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Designing for Darkness Urban Nighttime Lighting and Environmental Values

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Designing for Darkness

Designing for Darkness

Urban Nighttime Lighting and Environmental Values

Dissertation

for the purpose of obtaining the degree of doctor
at Delft University of Technology

by the authority of the Rector Magnificus prof.dr.ir. T.H.J.J. van der Hagen
chair of the Board of Doctorates
to be defended publically on

Monday 21 January 2019 at 12:30 o'clock

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There is a stereotypical image of a PhD candidate: sitting alone, engrossed in a dusty old book, surrounded by an endless pile of more books, and with only the pale glow of a laptop for company. And, imagining a PhD in *philosophy* especially brings this image to mind. Admittedly, there is some truth to this stereotype. Academic research in the humanities can be a lonely endeavour, professionally speaking. You spend a great deal of time becoming an expert on an esoteric topic, mainly through large amounts of independent research. Then you spend an equal amount of time writing and re-writing, which is in many ways a challenge of perseverance and a tedious dialogue with yourself.

However, that is only one side of the PhD journey. There is also a social side that provides a counter-balance to the long days and nights of reading and writing. In your early years you take courses, meeting new people and engaging with new ideas. You spend time formally interacting with colleagues via talks, reviewing one another's papers, and perhaps even collaborating on projects. Equally important, you spend informal time with colleagues at lunches, during (many) coffee breaks, and outside the office. You teach courses, meeting many bright young individuals. And if you're lucky, you get to travel around the world attending conferences, where you present your work, meet like-minded researchers, and have adventures during which colleagues become friends.

The impact of these factors cannot be overstated or overestimated. Many of the ideas in this dissertation were brought to life through conversations with my supervisors, colleagues, and friends, through feedback on my writing, or via lively discussions at a pub. These interactions play a crucial role in the completion of a PhD, providing much-needed support, reflection, encouragement, validation, and laughs. So, I see this section as an opportunity to acknowledge and thank all those who helped me along the way, and made the last four years of living, learning, and growing productive, enjoyable, exciting, and memorable. The space I have here is too brief to fully express my appreciation to each individual, and I fear I have forgotten to mention important folks (or not given certain people enough recognition). But please know I am extremely grateful to all those who helped me along the way.

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1 Introduction

People seldom look up in awe at the city sky... Our wealth of light is rarely noticed, much less appreciated. Nonetheless, the electric blaze of the city at night is one of the most fantastic sights of our times. It is all the more impressive if you consider that little more than a century ago this extravaganza of light was impossible. Yet at the same time, our urban pageant of light appears so permanent, so monumental, it seems impossible that it hasn't always been so. (Dewdney 2004, p. 95)

1.1. 'The electric blaze of the city at night'

Nighttime lighting is arguably one of the most influential and transformative modern technologies. The innovations to lighting technologies and their subsequent proliferation throughout the 19th and 20th centuries have been foundational to contemporary urban nightscapes – literally carving space and time out of darkness, and shaping nighttime behaviours and activities. Far more than simply providing illumination at night, nighttime lighting can be understood as a socio-cultural force influencing a diverse range of ideas and practices, such as nightlife, safety, mobility, modernity, our 24/7 societies, and civic and artistic expression. Yet, despite this formative role, its ubiquity and apparent permanence often causes nighttime illumination to be overlooked as a topic of inquiry unto itself. Dewdney's above quote poetically captures the paradoxical nature of nighttime lighting in the 21st century – simultaneously a technology of tremendous importance, and a taken-for-granted backdrop of daily life.

In recent years, however, a growing body of literature has put the “electric blaze” of our urban nights in the spotlight. This research is highly interdisciplinary, with contributions from historians, geographers, literary scholars, and social scientists. These studies position lighting technologies as shaping, and being shaped by, urban development, commercial activities, and modern city life. Artificial illumination is thus examined as a cultural phenomenon with profound normative, political, economic, behavioural, and aesthetic ramifications (e.g., Alvarez 1996; Beaumont 2015; Bijker 1992; Bogard 2013; Bowers 1998; Brox 2011; Dewdney 2004; Dunn 2016; Edensor 2017; Ekirch 2005; Hughes 1987; Isenstadt et al. 2014; Koslofsky 2011; Melbin 1987; Neumann 2002a; Nye 1990, 2010; Schivelbusch 1988; Schlör 1998; Sharpe

2008; Shaw 2018). To date, these studies have explored various topics interwoven with nighttime lighting, such as the origins of modern “nightlife” (Brox 2014), alterations in sleeping patterns (Ekirch 2005), the history of architectural illumination (Neumann 2002a), and the history and politics of “nightwalking” (Beaumont 2015; Dunn 2016). While increasingly diverse in both the method of inquiry and the particular themes or topic of exploration, this interdisciplinary field has coalesced around two guiding questions. At times it is mainly a descriptive and empirical endeavour, asking: *what are the impacts of the various technological developments and uses of nighttime lighting?* More recently, it is increasingly normative, contributing to debates over *how (and why) to light cities at night*.

While drawing on descriptive literature, I take an explicitly normative approach in my research of nighttime illumination. As such, I contribute to the latter question: this dissertation is about the ethics and aesthetics of urban nighttime lighting. More specifically, I draw attention to a topic of growing importance: environmental values and urban nighttime lighting. Commonly referred to as *light pollution*, the negative effects of artificial light at night are increasingly identified as a crucial issue for the 21st century – both for practical sustainability efforts, as well as theoretical research into human-environment relations (e.g., Davies and Smyth 2018). The adverse costs and effects of nighttime lighting have emerged as a research topic in a wide range of scientific disciplines, which examine its economic costs, energy usage, impacts on ecosystems and wildlife, effects to human health, and degradation of the starry night sky. Addressing these impacts, and more fundamentally understanding the underlying values shaping discourse, create a complex and pressing challenge with moral, aesthetic, political, and technical dimensions.

It was initially scholars from the sciences – namely astronomy and later ecology – that identified and addressed this challenge, and that continue to undertake research into the specific causes and effects of light pollution. Many have proposed policy and design solutions (e.g., Hölker et al. 2010; Mizon 2012; Schoer and Hölker 2017b), and it was astronomers who founded the International Dark-Sky Association, the largest anti-light pollution advocacy group (Sperling 1991). While focused on quantifying (and mitigating) specific effects, there is a consistent qualitative rationale underlying both advocacy work and academic papers: that regardless of any instrumental benefits, dark nights are something of immense cultural and ecological importance. For example, in their “world atlas of artificial night sky brightness” published in *Science*, Falchi

et al. (2016) conclude that light pollution “has a consequent potential impact on culture that is of unprecedented magnitude.” A normative stance is taken in advocacy work, with the International Dark-Sky Association having an explicit mission to combat light pollution in order to “preserve and protect” dark skies (IDA 2016). Schoer and Hölker (2017b, p. 1006) extend this normative stance, stating, “The greatest step toward the protection of natural night sites... will be to learn and teach the value of darkness.” What is invoked here and elsewhere is a claim to value – to the moral desirability and aesthetic qualities of darkness – that adds a new facet to the ethics of urban nighttime lighting.

In recent years, scholars from the humanities and social sciences have also taken up this challenge, analyzing the ethics and politics of light pollution and dark or “natural” nights (e.g., Bogard 2008, 2013; Dunnett 2015; Edensor 2013, 2015, 2017; Gallaway 2010, 2014; Gandy 2017; Henderson 2010; Lyytimäki and Rinne 2013; Meier et al. 2014; Prichard 2017; Shaw 2017, 2018). These works delve deeper into nuanced questions of why “natural” nights or unpolluted night skies are worth preserving, public perceptions of light pollution as an environmental issue, and the social and political forces shaping discourse. In this dissertation, I build on these strands of scientific and ethical research, and take steps towards addressing the environmental impacts of nighttime lighting. I do this by moving discourse in a new direction: a design-oriented approach focused on *darkness*.

The collection of papers that make up this dissertation are both theoretical, analyzing the values shaping, and shaped by, urban nighttime lighting, as well as practical, proposing forward-looking strategies for responsible urban lighting. To advance both theoretical understandings and practical possibilities, I argue for a move away from the concept of light pollution, and towards a focus on *darkness* – as a locus of environmental value in nightscapes, and as a design criterion for nighttime lighting. Following a *design for values* orientation, I introduce a framework that explores what it means to value, and ultimately design for, urban darkness. Through developing what I have termed a *designing for darkness* approach, I actively re-imagine the possibilities of urban nighttime lighting strategies informed by, and supporting, environmental values. In doing so, this dissertation provides a foundational, in-depth exploration and definition of *darkness* as something of value, both to frame evaluative judgments of nighttime lighting and as a design goal for responsible lighting strategies.

The remainder of the introduction will progress as follows. In Section 1.2 I elaborate on the moral concerns driving this investigation, briefly presenting the

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emergence of light pollution as a problem within nighttime lighting. In Section 1.3 I summarize the main contribution of this dissertation, namely the introduction and development of *designing for darkness*. I do this by first critiquing light pollution as a normative concept, and then presenting *darkness* as a more robust conceptual grounding for responsible lighting strategies. This is followed by an overview of the dissertation in Section 1.4, explaining both the narrative flow and the contributions of each chapter. In Section 1.5 I reflect on future research directions for the ethics of nighttime lighting that are opened by this dissertation. Finally, in Section 1.6 I present generalizable insights that can be drawn from this dissertation.

1.2. Illumination or pollution?

Properly assessing contemporary urban nightscapes requires an understanding of the developments that precipitated our current situation (a topic discussed in more detail in Chapters 2 and 3). Analyzing the relationship between lighting and darkness in its full complexity is outside the scope of this dissertation, but suffice it to say that artificial illumination has inherited a rich history of (positive) symbolic connotations. And in general terms, the opposite can be said about darkness.¹ Seen as both literally and metaphorically opposed, darkness and light have a storied and intertwined relationship that persists to this day. However, concerns about light pollution reformulate for this relationship, re-introducing darkness in juxtaposition to the longer history of urban nightscapes.

The modern history of urban nights begins in the mid-1600s, when the first public lighting measures were enacted. Throughout the 17th-19th centuries there was a necessity and desire for more illumination at night, spurring technical innovation, transforming nighttime behaviour, and drastically altering perceptions of the night. Throughout its development, lighting maintained positive connotations, manifesting in both its practical and symbolic functions. Artificial nighttime lighting has close associations to – and at times is even understood as synonymous with – values such as safety and security, civic order, nightlife, prosperity, and progress (Ekirch 2005; Nye 1990; Schivelbusch 1988).

¹ In-depth discussions of this legacy of values can be found in historical surveys on the evolution of understanding, and ascribing meaning to, light (e.g., Park 1997), the development of artificial nighttime lighting (e.g., Schivelbusch 1988), and past behaviours and perceptions of the night (e.g., Ekirch 2005).

Yet, despite the organization and formalization of public lighting projects in the 17th century, nights remained relatively dark. Streets were often lit for only a few hours a night during winter months, and only on major thoroughfares. However, with the invention and proliferation of electric lighting in the late-19th century, nighttime illumination increased to an unprecedented scale. “Lengthening the day” and “turning the night into day” were popular expressions in the 19th century (Schivelbusch 1988), and the advent of electric lighting made this realizable in ways never before possible. The electrification of our nights created levels of brightness previously unachievable in human history, the full extent and effects of which we have only recently begun to grapple with.

In opposition to our largely positive views of lighting, darkness has been seen as full of evil spirits, chaotic and dangerous, a space and time for immoral behaviour, and primitive in the face of new technologies – what Edensor (2015) summarizes as our *nyctophobic* past.² Yet, following the proliferation of electric lighting in the 20th century, a critical shift in perception was occurring underneath the spread of electricity. As new generations were born into a world of abundant electric light, it began losing its mysticism. Once dazzling and even otherworldly, its allure began to fade as early as the 1920s (Isenstadt 2014). By the 1930s, light was no longer considered a spectacle but sank into the background of everyday life (Nye 1990; 2010); it became a “pervasive banality” (Edensor 2017, p. 53). An abundance of light has become the expectation for urban nights, and it is only when lighting fails or during unique displays that we notice the technology.

Nighttime illumination, once scarce, is now possessed in abundance and unavoidably ubiquitous. As a result, interrelated shifts in perception and valuation have emerged – a shift that is critical to present discourse. With this abundance and ubiquity, attention is given to what is hindered by artificial light. Darkness has shifted from a “forbidding everyday occurrence” and an “emblem of backwardness” to a valorized and “sought-after luxury” of our electrified nights (Hasenöhr 2014, p. 119). A taken-for-granted infrastructure has been re-noticed, but in a new light. The recent “world atlas of artificial night sky brightness” concluded that 83% of the world’s population, and over 99% of people living in Europe and the United States, live in places with a sky

² It should be noted that, while this is a generally applicable perception in Western culture, there have been (and still are) many exceptions. For more on this, see footnote 8 on p. 31, and Edensor 2017, pp. 170-177.

considered to be light-polluted (Falchi et al. 2016). In densely populated urban regions, artificial brightness can be several magnitudes greater. Furthermore, it is estimated that artificial nighttime brightness is increasing annually by 3-6% worldwide (Hölker et al. 2010). Concerns over the extent of our nighttime illumination are increasingly articulated through a sense of loss – of the starry sky, a natural resource, or a piece of our cultural heritage – brought about by the disappearance of dark or “natural” nights (e.g., Bogard 2013; Gallaway 2014; Henderson 2010).

Over the past few decades, the concept of *light pollution* has become the dominant framing of discourse on the undesirable impacts of nighttime lighting, and has come to encapsulate a wide array of scientific research. The International Dark-Sky Association currently defines light pollution in broad strokes, as “the inappropriate or excessive use of artificial light” (IDA 2018). The term was first popularized in the 1970s by activist-oriented astronomers during the early days of environmentalism (Sperling 1991). In the decades since, the concept of light pollution has been widely adopted, including by ecologists (Longcore and Rich 2004), social scientists (Meier et al. 2014), economists (Gallaway, Olsen and Mitchell 2010), lawyers (Morgan-Taylor 2014), activist groups, policy-makers (Kyba et al. 2014), and professional lighting designers (e.g., LUCI n/d). It is supported by a growing body of research elucidating the negative impacts of artificial lighting: it wastes billions of dollars annually, uses enormous amounts of energy, harms ecosystems and wildlife, is detrimental to human health and well-being, and hinders experiences of the night sky (further details on the adverse causes and effects of nighttime lighting are discussed in Chapters 2, 3, and 4).

We have thus seen the emergence of a new environmental problem closely tied to a specific technology. Artificial light at night has long been seen as a force for good, illuminating our nights literally and symbolically. Now it is a site of contestation, increasingly scrutinized for its over-abundance, poor design, and negative impacts. This resonates with Feenberg’s (2010) notion of a “paradox of technology.” Specifically, the emergence of environmental values in nighttime lighting is akin to what Feenberg calls the “paradox of value and fact.” As technologies grow more pervasive, their effects become difficult to contain. As a result, stakeholders mobilize and help to formulate the values and priorities that direct future developments. While initially a contentious process, these values are gradually incorporated into technical design requirements. Eventually, these

previous conflicts are forgotten and values are translated into “technical facts,” becoming seemingly objective considerations of the technology.

We are arguably witnessing this contentious process today, through the growing popularization of the concept of light pollution. What was once an activist-oriented term used by astronomers and environmentalists is now gaining widespread acceptance in academia, lighting design, and popular culture. The mitigation of light pollution is quickly becoming a requirement for the design of outdoor lighting fixtures, and there are an increasing number of policies and guidelines aimed at curbing the causes and effects (for examples, see: Kyba et al. 2014; IDA-IES 2011; LUCI n/d). Challéat et al. (2015) detail this evolution and the contemporary “normalization” of light pollution (specifically in the context of France). They trace the forty-year history of lighting as an environmental issue: beginning as an emergent fringe concern of astronomers, to the coalescing of local and transnational advocacy groups and campaigns; later, to the legitimization of the issue through the production of scientific knowledge via peer-reviewed publications, leading to the recognition of light pollution by some lighting designers; to ongoing conflicts over the definition, scope, and ownership of the term, and finally to contemporary attempts at integrating light pollution mitigation into policy. The story is certainly not finished, but this narrative shows the evolution of light pollution from stakeholder value towards “technical fact.”

1.3. Re-framing the problem

We can thus see the emergence and development of a new environmental problem (the impacts of nighttime lighting), and the popularization of the concept of light pollution for framing this problem. Importantly, we are at a crucial stage in the evolution from value to “technical fact” where the problem frame has not yet solidified, but resultant policies and innovations have begun to emerge. We therefore have a unique opportunity to scrutinize the problem frame itself, and examine both how it defines the problem and how it orients possible solutions. In what follows, I argue that light pollution is an insufficient concept and problem frame. Instead, I propose that we should actively re-frame the problem, starting with understanding how and where environmental values manifest in our nightscapes, and seeking to incorporate that into the design of urban nighttime lighting. Thus, this section summarizes the main contributions

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of this dissertation: moving discourse beyond light pollution and instead developing *designing for darkness* as a framework.

1.3.1. Beyond light pollution

The concept of light pollution can be understood as a means to translate environmental values into “technical facts,” or design requirements, towards the goal of environmentally responsible lighting. However, while the concept has been useful in bringing attention to this issue during its nascency, it is ultimately inadequate as a framework for incorporating environmental values into urban lighting strategies. First, it is too limited in its scope. It focuses only on identifying and mitigating the bad or “polluting” aspects of artificial lighting – while saying little about the lighting deemed to be within the acceptable range of polluting – limiting its usefulness as a normative tool. The polluting framework thus directs us towards specific types of solutions that focus on designating acceptable thresholds and seek technical and political strategies for staying within these limits. However, as a concept, it does not provide a clear threshold for what should be considered “polluting,” due to factors such as the ambiguity of the “pollution” label, differing perspectives on what constitutes “necessary” lighting, and the intertwined symbolic and actual functions of lighting (see Chapter 2 for a longer critique of light pollution).

Further, through its focus on protecting and preserving “natural” nighttime conditions from “polluting” illumination, it tacitly relies on a built-natural dichotomy – or what has been described as a geographical dualism between cities and wilderness (Light 2001) – meaning that questions of environmental values within *urban* nightscapes are under-considered (an issue further discussed in Chapter 3). Finally, while there have been successful initiatives in specific cities and regions, as well as significant progress through the creation of dark sky reserves in national parks and conservation areas, our (urban) nights continue to get brighter (Falchi et al. 2016; Kyba et al. 2017), casting a shadow of doubt on light pollution as an effective framework.

Light pollution thus provides an incomplete problem frame, due to its limited applicability, specificity, and effectiveness. As the concept is still relatively young, these issues are understandable and can likely be addressed to varying degrees as further theoretical discussions and practical work is undertaken. This would conceivably take the form of clarifying thresholds and further developing policy tools for effectively enforcing these limits. Yet even if

the concept of light pollution were further refined to provide satisfactory answers to the above criticisms, there is still a more fundamental problem that the concept cannot easily overcome.

This problem concerns a foundational presupposition of light pollution, and how it positions environmental ethics in relation to the design of nighttime lighting. As a concept, it articulates environmental impacts as external *constraints* that stand in opposition to lighting practices and technologies, and thus something to mitigate largely via technical means. In this ethos, environmental costs and impacts can be addressed via added improvements to efficiency (e.g., a “green” building is then one that uses relatively less water, less energy, etc.). Similarly, light pollution imposes limits on how bad the effects of artificial illumination can be. So long as we stay within these limits, lighting is presumably morally, legally, and otherwise acceptable. Light pollution is then one item on a checklist for lighting fixtures and master plans, to be met alongside other technical standards. And, it can be mostly satisfied by technical fixes, without consideration of the values shaping, and shaped by, urban lighting strategies. This is certainly a useful step, but it does not go far enough. For a truly environmental approach to design (or city building, or lighting), doing less bad is simply not good enough (McDonough and Braungart 2002).

An alternative approach is not to see environmental impacts as a constraint, but instead as an opportunity to re-envision the goals driving urban lighting. To truly achieve environmental goals, these need to become fundamental presuppositions and manifest as constructive design requirements. Efforts need to be re-imagined from the ground up, with environmental values embedded in policies, lighting plans, and technical innovations. For this, a robust guiding concept is required to articulate and operationalize the environmental values at stake. This, in turn, must rely on a deeper philosophical reflection on how our built spaces relate to their environments – or more specifically how our urban nightscapes relate to darkness.

1.3.2. Designing for darkness

While the shortcomings of light pollution are a crucial point of departure, the majority of this dissertation is not a sustained criticism of the concept. This is the subject of Chapter 2, but the subsequent four chapters are constructive in their approach. They work to explore, articulate, and apply an alternative path forward. I undertake a value-level analysis, to both understand the conceptual

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roots of the problem and inform downstream design and policy decision-making. Instead of seeking to answer questions of how much to limit lighting, I start with understanding what we value about the night, and explore how to incorporate this into our urban nightscapes through responsible lighting strategies.

For this task, *design for values* is utilized as a theoretical basis for addressing ethical issues in the development and use of technologies (e.g., van den Hoven 2013a, 2013b; van den Hoven et al. 2012; van den Hoven et al. 2015). Design for values asserts that technologies are value-laden, and that social and environmental values should be incorporated into the development of technologies as “non-functional” design requirements. Analyses must therefore start by understanding the moral, social, and environmental values at stake in technological artifacts and systems, and explore how future innovations can address specific challenges or needs. By adopting such a starting point, I do not position the environmental impacts of lighting as a constraint to impose on policies and innovation, but rather strive to position environmental values as a foundational requirement for nighttime lighting.

A design for values approach to nighttime lighting requires us to take a step back from the technical details of lighting fixtures and policies, and instead undertake a value-level analysis of urban nightscapes. When analyzing *environmental* values, what comes to the fore is not lighting itself, but instead those features of the night that are hindered or degraded by excessive or poorly designed illumination. In this dissertation I encapsulate and define these various features via a single, unifying concept: *darkness*. I investigate what is good about darkness at night, why it is good, and how we could foster this goodness in our future urban lighting strategies. The five chapters of this dissertation thus work together to conceptualize *darkness* as a goal for urban nighttime lighting strategies, policies, and technologies.

Darkness is conceptualized via three interrelated facets: as an evaluative tool, as a quality of lived experiences, and as a contextualized phenomenon. As an evaluative tool, darkness is positioned as a node of concern that encapsulates the environmental goods we seek to protect, promote, or preserve in nightscapes. It can be seen as instrumentally valuable, bringing with it energy reductions, cost savings, and benefits to ecosystems and human well-being. It can also be understood as intrinsically valuable, as various aspects of the night that are valued – such as an “unpolluted” starry night sky – are an inherent feature of dark nights, and thus darkness is a necessary condition. Understood in this way,

darkness acts an evaluative consideration that directs our understanding of, and judgments about, urban nightscapes. In Chapter 4 I further discuss, as well as categorize, the value of darkness.

Yet, darkness is not only a useful orientation for abstract discussions of value – it is also a quality of lived experiences. There is a physicality and spatiality to darkness, just as there is one to lighting. And, it is through our experiences of darkness that value arises. It is the condition that must be achieved to bring about desired goals, and can thus give practical direction to the design of urban nightscapes. This means appreciating the aesthetic qualities of darkness and striving to incorporate positive experiences into urban nightscapes. To articulate this potential I focus on dark skies in cities, and in Chapter 3 I propose a re-envisioned *nocturnal sublime* that positions dark skies as a form of urban restoration. In Chapter 5 I further discuss the aesthetic qualities of darkness, and introduce strategies for achieving meaningful experiences via the design of smart LED streetlights.

Finally, darkness is understood as culturally situated and contextualized within current debates. I work to conceptualize darkness as it relates to our 21st century urban nightscapes, as a means to address the adverse costs and effects of nighttime lighting. Darkness is also understood as relational, in the sense that it is deeply intertwined with our lighting technologies. Artificial illumination actively co-constitutes, or mediates, our urban nightscapes (Verbeek 2011), and thus plays a formative role in co-shaping contemporary meanings of darkness. Overall, this results in a context-dependent definition and application of darkness. I do not attempt to arrive at an objective, universal, or final understanding. Rather, I accept that *darkness* is not an essential or static concept, but one that is co-constituted by our electrified nightscapes. This allows for a pragmatic conception of darkness that is highly relevant to contemporary problems, and that can be readily applied.

Through conceptualizing darkness in this way, a framework for incorporating environmental values into urban nighttime lighting is put forward. As a moral and aesthetic goal for responsible urban lighting strategies, it relies on three core principles developed throughout the chapters below:

- (1) Lighting strategies should, as a *prima facie* goal, work to preserve, protect, and promote the value of darkness
- (2) Lighting strategies should create the conditions for positive experiences of urban darkness, and in particular dark skies

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- (3) Darkening cities should be utilized as a means of urban (ecological) restoration, for both its instrumental benefits and the possibility of reconnecting cities with an ecological and cosmological sense of place

Importantly *designing for darkness* can overcome the concerns that were raised about light pollution in Section 1.3.1. By striving for a better balance of lighting and darkness, rather than delineating the “polluting” causes and effects of lighting, it allows for a comprehensive evaluation of the ethics and aesthetics of *all* nighttime lighting. Thus, it overcomes the normative limitations of light pollution. Relatedly, it circumvents the ambiguity of threshold conditions created by the “pollution” label, as it is not focused on defining bad types or wrong uses of lighting. Instead, it focuses on identifying and fostering the valuableness of darkness. As such, it is an evaluative guiding concept, rather than a rigid prescriptive tool for judging rightness or wrongness. By situating darkness as a form of urban restoration, it actively brings those features valued in “natural” nights into cities. In doing so, it challenges the geographical dualism between urban and natural nights. Finally, and perhaps most importantly, it situates environmental values as a constructive design goal, rather than a constraint. It thus embeds environmental values directly into the goals and strategies for urban nightscapes. *Designing for darkness* provides a new orientation for questions of how (and why) we light cities at night, and the possibility of envisioning and enacting environmentally responsible lighting strategies.

1.4. Overview of chapters

This dissertation can be divided into three steps. The first is a critical look at the concept of light pollution and its shortcomings as a guiding framework for incorporating environmental values into urban nighttime lighting (Chapter 2). Next is a largely theoretical discussion of darkness, laying the conceptual groundwork for an alternative approach to urban lighting (Chapters 3-4). Finally, I refine the framework via its application to two cases of emerging and innovative urban technologies (Chapters 5-6).

Chapter 2 takes a critical look at light pollution, presented as a concept gaining importance and acceptance in environmental discourse. It provides a framework for categorizing the adverse effects of nighttime lighting, which advocacy groups and regulatory efforts are increasingly utilizing. However, the ethical significance of the concept has, thus far, received little critical reflection.

In this chapter, I analyze the moral implications of framing issues in nighttime lighting via the concept of light pollution. First, the moral and political importance of problem framing is discussed. Next, the origins and contemporary understandings of light pollution are analyzed. Finally, the normative limitations and practical ambiguities of light pollution are presented. It is argued that the applicability of light pollution is limited due to its narrow focus on the negative impacts of lighting. Further, it is difficult to use as a decision-making tool due to the ambiguity of thresholds for determining “polluting” light, as well as the criteria for establishing said thresholds.

Chapter 3 looks more broadly at the normativity of contemporary nightscapes, via an examination of the aesthetic dimensions of urban and natural nightscapes and its impact on how we perceive and evaluate nighttime lighting. It is argued that competing notions of the sublime, derived from artificial illumination and the natural night sky respectively, reinforce a geographical dualism between cities and wilderness. To challenge this spatial differentiation, recent work in urban-focused environmental ethics, as well as environmental aesthetics, are utilized to envision the moral and aesthetic possibilities of a new urban nocturnal sublime. Through articulating the aspirations and constraints of a new urban nocturnal experience, this chapter elucidates the axiological dimensions of urban darkness, draws attention to nightscapes as a site of importance for environmental philosophy and philosophy of the city, and examines the enduring relevance of the sublime for both the design of nighttime illumination and the appreciation of the night sky.

Chapter 4 builds on the critical and conceptual discussions above to present an alternative moral framework for urban nighttime lighting. This chapter adopts a value-sensitive approach, focusing on what is good about darkness at night. In doing so, it offers a first comprehensive analysis of the environmental value of darkness at night from within applied ethics. A *design for values* orientation is utilized to conceptualize, define, and categorize the ways in which value is derived from darkness. Nine values are identified and categorized via their type of good, temporal outlook, and spatial characteristics. Furthermore, these nine values are translated into *prima facie* moral obligations that should be incorporated into future design choices, policy-making, and innovations to nighttime lighting. Thus, the value of darkness is analyzed with the practical goal of informing future decision-making about urban nighttime lighting.

