental Protection Authority

**FOV:** Field of View

**GIS:** Geographic Information System

**GPS:** Geographic Positioning System

**HVE:** Horizontal Visual Effect

**IPCC:** Intergovernmental Panel on Climate Change

**LCJ:** Law of Comparative Judgement

**MRET:** Mandatory Renewable Energy Targets

**NIMBY:** Not in My Back Yard

**OLS:** Optical Limitation Service

**PER:** Public Environment Report

**PLV:** Perceived Landscape Value

**PVA:** Percent of Visual Absorption

**PVC:** Percent of Visual Change

**PVI:** Percent of Visual Impact

**PWEP:** Portland Wind Energy Project

**RECS:** Renewable Energy Certificates

**RPS:** Renewable Portfolio Standard

**RRRC:** Recreational Resources Review Commission

**SEA:** Strategic Environmental Assessment

**SBE:** Scenic Beauty Estimation

**SLR:** Single Lens Reflex

**SNH:** Scottish Natural Heritage

**VA:** Visibility Analysis

**VCAT:** Victorian Civil and Administration Tribunal

**VE:** Visual Envelope

**VEDF:** Visual Effect of Development Form

**VLCV:** Visual Landscape Character Value

**VMS:** Visual Management System

**VR:** Virtual Reality

**VRIA:** Visual Resource Impact Assessment

**VRML:** Virtual Reality Modelling Language

**ZTV:** Zone of Theoretical Visibility

**ZTVI:** Zone of Theoretical Visual Influence

**VVE:** Vertical Visual Effect

**WTG:** Wind Turbine Generator

**WWEA:** World Wind Energy Association