Chapter 5 and 6 both, in turn, apply the insights and framework developed in Chapters 2-4 via a closer look at two emerging technologies. Chapter 5 examines

the ethical dimensions of a critical urban infrastructure: streetlights. Recent developments to lighting technologies, namely LEDs and “smart” systems, are spurring a new generation of streetlights, with retrofits being rapidly undertaken around the world. While they may offer substantial energy savings, their long-term environmental effects are still under debate. The confluence of technological innovations with the increasing recognition of environmental impacts creates new challenges, but also an opportunity to envision and enact new strategies. For this, *designing for darkness* is presented as a value-sensitive framework that incorporates both substantive environmental values and meaningful nighttime experiences into the next generation of streetlights, without compromising the instrumental benefits of new innovations. First steps are taken to explore how this framework can be operationalized within smart LED lighting systems, and three design concepts are put forward as a means to create darker urban nights.

Chapter 6 is a collaborative endeavour, co-authored with Filippo Santoni de Sio and Pieter Vermaas. In this paper we take a more explorative and radical look at the possibilities of *designing for darkness*. Instead of focusing on lighting technologies, we look at how a transformative emerging technology, namely autonomous vehicles, may be developed towards the goal of reducing light pollution and creating darker nights. In support of this proposal, a moral assessment of autonomous vehicles more comprehensive than the dilemmatic life-and-death questions of “trolley problem”-style situations is presented. The chapter therefore consists of two interrelated elements. The first is that autonomous vehicles are still under development and have not acquired their definitive shape, meaning the design of both the vehicles and the surrounding infrastructure is open-ended. Second, it is argued that nighttime lighting – a critical supporting infrastructure – should be a *prima facie* consideration for autonomous vehicles during their development phase. It is asserted that a reduction in light pollution, and more boldly a better balance of lighting and darkness, can be achieved via the design of future autonomous vehicles. Two use cases are examined (parking lots and highways) through which autonomous vehicles may be designed for “driving in the dark.” Nighttime lighting issues are thus inserted into the ethics of autonomous vehicles, while simultaneously introducing questions of autonomous vehicles into debates about urban nighttime lighting. More broadly, this chapter draws attention to the interrelation of (seemingly disparate) ethical issues in urban infrastructures, and how *designing for darkness* need not be restricted to lighting technologies.

1.5. Future research directions

The framework introduced here, as well as the specific proposals for how to operationalize darkness via emerging technologies, should be seen as a starting point in an iterative process towards realizing environmental values in responsible urban lighting strategies. Through articulating a new path forward for the ethics and aesthetics of urban nighttime lighting, there are a number of theoretical and practical questions that arise throughout the dissertation, both implicitly and explicitly, which will ideally be the subject of future research. On a theoretical level, *designing for darkness* can be further developed through continued research into the complex relationship between artificial lighting technologies and perceptions and experiences of darkness. On a practical level, a next step will be further exploring how to enact this framework via lighting policies and city lighting master plans. For example, case studies of specific cities working to operationalize darkness within unique geographical, social, and political contexts will help to elucidate practical limitations, and shed light on creative design solutions. These practical explorations will, in turn, offer insights that help to further refine the theoretical framework.

An important topic for future research is the impact of new and emerging technologies. There are various lighting technologies on the horizon that are currently in a development phase or are too cost-prohibitive for widespread use (e.g., OLEDs, bioluminescence). A proactive exploration into the moral challenges, uncertainties, and opportunities created by these technological innovations is needed to fully appreciate their potential impact, and to develop them in a responsible direction. It must also be appreciated that lighting does not exist in isolation, and will be influenced by the development of other infrastructures. The emergence of transformative innovations to other urban technologies and infrastructures can therefore have an effect on the use and function of nighttime lighting. Here I analyzed autonomous vehicles as one such technology, but the identification and exploration of other transformative innovations is a topic for future research.

The rapid development of “smart” systems will likely yield new possibilities for urban nighttime lighting, which will require continued ethical analyses into their environmental and social impacts (a topic discussed in Chapter 5, but which will quickly evolve). A second facet of the introduction of smart systems is more conceptual, blurring the ontological status of streetlights by changing the function and meaning of lampposts. The various smart technologies being added to streetlights can be used towards a variety of ends not necessarily related

to lighting: measuring (daytime) traffic and pedestrian activities, creating WiFi nodes, measuring air quality, etc. Given the ubiquity of streetlights in cities as an electrified, spatially dispersed infrastructure, this creates a host of new technical possibilities, as well as ethical issues related to values such as privacy, justice, and surveillance (e.g., Kitchen 2016; Sadowski and Pasquale 2015). This will presumably stretch the boundaries of research into urban lighting technologies, while also giving lighting infrastructure (and in particular streetlights) an added importance in the ethics of smart cities. It also raises an interesting philosophical issue of whether or not such innovations truly represent an ontological shift in street lighting. While it appears to represent a significant rupture in the function of public lighting, historical studies assert that nighttime lighting has been closely related to policing and surveillance since its modern conception (Schivelbusch 1988; Schlör 1998). This would suggest these new innovations are not a disruption but rather a continuity of values inherent to public lighting – a fruitful topic for future research.

Finally, alternative approaches to questions of lighting and darkness, as well as other values pertinent to the ethics of urban nighttime lighting, offer many avenues for future research. Given the formative role of nighttime lighting, it will continue to actively shape the accessibility and inclusivity of urban nightscapes. Most notably, lighting carries a long association with safety and security at night. A similar deep dive into the ethics of nighttime safety is needed, as well as an in-depth exploration of the historical and contemporary relationship between safety (both actual and perceived), lighting, and darkness. As a different approach to the ethics of nighttime lighting, questions surrounding access to artificial lighting in developing regions of the world – what Pritchard (2017) has termed “lighting poverty” – remains under-represented in discourse to date.

1.6. Methodological insights

This dissertation analyzes a specific problem closely intertwined with a specific urban technology. The most important substantive contributions are therefore to the ethics and aesthetics of urban nighttime lighting. Yet, the approach developed throughout, as a work of *practical* ethics, as well as the close look at an *urban technology*, offers generalizable lessons for future research outside the domain of nighttime lighting. As has been identified and discussed by scholars within the burgeoning field of *philosophy of the city*, urban technologies – and

especially urban infrastructures – require a modified approach to their moral appraisal (e.g., Epting 2016a, 2016b, 2017; Nagenborg 2018). Further, architecture and urban design has been identified as a rather complex domain for operationalizing a design for values approach (e.g., Schrijver 2015). Urban infrastructures, such as lighting, are complex systems with multifaceted impacts, functional and symbolic dimensions, and a far-reaching temporal resonance. Further, they can affect millions of people over multiple generations in varying ways. This stretches traditional approaches within moral theory, often focused on human-human interactions (Epting 2016b), and thus requires an approach that is sensitive to the unique aspects of urban infrastructure. Below are methodological insights that can be drawn from this dissertation on how to undertake ethical research, and in particular value-focused inquiries, into urban technologies.

(1) From artifacts to infrastructures

Urban technologies should be conceptualized and analyzed as an infrastructure, not as individual artifacts. Much of the ethics of technology has been focused on individual artifacts, investigating the values and politics embedded in a specific tool or device (ranging in scale from search engines to bridges), or how particular devices mediate human perceptions and behaviours (e.g., the obstetric ultrasound). Urban technologies, however, have a temporal and spatial resonance that exceeds any individual component. The morality of these technologies, then, is not entirely encompassed by an analysis of individual components. By expanding the boundaries of inquiry from artifact to infrastructure, we can arrive at a better understanding of the values at stake, as well as how to eventually evaluate the individual components – not as isolated artifacts, but as co-creating the system and reinforcing the values or goals thereof. The various studies of the history of urban nights consider nighttime illumination in its totality, as an encompassing infrastructure that shapes urban life at night. “Nighttime lighting” is thus approached as a holistic concept (at the city, regional, or even global level). Similarly, the contemporary moral problem of environmental impacts concerns the totality of lighting infrastructure, meaning that individual lampposts should not be assessed as isolated artifacts. For example, Chapter 5 provides high-level strategies for the responsible adoption of LED streetlights, which can inform specific choices at various smaller scales: citywide master plans, specific neighbourhoods and streets, or even individual lampposts.

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(2) *History matters*

Research into urban technologies should be historically situated. Urban development is typically a gradual process – when ethical issues emerge, the values, politics, and technologies that precipitated the current situation are crucial to know and understand, before looking forward. Urban technological innovations are often not entirely “new,” but built on past technologies and developments, therefore inheriting past ideals, perceptions, and use patterns. Arguments have been made for the importance of historically and culturally situated inquiry within environmental ethics and aesthetics (e.g., Holland 2011; Maskit 2014; O’Neill et al. 2008). A similar case can, and I believe should, be made for both the ethics of technology and philosophy of the city. This dissertation offers an example of how to carry out historically-informed research for a specific subject. The modern development of public nighttime lighting can be traced back across multiple technological leaps (i.e., oil lamps, gaslight, and electric light), which occurred over several centuries. And, this builds on deeply embedded cultural perceptions of light and darkness. Thus, a contemporary innovation such as LED streetlights should not be understood as a completely “new” technology, but one that is layered over, and responds to, a much longer history. Knowing the history of an urban technology – both its technical development, as well as the associated cultural forces that shaped its use – is crucial for appreciating the present context.

(3) *Symbolism matters*

Closely tied to situating urban technologies within their broader history, it is crucial to appreciate their symbolic dimensions. Technologies that shape, and are shaped by, cities do much more than fulfil their technical requirements. Artificial lighting has (and still does) function as far more than a practical source of illumination. It represents and embodies ideals such as safety and progress, to the degree that it is difficult to disentangle and disassociate the *actual* functions of lighting from its perceived role. This symbolism goes beyond subjective impressions or placebo effects (i.e., people feel safer in brightly lit areas), but is rather an essential and inexorably intertwined feature of the foundations, development, and use of the technology. In this sense, lighting is safety manifest in urban nightscapes. Through acknowledging and analyzing their historical and cultural embeddedness, urban technologies can be understood to carry a higher-order form of symbolism. Appreciating these deeply entrenched symbolic dimensions is key to analyzing the morality of

urban infrastructure; and importantly, it allows for questions of values to shine through.

(4) From values to valuableness

Striving for practical solutions to complex urban (and environmental) challenges requires a shift in focus from *values* to questions of what is *valuable*. A methodological criticism of design for values has been the lack of a clear definition of what is meant by *values* (Mander-Huits 2011). Often values such as autonomy and justice are described in abstract ways, which makes them difficult to operationalize in any practical sense. Similar critiques have recently been made about environmental values. For example, James (2016) offers a critical reflection on the conceptual troubles that arise if environmental ethics relies too exclusively on the philosophical notion of value. Depending on how “value” is interpreted, James argues that this position is either false (if too narrowly defined) or vacuous and without substance (if too broadly defined). By instead focusing on what is meaningful about a specific place, we can re-position discourse away from meta-ethical debates about the nature or definition of *value*, and instead draw out practical, workable ideas. Importantly, this leads to a prioritization of *things we find valuable*, rather than values themselves – something important for urban technologies, and the ethics of technology more generally. This means searching for, and analyzing, things that are valuable for a specific place and time. Here, darkness is put forward as something that is valuable for contemporary urban nightscapes, and through which claims to value both emerge and are fostered or hindered.

Important to note is that this does not require the abandonment of the word “values” in discourse, or of “designing for values” as a theoretical and methodological starting point. Rather, it requires that we re-orient inquiries to emphasize and focus on those things we find valuable, rather than striving to arrive at a final, defensible definition of certain values (or the philosophical nature of value).

(5) Abandon the quest for completeness

A final, summative lesson that combines the above four insights is the abandonment of conceptual completeness as a goal. The temporal and spatial longevity of cities and their technologies means that relevant values – and what their inhabitants find valuable – will necessarily evolve. Some may endure, but many will change in meaning, others will fade, and new values will emerge.

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Acknowledging this means focusing on a practical and contextualized solution, as well as appreciating that the “value” under investigation may not be clearly pre-defined beforehand. This still requires a rigorous analysis, however it abandons the goal of achieving a final, definite understanding of the values under investigation. Instead, it acknowledges that the topic under study is emergent and open to change – an issue recently highlighted regarding design for values research generally (van de Poel 2018).

Appreciating the dynamism of values provides a starting point for ethical analyses into urban technologies: first exploring the emergence and foundations of the value(s) at stake, rather than a systematic application of pre-given values. This requires combining open and explorative inquiries into the topic at hand with a testing of findings via their practical applicability. The back-and-forth deliberative and iterative exercise between conceptual debates and practical interventions allows for the topic of concern to take shape, and ideally for a useful framing of the problem at hand. In sum, this leads towards a pragmatic approach to the ethics of urban technologies, for which “The aim of ethics is not perfect rightness, then, since there is no absolute standard for reference, but rather creative mediation of conflicting claims to value, aimed at making life on the planet relatively better than it is” (Parker 1996, p. 27).

In the early days of electric lighting, such an analysis of, and argument for, darkness would have taken a different form (if it existed at all). And it will hopefully be different 50 years from now, for any success brought about by *designing for darkness*, or even light pollution mitigation, will also change the relative meaning, importance, and priority of “darkness” for the future ethics and aesthetics of urban nighttime lighting.

1.7. Conclusion: The ‘electric blaze’ re-imagined

The chapters of this dissertation weave together a critical investigation and constructive contribution to a pressing urban challenge for the 21st century. The development of *designing for darkness* as a framework offers both theoretical grounding and practical pathways for operationalizing environmental values within responsible lighting strategies. The overarching conceptualization of *darkness* as an evaluative tool and experiential goal, as well as the specific insights of each chapter (i.e., critiquing the concept of light pollution, a re-envisioned urban nocturnal sublime, defining and categorizing the value of darkness, presenting strategies for the responsible adoption of LED streetlights,

and developing autonomous vehicles for darkness), offer innovative contributions to the ethics and aesthetics of nighttime lighting.

Designing for darkness provides a conscientious path forward through Feenberg's (2010) paradox, constructively shaping the translation of environmental values into a design requirement for future policy, planning, and technical innovations to nighttime lighting. This requires an ongoing conceptual and practical re-imagining of urban nightscapes – and particularly the relationship between the “electric blaze” of nighttime illumination and the value of darkness – which is at the core of this dissertation.

2 Light Pollution: A Case Study in Framing an Environmental Problem³

2.1. Introduction

I have outwalked the furthest city light, ends the first stanza of Robert Frost's poem "Acquainted with the Night". For many contemporary urban dwellers, such a feat is becoming exceedingly difficult in our electrified, 24-hour societies. While artificial nighttime illumination has brought with it many advances and possibilities, the negative consequences of its ubiquity and proliferation have only recently emerged as a topic of inquiry. Discourse is increasingly framing concerns about nighttime lighting via the concept of *light pollution*, particularly with respect to environmental effects. However, light pollution has received relatively little attention compared to other environmental problems, remaining scientifically and culturally "in the dark" (Hölker et al. 2010). Equally important, the framing of environmental problems caused by artificial nighttime lighting *via* the concept of light pollution has received little critical attention. Understandings of light pollution are reliant on seemingly technical descriptions – light pollution is used to categorize and quantify the adverse effects of artificial nighttime illumination. But such a categorization carries an implicit normative judgment, and should not be accepted without critical reflection.

The purpose of this chapter is to elucidate light pollution as a normative concept, and focus specifically on its increasing role in shaping, or framing, future regulatory efforts and decision-making processes. The goal is not to condemn or approve of the use of light pollution from an ethical perspective, nor is it to arrive at definitive answers for the ambiguities inherent in the concept. Rather, I begin by accepting the term as the dominant concept for describing a novel environmental problem, and critically reflect on its ethical significance and potential limitations. While the implications of light pollution are far-reaching, here I will focus specifically on light pollution as it relates to urban nighttime

³ Originally published as: Stone, T. (2017). Light Pollution: A Case Study in Framing an Environmental Problem. *Ethics, Policy & Environment*, 20 (3): 279-293.

lighting. Such an analysis can be seen as an example of an issue discussed within this journal by Elliott (2009), namely the ethical significance of language and terminology choices for framing environmental policy decisions and debates. While Elliott discusses very different types of pollution, the themes highlighted are quite relevant for an examination of light pollution. Elliott – who draws from a more pragmatic branch of environmental ethics that I adopt here – describes the usefulness of practical ethics for policy discussions. Philosophers can help to create and define the moral space within which policy decisions will be made, and so can contribute to upstream policy decisions. Elliot (2009, p. 170) explains that,

Rather than attempting to develop controversial theoretical conclusions about debated environmental issues, scholarship of this sort elucidates ethically significant questions and promotes critical reflection, shared understanding, and informed decision making in response to them. This sort of work could also incorporate attempts to clarify how particular linguistic frames affect the attitudes of public groups toward environmental initiatives.

Thus, this chapter will help to define the moral parameters within which decisions on nighttime lighting regulation are housed, and will highlight critical questions that require further exploration alongside light pollution's "downstream" use in political decision-making.

The following section discusses the moral and political significance of framing problems, in relation to the novel environmental problem of excess artificial nighttime lighting in cities. Section 2.3 then analyzes the concept of light pollution in detail. Here, both the origins of the concept and its current manifestations are presented, in order to provide a more comprehensive understanding of light pollution. Section 2.4 returns to the question of how light pollution frames concerns and possible responses, and discusses two interrelated questions: the potential limitations of the concept as a normative or prescriptive tool, and the ambiguities and inconsistencies in its practical application that require clarification. Thus, first steps are taken in dissecting the ethical significance of the concept of light pollution and the role it can play in addressing the adverse effects of artificial nighttime lighting.

2.2. Framing a new environmental problem

We are faced with a new problem: simply put, we have *too much light at night*. For centuries, more and better urban nighttime lighting was largely seen as desirable and necessary. However, following the rapid proliferation of electric lighting throughout the twentieth century, the impacts of artificial nighttime illumination have become a research interest – or rather concern – in a variety of disciplines. Nighttime lighting uses enormous amounts of energy, in addition to costing billions of dollars, damaging ecosystems, and negatively affecting human health.⁴ With this emerging knowledge, continuing with the same use patterns and regulatory strategies can no longer be justified. We must rethink our urban nights. But, some amount of artificial light is, of course, still desirable and necessary at night. Therefore, our new problem comes with a novel question: *how much artificial light at night is appropriate?*

Such a question may not strike you as entirely novel or revolutionary, as surely such questions are as old as attempts to illuminate our nights. But, the context in which this question is posed –the growing recognition of environmental and health-related problems caused or amplified by nighttime lighting – gives it new meaning. We are now seeking a transition in nighttime lighting strategies toward reducing the amount of illumination. And, it has been acknowledged that traditional approaches have been ineffective to date. Kyba, Hänel, and Hölker (2014) note that despite improvements to efficiency in lighting technologies, energy usage for outdoor lighting and artificial nighttime brightness continues to increase annually. Thus, a complete conversion to efficient lighting technologies alone (i.e. LEDs) is unlikely to reduce energy consumption or other unwanted consequences; new approaches to nighttime lighting must look beyond the narrow focus of improving efficiency. They summarize this necessary change in perspective by stating that,

The challenge faced by 21st century policymakers is to provide outdoor light where and when it is needed while reducing costs, improving visibility, and minimizing any adverse effects on plants, animals, and humans caused through exposure to unnatural levels of light at night. (Kyba, Hänel and Hölker 2014, p. 1807)

In other words, we need to frame the problem in a new way.

Light pollution has emerged as the widely accepted term for the negative or adverse effects of artificial nighttime illumination (Hölker et al. 2010). A central

⁴ The effects are described in more detail in Section 2.3.3

assumption of this chapter is that the concept of light pollution – due to its increasing usage within professional, academic, and popular discourse – will substantially shape decisions about how to illuminate cities in the twenty-first century. In this role, it will actively inform the conditions for morally acceptable and desirable artificial nighttime illumination. Thus, to a large extent the concept of light pollution helps to provide a framing that addresses our new problem. This, however, necessitates an evaluation of the concept's usefulness – its strengths and limitations. Its increasing usage must be coupled with critical reflection, if it is to offer an effective framing for ongoing policy efforts. In *Policy Paradox*, Stone (2002) discusses the complex issue of defining problems within political discourse. It is never an objective statement, but rather a strategic representation from one point of view that will promote a certain course of action. While problem definitions can act as a "...vehicle for expressing moral values... there is no universal technical language of problem definition that yields morally correct answers" (p. 134). Nonetheless, focusing on how a problem is defined can help us see the situation from multiple perspectives and identify assumptions about facts and values embedded therein (Stone 2002). This can, in turn, help to strengthen the problem definition.

With our novel question in mind, we must then ask how the concept of light pollution frames current challenges and associated ethical questions, and what actions it will guide us toward. However, it is pertinent to first clarify the notion of "framing". Here, I use the term broadly to describe the conceptual lens through which problems will be defined and perceived, and through which solutions will be posed. Frames are helpful in crystallizing and formulating a problem, but in doing so also set the boundaries of possibility on potential solutions. In *Frame Innovation* (2015), Dorst explains a method of design thinking used to overcome seemingly intractable real-world problems, dubbed the "frame creation model". Building on the linguistic research of Lakoff and Johnson (1980), Dorst explains that frames may be simple phrases, but in reality are subtle and complex thought tools. "Proposing a frame includes the use of certain concepts, which are assigned significance and meaning. These concepts are not neutral at all: they will steer explorations and perceptions in the process of creation" (2015, p. 63). A good frame should be inspiring, original, robust, and create a common space for finding solutions. And once accepted, a frame will define the parameters of possibility. "Once frames are accepted, they become the context for routine behavior: once accepted, the frame immediately

begins to fade. Statements that started life as original frames become limiting rationalities in themselves, holding back new developments” (Dorst 2015, p. 65).

Creating a coherent and effective frame for the challenges of nighttime lighting carries its own idiosyncratic considerations. Beyond functionality, the symbolic meanings of lighting technologies have played an active role in determining their uses and acceptance (Nye, 2006). Throughout history, perceptions of nighttime lighting have consistently blurred the literal and the symbolic; intertwined actual lighting with metaphorical notions of the values that lighting embodies (Schivelbusch 1988). This is not entirely surprising, as metaphors are pervasive in our everyday language (Lakoff and Johnson 1980) and politics (Stone 2002). A metaphorical concept allows us to see one thing in terms of another – in this case, to see some outputs of artificial lighting as a “pollutant” of the night sky, our bodies, and ecosystems. Like sound pollution, it is a powerful framing that will shape how we think, speak, and act with regards to nighttime lighting technologies. Conceptual metaphors are useful but also can be troublesome, because

The very systematicity that allows us to comprehend one aspect of a concept in terms of another will necessarily hide other aspects of the concept. In allowing us to focus on one aspect of a concept, a metaphorical concept can keep us from focusing on other aspects of the concept that are inconsistent with that metaphor. (Lakoff and Johnson 1980, p. 10)

We need to ask what is highlighted and what is omitted with the concept of light pollution, when considered as a frame.

Central to Dorst’s frame creation model (2015) is the great length that designers go to assess the frameworks through which problems are approached. Complex problems – such as the impacts of artificial nighttime lighting – are often caused by underlying value conflicts, and the inability of current frameworks to adequately address said values. By looking into the origins and history of the problem, the key driving issue, and the current context, a more comprehensive picture of the problem and underlying values emerge. And simultaneously the possibility of new approaches, or frames, will also emerge (Dorst 2015). However, for our present purposes we will not search for a new or radically different approach, but rather ask how the coalescing frame of light pollution is responding to our problem. We have our core issue present in the novel challenge described above. The next steps are to examine the origins and

current context in turn, so see how light pollution can be improved as an effective frame.

2.3. The past and present of light pollution

For a comprehensive understanding of light pollution, contemporary discourse must be coupled with an exploration of the origins and emergence of the concept, which in turn requires a broad understanding of the development of urban nighttime lighting. Detailed historical studies into the technological innovations and social implications of artificial nighttime lighting have been published in the past few decades (e.g., Bowers 1998; Ekirch 2005; Isenstadt, Maile Petty and Neumann 2014; Nye 1990; Schivelbusch 1988). And, important studies on the social, economic, and legal aspects of nighttime lighting have also been published recently (e.g., Meier, Hasenöhr, Krause and Potttharst 2014). The brief discussion below cannot do full justice to the in-depth explorations of nighttime lighting that these scholars have explored, nor to the various cultural and geographical nuances of historical developments in lighting. Rather, I would like to highlight the conditions within which light pollution arose, which puts us in a better position to assess our contemporary definition and ask how the framing of light pollution responds to the core problem discussed above. In particular, I will highlight the shift away from how to light cities and, somewhat paradoxically, toward a desire for dark or natural nights. Put otherwise,

So while the fascination and allure of illuminations persist, darkness is today increasingly perceived as a rare and valuable commodity. This development could be regarded as a double paradigm shift from the dark night as a forbidding everyday occurrence that could only be lit up sporadically to its devaluation as an emblem of backwardness in the face of a new abundance of artificial light in the late 19 and early 20th centuries to its present valorization as a sought-after luxury in our densely populated and highly electrified world. (Hasenöhr 2014, p. 119)

This progression will lead us toward contemporary understandings of the adverse causes and effects of artificial nighttime lighting, discussed in Section 2.3.3.

2.3.1. The history of public urban nighttime illumination

Histories of nighttime illumination mainly focus on the seventeenth century onward, for a few reasons. First, lighting technologies remained essentially

unchanged for thousands of years before then (Schivelbusch 1988). Second and relatedly, *public* lighting in the modern sense only emerged in the mid-1600s. This was a time of societal changes in Europe that allowed for lighting technologies and associated urban behaviors to rapidly develop.⁵ In considering the origins of public nighttime lighting in the seventeenth and eighteenth centuries, two important points should be noted. The first is that, despite technical improvements to oil lamps, lighting was still poor and city streets were mostly dark; only major thoroughfares were lit, and often only on the darkest nights of winter for a few hours (Ekirch, 2005; Schivelbusch, 1988). Second, old habits did not die easily; darkness still represented a time both sacred and dangerous for many. In certain places it remained custom to stay home, except for special occasions, and devote evenings to prayer and rest (Ekirch 2005).

The first monumental technical development in nighttime lighting came at the turn of the nineteenth century with gaslight. It was with the adoption and proliferation of public gaslight that the modern notion of the city at night began to emerge, and nights started to become definitively brighter. Gaslight was first demonstrated publically in 1807, in London, and over the next few decades it was quickly adopted across Europe and North America.⁶ Gaslight was seen as symbolic of modern progress; it reordered the chaos of nature into rational, scientific principles (Schivelbusch 1988). *Turning night into day* and *lengthening the day* were popular expressions of the time (Schivelbusch 1988), and with gaslight this became a technological possibility for the first time, not simply an ideal to strive for. People were shedding old habits and fears of the night, and increasingly staying out later for commercial and social reasons. Brox (2014) notes that by the mid-nineteenth century a new word came into use: *nightlife*.

Gaslight was followed by the invention of electric lighting in the latter half of the nineteenth century – the most profound technological development in lighting, and arguably one of the most important developments of modern infrastructure. Figuratively, electric lighting became synonymous with – and symbolic of – modern progress. For a Russian poet visiting New York City in the 1920s, the bright electric lights were perceived as modernity's very medium (Isenstadt, 2014). Aided by various technical advances, for example, floodlights, electric lighting quickly became a “sophisticated cultural apparatus” that could

⁵ For a summary of these societal changes, see Ekirch's *At Day's Close* (2005, p. 72).

⁶ For example, by 1823 London had nearly 40,000 gas lamps covering over 200 miles of streets (Ekirch 2005).

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be used for advertising, commemorating history, expressing civic pride, highlighting monuments, etc. (Nye, 1990, p. 73). Via electrification, artificial nighttime lighting became, and remains, a prolific technological artifact capable of aesthetic and ideological expression well beyond functional requirements.⁷

Any scarcity of urban nighttime illumination was quickly diminishing as electrification spread across North American and Europe during the twentieth century, developing alongside urbanization and the growth of transportation networks (Isenstadt 2014). This proliferation of nighttime illumination has been continuous to the present day, save for two major disruptions: World War Two and the energy crisis of the 1970s. However, nighttime illumination efforts quickly resumed shortly after both of these events (Neumann, 2002b). Current estimates are that artificial nighttime lighting continues to increase globally by about 3-6% annually (Hölker et al. 2010). This has been, in many ways, the ultimate realization of values strived for since the seventeenth century. A *lengthening of the day* has effectively been achieved, creating unmistakably modern nights where the various facets of nightlife can occur, and where many daytime activities can continue well into the night. But this has come with unintended consequences. In his exploration of “the world after dark”, Dewdney (2004, p. 101) cleverly evaluates the two-sided nature of this achievement, stating,

The radical effect of the electric lightbulb cannot be overstated. More than any lighting technology that preceded it – candles, oil lamps, or gas lighting – the electric light revolutionized the night. Now the darkness, at least in cities, was in full retreat.

2.3.2. From lengthening the day to losing the night: the emergence of “light pollution”

It is worthwhile to quickly note that, as with most transformational technologies, nighttime lighting has not always been met with open arms. Hasenöhl (2014, 105) notes that while the introduction of new lighting technologies was in general positively received, this did not imply universal endorsement or “a

⁷ Neumann’s *Architecture of the Night* (2002a) is arguably the most important recent study of nighttime illumination in architectural history and theory, linking the history of nighttime lighting with the history of modern architecture. Neumann mainly focuses on the aesthetic and expressive qualities of “illuminated buildings” throughout the nineteenth and twentieth centuries, providing the first comprehensive catalogue of relevant architectural projects.

universal devaluation of the “dark night” as a whole”. The consequences of artificial nighttime lighting have been under debate since the nineteenth century, and some criticisms of artificial nighttime lighting can be found even earlier.⁸ The most outspoken critics have been astronomers, as reduced stellar visibility has been a long-noticed effect of urban lighting (Sperling 1991). Still, in the larger narrative of lighting technologies these objections were the exception – nighttime lighting was mostly seen as necessary and desirable for modern urban life (Hasenöhrl 2014).

With electric light, the illumination of our urban nightscapes was effectively realized. But with this realization, a critical shift in perception was occurring underneath the spread of electricity. As new generations were born into a world of abundant electric light, it began losing its mysticism. Electric lighting, once dazzling and even otherworldly, began fading into banality as early as the 1920s (Isenstadt, 2014). By the 1930s, light was no longer considered a spectacle but sank into the background of everyday life (Nye 1990). An abundance of light has become the expectation for urban nights in North America and Europe. As a consequence of this shift, lighting infrastructure went (and remains) largely unnoticed. It is only when lighting fails (e.g., power outages) or during unique displays that we notice the technology.

Nighttime illumination, once scarce, is now possessed in abundance and unavoidably ubiquitous. As a result, though, an interrelated shift in perception and valuation emerged – a shift that is critical to present discourse. With this abundance and ubiquity, a renewed attention was given to what is hindered by light. Darkness became, as Hasenöhrl notes, a valorized and “sought-after luxury” of our electrified nights (2014, p. 119). As a result, our taken-for-granted infrastructure of artificial nighttime lighting has been re-noticed, but in a new

⁸ Criticisms can be found as early as 1662, when a London pastor stated “We ought not to turn day into night, nor night into day... without some very special and urgent occasion” (Ekirch 2005, p. 74). This was due to the disruption of the perceived natural (Christian) order that such lighting may cause. However, most criticisms are found in the nineteenth century onward, and specifically around times of transition between technologies. Early objections were often aesthetic, however moral objections can also be found (Hasenöhrl 2014). There are documented criticisms of artificial nighttime lighting in astronomy-related literature as early as 1866 (Sperling 1991). Already in the 1880s, Alexander Pelham Tottler – generally regarded as the originator of the scientific study of lighting – identified issues with street lighting that predict modern debates. For example, he argued that too much light is wasted, and that glare causes safety concerns (Bowers 1998). Naturalists and artists expressed ambiguity (at best) towards artificial light as early as the 1920s (Nye 1990), and by this time there were already some calls for lighting engineers to reduce urban brightness (Isenstadt 2014).

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light. Concerns are increasingly articulated through a sense of loss – a loss of connection to starlight, or an aspect of nature, or the sublime, or a piece of our humanity – brought about by the loss of dark or “natural” nights (e.g., Bogard, 2013).

The concept of light pollution coalesced in the early 1970s, amid a climate of political activism, rising environmental awareness, and an energy crisis. In discussing lighting conflicts in Germany – but providing generally applicable conclusions – Hasenöhl (2014, p. 119) notes that “it was not before the oil crises and the growing environmental and heritage movements of the 1970s that lighting as a particularly visible form of energy consumption and as an object of cultural value regained public and political attention”. Lighting, at this point a ubiquitous everyday experience, was given new attention but in a very different framework: that it is polluting the night sky. Sperling (1991) gives a brief narrative of the term’s popularization, explaining that in the politically charged atmosphere of the 1960s and 1970s astronomers began advocating for the curbing of excess lighting detrimental to starlight visibility. Then during the 1973 energy crisis urban areas saw an increase in energy conservation efforts, resulting in decreases to public lighting (Neumann 2002b). Astronomers used the anti-waste strategies of the time to fight excess artificial nighttime brightness, which is when, according to Sperling, “the struggle took on its current aspect” (1991, p. 103). Thus, it was an opportune moment for astronomers to advocate for the mitigation of certain aspects of nighttime lighting. Around this time a paper was published in *Science* titled “Light Pollution: Outdoor lighting is a growing threat to astronomy” (Riegel 1973), which seemingly marks the academic acceptance and adoption of the concept.

2.3.3. Light pollution in contemporary discourse

Since its introduction by astronomers the concept of light pollution has been gaining momentum and widespread acceptance. Contemporary understandings of light pollution focus on categorizing the negative consequences of artificial lighting across a range of disciplines. Thus, it can be defined in many different ways, creating some issues with ambiguity (Morgan-Taylor 2014). However, efforts have been made to provide a universal definition and to codify negative effects, which go well beyond a sort of Luddism or a nostalgic pining for more darkness. The International Dark-Sky Association, arguably the leading authority on light pollution, defines light pollution simply as “any adverse effect

of artificial light” (IDA 2014). A more nuanced articulation of the concept states, “the unintended consequences of poorly designed and injudiciously used artificial lighting are known as light pollution” (Gallaway 2010, p. 72).

What all definitions have in common – either explicitly or implicitly – is the goal of establishing a base upon which the negative effects of artificial nighttime illumination can be categorized. Toward this end, Gallaway’s definition opens us to the broader range of concerns embodied by the contemporary usage of the term – light pollution is not meant to condemn nighttime lighting as a whole, but rather specific uses and outputs of artificial lighting. These negative or undesired aspects of nighttime lighting can be subdivided into four categories: *skyglow*, *glare*, *light trespass*, and *clutter*.⁹ Skyglow is light sent upward (directly or reflected) and scattered in the atmosphere, causing artificial ambient brightness and decreasing stellar visibility (Mizon 2012). This is the orange haze often seen above cities, and the largest burden for astronomy. It has also arguably been the dominant focus of efforts to quantify light pollution, as some landmark studies rely on satellite imagery (e.g., Cinzano, Falchi and Elvidge 2001). The other three forms of light pollution are more commonly experienced hinderences in daily life: glare occurs when excessive brightness reduces visibility (e.g. a floodlight at eye level), light trespass is unwanted or unintended light (e.g., light shining into your bedroom window at night), and clutter is caused by over-illuminated clusters of light sources (e.g., signage and advertising) (IDA 2014; Morgan-Taylor 2014).

With this definition and sub-categorization, the use of light pollution as a framework for evaluating artificial nighttime lighting begins to come into focus. The undesired outputs of artificial nighttime lighting – be it any of the four broad types listed above – can then be considered in terms of effects. The consequences of light pollution are far reaching, and supporting research is often still at an early stage. However, the effects can likewise be subdivided into five broad categories: *energy usage*, *ecology*, *health*, *safety*, and *the night sky*. The past few decades have seen the first large-scale investigations of energy usage by artificial nighttime lighting, as well as its connection to economic costs and greenhouse gas emissions. The International Dark-Sky Association estimates that 22% of all energy in the USA is used for lighting, and of that around 8% is used for outdoor nighttime lighting (IDA 2014). Another recent study concluded

⁹ These four categories of light pollution are used (although with slightly different terms) by the International Dark-Sky Association, and cited elsewhere as well (e.g., Morgan-Taylor 2014). As such, I am accepting these as the standard causes of light pollution.

that this number is closer to 6% (Gallaway, Olsen and Mitchell 2010). Such studies often focus not just on the amount of energy used for lighting, but specifically the amount of *wasted* light. A consistent estimate is that approximately 30% of outdoor lighting in the United States is wasted (Gallaway, Olsen and Mitchell 2010; Henderson, 2010).¹⁰ This translates into roughly 73 million megawatt hours of “needlessly generated” electricity, with an estimated annual cost of US\$6.9 billion. Eliminating this wasted light, in terms of CO₂ reduction, is equivalent to removing 9.5 million cars from the road (Gallaway, Olsen and Mitchell 2010). Similar estimates of wasted light in the European Union have predicted that the direct costs amount to €5.2 billion, or 23.5 billion kg of CO₂ annually (Morgan-Taylor 2014).

Research is also examining the effects on flora and fauna, especially birds, bats, turtles, and insects. While a few species benefit from increased brightness at night, many are negatively affected. Perhaps most notable are the effects of artificial light on migrating birds and newly hatched turtles attempting to reach the ocean (Gallaway 2010; Pottharst and Könecke 2013). The effects of artificial lighting on human health first emerged in the late 1960s, but have gained more attention by medical researchers in the last few decades. Pottharst and Könecke (2013) summarize ongoing research correlating nighttime lighting – and more specifically disruptions to our circadian rhythm – to insomnia, depression, obesity, loss of night-vision, and the suppression of melatonin (which is potentially linked to an increased risk of breast cancer). While the precise connection between human well-being and exposure to artificial nighttime lighting requires further research, the World Health Organization has nevertheless stated that exposure to certain lights at night is likely a carcinogen (Morgan-Taylor 2014).

The relationship between safety and lighting at night is complex at best, and often controversial. Historical surveys into the origins of public nighttime lighting (e.g., Ekirch 2005) describe the storied relationship between the value of safety and lighting efforts. Lighting served the practical function of making nighttime travel safer, but also the symbolic function of protection from the evils of the night (spirits, demons, etc.). In contemporary discourse, the exact relationship between safety and security and nighttime lighting remains contentious, with various studies proving or disproving a correlation (Pottharst

¹⁰ By wasted, we can assume this percentage of lighting is deemed to fall within one (or more) of the categories listed above (skyglow, glare, light trespass, or clutter).

and Könecke 2013). It is outside the scope of this chapter to comment on these studies in detail, but it is important to note that advocates for mitigating light pollution often cite the possibility that less (or more wisely designed) lighting may improve safety and reduce crime (e.g., Bogard 2013; Henderson 2010).

Concerns have also remained regarding the inverse of proliferating nighttime lighting, namely the rapidly declining access to a natural night sky in the developed world. In recent decades attempts to quantify skyglow and its global presence have emerged, however data is still somewhat sparse. The first attempt to map this phenomenon on a global scale was published by Cinzano, Falchi and Elvidge (2001). A more recent study by Gallaway, Olsen, and Mitchell (2010) built on their findings and concluded that the amount of people living in areas with a “polluted night sky” is extremely high: around 99% in both North America and the European Union.¹¹ Furthermore, on both continents approximately 70% of the population lives in areas where brightness at night is at least three times natural levels. From a dark rural area, our unaided eyes can normally see up to 3,000 stars; people with strong eyesight can even see close to 7,000 stars. However, in many urban areas today this number is reduced to around 50, or perhaps even less (Mizon 2012). Researchers caution that if the current pace of increasing brightness continues, the “pristine night sky” could become “extinct” in the continental United States by 2025 (Fischer 2011).

2.4. Questions for the moral space created by light pollution

We began with a problem (*we have too much light at night*) and a related question (*how much artificial light at night is appropriate?*). We now have the origins, context, and detailed definition in hand for the concept of light pollution. With this, we can return to the question of framing outlined in Section 2.2, and scrutinize the ethical significance of increasingly relying on light pollution for policy decision-making; we can assess the answer light pollution provides for our question. Increased regulation and alternative design approaches will be necessary to address the myriad of undesired effects uncovered in contemporary research. And, light pollution offers a framing to orient responses. Furthermore, in its broad understanding of causes and effects, light pollution accommodates

¹¹ Gallaway, Olsen, and Mitchell (2010) utilize the threshold criteria established by Cinzano, Falchi, and Elvidge (2001) for considering an area “polluted” by light. These criteria “consider the night sky polluted when the artificial brightness of the sky is greater than 10% of the natural sky brightness above 45° of elevation” (Gallaway, Olsen and Mitchell 2010, p. 660).

a variety of interpretations, allowing for a multiplicity of regulatory and technical solutions. Dark sky ordinances and new laws already exist, which often include detailed technical specifications.¹² However, it is pertinent to reflect on the framework in which these decisions were made, and to consider how light pollution will shape future initiatives.

The below discussion is organized under two broad questions, with the aim of elucidating the moral limitations and practical ambiguities existing within the concept of light pollution, when considered as a framework for moral and political decision-making. These two sections should not be seen as mutually exclusive, but as actively informing one another.

2.4.1. What are the normative limitations of the concept of light pollution?

A first step is to consider the limitations for application, for which a consideration of language will be helpful. As the above discussion in Section 2.3 makes clear, light pollution is not simply a description of certain environmental impacts, but also an evaluation of the effects of nighttime lighting technologies and infrastructure. Light pollution is both a descriptive statement and a value judgment with normative implications – it categorizes certain uses and types of lighting as *bad* or *wrong*. Historically lighting often functioned as a form of safety and protection at night, but there has been a reversal. Now humans, animals, and the night sky require protection from artificial light. Importantly, articulating this shift in perspective via the notion of light as a *pollutant* adds a moral level to an otherwise technical discussion of illumination. But, in considering the creation of a moral space for deliberation, we should reflect on the implications of this label. Garrard (2004), in assessing Rachel Carson's iconic *Silent Spring*, notes that one of the book's lasting achievements was expanding what was previously seen as a scientific issue (the usage of pesticides) into a social and ecological problem. By this, Garrard is referring to the categorization of pesticides as pollution. This is because "pollution" does not

¹² Morgan-Taylor (2014) provides a brief analysis of current regulatory efforts in Europe. France is cited as having perhaps the strongest law to date, which requires non-residential buildings to switch off exterior lights and window displays between 1am and 7am. Other examples cited include regions of Italy that have taken a technical approach, prohibited lights above a specific brightness to project above the horizontal. Additionally, an online appendix to the article by Kyba, Hänel, and Hölker (2014) lists all known regulations and ordinances that are currently in place, as well as their motivations and targets.

name an actual thing, but rather provides an implicit normative claim that “too much of something is present in the environment, usually in the wrong place” (2004, p. 6). Carson helped to reframe perspectives, allowing the usage of pesticides to be contested morally and politically. The same can be said of the concept of light pollution, generally considered: it breaks with the historical meanings and values associated with nighttime lighting, reframing discussions as a debate over how we ought to preserve and protect the night sky, as well as protect ourselves and ecosystems, from excess artificial light.

We can see the emergence of the concept of light pollution as – at least in part – a reactionary shift in perception to the widespread proliferation of electric illumination at night. A recent New York Times article quoted a behavioral ecologist as stating that we need to “start thinking of a photon as a potential pollutant” (St. Fleur 2016). To accept this re-framing is to begin seeing artificial nighttime lighting as spreading polluting photons into the atmosphere, the environment, and ourselves. Answers will likely take the form of either preservation or mitigation strategies – certainly not a bad approach, but it does draw attention to the importance of light pollution as a framework through which solutions can emerge. Regulations and strategies based on light pollution will necessarily focus on reducing the negative or adverse effects of nighttime lighting; on protecting those things or resources affected, and/or cutting out that 30% of lighting considered to be “wasted” (Gallaway, Olsen and Mitchell 2010). As a regulatory tool, this can be quite useful, and follows a similar strategy as attempts to regulate other pollutants.

Attaching the language and connotations of *pollution* to nighttime lighting is effective, but may also set boundaries on possible solutions. This is a very specific answer to the question of how much light is appropriate, which comes with limitations. As a moral concept, light pollution can tell us what *bad* lighting is, but says relatively little about what *good* lighting is. Because of the focus on the (adverse) causes and effects of artificial nighttime lighting, the concept is limited in its capacity to inform choices within the realm good lighting, especially in cities where there are other values at play. Light pollution says very little about artificial nighttime illumination deemed to be within the acceptable limits of polluting, or the many values and needs strived for therein (for example, aesthetics and nightlife). Thus, there are limits to the capacity of light pollution to inform moral evaluations, as it frames decisions as questions about acceptable levels of polluting.

2.4.2. What are the practical ambiguities of the concept of light pollution?

With the limitations known, we can next consider how to strengthen practical applications. Operating effectively in such a capacity necessarily means establishing the boundaries or thresholds for lighting considered to be “polluting”. If we focus solely on mitigating the negative or adverse effects of artificial nighttime illumination, we must then define what qualifies as *negative* or *adverse*, as well as what the acceptable levels of these effects are. And these levels – which will effectively delineate good and bad lighting – should not be arbitrary or ambiguous.

This comes with a rather unique set of challenges, because what is polluting for one person can be acceptable or even desirable lighting for another. There are uses of light that are necessary at night, especially in cities; no “dark sky advocate” would deny that. And there are obvious instances of excessive brightness and poorly designed lighting, which most reasonable people would agree is unnecessary and wasteful. But, there will also be instances that fall somewhere in an intermediary, gray area. These could be instances where the lighting does not obviously fall into one of the sub-categories of light pollution, or does not relate directly to one of the identified effects of light pollution, or is contested as a good by some stakeholders and a nuisance or excess by others. Or, it could be a new technological innovation that reduces energy consumption but will potentially increase skyglow – an emerging issue connected to LEDs (Morgan-Taylor 2014). In these instances, we will see the weighing of benefits versus negative effects by regulatory decision-makers. It is unclear how the current conception of light pollution can be used to resolve such conflicts, without drawing upon a larger moral framework – for example, a formulation of the precautionary principle, a definition of sustainable development, or perhaps an explicit focus on minimizing energy usage – that helps to elucidate exactly what an acceptable level of pollution is. And, different approaches may rely on rights-based or consequentialist moral frameworks. These may, in turn, offer different boundary conditions for what qualifies as acceptable levels of light pollution. For example, in 2007, a group of astronomers published the Starlight Declaration, asserting that access to the night sky should be an “inalienable right of humankind” (Starlight Initiative 2007, p. 3). Adopting such a rights-based approach would likely yield different conclusions than, say, a cost-benefit analysis. We would then need to ask if light pollution is, or should be, beholden to one broader moral framework, or how different manifestations can be reconciled. If we recall the discussion of defining problems within policy as a

means to guide action (Stone 2002), the concept of light pollution then requires further parameters beyond the causes and effects listed above.

Current calls for mitigation are often rested on an appeal to needs. For example, the International Dark-Sky Association cites needs-based principles of lighting as a way to minimize the negative effects of light pollution (IDA 2014). It seems to follow that “unneeded” nighttime illumination equates to light pollution, and therefore, contributes to the pre-defined negative effects. For, at the least, lighting deemed unnecessary wastes energy. This requires a clear justification for what is “needed” nighttime illumination, which is both a quantitative and qualitative question. However, the moral terrain of such claims has been left largely unexplored. A needs-based approach requires that we can confidently point to criteria for needed lighting. Yet, as historic surveys on nighttime lighting make clear, the blurring of symbolic and actual needs of nighttime lighting are complex, and needs are co-constituted by societal perceptions and values (Nye 1990; Schivelbusch 1988). If policies aimed at light pollution mitigation adopt a needs-based approach, adequate reasoning should be given for why a different approach – say one geared toward preferences and desires – is insufficient.

Kyba, Hänel, and Hölker (2014) mention the tricky issue of “shifting baseline syndrome”. As nights get brighter, people have a new conception of what “normal” levels of light are, and base their evaluations of acceptable levels of brightness on this. A focus on needs could help to overcome shifting baselines. But, such an approach risks omitting the preferences of local stakeholders, and as such may create technocratic and paternalistic policies. This may contribute to downstream value-level conflicts when regulations are enacted. For example, safety is a central facet of nighttime lighting, and an important value intertwined with urban nightscapes. While the correlation between increased lighting and increased safety is contentious, research suggests that lighting influences feelings and perceptions of safety (King 2010), and that feelings of fear increase at night (Li et al. 2015). Such findings represent a challenge for needs-based nighttime lighting efforts. Attention to the preferences of local stakeholders becomes critical to the creation of regulations that will be supported and successful. The frame creation model discussed above (Dorst 2015) is but one approach that incorporates the values and desires of stakeholders; a variety of other participatory or value-focused design strategies could also be effectively utilized to address conflicts of this nature.

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In establishing an acceptable level of polluting, some clarification of qualitative values will strengthen future decisions. Consider the research by Gallaway (2014), who explores the instrumental value of the night sky for promoting the broadly held values of happiness and sustainability. He concludes by stating, “We suggest that estimating the night’s value is not nearly as important as simply recognizing that it does have enormous value and then trying to preserve this value and put it to good use” (p. 280). Gallaway’s discussion of key night sky traits includes its ability to connect us to the natural world, its ability to engender a sense of wonder, and its beauty. Such an articulation of the value of reducing light pollution falls outside traditional economic calculations, as discussed elsewhere by Gallaway (2010). It also further calls into question a needs-based approach. As a frame, light pollution will set the boundaries on what sort of answers are possible, which requires a careful consideration of how “needs” are defined, and what needs ought to be encapsulated by future policies.

Clarifications to the ambiguities discussed above will likely change alongside differences in geographies, cultures, and belief systems. The recent edited volume *Cities of Light* (Isenstadt, Maile Petty and Neumann 2014) provides a first overview of historic developments in nighttime illumination with respect to individual cities, a format that could be expanded to contemporary environmental debates. But regardless, if light pollution will be the frame through which regulations are established, anticipating value-level conflicts and ambiguities is important. We must clarify – or at the least debate – the normative foundations of light pollution before the framework becomes normalized and fades into the background of presuppositions informing nighttime lighting strategies.

2.5. Conclusion

This chapter has critically engaged with the concept of light pollution and identified areas that require further clarification. The limitation of light pollution as a criterion for the moral evaluation of artificial nighttime lighting was discussed, concluding that it can best function in the limited capacity of mitigation or preservation efforts. This led to practical concerns, specifically the ambiguity of thresholds for acceptable levels of light pollution, and the mechanisms that could be used to establish said thresholds. The intention was

to highlight conceptual and practical issues that, if addressed, can help to strengthen future regulatory efforts in urban nighttime lighting.

The 350-year project of illuminating our nights has produced a challenging situation. The desire for more and better lighting at night has left us with an overabundance of artificial illumination, and has produced a novel problem. The realization of *lengthening the day* is increasingly perceived as a *loss of the night*, and a new frame has emerged to give shape to these concerns. The story of light pollution goes back much further than the 1970s, in juxtaposition but nevertheless linked to the technical and social history of modern nighttime illumination. Importantly, the concept of light pollution re-frames certain aspects and uses of nighttime lighting technologies. If we return once more to the driving question (*how much artificial light at night is appropriate?*), we can appreciate that the concept of light pollution provides a new starting point, and not an end point, for discussions about the future of nighttime lighting.

3 Re-envisioning the Nocturnal Sublime^{13,14}

3.1. Introduction

Cities given, the problem was to light them. So begins R.L. Stevenson's 1881 essay "A Plea for Gas Lamps" bemoaning the new technology of electric lighting in favour of gaslight. While the specifics of Stevenson's argument may seem antiquated, the sentiment is familiar. Lighting is fundamental to our nighttime spaces and experiences, the antecedent to any discussion of the city at night. It has brought momentous changes, creating space and time out of darkness, expanding human activity, and allowing for new forms of visual expression. The spectacle of electrical illumination is one of the great technological achievements of our age, and an integral part of cities: "The night skyline has become the signature image of the metropolis, a defining landscape of modernity" (Nye 2010, p. 12). However, the proliferation and abundance of illumination has created a new environmental problem: light pollution. Of the varied adverse impacts of artificial light at night, perhaps the most conspicuous is the elimination of darkness and the natural features it makes possible. The starry night sky has captured human imagination and curiosity for ages, but is becoming increasingly rare and difficult to experience. City lights and the night sky have come into conflict, adding a new dimension to the *problem* of lighting cities.¹⁵

This nascent conflict is a complex environmental challenge for the 21st century, yet it also creates an opportunity to propose new visions for urban nightscapes. Grounded in the practical problem of light pollution, this chapter examines the contemporary axiological dimensions of urban and natural

¹³ Originally published as: Stone, T. (2018). Re-envisioning the Nocturnal Sublime: On the Ethics and Aesthetics of Nighttime Lighting. *Topoi*. Online: <https://doi.org/10.1007/s11245-018-9562-4>

¹⁴ I am grateful to Thierry Cohen and Tyler Nordgren for granting me permission to use their original artwork in this paper.

¹⁵ This chapter is explicitly limited in scope, focused on developed regions where the ecological and social impact of overabundant nighttime lighting has become a concern. Lighting issues in regions of the world with limited or no access to electricity – what Pritchard (2017) describes as *lighting poverty*, the inverse problem to light pollution – are not discussed here.

darkness. In particular, competing notions of the *sublime* and their interrelated moral evaluations are examined. To do so, different threads analyzing conceptions and evaluations of nocturnal sublimines are gathered together from across disciplinary boundaries. Experiences of urbanized and natural nightscapes – of electric illumination and the starry sky, respectively – evoke similar aesthetic responses, but with different moral connotations. However neither can, nor should, be quickly or wholly disvalued. We must acknowledge the heritage of 20th century lighting developments without uncritically accepting the current state of affairs or ignoring its environmental impact. To do so, I propose that we must re-envision the urban nocturnal sublime, striving for nightscapes that are both aesthetically powerful and morally engaged. In doing so, explicit attention is given to the influence, and incorporation, of values into the built environment, an important theme for urban-focused philosophy (e.g., Epting 2016b; Schrijver 2015). Put otherwise, this chapter explores how philosophy can contribute to envisioning the future of cities at night.

The follow section investigates in turn the aesthetics of city nights, the value of naturally dark skies as understood via the threat of light pollution, and the resultant spatial differentiation. First urban nightscapes are presented, focusing on their legacy of positive values and notions of the *technological sublime*. Next, the problem of light pollution and resultant evaluative shift towards artificial lighting is discussed, focusing on ideas of the *astronomical sublime* as a motivation to protect the night sky. The moral implications of these competing sublimines are then examined. It is argued that a wilderness nightscape has been constituted, where the night sky is accessible and the preservation and protection of darkness is seen as a moral duty. These spaces require protection from light-polluting, urbanized nightscapes, which are defined and bounded by artificial illumination. These two distinct nightscapes reinforce perceptions of a nature-culture dichotomy, or what has been called a *geographical dualism* between cities and wilderness (Light 2001), with troubling implications for urban-focused environmental ethics. However, this chapter will not end with a critique. Section 3.3 proposes that urban nocturnal experiences be conscientiously re-envisioned, as a step towards addressing the problems of light pollution and overcoming this geographical dualism. After first situating dark skies as a form of urban restoration, recent works seeking to rehabilitate the sublime's relevance to contemporary environmental aesthetics are utilized to explore the possibilities of a new urban nocturnal sublime that incorporates the positive aspects of dark skies into city nightscapes.

3.2. Moralizing lighting, moralizing darkness

Throughout this section, close attention is given to two different manifestations of the sublime and the interrelated moral evaluations of contrasting nightscapes. While here interpretations of the sublime in contemporary (and context-specific) discourse are of primary concern, they can be broadly construed as invoking a Kantian notion of the sublime. While sharing some similarities with notions of beauty, the sublime should be understood as a distinct aesthetic quality and category. The sublime is at first overwhelming in its vastness or power before giving way to a pleasurable experience; it is in this tension between displeasure (apprehension, overwhelmingness, anxiety, etc.) and pleasure (a distanced delight or appreciation) that the sublime arises. Paradigmatic examples of the sublime are found in natural landscapes and events: mountain ranges, waterfalls, volcanoes, thunderstorms, and the night sky. In particular, the experiences described below elicit the *mathematically* sublime, concerned with experiences of immense size and vastness rather than power, which is alternatively categorized as the *dynamically* sublime (Kant 1987; Brady 2013).

Following a common theme (i.e., the sublime) is useful for giving form to a nebulous issue. *Darkness at night* and nighttime illumination are so familiar that analyzing our experiences of them seems almost trivial. However they are malleable and variable concepts with many different manifestations, and their experiences have become closely entwined. On a conceptual level, “darkness does not trigger essential human responses but is always mediated by human practices and values” (Edensor 2017, p. 170). The sublime is thus a useful – and formative – lens through which to analyze the symbolic meanings and evaluative judgements of differing nightscapes. And importantly, the sublime draws attention to the entwinement of aesthetic *and* moral judgements of contemporary nightscapes.

3.2.1. City nights and the technological sublime

The modern era of formalized public lighting efforts (roughly since the mid-17th century onwards) has brought with it many benefits. The various technological innovations to oil lamps, gaslight, and electric light, in combination with changing commercial and social practices, have fundamentally altered urban nights. Historical accounts of these developments tend to put forward a broad thesis that the ramifications of nighttime lighting are as much a product of symbolic and social meanings as technical innovation or functional purpose

(e.g., Nye 1990; Schivelbusch 1988; Schlör 1998). Artificial illumination has long been positively associated with values such as safety and progress, while darkness has maintained antithetical associations with danger, evil, and primitiveness. Dunnett (2015, 622) explains that, “the idea of light, both in a practical and symbolic sense, has come to be associated with modernization and the so-called ‘Enlightenment project’ in various different ways... Here we can also see how the metaphor of light has taken on a moralizing tone, seen as an all-encompassing force for good, banishing the ignorance of darkness in modern society.” Electric lighting in particular embodies this symbolism, understood as providing “a visible correlative for the ideology of progress” (Nye 1990, 35). While this has been challenged and disrupted by concerns over light pollution, the legacy of positive values shaping and shaped by lighting infrastructure remains.¹⁶

Alongside the moral symbolism of illumination has been a profound transformation of nocturnal experiences. In *Acquainted with the Night* (2004, p. 95), Dewdney reflects on the “electric blaze of the city at night” as being “one of the most fantastic sights of our times.” This experience, explains Dewdney, is paradoxical, in that its monumentality gives a feeling of permanence, but is also made more impressive knowing that it has only been possible for little more than a century. Electrified skylines, a defining feature of urban nightscapes, have become paradigmatic of what Nye (1994, 2010) calls the *electrical sublime*, a subcategory of the *technological sublime*. With this concept, Nye (1994) extends theoretical understandings of the sublime beyond solitary experiences of natural settings to also include collective experiences and popular accounts of modern technological feats, such as railroads, skyscrapers, and spacecraft. As applied to illumination, Nye explains that during the initial electrification of cities (ca. 1880s – 1920s), nighttime lighting was somewhat disorganized and had many competing actors and interests, creating a nightscape of different lighting intensities, types, colours, etc. This development, while unplanned, created a distinct and novel aesthetic. “Taken together, the myriad lights produced a lively

¹⁶ While this chapter focuses on contemporary environmental issues and the influence of artificial lighting technologies, particularly electric lighting, the symbolism of light and darkness recedes well beyond the modern era of public lighting. There is a rich and complex history of scientific, metaphysical, theological, and moral interpretations of light, as well as related symbolisms of night and darkness, that have shaped contemporary understandings but are outside the scope of this chapter. For in-depth analyses, see for example Ekirch (2005), Park (1997), and Zajonc (1993).

landscape with strong popular appeal. Like the accident of the city skyline, the electrified city was something fundamentally new, an unintended sublimity” (Nye 1994, p. 173).

While Nye (1994) is referring specifically to developments in the United States (he points out that European cities were not quite as enthusiastic about commercial lighting in the early 20th century), his observations bring to mind contemporary urban experiences around the globe. To walk through a downtown core at night is to be immersed in artificial light, to be encompassed by this technology. Illumination re-shapes the urban fabric, sometimes seemingly ad hoc and at times carefully planned, with attention paid to what and where is lit, and how. In either form it effectively *creates* the city at night, carving space and time out of darkness. There is a reverence and excitement when entering a metropolitan city at night, with its innumerable lights creating a vibrant atmosphere. Entering a space like Times Square in New York City for the first time, it is hard not to be taken aback and in awe of the brightness and multitude of lights. In *New York Nocturne* (2008, p. 19), Sharpe presents the sublimity of New York as “both inspiration and example, projecting an all-encompassing script of light that stunned observers with its unnatural brilliance and cryptic, seemingly cosmic significance.” Upon visiting New York City in the 1930s, the architect Le Corbusier described it as a “Milky Way come down to earth” (quoted in Sharpe 2008, p. 6). In moments when you become aware of the immensity and scale of artificial illumination in places like this, it takes on an almost otherworldly quality. It is all the more powerful if we see these nightscapes as wholly artificial environments, as human creations. City nights create a sort of human-made constellation, erasing the heavens in favour of “man-made stars” (Nye 2010, p. 12).

3.2.2. Light pollution and the astronomical sublime

Electric lighting proliferated during the late 19th and early 20th centuries, and was subsequently normalized as a taken-for-granted backdrop to city nights (Nye 1990). The spectacle of artificial illumination, though, has had consequences. Its proliferation has never been universally celebrated (see Edensor 2017, pp. 170-77), and has been increasingly criticized from an environmental perspective. There is a growing appreciation that the developed world is now over-illuminated, or at least poorly illuminated. The adverse causes and effects of artificial nighttime lighting have come to be known as *light pollution*, and an

increasing body of literature is highlighting the consequences.¹⁷ Billions of dollars are spent annually to power hundreds of millions of lights around the world, and their necessity and efficiency has come under scrutiny. For example, in the USA it is estimated that approximately 30% of outdoor light is wasted, at a cost of almost \$7 billion dollars annually. This equates to vast amounts of energy usage – approximately 66 million metric tons of CO₂ – equivalent to the emissions from roughly 9.5 millions cars (Gallaway, Olsen and Mitchell 2010). The effects are not limited to efficiency, as there is also concern over the effects of artificial nighttime lighting on different species and ecosystems, termed *ecological* light pollution (Longcore and Rich 2004). Likewise, the effects of artificial lighting on human health are quickly emerging as a contentious and important subject of inquiry (e.g., Chepesiuk 2009). While there is still debate over the extent of the effects and costs, it can nevertheless be appreciated that artificial lighting is giving rise to a new domain of moral and political concern. The growing recognition of light pollution has inverted the problem of how to light cities, with questions of environmental degradation, energy efficiency, and health impacts coming to the fore.

A particularly conspicuous effect of light pollution is the ambient atmospheric brightness created by light directed or reflected upwards into the night sky, termed *skyglow*. It is a familiar phenomenon: being on the outskirts of a city and seeing a glowing horizon, almost like an artificial dawn; observing an orange-coloured haze above you in cities (especially on overcast nights). In fact, it is so common that it has become the norm in many parts of the world. Falchi et al. (2016) have found that 83% of the world's population, and over 99% of people living in Europe and the United States, live in places with a night sky considered to be light-polluted (a minimum of about an 8% increase above natural nighttime conditions). In cities, the artificial night sky brightness is typically several magnitudes greater. Furthermore, our nights continue to get brighter by around 3-6% annually worldwide (Hölker et al. 2010).

Light pollution – and in particular skyglow – has spurred a deeper reflection on the need and desire for lighting at night, and on what is hindered or degraded by artificial illumination. This has drawn attention to the environmental and cultural value of darkness, and in particular the value of night sky (e.g., Bogard 2013; Gallaway 2014; Henderson 2010; see Chapter 4). In

¹⁷ For an overview of the costs and benefits of nighttime lighting, see for example Gaston et al. (2015) and Pottharst and Könecke (2013).

response to the growing pervasiveness of artificial lighting and its negative impacts, efforts and organizations have emerged that work towards the protection and preservation of dark skies. The largest advocacy group, the International Dark-Sky Association, has the stated mission of “protecting the night skies for present and future generations” (IDA 2016). Their work, along with other similar organizations, includes advocating for best practices in lighting policies and design (e.g., IDA-IES 2011), as well as the creation and protection of dark sky reserves around the world (Meier 2014).

While quantitative reasons for the mitigation of light pollution are often highlighted – the billions of dollars wasted annually on poorly designed lighting, for example – arguments likewise rest on qualitative rationale. Skyglow cuts off experiences of the night sky, causing concerns over the “loss of the night.” For all of human history we have had a starry night sky above us, so the argument goes, which has been a resource for mythology, religion, navigation, scientific discovery, etc. The cultural losses that we will suffer from the disappearance of the night sky underlie judgements that light pollution is bad and the protection of the night sky is a moral duty. This is perhaps best exemplified in initiatives such as the Declaration in Defense of the Night Sky, which asserts that access to an unpolluted night sky should be an inalienable right (Starlight Initiative 2007).

Closely interwoven with these ethical arguments is the position that, at a basic level, it is an experience worth preserving. To explain the related aesthetic value of the night sky invoked by astronomers and environmentalists, Dunnett (2015) draws on notions of the *astronomical sublime* (Kessler 2012). A starry sky is beautiful and inspires a sense of wonder, yet there is also an immensity and vastness that inspires a sense of awe. This feeling, a seemingly inescapable response to the starry sky, is both a visceral response and one reinforced by modern science (Shapshay 2013). To look out into the night sky is to see billions and billions of stars and galaxies shining their eon-old light from incredible distances, through a harsh and inhospitable universe. It has temporal and spatial dimensions that we can comprehend abstractly, but its scale is difficult to fully grasp (Hepburn 2010). Put more simply, it is the epitome of the mathematical sublime in nature.

The contemporary axiological dimensions of the night sky are encapsulated by the “Milky Way” poster series of artist and astronomer Tyler Nordgren (Fig. 3.1). The series features stylized and semi-abstracted nightscapes of various United States national parks, typically featuring a few solitary, contemplative

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figures staring up at a star-dotted sky with the Milky Way meandering across. Nordgren's posters present a tamed, domesticated sublime encounter, providing a contemporary view of darkness far different from the values discussed in Section 3.2.1. Instead of a threatening landscape the posters present a pleasant and inviting scenic sky, with a monochromatic colour palette of various shades of blue – in contrast to the pitch-black darkness typically associated with sites of danger or evil. In sum, Nordgren's Milky Way posters capture the moral-aesthetic essence of the astronomical sublime evoked by dark sky activists. However, to re-focus on the urban nightscape, it is exactly this type of sublime – both its domestication and its geographical boundary – that must be scrutinized.



Figure 3.1 An example from the Milky Way poster series: Death Valley National Park, Tyler Nordgren, c. 2012-16 (<http://www.tylernordgren.com/milky-way-posters/>)

3.2.3. The geographical dualism of artificial lighting and natural darkness

Nighttime lighting, understood and evaluated via the concept of light pollution, is creating a contemporary relation between lighting and darkness that is far different from the symbolic heritage discussed in Section 3.2.1. Artificial lighting has become so pervasive, so ubiquitous in our daily life, that darkness has become a “sought-after luxury” (Hasenöhl 2014, p. 119) needing protection and preservation. Knowing and experiencing true darkness and its features takes a concerted effort, perhaps best exemplified in Bogard’s *The End of Night* (2013). To experience a truly dark, or natural, night sky, we must seek it out. This means escaping our cities and journeying into the wild. Only away from the encroaching skyglow of cities is access to a starry sky, and to the astronomical sublime, possible. In analyzing the Campaign for Dark Skies in Britain, Dunnett (2015) explains that urbanization is seen as the primary threat to dark skies, creating a “moralized geography.” Here, we see the reinforcement of a conceptual divide between nature and culture, and the resultant spatial differentiation between natural and built environments, that has been a central concern of urban-focused environmental ethics (e.g., King 2000; Light 2001; Stefanovic 2012). In its contemporary manifestation, the sought-after unpolluted dark sky is categorized as something *out there*, outside of cities and human activities, which are in turn defined and bounded by artificial light.

While the value of the night sky should not be solely ascribed to the contemporary effects of lighting technologies, they do – at the very least – actively draw attention to the loss of this experience, in turn re-positioning the technological sublime as a *pollutant*. Sharpe (2008, p. 24) notes that “The arrival of artificial light had, almost paradoxically, “invented” natural light, for no such conceptual category existed before the new technologies posed alternative forms of illumination.” Pritchard’s “The Trouble with Darkness” (2017) places this issue in its historical and political context, problematizing how we conceptualize both light pollution and darkness. The paper focuses on NASA’s 2012 image *City Lights of Africa, Europe, and the Middle East*, a composite satellite image of the earth at night (Fig. 3.2). Through a close reading of the image, Pritchard highlights the creation of a new site of environmental concern (the nightscape) and a related new environmental issue (light pollution). However, *City Lights of Africa, Europe, and the Middle East* is not a photograph but an altered image: sources of lighting deemed natural – fires, volcanoes, etc. – were filtered out, increasing the contrast between dark regions and brightly-lit urban areas. This is troubling for a variety of reasons, explains Pritchard, including the

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romanticizing and depoliticizing of the *natural* darkness of Africa, as well as the artificially sharp delineation of illuminated (urban) zones. Here we see the reinforcing of what Light (2001) calls a *geographical dualism* between cities, as sites of human activity, and wilderness, as the site of pristine and authentic nature.



Figure 3.2 *City Lights of Africa, Europe, and the Middle East.* NASA Earth Observatory image by Robert Somon, using Suomi NPP VIIRS data provided courtesy of Chris Elvidge, April-October 2012
(<https://earthobservatory.nasa.gov/NaturalHazards/view.php?id=79793>)

Pritchard's title is a reference to Cronon's "The Trouble with Wilderness" (1995), a critique of the concept of wilderness as morally dubious grounding for environmental ethics. Seen as harkening back to Romantic ideals of nature,

Cronon argues that wilderness is a social construct reinforcing a human-nature divide, idealizing natural landscapes as places devoid of humans, and as sites mainly for affluent urbanites seeking leisure and tourism. Cronon is explicitly critical of romanticized notions of sublime experiences in wilderness, for its role in both idealizing and domesticating experiences of the natural world (something arguably present in the astronomical sublime described above).¹⁸ By placing the night sky within the realm of wilderness, we place our urban nightscapes in a morally precarious position. In the extended quote below, seeing “artificial lighting” and “natural darkness” as synonymous with “civilization” and “wilderness,” respectively, highlights the predicament:

We inhabit civilization while holding some part of ourselves – what we imagine to be the most precious part – aloof from its entanglements. We work our nine-to-five jobs in its institutions... we benefit from the intricate and all too invisible networks with which it shelters us, all the while pretending that these things are not an essential part of who we are. By imagining that our true home is in the wilderness, we forgive ourselves the homes we actually inhabit. In its flight from history, in its siren song of escape, in its reproduction of the dangerous dualism that sets human beings outside of nature – in all of these ways, wilderness poses a serious threat to responsible environmentalism at the end of the twentieth century. (Cronon 1995, p. 81)

This geographical distinction creates a discrete problem frame, affecting what sort of solutions to light pollution are possible. We place the night sky – a key feature we seek to preserve and protect – outside of the boundaries of urban settings, which are the main culprit of skyglow. In doing so, we create a fallaciously clean distinction between the natural night sky and the city, between the positive, authentic astronomical sublime and the polluting technological sublime. Solutions then take the form of preservation (of sites of wilderness) and containment (of the impacts of urban illumination). This is helpful in advocating for dark sky reserves, but implicitly accepts a separation of cities and nature. Like environmental ethics more generally, an ethics of nighttime

¹⁸ Cronon (1995) is speaking explicitly about the American experience and conception of wilderness. Kirchhoff and Vicenzotti (2014) discuss perceptions of wilderness from a European perspective, which does differ but carries similar characteristics. Most important for the present discussion is the position that wilderness is constituted by “specific meanings ascribed to it according to cultural patterns of interpretation” (p. 444). Furthermore, they also assert that contemporary perceptions of wilderness stand in opposition to urban spaces and human activities, and continue to embody ideas of the sublime.

lighting must also attend to the experiences and impacts found within urban spaces (see Light 2001, pp. 19-27).

3.3. Re-envisioning the urban night sky

The profound moralizing effects of artificial lighting technologies have had far-reaching consequences, reframing lighting as a pollutant while simultaneously re-positioning dark skies as a valuable natural feature worthy of protection. So entrenched is the darkness-as-wilderness association that urban darkness is now perceived as somehow unnatural – blackouts or other disruptions to electricity create a temporary “artificial darkness,” before the normal state of affairs is reinstated (Nye 2010). But this perception can, and here I argue should, be challenged. In what follows, I propose that we actively re-envision urban nightscapes of the 21st century in a way that is sensitive to the axiological dimensions of artificial nighttime lighting and natural darkness. Bringing dark skies back into cities can be seen as a form of urban restoration, discussed in Section 3.3.1. This in turn informs how we should address the spatial distinction between the technological and astronomical sublimities, discussed in Section 3.3.2. The sublimity of urban nights is examined as a design criterion that will affect how we see our urban nightscapes, and ultimately what sort of restorative potential dark skies possess. For this, I explore the possibilities of a new urban nocturnal sublime that seeks to incorporate the morally engaged aspects of the astronomical sublime into cities.

3.3.1. Darkening skies as urban restoration

The unique characteristics of urban darkness require a somewhat different conception of *ecological restoration* than is typically debated in environmental ethics (e.g., Katz 2003; Light 2003). It is not an act of re-creating an aspect of nature via technological means, for the night sky is not actually destroyed; it is only cut off from experience. Acts of restoration are therefore focused on the technology that mediates our nighttime experiences. The analysis above reveals, at least in part, how contemporary meaning has been ascribed to dark skies, and what the implications are for an urban environmental ethic. This geographical dualism can be seen as a socially constructed response to the effects of our lighting technologies, and challenged in a conscientious way. *How we light* (and how we have lit our nights in the past) plays in active role in co-constituting our

perceptions and understanding of the night and of darkness, and will continue to do so (Verbeek 2011). The mediating influence of our lighting infrastructure thus embodies both the primary challenge, and opportunity, to re-orient our urban nightscapes.

In arguing for an urban environmental ethic, King (2000) discusses the built environment's influence over our ability to "imagine and implement an environmentally responsible world" (p. 122). King further explains that contemporary cityscapes and their technologies act as an external constraint, minimizing our contact with the natural world. Dewdney (2004, p. 96) poetically describes the way in which artificial lighting technologies now encompass our lived experiences and keep darkness at bay, stating, "In a way we are like miners, tunnelling with light into the bedrock of darkness. Artificial lights carve tunnels and caverns out of the night, spaces in which we can operate as if it were day." Despite the benefits nighttime lighting brings, argues Dewdney, our light also confines us, and we rarely leave its boundaries. Where darkness does enter our cities, at present, it is largely perceived to be much different than the experiences described in Section 3.2.2. It is often considered to be unsafe and a place and time for questionable behaviours, both spatially and symbolically in opposition to the values of *natural* darkness.

Bringing the night sky into cities is an act of bringing a positively valued feature of darkness into urban settings, and of allowing us to see past our lighting technologies. The re-instating of urban dark skies can be seen as an act of urban restoration in the holistic sense, as described by de-Shalit (2003). Literally, it is an act of clearing the city of skyglow and removing one type of "pollution," bringing with it energy and cost savings, as well as reducing the harmful effects to urban wildlife and human health. Symbolically, it is an act of blurring the city-wilderness geographical dualism, of taking a step towards the creation of a city aesthetic in sync with the natural rhythm of day and night – an act of letting nature back into our cities, and vice versa. Restoring urban dark skies, then, can be understood as an act of re-orienting the ecological and cosmological sense of place for cities and their inhabitants, of re-connecting the urban with the natural. It allows for the incorporation and fostering of the full spectrum of values associated with darkness, from efficiency and sustainability to a connection to nature (see Chapter 4).

The restorative potential of dark skies can also extend to socio-political concerns over the separation of wilderness from cities. The embedded-ness of values and politics in technologies has been acknowledged at least since

Winner's seminal article "Do Artifacts Have Politics?" (1980), and lighting technologies are no different. If anything, their longevity of influence, as well as ubiquity, makes lighting infrastructure unavoidably political. Like wilderness, dark sky reserves are a site of leisure and tourism far outside cities, raising questions of accessibility (Light 2001; Pritchard 2017). Bringing dark skies back into cities is certainly not a silver bullet, but there is the potential to address issues such as accessibility to nature, in turn re-positioning the (environmental) moral status of urban nightscapes.

Restoring urban dark skies requires the extension of current debates about the meaning and make-up of a *natural city* (Stefanovic 2012) beyond acts of *greening*, to also include acts of *darkening* cities. This will require attention to the over-use of lighting, combined with capitalizing on the instrumental and intrinsic value of dark skies (Gallaway 2014; see Chapter 4).¹⁹ Such an approach has begun to percolate in the practice and discourse of professional lighting designers – what Edensor (2017) calls "dark design." We can see examples in the work of the lighting design firm Concepto and their master plan for Rennes, France, which introduces *dark zones* into the city core (Concepto 2012; Narboni 2017). Similarly, the Dark Art Movement started by lighting designers Chris Lowe and Philip Rafael champions a conscientious usage of darkness within lighting design, contending with the "collective nyctophobia" of the profession (Lowe and Rafael 2011; 2014). In sum, these designers are envisioning a return of darkness to cities far different from the ominous gloom of the past, rather as an environmental good and a "re-enchantment" of the night (Edensor 2015).

If such trends are to continue, there is a question of what aesthetic principles can guide future decision-making and help to position dark skies as a form of urban restoration. de-Shalit (2003) notes that each city has its own conception of "the good," or its own story, meaning that the realization of dark skies will, and likely should, manifest differently in different contexts. And, the goal of darkening cities must be prioritized in relation to other environmental and social urban issues, through processes such as the *complex moral assessment* proposed by Epting (2017). But I assert here that within such decision-making processes the achievement of dark skies should be a *prima facie* consideration in the design of urban nightscapes. Thus, we can take first steps towards

¹⁹ The most common objection to reducing nighttime lighting relates to concerns over safety. While outside the scope of this chapter, an overview of the contentious relationship between safety and lighting can be found for example in Gaston et al. (2015).

articulating the overarching aspirations and constraints that can guide the restoration of urban dark skies. For this task, I return to the sublime.

3.3.2. In search of a new (urban) nocturnal sublime

Building on the above moral rationale is a question of what sorts of experiences are sought after with the restoration of urban darkness. As described in Section 3.2, the tension between the natural night sky and artificial illumination can be understood as a clash of sublimes. The astronomical and technological sublimes were identified as two distinctive experiences of the world at night – two types of *nocturnal sublime*. In one, we gaze upwards at the firmament, a quasi-religious experience of the natural world. In the other, we have brought the heavens down around us, supplementing the starry sky for an electrified skyline. Darkening cities, as an act of urban restoration, must explore these competing experiences, and seek to collapse – or at least challenge – their spatial distinction. This requires an acknowledgment of the powerful features that draw people to the night sky, and an exploration into if, and how, this can be brought into cities. In doing so, we can start to envision what exactly we are seeking to restore, and how this could look in practice.

We must be wary, though, not to completely dismiss the value of the technological sublime as outmoded or only see its undesirable effects. The concept of light pollution has two competing effects on understandings and experiences of city nights. In one sense, it re-frames our appraisals and judgments. Lighting's monumentality and scale is increasingly seen as irresponsible and polluting, no longer marvellous and exciting. Alternatively, we can see light pollution as depreciating the value and experience of nighttime illumination, for skyglow should not be understood as synonymous with the technological sublime. A city encompassed by skyglow is washed out in a haze of light. Nighttime lighting is part of the basic fabric, the essential core, of contemporary cities, but over-illumination degrades its aesthetic value. A backdrop of darkness can enhance the sublimity of electric lighting. Reducing ambient illumination can introduce some humility to our urban nightscapes, and provide a renewed perspective on the value and beauty of nighttime lighting – not as an artificial extension of day, but as its own unique space. As the architect Peter Zumthor (2010, p. 93) notes,

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Between sunset and sunrise, we furnish ourselves with illumination of our own making, lights that we can switch on at will. These lights cannot be compared to daylight; they are too weak and too breathless with their flickering intensities and swiftly spreading shadows. But when I do not think of these lights that we make ourselves as an attempt to eliminate darkness, when I think of them as night-time lights, as accentuated night, as intimate illuminated clearings that we carve out of the darkness, then they can become beautiful, then they can have a magic all their own.

Considered in this way, restoring darker skies can also re-orient and re-energize the excitement and vibrancy of electrical illumination, and imbue it with new symbolic meaning that is complimentary to the environmental value of darkness. In doing so, it can create a new experience of urban nightscapes – not the electrical sublime of the early 20th century, but a new, environmentally conscious nocturnal sublime.

In considering what aspects of the night sky we wish to capture in cities, we can draw from recent articulations of the sublime in environmental aesthetics. Shapshay (2013) puts forward the idea of the *thick sublime*, arguing for its relevance to contemporary aesthetic appreciations of the environment. This type of experience goes beyond purely emotional, visceral responses (what Shapshay calls the *thin* sublime) to also include an intellectual component. Hence, increasing scientific knowledge – as part of an intellectual, reflective response – does not diminish sublime responses to the night sky. Instead, it can prompt a “more-informed reflection on how infinitesimally small she is in the universe, how short a human lifespan is, and even how brief the human species has walked this planet, in comparison with the spatial and temporal vastness of the night sky” (Shapshay 2013, p. 196). Importantly, such a response involves a reflection on humanity’s position within nature and the larger cosmos. Also worth noting is that Shapshay argues for a “secular, non-metaphysically extravagant” understanding of the sublime in nature (p. 190), seeking to disentangle it from religious or sacred connotations – a criticism raised by Cronon (1995). Shapshay, however, stops short of assigning the thick sublime an explicit moral weight. Although, the engagement described – awe, wonder, and humility in the face of nature – certainly seems to engender, or at least make possible, morally transformative experiences. Indeed, the thick sublime is connected to theories arguing that the aesthetic appreciation of nature should be morally engaged (e.g., Carlson 2010).

While somewhat different in theoretical origins, Brady’s (2013) *environmental sublime* shares common ground with Shapshay’s (2013) idea of the *thick sublime*.

Most important for the present discussion is that Brady goes one step further in developing and articulating the relevance of the sublime for environmental ethics. Acknowledging the criticisms raised by Cronon (1995) regarding the sublime's role in socially constructing wilderness, Brady nevertheless sees potential for morally transformative – or at least morally relevant – experiences. Aesthetic experiences can reinforce and cultivate environmental values, although they are not a necessary condition. Of particular relevance for the night sky is the humility generated by sublime experiences. Whether through knowledge of astronomy or direct experience, the night sky engenders a feeling of the ungraspable. And, “In an important sense, aesthetic experience of this kind can bring home some of the ways we cannot place ourselves over and above nature” (Brady 2013, p. 197). We see the smallness of ourselves, and experience something that we cannot place ourselves above or outside.

In sum, the sublime contains the possibility of putting us into contact with the natural world while generating feelings of humility and reverence. While the (natural) sublime can be criticized for reinforcing the otherness of nature, this is not necessarily an intrinsic quality thereof. Rather, the sublime can offer a unique experience and perspective on our relationship with natural environment, creating experiences relevant, if not fundamental, to an environmental ethic: humility, wonder, respect, etc. (Hitt 1999). It is therefore this facet of the *astronomical sublime* that must be drawn out and incorporated into urban restoration efforts. Cultivating such experiences in urban settings can be understood as an act of breaking down the barrier between urban and wild nightscapes, of creating a new category of nocturnal sublime. This carries exciting potential but requires further work – both conceptually and technically. Envisioning and implementing this will not be an easy task, for it requires designing for things notoriously hard to define. “Beauty and mystery: intangible qualities we all know are valuable but don't always know how to value” (Bogard 2013, p. 254).

We can see both the transformative potential, as well as the tensions, of creating a new urban nocturnal sublime in Thierry Cohen's photo series *Darkened Cities* (Fig. 3.3). The series features major global cities at night – New York, London, Paris, Tokyo, Hong Kong, Rio de Janeiro, etc. – altered so as to remove all presence of artificial illumination. The cityscapes are then overlaid onto a night sky from a position on Earth around the same latitude with no skyglow (for Fig. 3.3, the Paris streets are combined with a northern Montana sky). Thus, *Darkened Cities* shows what these spaces could look like if they were

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lit only by starlight. The images are certainly provocative, and nothing short of sublime. There is a beauty and quietness to these photos, but also a haunting, awe-inspiring feeling – not least of all because of the juxtaposition of seemingly disparate geographies. It indeed reinforces the observation by Nye (2010) that cities without light now seem somehow unnatural. To see all lighting stripped away, it feels as if something fundamental to the modern city has been removed. The haunting atmosphere of the series, however, is not created solely by the night sky above – these urban sites are also edited so as to remove all signs of human activity. Images of a Shanghai highway without a single car, or downtown Paris without a single person, evoke an almost post-apocalyptic scene (albeit a serene one). It implies that to have a truly dark sky – to be devoid of light pollution, and artificial light in general – cities also need to be devoid of human activity. The night sky is brought back into cities, but at the expense of urban nightlife. In *Darkened Cities*, the geographical dualism of city lights and natural darkness is subverted, but not overcome.



Figure 3.3 © Thierry Cohen, *Paris 48° 52' 16" N 2012-06-17 LST 17:30*, from the *Darkened Cities* series, courtesy Danziger Gallery, New York / Esther Woerdehoff Gallery, Paris and the Artist (<https://thierrycohen.com/pages/work/starlights.html>)

Cohen's photo series is thought provoking, creating scenes both beautiful and haunting, and powerfully communicating the effects of skyglow. And as works of art, not a prescriptive statement, they need not be interpreted as visions of how city nights *should* be. But they do provide a visual counter-position to our cities as they exist, a supplanting of the technological sublime with the astronomical sublime. In doing so, it reminds us that the geographical divide between city nights and dark skies is a construct, and a result of our abundant artificial lighting. The starry night sky is not truly gone, or only *out there*, but temporarily hidden behind our pervasive illumination. In this sense, Cohen's series provides an opposing extreme to our current nightscapes, allowing for a consideration of where on such a spectrum we should strive to situate actual urban nightscapes. It is worth imagining a *Darkened Cities* image with a vibrant, active city below the night sky – a city that does not completely cast out the benefits and aesthetics of electric lighting for a natural night sky, but seeks to merge the two. Certainly not as bright as our current city nights, and perhaps not featuring a pristine, completely *unpolluted* night sky, but a re-oriented urban nightscape nonetheless. This may not allow for the experiences referenced in Nordgren's Milky Way posters (Fig. 3.1) within downtown cores, but that need not be the final goal for a new urban nocturnal sublime. Instead, it can offer a new relationship between the stars above and the lights below. It allows for a re-imagining of urban nights and all the possibilities that come along with it.

3.4. Conclusion

This chapter has engaged with the contemporary axiological dimensions of nighttime illumination and darkness, focusing on the geographical dualism reinforced by differing manifestations of the sublime. The possibilities of a re-imagined urban nocturnal sublime was put forward as a means to challenge the juxtaposition between urban and natural nightscapes, as well as give shape to the qualities, constraints, and ideals to strive for in urban nighttime lighting. Importantly, focusing on the impact of artificial lighting technologies emphasizes the control we have over this dualism – nighttime illumination can either re-enforce long-standing connotations of light and dark, or challenge them in a conscientious and morally engaged way. In a narrow sense, this analysis contributes to growing discourse on the ethics of light pollution and nighttime illumination, examining the aesthetic dimensions of the issue. In a

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broader sense, it introduces the nightscape as a new site of concern for urban restoration, and urban-focused environmental ethics more generally.

A key theme throughout has been the symbolic resonance of lighting and darkness, and that seeing problems of nighttime lighting solely as a technical issue overlooks key philosophical questions. Addressing light pollution is not exclusively a task of designing efficient lighting with an appropriate level of brightness and properly shielded lighting fixtures. Nor can it be reduced to a task of creating new policies that reduce illumination (or costs) by $x\%$ at night, although all such efforts are undoubtedly important. It is also about seeing darkness differently; about finding new meaning, and ultimately value, in darkness. And as discussed here, the night sky – an experience that is at once beautiful, sublime, and awe-inspiring – can be immensely powerful. It can provide cities with an ecological and cosmological sense of place, and allow residents to glimpse beyond the artificial illumination that now dominates our lives. In doing so, it may allow us to see our cities in a new light.

4 The Value of Darkness²⁰

4.1. Introduction

Cities at night evoke a variety of images, ranging from a perilous time filled with nefarious characters to the vibrancy and excitement of nighttime entertainment. Here a novel issue of increasing importance to cities at night will be analyzed: the evolving morality of darkness. In recent years the negative impacts of artificial nighttime lighting have come under scrutiny, and the concept of *light pollution* has become the dominant driver of this discourse. Resultant policy-oriented research largely focuses on delineating the bad or detrimental aspects of artificial light at night, while saying very little about the goodness of a lack of light. Current literature is missing a comprehensive account of the positive value of darkness at night, and an understanding of how this can be incorporated into the design of nighttime lighting. Often, darkness is assumed to be antagonistic to the benefits of artificial lighting, or a neutral backdrop for the possibilities created by nighttime illumination. Alternatively, darkness is seen as similar to other natural features: as something valuable “out there,” to be experienced in parks and wilderness reserves. However, current debates over light pollution provide an opportunity to re-examine darkness at night and ask why (and how) we should protect or re-introduce darkness into our urban nightscapes. Towards this goal, a first comprehensive analysis of the value of darkness, as related to decision-making about urban nighttime lighting, is provided. This chapter will conceptualize, define, and categorize the value of darkness at night from an environmental perspective, providing a detailed account of the goodness being degraded or hindered by light pollution. In doing so, a framework is introduced that goes beyond reducing the negative effects of lighting, aspiring to promote and preserve what is valuable about darkness. Thus, it puts designers and policy-makers in a better position to make informed, value-sensitive decisions about urban nighttime lighting. As such, this framework is best understood as being constructively critical of, and ultimately complimentary to, the existing framing offered by the concept of light pollution.

²⁰ Originally published as: Stone, T. (2018). The Value of Darkness: A Moral Framework for Urban Nighttime Lighting. *Science and Engineering Ethics*, 24 (2): 607-628.

Concerns about light pollution are often articulated as a *loss of the night* (e.g. Bogard 2013), but what exactly are we losing? In a world of abundant and increasing artificial lighting, a better understanding of why we should protect or preserve darkness is urgently needed. A philosophical, and especially moral, investigation into the disappearance of darkness should be seen as a pragmatic endeavor. Falchi et al. (2016) recently published an updated “world atlas of artificial night sky brightness,” concluding that 83% of the world’s population, and over 99% of people living in Europe and the United States, live in places with a sky considered to be light-polluted (a minimum of about an 8% increase above natural nighttime conditions). In densely populated urban regions, artificial brightness is often several magnitudes greater. And, it is estimated that artificial nighttime brightness is increasing annually by around 3-6% worldwide (Hölker et al. 2010). Faced with such a reality, there is a need to move beyond a metaphysical reflection on the nature and meaning of darkness and look critically at our current context. This means assessing if (or why) the disappearance of darkness is bad, and why its preservation is good. And, it means considering how this should factor into the articulation of morally acceptable uses of artificial lighting at night.

This chapter is focused on two interrelated goals: articulating a pluralistic, value-sensitive understanding of darkness relevant to contemporary discourse, and a detailed analysis of the ways in which darkness can be valued – and ultimately operationalized – from an environmental perspective. Section 4.2 discusses the context of this analysis in more detail, explaining the shortcomings of the concept of light pollution and the usefulness of a *design for values* approach. Section 4.3 then articulates a pragmatic view of the value of darkness that is sensitive to the influence of nighttime lighting technologies. In Section 4.4 nine valuations of darkness are identified and defined, which are then compared and categorized based on three criteria: type of good, temporal characteristics, and spatial characteristics. Section 4.5 considers how this framework can be utilized as a tool for decision-making. The nine valuations of darkness are translated into *prima facie* moral obligations, and the prescriptive potential of this framework is shown via a brief critique of the increasingly popular adoption of LED streetlights.

4.2. The value of investigating the value of darkness

The following section provides further context for this analysis. First, a brief discussion of the concept of light pollution (and its shortcomings) is presented. Next, the theoretical orientation of *design for values* is articulated in light of the present endeavor.

4.2.1. Beyond the concept of light pollution

Properly assessing contemporary evaluations of darkness requires an understanding of the concept that currently shapes discourse: light pollution. More generally, it must be appreciated that any discussion of darkness at night is also a discussion of lighting. The modern history of the night is largely a history of developments in artificial nighttime lighting and the technological, social, economic, and spatial changes it brought about (e.g., Melbin 1987; Nye 1990; Schivelbusch 1988; Schlör 1998). It is no surprise, then, that when concerns emerged about the effects of artificial lighting at night, they followed this same narrative. The concept of *light pollution* emerged in the 1970s as term to encapsulate and categorize the adverse impacts of nighttime illumination (Sperling 1991), and has gained significant academic and public attention in recent years. The International Dark-Sky Association defines light pollution simply as “any adverse effect of artificial light” (IDA 2014). A more nuanced articulation of the concept states, “the unintended consequences of poorly designed and injudiciously used artificial lighting are known as light pollution” (Gallaway 2010, p. 72). There are compelling reasons for the increasing attention on the negative impacts of artificial nighttime lighting: it wastes billions of dollars and massive amounts of energy, it is damaging habitats and biodiversity in ways we are only beginning to understand, it likely has a negative effect on human health and well-being, and it cuts off experiences of a natural night sky.²¹ Thus, it follows that existing policy-oriented work is focused on mitigating the causes and effects of light pollution, and defining acceptable uses of artificial lighting at night (e.g., Falchi et al. 2011; Hölker et al. 2010; Kyba, Hänel, and Hölker 2014; Meier et al. 2014; Mizon 2012).

²¹ The details and figures on light pollution will not be discussed further in this chapter, except as needed to support the different values of darkness presented in Section 4.4. See Chapter 2 for a summary of the causes and effects of light pollution. Much of this data can also be found on the website of the International Dark-Sky Association (darksky.org), as well as in articles by Henderson (2010) and Pottharst and Konecke (2013).

With the growing recognition that light pollution is a pressing urban and environmental issue of the 21st century, we will increasingly be faced with complex moral and political debates about responsible uses of, and technological innovations to, artificial lighting at night. Elsewhere, I discuss the effectiveness of the concept of light pollution in framing the environmental problems – and potential solutions – of artificial nighttime illumination (see Chapter 2). A practical outlook was adopted, with the idea that an “upstream” ethical analysis can contribute to later decision-making and policy choices (Elliott 2009). In taking this approach, two important criticisms were highlighted. First, light pollution – as a prescriptive moral concept – is limited, as it only delineates bad types (and effects) of lighting while saying very little about what good lighting is (save for it being absent of adverse effects). Second, the threshold or boundary conditions for lighting deemed to be “polluting” is often ambiguous, and the evaluative foundations and mechanisms for such a categorization require further clarification.

This chapter works to address the shortcomings of the concept of light pollution by providing a conceptual analysis and categorization of what is good about a lack of light at night. When considered from a values-level perspective, focusing solely on negative consequences gives an incomplete picture. Historical studies illustrate that the development of nighttime illumination has shaped, and been shaped by, various social values, such as safety, prosperity, and progress (e.g., Ekirch 2005; Nye 1990; Schivelbusch 1988). Arguments against light pollution likewise rest on an appeal to value claims, albeit from an environmental perspective; technical studies are intertwined with evaluative judgments about where and when artificial nighttime lighting should or should not be. The aim here is to tease out and explicate what those value claims are. In doing so, this framework effectively flips the discussion on light pollution away from what is wrong about artificial light at night, and towards what is good about not having so much light. This is accomplished by moving away from an analysis of why we should have less artificial light, and instead asking why we should have more darkness. A way to realize this task is to understand what is valuable about darkness at night. For this, a theoretical orientation focused on values in engineering and design is useful.

4.2.2. Designing for (new) values

A *design for values* approach is utilized, which takes the incorporation of moral values as a primary goal for design. It contends with the traditional view of design as a purely technical and value-neutral process, instead asserting that moral and societal values are inextricably linked to the design process and outcome (van den Hoven, Vermaas and van de Poel 2015). The potential of a value-sensitive approach is that, by articulating what values we seek to achieve and incorporating them into design requirements and processes, we can help to create nighttime lighting infrastructure that is socially and environmentally acceptable. Such an approach resonates with the view that sustainable or ecological design has a moral requirement to go beyond simply mitigating the bad stuff – it should also strive to do more good (e.g., Buchanan 2005; McDonough and Braungart 2002; Wines 2005).

Such an analysis requires that we look past our artificial lights and explore the goodness, or valuableness, of more darkness. This requires an exploration of new moral terrain. However, this does *not* imply that darkness has yet to be given serious attention, for – as it will become clear – this analysis builds on an existing foundation of empirical research and a small but important body of environmental literature on the subject. Rather, this is meant to highlight that ideas about darkness, similar to other environmental values, are still in an *originary* stage – the time during which characteristics are “only beginning to be constituted and consolidated” (Weston 1996, p. 147). This requires a different sort of ethical analysis, focused more on the elucidation of value claims rather than the application of an established normative position. This is challenging, because “Operating within a culture in which certain basic values are acknowledged, at least verbally, by nearly everyone, there is little practical need to raise the question of the ultimate origins or warrants of values” (Weston 1996, p. 144). The origin of the concept of light pollution is a worthwhile study in itself, and one that I discuss elsewhere (see Chapter 2). Here, the task is to identify, dissect, and systematize the value of darkness. Thus, defining and categorizing the value of darkness is, to use Weston’s (1996) phrasing, exploring an emerging issue before it hardens into an “analytic category.”

A better understanding of darkness now will provide an important step towards establishing the conditions for morally desirable nighttime lighting infrastructure; it will help to establish how we should light our 21st century nightscapes. Epting (2016b), in assessing the moral dimensions of infrastructure, proposes that their complexity necessitates a “supplemental

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measure” in addition to traditional moral theory. A supplementary consideration – here the value of darkness – allows for a better articulation of morally desirable outcomes for large-scale, multi-faceted urban infrastructures. Like Epting (2016b), here no definitive position is taken regarding how to achieve these outcomes. Rather, an evaluative moral tool is presented that can be utilized and applied via different moral theories. Promoting and preserving darkness at night can be coupled with the mitigation of light pollution to help assess current lighting strategies, as well as foresee issues with new policies and future technological innovations. With this elucidation of darkness, we will be in a better position to analyze, judge, and ultimately make value-sensitive decisions.

4.3. Articulating the value of darkness

This section will further elaborate on the meaning of darkness applied in this chapter. Before going further, though, a quick note on terminology is required. *Darkness* and *night* are closely linked, but not synonymous. *Night* is too broad and indefinite to be seen as valuable in any meaningful sense. *Darkness*, alternatively, is a central feature of the night, and one that we – by way of artificial lighting technologies – have the capacity to influence. Literature on light pollution refers to a similar claim while using different terminology: the night sky, natural nights, natural nighttime conditions, etc. I see *darkness* as most appropriate given its achievability via technical means, as well as the related quantitative and qualitative control that lighting technologies have on when, where, and how much darkness to (re)introduce into our urban nights.

4.3.1. Foundations of valuing darkness

Historically, darkness has been seen as full of evil spirits, chaotic and dangerous, a space and time for immoral behavior, and primitive in the face of new technologies – what Edensor (2015) summarizes as our “nyctophobic” past. For centuries, darkness was largely seen as dangerous and necessitating control and domination (Schlör 1998), and later as antithetical to progress (Nye 1990). In sum, we have inherited a narrative that champions the expansion of artificial nighttime illumination:

Our image of night in the big cities is oddly enough determined by what the historians of lighting say about *light*. Only with artificial light, they tell us, do the contours of the nocturnal city emerge: the city is characterized by light. From this perspective the history of the city is a history of progressive illumination. Night is inevitably expelled into the realm of prehistory and mythology. None of the many histories of lighting, which in their different ways all describe the triumph of light, is able to dispense with a preliminary description of the impenetrable terrain of the nocturnal as an alien region of fear that is conquered and finally subjugated. (Schlör 1998, p. 57)

The modern history of nighttime illumination begins with the organization and formalization of public lighting projects in the 17th century. In reality, though, nights remained relatively dark for some time. Outdoor lighting was often only used for a few hours a night, and only on major thoroughfares (Schivelbusch 1988). However, with the invention and proliferation of gaslight and later electric light throughout the 19th and early 20th centuries, nighttime illumination reached an unprecedented scale. With electric lighting, the popular ideals of *turning night into day* and *lengthening the day* became achievable in ways never before possible. As a result perceptions of darkness at night underwent a profound transformation during this time, as artificial illumination became the expectation of urban nights (Isenstadt 2014; Nye 1990). It is in this context – a world of abundant and readily available artificial light – that darkness gradually shifted from a “forbidding everyday occurrence” and an “emblem of backwardness” to a valorized and “sought-after luxury” of our electrified nights (Hasenöhl 2014, p. 119).

Contemporary responses to the ubiquity of artificial illumination vary, although typically focus on concerns over a *loss of the night*. Some advocate for an increase in darkness for its instrumental value (e.g. Gallaway 2014), while others highlight the underappreciated cultural and environmental losses that will result from its disappearance (e.g. Bogard 2013). Others go further still, proposing that access to dark or natural nights should be an inalienable right of all people (Starlight Initiative 2007). Taken together, there is an emerging perspective increasingly shaping, and shaped by, our modern, highly technified and illuminated nightscapes.

4.3.2. Axiological and ontological dimensions of darkness

It is important to briefly clarify what is meant here by “value,” as *design for values* has been criticized for lacking a precise definition (Manders-Huits 2011). At a

general level, a value is something sought to be preserved, protected, pursued, or promoted (Alfano 2016). Values are not concrete objects, but rather abstract ways of understanding our relation to the world. Put more provocatively, “There are no such *things* as values. There are rather the various ways in which individuals, processes and places matter, our various modes of relating to them, and the various considerations that enter into our deliberations about action” (O’Neill, Holland, and Light 2008, p. 1). Here the value of darkness is similarly approached as relational – deeply entwined with perceptions, interactions, and technologies. Furthermore, the value of darkness is considered to be highly contextual, both geographically and temporally. This analysis is situated in the context of our early 21st century nightscapes in developed regions, where the ubiquity of artificial lighting (and the related disappearance of darkness) has become an inescapable reality. This requires questioning what contemporary values of environmental importance are at stake in discussions about light pollution and darkness. Thus, the focus here is on articulating what is *valuable* about darkness in our present context, and not arriving at a fundamental understanding of darkness *as a value*.

In analyzing the valuable-ness of darkness, I will not take a reductive approach that relates arguments to an overarching or meta-level principle for adjudicating and evaluating its moral worth, but rather give close attention to real-world complexities (Norton 1996). In this sense, it will be an examination of how different values manifest via darkness. Often, environmental debates are as much about intra-value conflicts as inter-value conflicts – an issue that has been identified as being particularly important for a *design for values* approach (Dignum et al. 2016). Analyzing the different facets of darkness will help to clarify its potential manifestation in norms or design requirements, and the conflicts and opportunities that could arise therein.

Such an analysis must be sensitive to the interrelated axiological and ontological dimensions of darkness. On one hand, it is the unifying, fundamental characteristic of our nightscapes, the base from which a multiplicity of experiences and meanings emerge. Taken in this way, darkness is not a concrete *thing* but rather an evaluative consideration that directs understandings of, and relationship with, the world at night. Yet at the same time it is a real, tangible thing accessible to direct experience. Thus, it can also be seen as a surface-level, achievable goal, as it is the condition that must be obtained or preserved to bring about desired ends. To say there is value in the ability to see the Milky Way, or alternatively an efficient and responsible use of

nighttime lighting for the purpose of energy reduction, or a decrease in the deaths of migratory birds from light pollution, or a mitigation of the unwanted health effects caused by obtrusive nighttime lights, implies that darkness has value (and those things that needlessly eliminate darkness should be seen as bad in some way, or to some degree). Considered in this way, focusing on the value of darkness gives form and direction to the evaluation of our nightscapes, and provides a novel vantage point for assessing the morality of nighttime lighting. To say “the value of darkness,” then, is a convenient shorthand for a complex field of moral valuation. And it is the elucidation and categorization of this field that is the focus of the remainder of this chapter.

4.4. Categorizing the value of darkness

The theoretical account above positions darkness as relational, contextual, and multi-faceted. What follows is an expansion and application of this perspective via a categorization of darkness in relation to environmental concerns. As such, it reflects the existing landscape of empirical research into the effects of light pollution. It gives form and clarity to the *goodness* of darkness, as a pre-cursor to establishing how one could strive for its protection, promotion, or preservation.

4.4.1. Defining the ways darkness is valued

The first step is to clarify how darkness is, or could be, conceived as an environmental good. The five commonly agreed upon effects of light pollution are taken as a starting point: *energy*, *ecology*, *health*, *safety*, and the *night sky* (IDA 2014; Morgan-Taylor 2014). A review of recent literature and empirical research has expanded these categories into nine valuations of darkness (Table 4.1). However, it must be noted that safety will not be discussed further in this section. There are two reasons for the choice to exclude safety from this framework. First, research and discussions about safety and security at night rarely articulate darkness as *valuable* – instead, most research seeks to show that it is value-neutral by questioning the assumed relationship between more light and more safety (e.g., Bogard 2013; Gaston, Bennie and Hopkins 2015; Henderson 2010). Second, safety at night does not lead to any environmentally-relevant value of darkness. Thus, the question of where and when (and how much) lighting is useful for improved or optimal safety is a topic in itself – one that should be put in dialogue with this framework in the future, but outside of

the scope of this discussion. As such, questions of safety will be put aside until the conclusion.

Table 4.1 Re-framing the effects of light pollution as values of darkness

Effect of light pollution	Associated valuations of darkness
Energy	(1) Efficiency
	(2) Sustainability
Ecology	(3) Ecology
Health	(4) Healthiness
	(5) Happiness
Night sky	(6) Connection to nature
	(7) Stellar visibility
	(8) Heritage and tradition
	(9) Wonder and beauty

The four relevant effects of light pollution have been re-conceptualized as nine ways by which, or through which, environmental value is derived from darkness. Recent works giving serious consideration to questions of value and the night sky have served as useful foundations for this list.²² These nine valuations offer a comprehensive starting point that takes into account both the empirical work underway by biologists, economists, and astronomers, and also the qualitative arguments made by those same researchers, as well as scholars from the humanities and social sciences. They are also meant to better capture the moral arguments made against light pollution. For example, arguments against the adverse effects of artificial nighttime light to ecosystems and wildlife – while a diverse and complex field of research – appear to follow a coherent moral argument focused on conservation efforts. Comparatively, arguments for the protection of dark or natural night skies seem to rely on a more varied (if interrelated) set of moral concerns. As such, an expansion of that category was deemed appropriate. In what follows, each of the nine identified valuations are briefly defined.

²² Two works have been particularly useful in establishing this list. The first is Gallaway’s “The Value of the Night Sky” (2014), which categorizes the instrumental value of the night sky in relation to the goals of happiness and sustainability. The second is Bogard’s *Let There Be Night* (2013), a detailed investigation into the intrinsic and instrumental value of natural nights.

- (1) **Efficiency:** Outdoor nighttime lighting is a large consumer of energy. Globally, it represents 8% of total electricity consumption for lighting, estimated at 218 TWh (De Almeida et al. 2014). Furthermore, it is estimated that upwards of 30% of outdoor light is wasted in the United States, with a cost of almost \$7 billion dollars annually (Gallaway, Olsen, and Mitchell 2010). Likewise, an estimate of wasted light in the European Union predicts the annual costs to be around €5 billion (Morgan-Taylor 2014). Unneeded or wasteful nighttime lighting can be a particularly visible form of excessive consumption, and a reintroduction or protection of darkness becomes symbolic of the efficient use of lighting resources, only using lighting where and when it is needed. Darkness, when understood as a manifestation of efficiency, can conceivably have immense economic value, particularly in urbanized regions.
- (2) **Sustainability:** While “sustainability” can be interpreted in many ways, here it is meant to invoke the inter-generational concerns of sustainable development, and in particular the reduction of energy usage as a means to combat and/or mitigate climate change. Considered in this way, the wastefulness of outdoor lighting can be associated with energy usage and greenhouse gas emissions. The use of outdoor artificial lighting is a significant contributor to greenhouse gas emissions, to the degree that cutting all wasted light in the United States could have the equivalent effect on CO₂ emissions as removing 9.5 million cars from the road (Gallaway, Olsen and Mitchell 2010). From such a perspective, advocating for darker nights becomes a way to promote responsible energy usage and mitigate CO₂ emissions.
- (3) **Ecology:** Research indicates that nighttime lighting has profound effects on wildlife, notably migratory birds, sea turtles, and bats (Pottharst and Konecke 2013; Rich and Longcore 2005). While a diverse and complex set of issues and research is represented by this valuation, it rests on a coherent moral claim associated with the notion of “ecological light pollution” (Longcore and Rich 2004). Species and ecosystems have evolved within natural diurnal cycles that are being drastically altered by artificial light at night, especially in urbanized areas. It can be argued that naturally occurring levels of daylight and darkness at night are not only essential to the protection of species and habitats, but also inherent to

their functioning and thriving. As such, the protection or re-introduction of darker nights is closely aligned with species and biodiversity protection, as well as nighttime habitat conservation efforts.

- (4) **Healthiness:** Humans are also affected by excess artificial nighttime illumination. Our bodies have evolved within natural cycles of light and dark, and the relatively rapid change may have negative effects. The disruption of our circadian rhythm has been linked to reduced visibility at night, obesity, insomnia, and certain types of cancer (Chepesiuk 2009; Cho et al. 2015; Falchi et al. 2011). While understandings of these effects is still somewhat preliminary, the World Health Organization recently upgraded the exposure to certain types of light at night to the category of “likely carcinogen” (Morgan-Taylor 2014). Thus, allowing access to, and the experience of, darker nights can be seen as valuable for personal health. In this capacity, it would appear that darkness is less analogous to a broader societal value, but rather a physical characteristic that one should seek to achieve and foster towards the goal of a healthy lifestyle.
- (5) **Happiness:** There can be a further distinction made between physical well-being and psychological or emotional well-being. With respect to the latter, Gallaway (2014) proposes a link between happiness and access to a natural night sky, outlining the many beneficial traits of dark nights. In this analysis, Gallaway draws on recent economic literature, as well as research from environmental psychology asserting the restorative and beneficial effects of contact with natural settings (e.g., Berman, Jonides and Kaplan 2008; Mayer et al. 2009). Gallaway (2014) posits that the night sky can contribute to happiness via factors such as: the focus on experiences rather than consumables; increasing small, regular experiences of pleasure over infrequent, intense ones; the pleasure derived from experiences of (natural) beauty; and, the relaxing and restorative powers of interactions with natural nights skies. Thus, darkness can be seen as something with the potential to facilitate and promote psychological well-being, broadly conceived.
- (6) **Connection to nature:** Fostering a connection to nature, and the ability to experience natural settings, is a central concern within environmental philosophy. It is also an identified goal for some conceptions green

design (e.g. Buchanan 2005; Wines 2005). *Let There Be Night* (Bogard 2008) offers a collection of reflections on the powerful experience of natural nighttime conditions, and in particular the night sky, made accessible via darkness. In this respect, darkness can be understood as analogous to, or symbolic of, natural nighttime conditions. Concerns over the *loss of the night* are not about a literal loss – the night is not going anywhere. Rather, a lack of darkness signifies the vast anthropogenic changes that have occurred to nightscapes during the last century. Artificial lighting is altering nighttime conditions, to the extent that the ability to experience natural nighttime conditions is becoming increasingly rare. Thus, promoting dark nights can be understood as a way to preserve a connection to the more-than-human world.

- (7) **Stellar visibility:** A closely related concern to the notion of a “connection to nature” is the decreased visibility of starlight. In fact, this issue was an early reason for criticisms of nighttime illumination (Hasenöhl 2014), as well as the eventual emergence of the term light pollution (Sperling 1991). In most urbanized areas you are lucky to see a few dozen stars, compared to a few thousand on a clear, dark night. This concern is often practical, as astronomical observatories have been relegated to remotely inhabited areas. However it has also emerged as an aesthetic, spiritual, and moral concern. Starlight is a central feature of natural nighttime conditions, and often invoked as the primary aspect of the night we risk losing. Darkness at night, and especially dark skies, is a precondition for access to the firmament.
- (8) **Heritage and tradition:** Historically, the night sky has played a central role in various cultures and traditions across the world, having a prominent role within mythology, religion, art and literature, navigation, conceptions of time, and scientific discovery (Gallaway 2014). The *loss of the night* also implies the loss of this heritage, and darkness at night is the precondition through which continued access is possible. The preservation of the night sky, made possible by dark nights, is therefore also a preservation of this heritage for present and future generations.

- (9) **Wonder and beauty:** Darkness at night, and in particular the features of the night made accessible by dark skies, is an awe-inspiring experience. To look out at the night sky is a truly sublime experience in which you instantly travel across unimaginable distances and sense a universe larger than our own world. The wonder and beauty of the night sky is often argued to be of immense value, and a value that cannot be properly captured in quantitative terms (e.g., Bogard 2013; Gallaway 2014; Henderson 2010). Thus, it is important to recognize the aesthetic appeal of the night sky – inextricably connected to the preservation and promotion of darkness.

This list offers a comprehensive overview of the ways in which darkness is valuable and likewise conceived as an environmental good. The following three sections build on these definitions by comparing their characteristics in three ways: by type of good, temporal outlook, and spatial characteristics. It should be noted that a definitive claim about the completeness of this list is not being made. It is certainly possible that an environmentally-relevant reason for valuing darkness is missing, or that an argument can be made for further separating (or combining) one or more of the above values. That said, it is postulated that any such amendment will still fit into the framework developed here, thus ultimately serving to strengthen its usefulness.

4.4.2. Categorizing by type of good

As a first step in assessing the relationship between these nine values of darkness, a distinction can be made between those values for which darkness is *inherent* – meaning that darkness is an intrinsic quality of the desired end – and those values for which darkness is merely *instrumental* to their achievement. The main question under consideration is thus: *is darkness a means to some other end, or a component of the end itself?* The distinction comes with important implications. To achieve certain values in the context of designing nightscapes, such as a stellar visibility, darkness is inextricably linked to the desired end. It is darkness *itself* that we seek to preserve or promote, because of the good it is expected to bring about. To see darkness as intrinsically valuable attaches an increased, and arguably more permanent, importance to its preservation or protection. Alternatively, to see darkness as instrumental makes it only valuable insofar as it achieves a pre-established end, and thus highly conditional. To say

that darkness is valuable for sustainability or efficiency only remains true so long as darkness does in fact lead to energy reduction and cost savings. If new lighting technologies reach the same end of, say, a certain percentage reduction in energy usage, that goal is presumably satisfied regardless of any increase in darkness. The same could be said for achieving the health-related benefits of darker nights. Because of this, instrumental valuations of darkness are likely much less robust, and contingent upon technological developments.

Thus, the valuations of darkness can be categorized into two broad types of goodness: *inherent* and *instrumental* (Fig. 4.1). However, while each valuation has been placed into a single category, this does not imply mutual exclusivity. Rather, these categories can be understood as qualitative lenses that clarify the meaning (and importance) of darkness in relation to desired ends.

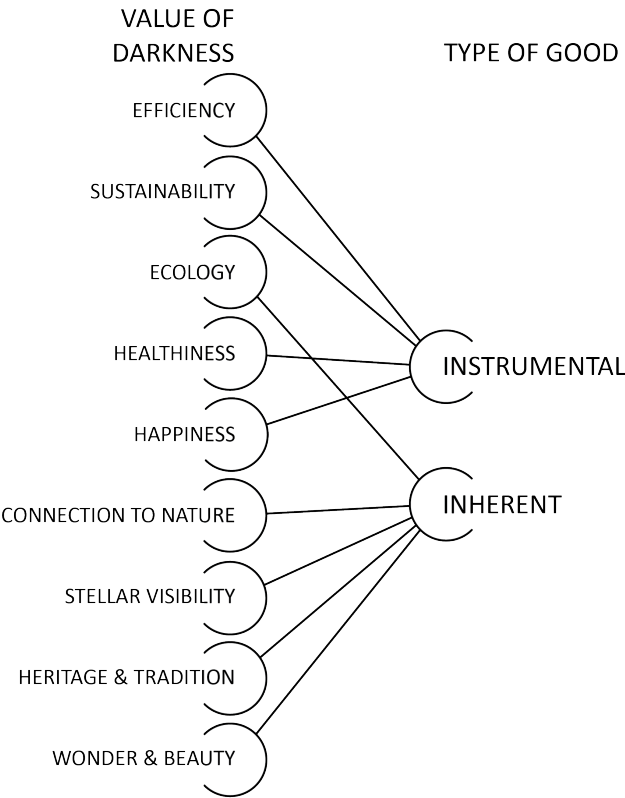


Figure 4.1 The value of darkness categorized by type of good

4.4.3. Temporal Characteristics

The temporal nature of environmental problems has become a salient topic in environmental ethics. But compared to other environmental concerns, the effects of light pollution do have somewhat unique temporal characteristics. The first is that, despite the label of “pollutant,” artificial light does not act in the same way. While the effects may linger, all the “pollution” can be effectively eliminated with a flick of a switch. Second is that the “loss of the night” does not have the same permanence as, say, the depletion of non-renewable resources or species extinction. The night – and by proxy darkness – is not actually lost, but rather access is hindered or obstructed. However, this does not necessarily make the effects of diminished darkness less important, or less impactful. We can consider the temporal characteristics of each valuation of darkness, and specifically how the longevity of their implied objectives relate.

For some valuations (e.g., efficiency, healthiness), arguments rest on the immediate, *present-oriented* benefits offered by a reduction in lighting and increase in darkness at night: it will save money today, it will improve our well-being now, etc. Other arguments have an ongoing outlook, seeking to mitigate certain effects over a period of several years or decades (e.g., energy reduction as a way to curb CO₂ emissions, the protection of species and habitats). This, one could argue, is the temporal category of strongest moral concern, as these effects are largely irreversible. Thus, these valuations have been categorized as *imperatives* to signify that they have both an immediate and ongoing temporal importance. Still other arguments rest on a duty to protect access to the night sky for future generations, and ensure these meaningful experiences are recovered or preserved. For these arguments, there is often an assumption that many people have already lost, or are in the process of rapidly losing, these features of dark nights – an assumption supported by the world atlas of artificial night sky brightness mentioned in the introduction (Falchi et al. 2016). Actions taken now can therefore reverse or halt the disappearance of the night sky. As such, these have a *future-oriented* temporal characteristic.

Thus, the valuations darkness can be further categorized into three broad temporal outlooks: *present-oriented*, *imperative*, and *future-oriented* (Fig. 4.2).

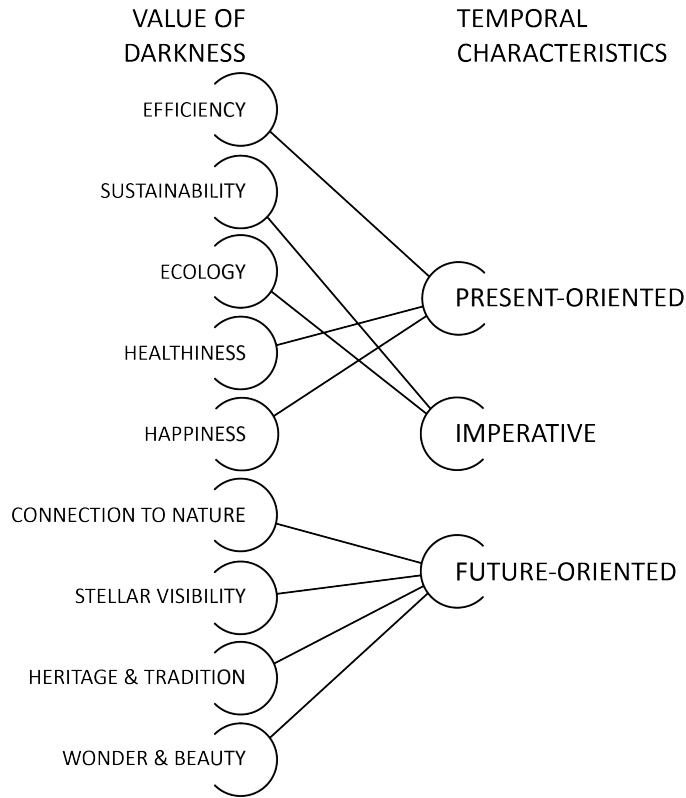


Figure 4.2 The value of darkness categorized by temporal characteristics

4.4.4. Spatial characteristics

In addition to temporal characteristics, spatial considerations are important for understanding the value of darkness. As discussed in Section 4.3, darkness here is considered as both an abstract concept and a tangible, accessible nighttime feature. Like other environmental considerations it can be directly experienced, and it is often via that direct experience that the act of valuing is derived. In this sense, exactly *where* the achievement of darkness is most valuable can be considered. For health-related impacts, as an example, it is most important that the places inhabited – our directly experienced surroundings – are dark. So, healthiness has a *terrestrial* characteristic. Not unsurprisingly, values related to the night sky take on a different spatial emphasis. For stellar visibility, as an example, the lighting quality of a streetscape is of little importance, so long as it is designed so that minimal skyglow is produced. Therefore, an *atmospheric*

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spatial characteristic for some valuations can also be identified. Interestingly, Gallaway (2014) identifies features associated with dark skies as most pertinent for fostering happiness, which gives this value an atmospheric spatial orientation. Ecological value derived from darkness is not easily categorized into one of these two spatial realms, as the identified effects of ecological light pollution (for example “disorientation”) have been attributed to both atmospheric skyglow and ground-level street lighting (Longcore and Rich 2004). At a general level, the ecological value of darkness encapsulates both spatial categories.

Thus, valuations of darkness can be further categorized into two broad spatial scales: *terrestrial* (concerned with localized environmental conditions), and *atmospheric* (concerned with dark skies) (Fig. 4.3). However, these categories should not be seen as mutually exclusive. The achievement of darker streets will often create darker skies (and vice versa). This distinction is meant to highlight where, spatially, the focal point of concern is situated. Interestingly, this categorization does not seem to hold for all instrumental valuations. Efficiency and sustainability, when understood via darkness, are most concerned with questions of quantity rather than spatial characteristics.

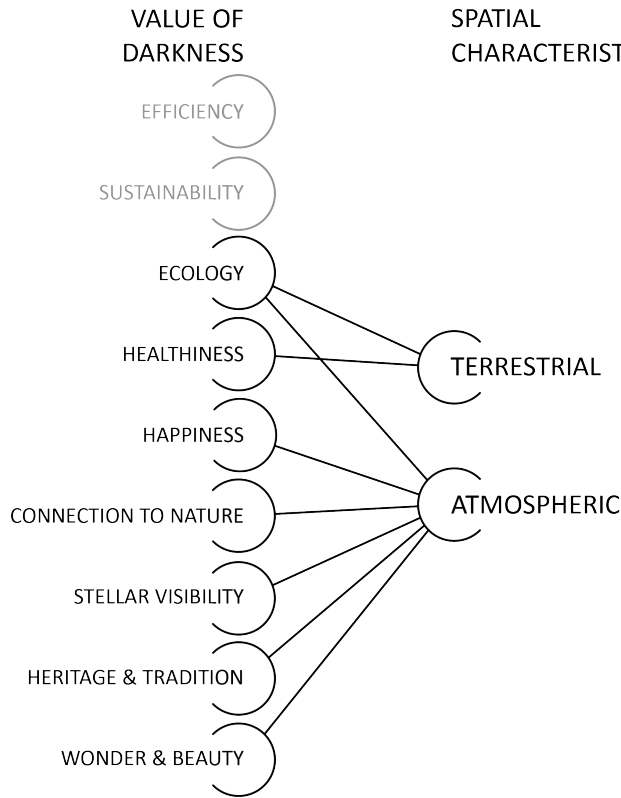


Figure 4.3 The value of darkness categorized by spatial characteristics

4.5. Applying the value of darkness: from evaluation towards prescription

Section 4.4 provides a systematic analysis of the environmental value of darkness. With this evaluation and categorization of darkness in hand, one can reflect on the implications for normative assessments of – and subsequent decision-making about – artificial nighttime lighting. Most would agree that each of the nine values discussed above is worthy of promotion or preservation, when considered abstractly. However, it is currently far less common to assign these (positive) values to darkness at night. In doing so, this analysis offers a way to engage with, and appreciate, the positive potential of darkness at night. It can help with asking just how much darkness is wanted in our urban nightscapes, and what exactly the preservation or reintroduction of darkness is trying to achieve. The following section presents the potential operationalization of this framework in broad terms (4.5.1) and via a brief case study (4.5.2).

4.5.1. Darkness as a set of *prima facie* obligations

Each of the nine values of darkness represents an important goal that darkness helps to preserve, protect, or promote. In considering how to incorporate these values into design and policy decisions, a *prima facie* moral obligation can be derived from each identified value (Table 4.2). To call these nine values a *prima facie* obligation is to say that there is a morally relevant reason for us to perform actions that uphold or strive for their achievement, and that “were it the only morally relevant feature of my situation, then the act in question would be my duty proper” (Timmons 2013, p. 249).²³ As a *prima facie* obligation, the achievement of each value in every situation is not categorical. But, there is a duty to see each as an obligation that *should* be achieved if possible, and this comes with important implications. If it is accepted that darkness is worthy of moral consideration and is valuable in some ways, and that these nine obligations encapsulate the environmental value of darkness, and allow their translation into *prima facie* duties, then there is an important switch in the burden of proof. It becomes one of showing why it is good, or better, *not* to not promote, preserve, protect, or pursue some aspect of the value of darkness. There is a responsibility to incorporate these obligations, and the values they represent, into future decision-making about nighttime lighting.

²³ While not explicitly referenced, it should be noted that this section invokes a Rossian approach (Ross 2002). While I do not endorse Ross’s specific list of *prima facie* duties or intrinsic goods, I do apply his notion of *prima facie* duties to translate the value of darkness into moral obligations.

Table 4.2 The environmental value of darkness articulated as *prima facie* obligations

Value of darkness	<i>Prima facie</i> obligation derived from value
Efficiency	The responsible use of lighting where and when needed; money-saving
Sustainability	The responsible use of lighting where and when needed; energy-saving and preserving non-renewable resources
Ecology	The protection and preservation of species and biodiversity; habitat conservation efforts
Healthiness	Promoting and fostering human health; physiological well-being
Happiness	Promoting and fostering happiness; emotional well-being
Connection to nature	Preserving a connection to the more-than-human world
Stellar visibility	Preserving conditions for access to the firmament
Heritage and tradition	Preserving the cultural heritage of the night sky for future generations
Wonder and beauty	Preserving the aesthetic appeal of the natural night sky

These nine obligations encapsulate the environmental value of darkness. Whether each can be achieved at once, or are in fact equally desirable in every instance, is a practical and procedural question. A way to conceive of the operationalization of these obligations is as a set of second-order moral obligations, where one *ought* to uphold them even if it is currently not possible to achieve all nine simultaneously (van den Hoven, Lokhorst and van de Poel 2012). There is then an increased responsibility for designers, engineers, and policy-makers to strive for innovations that make possible the full landscape of values, to avoid the problem of *moral overload*. Such problems occur when there are conflicting values or obligations that cannot all be satisfied at the same time. It has been argued that, in situations of moral overload, if we can bring about future change via innovation to satisfy all conflicting values or obligations, then there is a moral obligation to develop technologies towards this goal (van den Hoven 2013b). Finding solutions that can accommodate the multi-faceted value of darkness, in combination with other values important to the use and enjoyment of urban nightscapes, becomes a primary design goal for nighttime illumination.

How can steps be taken towards achieving such innovations? The analysis in Section 4.4 gives some direction for starting points by identifying

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interconnections and mutually reinforcing facets of darkness. Within this brief categorization, two general clusters can be seen emerging: present-oriented instrumental valuations of darkness, and future-oriented intrinsic valuations of dark skies (Fig. 4.4). The instrumental valuations are somewhat dispersed in their goals, however it seems – perhaps unsurprisingly – that the intrinsic valuations associated with the night sky (*connection to nature*, *stellar visibility*, *heritage and tradition*, and *wonder and beauty*) are much more closely intertwined. Within this cluster are a series of reciprocal relationships, as achieving any one of these goals creates conditions for the others to be met. While not adhering to as strict of a spatial boundary, *ecology* can also be seen as closely aligned with this cluster. Furthermore, inherent future-oriented values appear very likely to accommodate instrumental, present-oriented goals. Achieving something like a stronger *connection to nature* will likely lead to an increase in *efficiency* and *sustainability*, given the necessary reduction in brightness required for darker skies. However, it is far less obvious if the opposite holds true. More work can be done to understand these interconnections, but it seems that from a conceptual viewpoint there is reason to focus on those values (and related obligations) that are inherent to darkness.

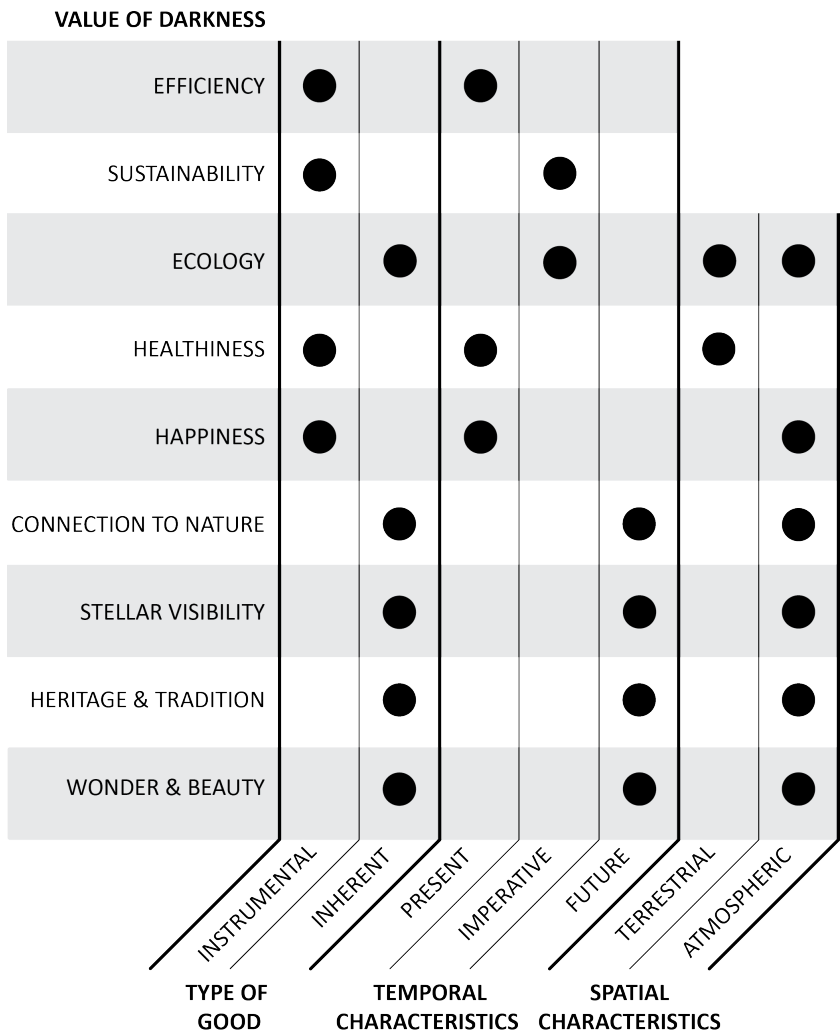


Figure 4.4 The value of darkness categorized by type of good, temporal characteristics, and spatial characteristics

4.5.2. Darkness as a prescriptive tool: LED streetlights

The usefulness of the above framework can be shown via a brief and preliminary look at the growing adoption of LEDs for outdoor lighting. From the perspective of this framework, it would appear that the widespread retrofitting of street lamps with brighter, whiter LEDs is a shortsighted design and policy choice. While championed by many due to their energy-saving potential, longer lifetime, and improved visibility (e.g., De Almeida et al. 2014), the implementation of

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LEDs has been criticized for their potential environmental, health-related, and aesthetic consequences (e.g., IDA 2014). It appears that, while potentially saving money and energy in the short term (although even the reductions in cost and energy consumption from efficiency improvements to lighting has been debated due to the “rebound effect” (Kyba, Hänel and Hölker 2014)), they may exacerbate other negative effects of light pollution. There is growing evidence that blue-rich LED lighting may increase skyglow (Morgan-Taylor 2014), thus decreasing access to dark skies. Furthermore, the health effects of LEDs are likely much worse for both humans and wildlife (AMA 2016). While colour adjustment may decrease the atmospheric effects, studies suggest this may not decrease the adverse ecological impacts (Pawson and Bader 2014).

It appears that the current usage of LEDs runs into the problem of moral overload, only satisfying a narrow interpretation of the value of darkness. While fulfilling the values of *efficiency*, and perhaps *sustainability*, they likely have negative effects on the other seven environmental values of darkness. Furthermore, a focus on dark skies alone may not address health or ecological concerns. In their present usage LEDs only satisfy an instrumental, present-oriented conception of darkness, and in doing so provide an incomplete solution to the problems of light pollution. Put otherwise, they satisfy two *prima facie* obligations at best. This does not imply a universal condemnation of LEDs, but does show that current strategies can be improved if a value-sensitive approach is adopted. The qualities of controllability and efficiency that make LEDs appealing can be utilized to foster and promote a wider range of desired goals (e.g., Gaston et al. 2012). By accounting for the value of darkness, emerging downstream issues can be avoided.

4.6. Conclusion: designing with darkness

This chapter provides a first comprehensive, systematic analysis of the value of darkness as a moral framework for evaluating urban nighttime lighting. Darkness has been conceptualized as an environmental good via a pluralistic definition informed by contemporary research into light pollution, and further categorized by type of good, temporal outlook and spatial characteristics. *Prima facie* obligations were derived from the value of darkness, which provide a value-sensitive starting point for new innovations and policy choices. Furthermore, a brief discussion of LED streetlights shows how this analysis can be further

developed and applied as a prescriptive tool for decision-making about nighttime lighting.

The analysis of darkness presented here is a first step, but certainly should not be the last. In conceiving of darkness as something worth pursuing in our urban nightscapes, future developments must remain cognizant of its origins. The very foundations of valuing darkness from an environmental perspective – at least in its present form – is transitory. It is part reactionary, part proactive. And any achievement of “more darkness” will inevitably have consequences on its future conception, as well as broader understandings of cities at night. The challenge now for designers, innovators, and policy-makers is to incorporate darkness back into our nights without marginalizing other values inherent to, and inherited in, our nighttime lighting.

More work is needed to understand how darkness can be re-introduced into urban nightscapes in ways that do not denigrate or hinder values tied to lighting, such as safety and security, accessibility, nightlife, 24-hour societies, civic expression, etc. For example, the relationship between this framework and safety – in particular the complex dynamics of nighttime illumination, perceptions of safety, and actual safety – is an important topic for future research. Despite assumptions that brighter lights create safer nights, studies have reached contradictory conclusions regarding what level of lighting actually reduces traffic accidents and crime, and question whether lighting is the most pertinent factor to consider (Gaston, Bennie and Hopkins 2015; Henderson 2010). However, nighttime lighting has long been symbolically connected to safety and security (Schlör 1998), and a fear of the dark is arguably an innate human quality (Ekirch 2005). Further work towards understanding how this framework intersects with research on nighttime safety, and feelings of safety (e.g., Boomsma and Steg 2012; Haans and de Kort 2012), is paramount for determining design possibilities that are socially acceptable.

In addition to addressing potential value conflicts, other positive aspects of darkness at night can be considered alongside this framework. This includes non-environmental reasons for valuing darkness, such as intimacy, privacy, and anonymity. And for all these factors localized contexts should be further explored, as the geography, culture, and perspectives of local stakeholders will likely lead to different norms and design requirements. Operationalizing the value of darkness in localized settings will also bring to the fore important procedural considerations for including stakeholders in decision-making processes, as well as bring clarity to questions of just how much darkness is

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acceptable (and why). In sum, how the environmental value of darkness should be operationalized and put into dialogue with other values and needs related to nighttime lighting is a task for future research.

As a final thought, I would like to return to an idea that began this chapter, namely re-framing the moral issue of light pollution. Utilizing the value of darkness to inform our decision-making offers a framework that encapsulates, but goes beyond, simply dealing with the negative effects of light pollution. It asks that we reconsider darkness, not as an opponent of lighting, but as an equal consideration in the design of nighttime spaces. And with this comes new opportunities, especially in cities. Edensor (2015, p. 436), in reflecting on the evolving perception of darkness in cities, states, “Rather than being lamented, the reemergence of urban darkness, although not akin to the medieval and early-modern gloom that pervaded city space, might be conceived as an enriching and a re-enchantment of the temporal and spatial experience of the city at night.” New possibilities lie ahead if we can design not just for less light pollution, but start designing with darkness.

5 Towards a Darker Future? Designing Environmental Values into the Next Generation of Streetlights²⁴

5.1. Introduction

Nighttime lighting is so ubiquitous, and such a commonplace component of urban spaces, that it readily fades into the backdrop of daily experience. The historian of technology David Nye (2010) remarked that nighttime illumination has become so normalized that it seems natural, and temporary blackouts now seem “unnatural.” But it is because of its omnipresence that it must be scrutinized, for artificial illumination is formative to our urban nighttime experiences and resultant moral judgments. Lighting shapes the spaces and defines the boundaries of urban nightscapes, effectively creating city nights on both a physical and symbolic level. Historians of city nights and lighting technologies have shown that illumination has been equally important for its practical applications as for its influence in shaping, and being shaped by, various societal values – for example, safety, policing, nightlife, and progress (e.g., Brox 2014; Koslofsky 2011; Nye 1990; Schivelbusch 1988; Schlör 1998). Understood in this way, “Light is far more than “infrastructure” in a narrow sense of technological networks, but encompasses a range of developments including material and symbolic dimensions to state formation, the coevolutionary dynamics of different modes of governmentality, and the delineation of distinctive forms of public culture ranging from the mundane to the spectacular” (Gandy 2017, p. 1096). In this chapter I provide a forward-looking analysis of an additional dimension of increasing importance, namely the environmental values and human-environment relations influenced by artificial nighttime lighting. I will consider how these factors can inform the

²⁴ Forthcoming as: Stone, T. Towards a Darker Future? Designing Environmental Values into the Next Generation of Streetlights. In M. Nagenborg, T. Stone, M. Gonzalez Woge, & P. Vermaas (Eds.), *Technology and the City: Towards a Philosophy of Urban Technologies*. Dordrecht: Springer.

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design of streetlights, and more generally, how we can re-think the design of our urban nightscapes via new technologies and evolving moral concerns.

We are on the precipice of two converging changes to outdoor lighting, which will profoundly change how we light cities at night. The various forms of electric lighting that have dominated the 20th century are poised to be replaced by light-emitting diodes (LEDs), which has been described as a shift from electric to *electronic* lighting (Gandy 2017). Concurrent to LEDs is the introduction of a variety of “smart lighting” applications and systems, adding another layer to the shift towards electronic outdoor lighting. The controllability and, most important, the efficiency of smart LED lighting has fostered the rapid development and uptake of this technology, with an increasing number of cities across the world undertaking lighting retrofit projects.

At the same time as these technological developments, a growing acknowledgment of the adverse effects of artificial nighttime lighting is causing a paradigmatic shift in evaluative judgments. Commonly referred to as *light pollution*, these negative impacts are far reaching: nighttime lighting has been shown to cost (and waste) billions of dollars and enormous amounts of energy, effect human health and well-being, disrupt ecosystems, and cut off experiences of the natural night sky (see Chapter 2). Growing recognition of light pollution has resulted in a shifted moral landscape, with over-abundant and poorly designed illumination being scrutinized for its inefficiency, as well as the resultant “disappearance of darkness” (e.g., Bogard 2013). This has led to a re-evaluation of darkness, previously seen as foreboding and dangerous, now increasingly perceived as a threatened source of cultural and environmental value (see Chapter 2,3, and 4). This complicates the adoption of smart LED lighting technologies, as current retrofit strategies – while championing lower costs and energy efficiency – are expected to exasperate many adverse effects of light pollution. Concerns have been raised regarding their impacts on ecosystems and human health, as well as the likelihood of further degrading dark skies and stellar visibility (e.g., Falchi et al. 2016). Furthermore, despite the promises of smart LED lighting, studies suggest they may ultimately lead to greater energy usage if not accompanied by new policies and strategies (e.g., Kyba et al. 2014; Kyba et al. 2017).

This confluence of technological innovation and changing moral evaluations creates complex challenges for a ubiquitous but critical urban infrastructure. Yet, it also offers a rare opportunity to re-imagine how and why we light our nights, and to envision and enact new strategies. Taking into account the

shifting terrain of technical and moral factors, this chapter will articulate a morally engaged design strategy for the adoption of (smart) LED lighting. In particular, this chapter will focus on how to incorporate environmental values into the next generation of streetlights. To do so, *designing for darkness* will be introduced as a framework that strives to foster a range of environmental values through the design of nighttime lighting. Though darkness is identified and presented as a design goal, nighttime illumination is not actively de-valued. Rather, the focus is on achieving a better balance of illumination and darkness, and of letting dark skies – as a form of ecological restoration – back into our urban spaces. Through applying this framework, I will propose that the functionality of smart LED lighting can be exploited in creative and innovative ways that supersede a narrow focus on efficiency and achieve a broader range of environmental values.

It is important to recognize the momentous and rare opportunity created by the present convergence of technical and moral changes, as well as the stakes. In the longer history of public lighting, we can observe that major technological leaps happen at a somewhat gradual pace, roughly once every century or so. It seems that we are now in the early stages of the next leap, replacing the technologies that have lit the 20th century and shaped contemporary debates. We can thus assume that the transition to smart LED lighting will come with a large degree of physical and temporal permanence, and may very well shape the next century of urban lighting – technically, politically, and morally. In the face of light pollution, as well as lighting's contribution to global problems such as climate change, we cannot let this opportunity pass us by. We are encountering a rare moment where we can re-imagine our urban nightscapes, and envision how 21st century nights could, and should, look. The values that have driven the proliferation of electric lighting must be met with scrutiny, and re-purposed to fit contemporary needs and goals.

Streetlights constitute the primary source of nighttime illumination, making them fundamental to any strategies addressing light pollution and incorporating the positive aspects of darkness into urban nightscapes.²⁵ Globally, there are estimated to be over 100 million streetlights in use. There is an estimated

²⁵ Here, “streetlights” should be understood as synonymous to “outdoor lighting” or “outdoor stationary lighting.” It refers to lighting used for roadways, parking lots, pedestrian walkways, etc., and typically lighting infrastructure that is publically owned and operated. Because of the level of analysis in this chapter, there is no need to make a more fine-grained distinction between the functions and locations of streetlights.

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additional 55 million lights used for parking lots in OECD countries alone. Together, these sources make up over 90% of outdoor illumination (with traffic signals, billboards, and airports making up most of the remaining 10%). As could be expected, illumination outputs are not evenly distributed globally – the 35 nations of the OECD use 71% of the energy and produce 75% of the outdoor illumination (International Energy Agency 2006). Streetlights are especially important for cities, being essential for urban nighttime activities and constituting a significant portion of electricity consumption and costs. In the United States, for example, outdoor lighting is estimated to cost about \$10 billion annually (enough energy to power six million homes for a year), and can account for up to 60% of a city's public amenities electricity bill (Murthy et al. 2015). Major cities typically have tens of thousands of streetlights, or more. For example: Washington, DC has over 70,000 publically owned streetlights (which are bound for LED retrofit in the coming years), Helsinki has approximately 85,000 streetlights, Milan's recent LED retrofit saw the installation of 100,000 new lamps, and New York City has approximately 262,000 streetlights. While such numbers serve as useful illustrations of the prevalence of streetlights, most important for this discussion is the recognition that streetlights constitute a massive and critical infrastructure. They are foundational to nighttime illumination, as well as the problems of light pollution.

The chapter progresses as follows. The next section provides practical details to inform the later discussion, both introducing and describing the benefits and (potential) harms of LEDs and smart lighting systems. In Section 5.3, I articulate a move towards environmentally responsible lighting, using Responsible Innovation as a value-sensitive orientation to guide the development and design of nighttime lighting. *Designing for darkness* is then presented as a technology-specific form of Responsible (Urban) Innovation (Nagenborg 2018), and defined via two interrelated components: the substantive environmental values to be fostered and preserved, and the striving for morally engaged nighttime experiences. Section 5.4 then explores how to operationalize a *designing for darkness* approach. First, it is translated into a tangible design goal aimed at addressing the issue of “shifting baseline syndrome.” Next, three design concepts are put forward as actionable strategies to guide the re-introduction of darkness into urban nightscapes. Throughout, this chapter relies on some (basic) lighting terminology – a quick reference guide for these various terms is included as an Appendix (p. 112).

5.2. LEDs: The next generation of streetlights

Light-emitting diodes (LEDs) are a semiconductor light source, and a type of solid-state lighting (SSL). While they have been used in electronic devices for some time, their utilization for streetlights is a recent development. Early retrofits and prototypes began in the mid-2000s, and the trend has been quickly growing in the decade since. There is a high amount of enthusiasm for LEDs coming from both industry and municipalities, which typically cite their improvements to efficiency, colour quality, and controllability as the rationale for adoption (see Table 5.1). Given the novelty of LED outdoor lighting, there has been a relatively quick uptake, with cities around the world rapidly adopting the technology. For example, a study done by the National Academic of Sciences (NAS 2017) on SSL applications in the United States found that by 2015, LED lighting already accounted for 20% of area and roadway luminaires and 13.9% of parking lot lights. Overall, they found a total market penetration of about 18% for all exterior lighting applications. Further, they found that market penetration is increasing rapidly, and more than doubled (for all interior and exterior applications) between 2014 and 2015. A similar trend of rapid and increasing adoption is predicted for Europe (De Almeida et al. 2014). It would therefore be reasonable to assume that a large-scale conversion to LED outdoor lighting is no longer speculative or even prospective, but a dawning reality. All factors seem to point to the continued (and increasingly rapid) adoption of LED streetlights as their costs continue to go down and their efficacy continues to improve.

Table 5.1 The beneficial characteristics of LEDs, adapted from De Almeida et al. (2014) and the National Academy of Sciences (NAS 2017). Discussions of potential improvements often use high-pressure sodium (HPS) lamps as a benchmark, as it is the most efficacious and affordable precursor. As of the International Energy Agency’s 2006 report, about 62% of outdoor lighting was high or low-pressure sodium, and 30% mercury vapour.

Lighting Consideration	LED Advantages
Efficacy	• High luminous efficacy (lumens/Watt), with rapid improvements in recent years; assuming that LEDs reach their projected efficacy of 200 lm/W by 2025, this can result in up to 40% energy savings for all lighting by 2030
Efficiency	• High efficiency (lower power consumption, lower operating voltage, reduced energy costs); can be up to 50% more efficient than HPS lamps • Longer lifespan; can last 3-6 times longer than HPS lamps
Environmental impacts	• No mercury; no UV or IV radiation
Controllability	• Easy dimming control compared to current technologies • Less light spillage, better directional light output
Lighting quality	• Vivid colour range and control • Cool white light (high CCT) allows for improved colour rendition

Alongside the conversion to LEDs, new streetlights are increasingly being fit with “smart” technologies, often with the stated goals of further improving the benefits described in Table 5.1. The label of “smart” for city systems and master plans has been met with scrutiny, for there is no clear consensus about the meaning or boundaries of the label, or its actual benefits (e.g., Kummitha and Crutzen 2017; Sadowski and Pasquale 2015). However, at the most general level, smart technologies can be understood as the use of ICT or Internet of Things (IoT) technologies for infrastructure and public services. We can therefore broadly understand “smart lighting” as the incorporation of ICT or IoT technologies to lighting – for example, adaptive controls, sensors, etc. – with the goal of improving performance (e.g., Juntunen et al. 2015; Murthy et al. 2015). For streetlights, this typically means incorporating sensors or cameras to light

poles and fixtures towards the goals of increased (cost and energy) efficiency and safety (NAS 2017). LEDs, given their controllability, are ideal for coupling with smart lighting systems, which has made for a high degree of complementarity between LEDs and smart lighting initiatives (Gandy 2017). For example, Juntunen et al. (2015) prototyped a smart LED lighting system that was responsive to both natural lighting levels (e.g., increased brightness levels after a fresh snowfall, as well as during sunrise and sunset) and pedestrian activities. Through these innovations they were able to see significant power reductions, and further predict that smart LED lighting can offer up to 70% energy savings – far more than just switching lighting to LEDs.

Despite the potential benefits brought by (smart) LEDs, both scientific researchers and advocates for light pollution reduction have voiced concerns over the rapid proliferation of LED outdoor lighting. At the most general level, seeing LEDs as an environmentally sustainable infrastructure solution “is highly ambiguous because their introduction facilitates the development of more energy-efficient sources of light pollution” (Gandy 2017, p. 1097). Gandy (2017) further asserts that LEDs, as a more efficient and cheaper source of lighting, could lead to a dramatic increase in light consumption. Kyba et al. (2014) also predict that an adoption of LEDs may not decrease energy consumption, unless linked with strategic and effective policies. A more recent study seems to support these warnings, finding that at a local scale there may be savings, but at a global (and often national) scale this is not the case – likely due to rebound effects and the installation of lights elsewhere with the cost savings (Kyba et al. 2017). There is also concern that LEDs will increase *skyglow*, the ambient atmospheric brightness caused by nighttime lighting, arguably the most conspicuous form of light pollution. It has been estimated that the replacement of current technologies with cool white LEDs could more than double skyglow levels in Europe (Falchi et al. 2016), further cutting off experiences of the night sky, especially in cities. Finally, there are concerns about the long-term health impacts caused by blue-rich white LEDs (American Medical Association 2016), as well as the increased ecological impacts (Schoer and Hölker 2017a). A proposed solution is to promote warmer colour temperatures, which may mitigate some of the harmful effects to humans as well as skyglow. However this decreases efficacy, and a recent study suggests this will not decrease the ecological impacts of LEDs (Pawson and Bader 2014).

In sum, we can observe that LED outdoor lighting is being met with both optimism and scrutiny. As with any large-scale infrastructure, they carry a range

of (potential) positive and negative effects. While the extent to which LEDs will exasperate negative environmental effects is still under debate, as is the exact costs of wasted light, these concerns nevertheless signal that there is a broad range of environmental issues at stake. And, the exact impacts will likely not be known with certainty until a greater number of LEDs have been installed and in operation for a longer period of time. Of course, by then the possibility of reversing any negative effects will be much more difficult. Regardless of these debates, it seems that barring some dramatic and unforeseen policy or market shift, their widespread adoption will continue over the coming years. We should therefore see this moment as an opportunity to anticipate downstream issues and explore alternative pathways that supersede a shortsighted focus on efficiency. For this, I propose that we strive to proactively incorporate *moral* values into the design and use of this new technology, without dismissing the potential benefits that LEDs (and smart lighting systems) can provide. By doing so, we can actively search for ways to reframe existing debates, take into account a full range of environmental concerns *before* the infrastructure's design and use is solidified, and articulate a value-sensitive framework for the adoption of this new technology.

5.3. Designing for darkness: A value-sensitive approach to responsible nighttime lighting

How then to incorporate the instrumental benefits of new innovations, while also avoiding downstream detrimental impacts, in the development and design of new lighting technologies? To orient such an approach to urban nighttime lighting, I use Responsible Innovation as a starting point. At its most general level, this concept adds the qualifier of responsibility (via transparent, inclusive processes and the articulation ethical end goals) to innovative practices (e.g., van den Hoven 2013; Stilgoe et al. 2013). Nagenborg (2018), in the context of urban technologies, defines Responsible (Urban) Innovation via three key features. First, it requires that the ethical and societal implications of products and projects be considered. Second, it emphasizes a non-instrumental view of technologies, asserting that they are not value-neutral but instead value-laden. Third, innovations should strive for ways to include values in the design process that do not at the same time have a negative impact on other moral values. This problem of satisfying conflicting obligations or moral values is referred to as *moral overload* (van den Hoven et al. 2012). However, the very notion of

Responsible Innovation – to innovate in a way so as to “expand the set of relevant feasible options regarding solving a set of moral problems” (van den Hoven 2013b, p. 82) – is conceptualized as a way to overcome such conflicts. Importantly, this necessitates a shift in how we conceptualize innovation – no longer just about technical improvements but also about ethics and moral values (van den Hoven 2013b). When applied to technologies embedded in urban contexts, this can take the form of either the responsible design and use of a technology in the urban environment, or more constructively exploring how new innovations can be developed to address specific urban challenges (Nagenborg 2018).

As an example of an urban challenge specific to nighttime illumination, we can briefly look at the tensions between darkness and safety. In helping to avoid injury and find your way at night, lighting serves a necessary functional requirement for urban nightscapes. But beyond these basic practical functions, the effects of lighting are a debated issue. Recent studies examining the contentious relationship between crime and lighting – as well as the complex relationship between *feelings* of safety, *actual* safety, and fear of the dark – tend to show that while *actual* safety may not increase with more illumination, feelings of safety often do (e.g., Boomsma and Steg 2012; Fotios et al. 2015; Gaston et al. 2015; Haans and de Kort 2012; Marchant 2004; Li et al. 2015; Pena-Garcia et al. 2015). Further, the associations between lighting and safety are deeply embedded connotations, with the goals of safety and security (as well as policing and surveillance) inexorably tied to the very foundations of modern public lighting efforts (e.g., Schivelbusch 1988; Schlör 1998). This relied on both a practical and symbolic interpretation of safety, as artificial illumination inherited a much longer history of lighting-as-good and darkness-as-evil cultural metaphors (Ekirch 2005). We can thus appreciate that lighting-as-safe and darkness-as-dangerous associations are deeply embedded perceptions. However, neither are essential or static concepts, but influenced by our lighting practices. It would therefore appear that we are confronted with a situation of moral overload, and thus a challenge for responsible lighting strategies. While an in-depth analysis of the relationship between safety and darkness is outside the scope of this chapter, Section 5.4 will put forward innovative approaches to incorporating darkness into urban nightscapes without necessarily compromising safety.

Taking Responsible (Urban) Innovation as an orientation for light strategies requires a re-framing of the goals driving innovations to nighttime lighting,

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moving beyond technical improvements as the primary goal for future lighting systems. The current focus on efficiency and cost-savings are certainly important goals for a municipality, however a value-sensitive approach emphasizes that other “non-functional” requirements also be incorporated into the development, design, and adoption of technologies and systems (van den Hoven 2013b). We must therefore begin with a value-level discussion, and *then* ask how these technical capabilities can be developed to serve desired goals. Only then, with goals clearly identified, can we judge the responsible usage of new lighting technologies, and how they may address the environmental impacts of nighttime lighting. For this, we need a framework that articulates morally relevant values as a starting point and uses them to better elucidate the “good” we can strive to achieve with smart systems and LED streetlights. Put otherwise, it forces us to ask, *exactly what we are designing for?*

A framework for responsible urban lighting must respond to the unique historical, social, and technological context of nighttime illumination. For conceptualizing the environmental values at stake, I propose the adoption of *darkness* as a key design feature to be sought after in future nighttime lighting strategies. To understand exactly what it can mean to *design for darkness*, and what such an approach would entail, I first present the substantive values associated with darkness. This leads into a longer discussion about how meaningful experiences can be wrought out of our urban nightscapes through a conscientious (re)introduction of dark skies. While focused on the positive features of darkness, this approach is not meant to de-value lighting or the various benefits nighttime illumination undoubtedly brings. Rather, it is about highlighting the many benefits that darker nights, combined with a restrained and conscientious use of lighting, can bring. Hence, it is ultimately about situating darkness as a design criterion and value-level consideration in nighttime lighting, and in the process achieving a better balance of lighting and darkness (Edensor 2015; 2017). However, given the over-illuminated state (or at least poorly-designed illumination) of most of our cities, this requires an explicit focus on re-introducing darkness into our urban nightscapes. Also important to emphasize is that this approach is focused on elucidating and realizing environmental values. This is not to say that social or procedural values are less important, or should not be considered in future innovations to outdoor lighting, only that environmental impacts are the topic at issue here.

5.3.1. Valuing Darkness

A first step is to articulate what sorts of environmental goods should be pursued or protected in the decision-making and design of urban nighttime lighting. For this task, *darkness* can be conceptualized as a medium through which, or from which, a range of environmental values arise (see Chapter 4). As such, darkness should be understood as an umbrella term encompassing various environmental concerns that are seen as negatively impacted (degraded, hindered, threatened, or otherwise) by light pollution, and nighttime lighting more generally. When arguing for a reduction in illumination levels for energy savings, or alternatively when striving to protect access to the starry night sky, there is the implication that darker nights – and hence *darkness* as an evaluative concept – contains or fosters desirable value. To articulate the value of darkness, the commonly agreed upon effects of light pollution are re-framed as nine ways by which, or through which, value is derived from darkness (see Chapter 4). Importantly, a key facet of focusing on darkness is that it allows for the assessment of *all* lighting and its quantitative and qualitative impact. Light pollution is a concept primarily concerned with identifying and mitigating the negative effects and thus undesirable uses of lighting. Preserving and fostering the valuable aspects of darkness incorporates these concerns, while also allowing for a more fundamental and holistic re-consideration of *all* urban lighting and its impact on environmental values.

Towards operationalizing for the design and use of LED streetlights, the value of darkness can be further refined in two ways. First is a consideration of how darkness, as an environmental good, should be weighed in comparison with other values associated with both darkness and lighting. For incorporating darkness into this larger landscape of concerns, the nine values are further translated into *prima facie* moral obligations that future lighting strategies should – at the least – take into consideration (see Table 4.2, p. 83). Thus, each is presented as a first-order requirement in the design process, even if each obligation may not be achievable in every case. However, this creates an important shift in the burden of proof – to show why *not* to incorporate the obligation, and give justifiable cause for that choice.

Second is a consideration of how to weigh and prioritize the nine identified values internal to darkness. Darkness has instrumental value, both from an anthropocentric and non-anthropocentric point of view. For example, it can be economically valuable, saving money and reducing energy usage, and can promote eco-tourism via “dark sky reserves.” And, it is beneficial for many

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nocturnal many species. Darkness also has intrinsic value, in the sense that there are reasons to preserve darkness for non-instrumental reasons. Certain phenomena and experiences, such as the starry night sky, are an inherent and inseparable quality of dark nights. In such cases, darkness is not a means to an end, but a facet of the end goal itself. These intrinsic qualities of dark nights, I assert, should be the focus of a designing for darkness approach on two grounds. First, they are more robust, in the sense that they offer enduring, powerful experiences that are not contingent on external goals (e.g., cost-saving efforts). Second, achieving them will necessarily lead to instrumental benefits. Achieving darker skies offers the possibility of reconnecting urban spaces with their natural settings, and allow access to the starry sky, but it will also lead to a reduction in energy usage, cost savings, and health and ecological benefits. To the contrary, installing energy-efficient lighting may achieve instrumental benefits while remaining neutral, or even having a negative effect, on access to the night sky. Thus, the cluster of values associated with dark skies (*ecological conservation, connection to nature, stellar visibility, heritage and tradition, and wonder and beauty*) is prioritized as the main goal for environmentally responsible urban lighting.

5.3.2. Experiencing darkness

Darkness, as presented above, can be understood as an evaluative concept to define and categorize the environmental goods to be strived for in nighttime lighting. However, darkness is also a quality of lived experience – there is a physicality and spatiality to darkness, just as there is one to lighting. And, it is through such experiences that meaning ultimately arises. We must therefore understand darkness as both an evaluative concept *and* an experiential goal. This means that in addition to articulating darkness as something of value, we must also explore how darkness can be realized in urban nightscapes in ways that foster morally transformative, or at least morally engaged, experiences.

To properly situate the positive features of darkness into the context of lived urban spaces, it is important to understand the relationship between lighting and darkness, and how nighttime illumination shapes our perceptions of darkness. A basic presupposition of Responsible Innovation is that technologies are value-laden, and lighting is no exception. The many histories of nighttime illumination (e.g., Schivelbusch 1988; Schlör 1998) have done excellent jobs of highlighting the various values that have shaped, and been shaped by, nighttime

lighting – a topic I summarize in Chapter 2. Here though, I will not discuss these various values further, but rather focus on the phenomenology of human-technology-environment interactions; or more specifically, the interaction between nighttime experiences, lighting technologies, and darkness. This requires that we appreciate the profound moralizing role lighting plays in shaping our perceptions and evaluations of darkness, and the capacity of lighting technologies to either foster or hinder those valuable aspects of darkness described above.

To understand the profound influence that technologies have on our morality, we can draw from recent work in *technological mediation* (Verbeek 2011). Focused on human-technology relations, it interprets our actions and perceptions as “always closely interwoven with the material environment in which they play out” (Verbeek 2011, p. 22). Technology is not something *out there* to be dealt with. Instead, our interactions and uses of technological artifacts play an active role in constituting our reality. Hence, we experience the world – and morality – *through* or *by way of* technological artifacts (Verbeek 2011).²⁶ Urban infrastructures thus act as external constraints, limiting our ability to perceive beyond them, both figuratively and literally, as well shaping how we see ourselves in relation to the natural world (King 2000).

As discussed in the introduction, streetlights dominate our nights. They are the most prominent source of illumination, both historically and in contemporary cities, effectively creating nighttime spaces (Major 2017). Streetlights are an encompassing technology that not only mediate perceptions,

²⁶ The case of nighttime lighting arguably stretches the theory of *technological mediation*, focused primarily on individual artifacts. The moral implications of lighting can be traced back centuries and across multiple technological leaps (i.e., oil lamps, gaslight, and electric light). Furthermore, these moralizing effects are a product of the totality of lighting infrastructure, not individual lights. The paradigmatic examples of mediation show the moralizing effects of specific devices on individual experiences, such as the obstetric ultrasound. Such devices, argues Verbeek, expand the “moral community” to include nonhuman artifacts (2011, p. 39). However, I am not interested in an individual artifact (or the agency thereof), but rather the infrastructure in which they operate. What can be said about the larger system of nighttime lighting in which individual devices (i.e., a single streetlight on a lamppost) operate? The moralizing effects of nighttime lighting have a far greater temporal and spatial resonance than any single lamppost, or any one technological development. Thus, it would be untenable to analyze LED streetlights as a completely novel technology, or assert that they should be assessed as isolated artifacts. Nevertheless, the relationship between technologies and morality presented in mediation theory provides useful insights into the evolving morality of darkness, and the central role of lighting technologies.

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but are foundational to our experiences and understanding of the city at night. They provide the backdrop and ambient lighting for all nighttime activities. In this sense, streetlights actively constitute our nights, both literally and figuratively. They are at the crux of the question of how darkness is perceived, and ultimately evaluated. Any attempt to re-introduce and re-imagine darkness must therefore begin with the lighting technologies themselves. To design for the value of darkness, we must focus on our lighting. Only by first appreciating that our cities are understood from *within* the illumination created by streetlights, can we move to re-design them in a conscientious way.

A designing for darkness approach must therefore acknowledge the profound mediating power of nighttime lighting, and strive for the incorporation of meaningful experiences of darkness *through* the design of streetlights. Given the hierarchy of substantive values identified above, such designs should strive to incorporate the intrinsic, future-oriented values of darkness into urban nightscapes. For hints at how such meaningful experiences could look, here I draw on the idea of a re-envisioned *nocturnal sublime* discussed in more detail elsewhere (see Chapter 3). It is argued that focusing on incorporating the desirable aspects of dark nights – namely the starry night sky – into urban settings can engender aesthetic responses that are relevant to fostering an environmental ethic. The proposed re-envisioned nocturnal sublime is further situated as a form of holistic urban restoration (de-Shalit 2003; see Chapter 3). On a practical level, it helps to mitigate the negative impacts of light pollution, and satisfies the instrumental benefits of darkness (e.g., a reduction in energy usage). Yet it also attends to the moralizing effects of lighting infrastructure, in the process fostering the intrinsic value of dark skies. It allows for a glimpse beyond the lighting that now envelops our urban nightscapes, and opens the possibility of cities and their inhabitants (re)discovering an ecological and cosmological sense of place. Speaking about the future of “green” design generally, the architect James Wines (2005, p.18) stated, “The mission now in architecture, as in all human endeavour, is to recover those fragile threads of connectedness with nature that have been lost for most of the century.” Experiencing the sublime night sky in cities can help to re-discover one of those “fragile” threads of connectedness with nature, and bring it back into our urban spaces. Thus, we can extend ideas of “greening” cities to also include “darkening” city nights as a form of environmentally restorative urban design.

5.4. Designing for darkness: Practical possibilities for (smart) LED streetlights

Designing for darkness provides a value-sensitive framework for urban nighttime lighting, articulating a range of substantive environmental values that can be fostered through the achievement of darker night skies. It also situates darkness as a form of urban (ecological) restoration, which can help to create meaningful experiences for city inhabitants. A necessary next step is to translate these abstract philosophical ideas in actionable design requirements, and explore how smart LED streetlights can be put towards these goals. Thus, here I take preliminary steps in operationalizing designing for darkness. To do so, I first identify a target issue of relevance to our evaluations and experiences of darkness, namely *shifting baseline syndrome*. This is followed by three possible designing for darkness scenarios, presented as a means to overcome shifting baselines and re-introduce darkness into our cities.

Important to note is that steps have already been taken towards formulating responsible urban lighting strategies. There exists a growing body of research investigating ways to curb light pollution, with a number of recommendations proposed in recent years (see Table 5.2). And, various countries and municipalities have already introduced ordinances to mitigate light pollution, towards the goals of cost savings and energy efficiency, and in some cases dark sky protection (Kyba et al. 2014). These existing strategies typically take the form of technical recommendations to minimize specific causes and effects of light pollution. The concepts presented in Section 5.4.2, however, are meant to go further than mitigating light pollution, instead evaluating *all* nighttime lighting and actively re-imagining our future urban nightscapes, and the relationship between lighting and darkness therein. In this sense, the concepts presented here are more encompassing than, but ultimately complimentary to, these existing strategies for addressing light pollution. They are focused on broader visions of urban nightscapes within which various technical strategies and policies can be implemented.

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Table 5.2 Overview of proposed recommendations and policies for mitigating light pollution; adapted from Falchi et al. (2011), Gaston et al. (2012), IDA (2016), IDA-IES (2011), and Schoer and Hölker (2017b).

Recommendation(s)	Suggested Policies
Reduce skyglow, light trespass, and glare	• Properly positioned installations – for overhead lights, angled below 70 degrees from the downward vertical • Fully shielded lighting luminaires to further direct light
Eliminate unnecessary lighting	• Switching off or dimming lights when not in use, to both reduce light pollution and save energy consumption and costs
Proper illumination levels	• Establish proper levels of illumination required for safety and visibility. Research suggests only 1-3lx required for facial recognition and visibility (save for roadways with higher speeds); current streetlights have illumination levels of 10-60lx
Proper colour spectra	• Avoid cold white light due to effects on ecosystems, human health, and skyglow; use “warm” or filtered LEDs with a CCT below 3,000K
Ecological sensitivity	• Maintain naturally unlit areas while promoting and enforcing “dark sky reserves” • Harmonize light levels with the needs of local flora and fauna

5.4.1. Shifting baseline syndrome

A *designing for darkness* approach can take many forms, and respond to the values and experiences articulated in Section 5.3 in varying ways, and to varying degrees. However, it does require a specific orientation: that we assess new innovations to, and uses of, artificial lighting via both their quantifiable impacts *and* as a manifestation of social and environmental values. For translating darkness into an actionable design goal for LED streetlights, the abstract ideas of “connection to nature” and “mediation” require a tangible focal point for design interventions. For this, I will elaborate on a specific facet of urban nights that makes evident the mediating (and moralizing) capabilities of nighttime lighting, and can be directly addressed through new technological innovations: *shifting baseline syndrome*. It has been applied to issues of light pollution by Lyytimäki

(2013), and is a term originating in ecological conservation research (Papworth et al. 2009). Lyytimäki (2013, p. e46) explains that,

Shifting baseline syndrome refers to the changing human perceptions of biological systems due to loss of experience of past conditions. Simply put, people may view the current situation as the typical or normal state, even when the ecosystem is considerably degraded compared to earlier states.

Broadly, there are two types of shifting baseline syndrome: *generational* and *personal amnesia*. Generational amnesia occurs when previous experiences are not passed on to new generations, causing past conditions to be forgotten; personal amnesia occurs when individuals forget or “update” their own experiences, and come to believe that current conditions are the same as past ones, and thus normal (Lyytimäki 2013; Papworth et al. 2009). In both cases, it causes a shift in perceived baselines, and thus an evaluative shift in accepted norms.

Lyytimäki (2013) posits that the loss of the night sky, and experiences of (especially urban) nights, cause of both types of amnesia. This assumption is largely supported by scientific evidence that investigates the brightness (and brightening) of our contemporary nights. It is estimated that 83% of the world’s population, and over 99% in the USA and EU, live in areas considered to be above the “polluted” threshold, and in cities the artificial brightness can be several magnitudes greater. The Milky Way – arguably the key feature of the sublime starry sky – is no longer visible to 60% of Europeans and almost 80% of North Americans (Falchi et al. 2016). This trend is only increasing, with nighttime brightness estimated to be increasing 3-6% annually on a global scale (Hölker et al. 2010). And, as mentioned in Section 5.2, these trends are not expected to decrease with the adoption of white LEDs, unless new policies are enacted.

In applying shifting baseline syndrome to nighttime lighting, Lyytimäki is mainly concerned with addressing the effects on ecosystem services, typically known as ecological light pollution (Longcore and Rich 2004), and how this effects value-level discussions about the need and use of artificial lighting. However, Lyytimäki’s argument provides much broader and profound possibilities, offering a new perspective on urban darkness. Shifting baselines of darkness can be understood as the manifestation of lighting technology’s mediating presence in our perceptions of nighttime environments. The repercussions of nighttime lighting on our baseline understanding of darkness

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can be considerable, as living in constant artificial brightness can lead to perceptions of darkness as unnatural or unsafe (Lyytimäki 2013). Yet, it also reveals that darkness – as both a normative and phenomenological concept – is not essential or static. It highlights the relative nature of everyday perceptions of “darkness” and calls into question evaluative categories such as “too dark.” Such labels are not absolute, but shaped by our abilities to see (or not see) past our current conditions, and our tendencies to update our accepted and expected norms of illumination levels. As nights continue to get brighter, and we introduce new, more efficient technologies, we risk continuing to increase our *generational* and *personal* baselines. However, with the controllability offered in new lighting technologies, we can actively challenge this trend. Thus, shifting baselines are where a designing for darkness approach can focus: on seeking to reverse our baselines and re-introduce darker nights, while still maintaining sufficient levels of illumination for nighttime activities. This can allow for meaningful experiences to emerge, as well as the achievement of the intrinsic (and instrumental) values associated with darkness. And importantly, it can allow for the achievement of these goals without creating (or exasperating) a situation of moral overload between darkness and safety.

5.4.2. Realizing darkness

As a practical strategy for realizing darker nights – and specifically realizing the values and experiences elucidated in Section 5.3 – we can thus explore possibilities that directly address our personal and generational shifting baselines. Here three design concepts for darkening cities are presented with these goals in mind. As with any urban planning strategy, a great deal more research into the feasibility and city-specific manifestations is required. However, here these concepts are presented as broadly applicable guiding visions that could be included in planning instruments such as a lighting master plan, as a means to speculate on the real-world potentials of designing for darkness. Each concept should, in principle, incorporate the instrumental benefits of smart systems and LEDs (energy savings, etc.), but also go much further in helping to re-position the relationship between lighting and darkness in urban nightscapes.

Concept 1: Incremental Darkening

A straightforward design solution is to quite simply turn down the lights. Current lighting practices typically give rise to street-level illumination of between 10 and 60 lx, which is several magnitudes greater than natural conditions. With no artificial light, a clear sky with a full moon provides an illumination of c. 0.1–0.3 lx, a clear moonless starry sky c. 0.001lx, and an overcast night sky as low as c. 0.0001 lx (Gaston et al. 2012). Further, current lighting is often inconsistent in the amount of brightness depending on distance from the light source – something that can be addressed via the uniform lighting distribution of LEDs (Gaston et al. 2012). Recent studies have found that only 1–3 lx is necessary for visibility and facial recognition, although roadways with higher speeds require higher levels (Schoer and Hölker 2017b). This would suggest that the lighting levels on many of our streets and public spaces could be significantly reduced without necessarily compromising visibility or nighttime activities. This would have a range of economic and ecological benefits, as well as potentially avoiding downstream health issues. And, it would decrease skyglow and allow for increased stellar visibility.

For realizing an incremental darkening strategy, we can take inspiration from other domains of urban planning – for example, Copenhagen’s initiative to reduce vehicle traffic and increase cycling. For several decades, Copenhagen has been gradually “removing driving lanes and parking places in a deliberate process to create better and safer conditions for bicycle traffic” (Gehl 2010, p. 11). This has been combined with investments in cycling infrastructure, yielding positive results: bicycle traffic doubled between 1995 and 2005 (Gehl 2010). A similar lighting strategy can be enacted that conscientiously slows, and potentially reverses, shifting baselines. A radical or abrupt change in lighting levels would likely cause concern, and may not be socially accepted. If shifting baselines create the perception that current levels are the norm, any drastic reduction could seem “too dark,” and decrease feelings of safety. To avoid this, we can exploit the potentials of this new technology, and specifically its dimming capabilities, to gradually reduce brightness. Both illumination levels, as well as colour temperatures, could be uniformly reduced in incremental steps, in a way that is not overly impactful on daily experiences. Like Copenhagen, this could be done over several years, and could include regular feedback loops with public input as well as studies on crime and safety. Importantly, such a strategy should be planned and implemented citywide after smart LED retrofits, to ensure a uniformity of gradual darkening and colour

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changes. Otherwise, this may lead to increased contrast between adjacent spaces, which may have the reverse effect on perceptions of darkness, and perhaps cause (or reinforce) segregation between spaces or neighbourhoods. In sum, this concept positions the act of darkening cities as a long-term process implemented uniformly across an entire city or region, to reverse our shifting baselines and gradually re-introduce darkness into our lived spaces.

Concept 2: Environmentally Responsive Lighting

A central goal of designing for darkness is to reconnect cities, and their inhabitants, with an ecological and cosmological sense of place. In doing so, the act of darkening cities can become a form of holistic urban restoration, that lets the night sky back into urban experiences. The smart sensors and systems that offer increased controllability and real-time responsiveness can be developed towards this goal. Illumination can thus be responsive to changing natural conditions (moonlight, clouds, etc.), creating a lighting strategy closely attuned to seasonal cycles and weather.

These technological capabilities already exist, or are under development. Street lighting has traditionally been controlled by a clock, with modern systems often controlled by a photoelectric cell to detect daylight and adjust operating times accordingly. Still, such systems are limited because they operate as binary on/off systems. However, with LEDs, greater control is now possible (Juntunen et al. 2015). Tests have been done in which lighting levels respond to changing environmental conditions. For example, a study in Helsinki found that lighting levels could be significantly reduced when there was fresh snowfall, due to ambient brightness. The same study found that lighting could similarly respond to the brightening sky during sunrise (Juntunen et al. 2015). A similar approach has been suggested elsewhere as a strategy for mitigating light pollution, positing that future lighting systems could respond to changing lighting conditions during twilight hours (Schoer and Hölker 2017b). Future systems could even incorporate more creative or informative dimensions that are unique to local geographies and social circumstances. For example, lighting could be developed that changes colours or brightness in the minutes before rainfall, or in response to wind speeds, as both a warning system and safety measure.

The key here is to develop sensors towards the explicit goal of illumination that is responsive to, or symbiotic with, natural brightness levels; to see lighting not as eliminating the night, or of pushing back darkness, but of responding to it. At the very least, this will save energy and costs. More optimistically, it can re-

connect lighting infrastructure – and city inhabitants – to diurnal and seasonal patterns. In this sense it is less about “darkening” in a literal sense (as in Concepts 1 and 3), but rather attuning cities to their environment’s natural rhythm. Instead of leaving cities awash in a static, uniform illumination from sunset to sunrise, cities respond to their nocturnal context and its idiosyncrasies.

Concept 3: Urban (Dark) Acupuncture

The previous two ideas are more gradual, aimed at incremental changes to ambient brightness, and should be implemented somewhat uniformly across a city or region. Another option is to strive for more radical or transformative experiences aimed at a direct and explicit confrontation with darkness, bringing artificial lighting out of the backdrop of daily life. For this, specific spaces – public squares, pedestrian streets, parks, etc. – could be explicitly and conspicuously left dark, perhaps not without any lights, but at near natural levels to contrast our current (perceived) norms. Through this, we can create moments of accentuated darkness throughout cities, to give inhabitants a glimpse of another possibility for urban nightscapes.

As inspiration for such an approach, we can draw from Jaime Lerner’s idea of *urban acupuncture* (2014). This planning theory posits that a few well-placed “pricks” of a certain service, amenity, or structure can begin a process of urban renewal. The concept is most often applied to social concerns, such as safety, or of “restoring the cultural identity of a place or community” (Lerner 2014, p. 9). This could mean, for example, strategically placing a new public amenity such as a library so as to stimulate visitors to the surrounding neighbourhood (and thus economic activity, educational services, safer streets, etc.). As another example, Lerner discusses nighttime lighting as a means to accentuate a space and create dynamic, interactive moments. Why not attempt to likewise accentuate a public square, or bridge, or otherwise, with darkness (perhaps accompanied by some explanatory or educational materials)? Alternatively, a darkened space can serve as a backdrop for a lighting installation, highlighting both the presence of darkness and the beauty of illumination (as well as their complementarity). The controllability of the brightness and directionality of LED lighting could be developed so as to make such moments possible.

Experiencing darkness – or alternatively, purposeful illumination within a darkened space – could allow moments where people glimpse past the lighting that now mediates our urban lives, and see a nighttime space oriented otherwise. In doing so, we could be forced to confront our (often unquestioned)

expectations and perceptions of lighting, and possibly plant the seeds for a new version of darkness to permeate through our cities.

5.5. Conclusion

This chapter has presented a forward-looking analysis of nighttime lighting, and in particular streetlights, a critical and formative urban technology. It focused on two interrelated issues: the ethics of the rapid introduction of smart LED outdoor lighting, and the incorporation of environmental values into the design of public nighttime lighting. To do so, the challenges posed by the introduction of these new technological innovations were re-framed using Responsible Innovation, to argue for a shift from “smart” to responsible lighting. This requires a shift in thinking regarding new lighting strategies – away from efficiency as a primary goal and towards the proactive inclusion of a broader range of values into the development and design processes. *Designing for darkness* was then put forward as a value-sensitive, and technology-specific, framework for incorporating substantive environmental values and meaningful experiences of dark skies into city nights. Potential strategies for realizing *designing for darkness* were put forward by first identifying *shifting baseline syndrome* as a target concern, and then presenting three design concepts that utilize the features of smart LED lighting systems: incremental darkening, environmentally responsive lighting, and urban (dark) acupuncture.

Re-introducing darkness into cities is the primary goal of the approach defined here, as a means to both address the costs and impacts of light pollution, while also more fundamentally re-imagining urban nighttime lighting. However, this goal does not de-value or wholly dismiss the importance of nighttime illumination. Rather, it strives to foster an appreciation of the quantitative and symbolic goods that can be achieved through a better balance of light and dark. It is thus about learning to appreciate the value of darkness, and to experience it – not as dangerous or evil – but as a feature that can reconnect with us with natural rhythms and the starry night sky. For cities, this will not be an impenetrable pitch dark, but a better lighting-darkness balance. “The presence of urban darkness, like a phantasmogoric manifestation of “weeds,” has been characterized as a symbol of disorder, neglect, or abandonment, but there is an intermediate spectrum of illumination that lies between a disorientating gloom and the incessant glare of late modernity” (Gandy 2017, p. 1102). Through this process, the power and spectacle of artificial lighting can

also be re-appreciated. Instead of being seen as a pollutant, the new era of *electronic* lighting can revitalize the positive symbolism of nighttime lighting, but with the added dimension of environmental values.

If we accept that designing for darkness is a justified goal, and that this is achievable through new smart LED lighting, a future question is how this compares to, and is prioritized within, the larger arena of moral and political concerns shaping decision-making for lighting, and cities more generally. This will require a consideration of how this conceptual framework, as well as strategies for realization, affects safety, traffic, and nightlife within localized settings. It will have to be put into dialogue with current concerns related to smart city initiatives, such as privacy and surveillance. And, the processes for enacting such visions will need to be done in a transparent and inclusive manner. However we should also be wary of too quickly relegating darkness solely into the category of an “environmental concern,” or worse fall back onto old symbolic connotations, when confronted with the broader landscape of social and moral values. I would instead propose that a greater consideration of the societal benefits (or at least disruptive qualities) of darkness also be considered. For this, we can take inspiration from Dunn’s “Manifesto for the Nocturnal City” (2016, p. 96), in which he reflects on the potentials of nightwalking:

Walking in cities at night, therefore, enables us to sense, connect and think with the city around us. We are able to give things our undivided attention, a welcome respite from the ongoing erosion and subdivision of our time and sense of belonging in the world. Deliberately moving out of the glare and stare of our commoditized and highly structured daily routines and into the rich shadows and patina of our cities at night may be one of the few truly beautiful and sublime practices available to us. Far from being dead hours, for the wakeful the night affords investigation and liberation.

In sum, it would seem that a darker future might indeed be on the horizon for our urban nightscapes.

Appendix: Lighting terminology quick reference guide

CCT: Correlated colour temperature; a description of the colour of (white) light sources as perceived by humans, measured in Kelvins (K).

Warm: white light with a yellow or reddish tint ($\leq 3,000\text{K}$)

Neutral = warm white (3- 4,000K)

Cool = white light with a blush tint (4,500-6,500K)

Daylight = $\sim 6,500\text{K}$

HPS: High-pressure sodium, a commonly used lamp type for outdoor lighting

Light pollution: Any adverse impact caused by artificial light at night. It is typically sub-categorized into *skyglow* (light sent upward and scattered in the atmosphere, causing artificial ambient brightness and the orange-ish haze above cities), *glare* (excessive brightness that reduces visibility, such as bright floodlights at eye level), *light trespass* (unwanted or unintended light, such as a streetlight shining into your bedroom), and *clutter* (over-illuminated clusters of light sources, often found in downtown areas). The effects of light pollution are typically also sub-categorized into *energy usage*, *ecological impacts*, *(human) health*, *safety*, and it's obscuring the visibility of the *night sky*.

Lumens: Measure of the quantity of light (luminous flux) emitted by a source

(Luminous) Efficacy: Measurement of how effective a light source is at converting energy into lumens of visible light; measured in lumens-per-watt (lm/W)

Lux (lx): the unit of light (illuminance) falling onto a surface; 1 lux = 1 lumen per square meter

LED: light-emitting diodes, a semiconductor light source used in solid-state lighting (SSL) devices

6 Driving in the Dark: Designing Autonomous Vehicles for Reducing Light Pollution²⁷

6.1. Introduction

The impending introduction of autonomous vehicles has the potential to revolutionize transportation networks. Exactly what this future transportation system will look like, though, is still open for debate and scrutiny. Yet while visions of future cities and roadways dominated by “driverless cars” remain nebulous, their impending realization has garnered a growing technical and ethical debate.²⁸ Current technical discourse largely focuses on the potential benefits in terms of safety, easing congestion, and emissions reductions (e.g., Hoogendoorn et al. 2014; Diakaki et al. 2015; Fagnant and Kockelman 2014, 2015). Research is also exploring the tangential effects of driving automation on issues such as vehicle ownership and sharing, land use, energy consumption, air pollution, and public health (Milakis et al. 2017). Taking a more critical approach, ethical discourse has largely focused on how vehicles should be programmed to behave in dilemmatic life-and-death scenarios, and what decision-making criteria should be followed (e.g., Gogoll and Müller 2017; Lin 2016; Santoni de Sio 2017). The issues under debate are then how these vehicles should be programmed to operate in such circumstances, who should decide on this programming, and where the resultant moral and legal responsibility lies.²⁹

While important considerations, critiques have been raised about this pathway for ethical discourse, including the over-reliance on viewing

²⁷ Forthcoming as: Stone, T., Santoni de Sio, F., & Vermaas, P. Driving in the Dark: Designing Autonomous Vehicles for Reducing Light Pollution. *Science and Engineering Ethics*.

²⁸ We use “autonomous vehicles” and “autonomous driving systems” interchangeably. However, this is meant to be a broader categorization than “driverless cars” or “self-driving cars,” which refers to a specific level of (high) automation and a specific use and function of the vehicles. Thus, these latter terms represent a set of assumptions we are wary of (see Section 6.2).

²⁹ With the exception of Sparrow and Howard (2017) who reflect on the moral obligation to realize the transition to a fully autonomous transport system (assuming that this will be safer).

autonomous vehicles as a real-life manifestation of the “trolley problem” (JafariNaimi 2017; Nyholm and Smids 2016), the lack of attention to social justice issues (Epting 2018; Mladenovic and McPherson 2016), and the need for systems level analyses (Borenstein et al. 2017). These critiques highlight a broader issue with over-emphasizing hypothetical dilemmatic scenarios: they focus on a yet-to-be-realized endpoint, assuming that fully autonomous vehicles have been introduced into the existing physical, behavioural, and institutional landscape. This risks overlooking the short-to-medium-term development of transportation systems, and what moral problems – and opportunities – can arise during this process.

Given the potentially transformative impact of autonomous vehicles on a broad range of moral, social, and environmental values, we have an opportunity – and arguably a duty – to broaden ethical analyses and consider how (and why) to develop this technology. For this task we adopt a *design for values* approach, which asserts that we should be pro-active and take societal and moral values into account from the early stages of the design and development process, thus embedding values into the technical system (van den Hoven et al. 2015). Importantly, this approach allows us to question basic presuppositions about both vehicle design *and* the surrounding infrastructure that this new technology will shape, and be shaped by (e.g., Heinrichs 2016; Milakis et al. 2017). We assert that these two dimensions – the vehicle and surrounding infrastructure – need to be (re)designed in tandem, which requires an expanded ethical debate and an examination of how various values and design considerations can, and should, influence one another.

Such an approach necessitates ethical research into a range of issues related to physical infrastructure, institutions, and socio-technical systems interwoven with our transportation networks. In this chapter we examine one specific topic in detail, namely the relationship between autonomous vehicles and a critical piece of transportation infrastructure that has yet to receive significant attention: streetlights. The adverse effects of artificial nighttime lighting – known as light pollution – have emerged as a pressing environmental issue, costing billions of dollars, using enormous amounts of energy, negatively affecting human health and ecosystems, and hindering experiences of a natural night sky (see Chapter 2). To combat these effects, “The challenge faced by 21st century policymakers is to provide outdoor light where and when it is needed while reducing costs, improving visibility, and minimizing any adverse effects on plants, animals, and humans caused through exposure to unnatural levels of light at night” (Kyba et

al. 2014, p. 1807). The introduction of autonomous vehicles is a rare and pivotal opportunity to take up this challenge. We therefore propose that questions of light pollution, and more radically the value of darkness, should be part of the landscape of values and goals influencing the development of autonomous vehicles and surrounding infrastructure. Thus, this chapter offers a novel analysis of the confluence of two technologies with seemingly disparate moral challenges – autonomous vehicles and nighttime lighting – exploring how autonomous driving systems could be designed to reduce light pollution and create darker nights.

Before looking at the possibilities of “driving in the dark,” we first contextualize our case by arguing for a comprehensive moral assessment of autonomous vehicles, using a *design for values* approach to pro-actively incorporate ethical concerns into the predicted short-to-medium term development phases (Section 6.2). In Section 6.3 we turn to the ethics of nighttime lighting. We introduce the concept of light pollution and the *value of darkness* (see Chapter 4) as a moral framework for nighttime lighting, and apply this to the adverse impacts of road lighting. In doing so, we articulate a weak and strong moral claim for the development of autonomous vehicles. At the least, this development must minimize the negative effects and costs of light pollution. Yet it can also go further, striving to actively promote the valuableness of darkness and help to re-envision our urban nightscapes. In Section 6.4 we explore how darkness can be realized through the development of autonomous vehicles. We make our case by sketching two scenarios in which lighting infrastructure can be adapted for “driving in the dark” – parking lots and highways – and briefly reflect on the design requirements this places on future high-automation vehicles.

6.2. Towards a comprehensive ethics of autonomous vehicles

To examine the full extent of potential impacts caused by autonomous vehicles, we adopt an approach with the following features (adapted from Santoni de Sio 2016):

- (1) Focusing on the process towards full automation and the full range of possible varieties of (partial) autonomy rather than only on one hypothetical fully- autonomous (“driverless”) scenario;

- (2) Going beyond collision programming and towards the design of the entire socio-technical system, including technical infrastructures, social and legal norms, and educational systems;
- (3) Broadening the scope of possible ethical issues involved in the design of future systems – not only risks for life and physical integrity, but also justice, privacy, inclusion, environment, etc.;
- (4) Taking a pro-active approach and considering how ethical trade-offs (moral dilemmas) can be solved through design, by relying on a value-sensitive approach

We apply this approach to the ethical issue of how to design autonomous driving systems for reducing light pollution and realizing a better balance between lighting and darkness. In later Sections (6.3, 6.4) we spell out in more detail what this proposal precisely amounts to, while in this section we elaborate on the two key methodological suggestions we rely upon: looking at varieties of automation (not only at full automation), and taking seriously a pro-active design for values approach. These two issues, discussed in the remainder of this Section, establish the technical and theoretical foundations for the “driving in the dark” scenarios presented below.

6.2.1. Varieties of automation

Ethical debates often focus on “driverless” or “self-driving” cars – in other words, fully autonomous vehicles. However, such debates often jump to a hypothetical endpoint of both technical development as well as social and institutional adoption of this new technology. Thus, these are simplifications that a comprehensive ethical approach – with an attention to the full range of values at stake in the development of technology, *as well as* maintaining relevance to the real world of technology and policy – cannot afford. Therefore, before engaging in any ethical reflection on autonomous vehicles we should be clear on at least two issues: what different levels of automation are possible, and, what reasonable timelines for their adoption would be.³⁰

According to a standard taxonomy, SAE International standard J3016 (SAE 2016), vehicle autonomy ranges from 0 – no automation, to 5 – full automation

³⁰ Other factors to be included in a comprehensive analysis would be ownership and business models (see ITF Roundtable 2016).

with the autonomous driving system controlling all aspects and modes of driving. A key distinction in the taxonomy is between level 2 and 3, when the autonomous system takes over an entire “dynamic driving task.” However, at level 3 the human driver still has a responsibility to intervene at the request of the system. In levels 4-5 – “high automation” and “full automation,” respectively – this is no longer the case. Levels 4 and 5 are also called higher-order automation, insofar as “the driver no longer has to monitor the vehicle or system continuously” (Beiker 2016, p. 194). However, a critical difference is that whereas in level 5 the vehicle can drive autonomously under all scenarios – mixed traffic, city centers, highways, parking, high and low speed roads etc. – at level 4 vehicles can only drive without human supervision in specific scenarios, for instance highways and parking lots.

Ethical literature focused on dilemmatic scenarios typically take level 5 vehicles as a given – “driverless cars” operating in mixed traffic scenarios and interacting with different sorts of road users (e.g., non-autonomous vehicles, motorized bikes, pedestrians) in various driving scenarios (highways, urban roads, country roads). However, notwithstanding the recurrent claims in the media that driverless cars “are coming,” and although some in the car industry cite 2020 as a target date for fully autonomous vehicles, scientific researchers tend to be more cautious. An expert and enthusiast pioneer in vehicle automation like Steven Shladover (2016) is sceptical that full automation (level 5) will happen anytime before 2075; however he believes that level 4 as defined by SAE (full automation for limited tasks) will likely be possible in the next decade. For example, he believes that autonomous valet parking and autonomous freeway systems will be realities within 10 years (which form the basis of our two case studies in Section 6.4). However, once the technology is available, there are still questions regarding the rate of consumer adoption, as well as necessary policy and institutional changes. According to Beiker (2016), in a scenario of continuous technological (and market) evolution, it would likely still take at least 15-20 years for there to be a significant share of cars in operation with higher-order automation (even though more niche-based innovations like autonomous taxis might take hold more quickly).³¹ The Netherlands Institute for Transport Policy Analysis (KiM) predict a similar

³¹ Beiker (2016) bases this prediction on the timeline of adoption of other new features introduced in the past, such as ABS, and that vehicle fleets are typically replaced over a 20-year period.

trajectory, expecting a full transition to high-automation occurring around 2060-2100 (KiM, 2015).

In this chapter we assume that while full automation (level 5) is not likely to happen on a large scale in the near future, automation under limited conditions (level 4) is likely to be achieved and in use within the next 15-20 years. Therefore, we should investigate the various societal opportunities (and risks) that less-than-fully autonomous vehicles may bring. This puts an added emphasis on asking what sorts of ethical issues can arise during the transition period towards higher-level automation. As we argue in the next section, by being aware of the various possible scenarios and their respective opportunities we can steer the future of vehicle automation in a desirable direction, by designing autonomous vehicles and surrounding infrastructure according to social and environmental values.

6.2.2. Steering the future: design for values

Accepting that the future of autonomous vehicles is open, and that different scenarios for development and adoption can unfold, this future becomes one influenced by the choices of actors within all kinds of technical and social processes, including industry, governance, economics, and politics. Rather than retroactively observing how these choices and processes eventually realize specific scenarios, we assert that social and environmental values should guide a process of pro-actively creating scenarios that comply with these goals. From an engineering perspective, this idea of including values in the design of technology may seem counterintuitive, since engineering design has traditionally viewed new products or technologies as value-neutral, developed only on the basis of functional requirements. However, from the perspective of (consumer) product development, and fields such as architecture and fashion design, values are standard elements that co-shape design processes. For example, cars are already designed not only for enabling transportation with a specific speed, but also for expressing personality, style, wealth, masculinity, etc. Likewise, various requirements for a wide range of engineered products and services, such as safety and sustainability, are in fact value-laden concepts deeply embedded into the design process.

There are roughly two ways in which social and environmental values can be injected into the design of technologies. The first is to take identified values as *constraints* to design. Designers should actively explore whether the new product

or technology could violate or come into conflict with the values of stakeholders. If so, designers should adjust the design of the product or technology such that these conflicts are avoided. The *value-sensitive design* method developed by Friedman et al. (2006) follows in part this more precautionary, constraint-oriented approach.

Alternatively, social and environmental values can be articulated as requirements within the design process, alongside functional requirements. In this way, values are not only constraints against which designs should be checked, but also targets that immediately co-define the product or technology under development. For example, the design of a new bridge in a city can be seen as a project aimed at meeting functional requirements, such as allowing specific traffic flows, as well as at realising values such as expressing the innovative character of the city, or inclusiveness by also allowing pedestrians and cyclists to use it. This more integrated approach is developed under the heading of *design for values* (van den Hoven 2007, 2013b; van den Hoven et al. 2015).

Here we follow the latter design for values approach. The openness of the development of autonomous driving systems, combined with their potential to fundamentally transform transportation networks, creates a unique and pivotal opportunity to include social and environmental values as design criteria. This approach then leads to the question: *what values should be incorporated into the design of autonomous vehicles and surrounding infrastructure?*

6.3. The function and morality of nighttime lighting

Within this more comprehensive ethics of autonomous vehicles, a careful articulation, and justification, of values worth pursuing becomes an important task. Here, we zoom in on one particular set of values (and one particular technological domain) that has yet to receive critical attention, but for which the introduction of high-automation vehicles introduces important possibilities: nighttime lighting. It is worth restating that by focusing on nighttime lighting we are not suggesting that this is the only, or the most important or urgent, value to be pursued by the design of future autonomous vehicles. We just claim that this is *one* value, among others, for which autonomous driving systems can and should be designed for, and thus taken as a *prima facie* consideration.

A recent editorial in *Lighting Research & Technology* hints at the impending impact of autonomous vehicles by highlighting the existential crisis facing streetlights:

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It is predicted that by 2040 most vehicles sold will be autonomous. This raises an interesting question. If there is no driver who needs to see the way ahead, is the rationale for providing much road lighting gone? The potential represented by these impending technologies suggests to me that now would be a good time for all those involved in road lighting to ask themselves some fundamental questions. What is the purpose of road lighting? If it is no longer necessary to allow drivers to see where they are going, what is it for? (Boyce 2016, p. 787)

While in Section 6.2 we offered a critique of the timeline proposed by Boyce, as well as clarified what sorts of autonomous tasks may soon be realized, this call to action nevertheless signals a need to elucidate the values informing the “fundamental questions” driving the future need and function of streetlights. This means extending technical and moral discussions of autonomous vehicles to include the impacts of (transportation-related) nighttime lighting, and vice versa. Considered in tandem, we can take first steps towards articulating a design for values approach that weaves together autonomous vehicles and nighttime lighting.

6.3.1. Light pollution and the value of darkness

As Boyce’s (2016) editorial notes, autonomous vehicles can fundamentally disrupt tacit assumptions about the necessity of our transportation-based nighttime illumination. We can thus consider what issues and values are affected by nighttime lighting, and how the design of autonomous vehicles (and surrounding infrastructure) can work to address these concerns. One such concern is the adverse effects of artificial light at night, known as *light pollution*. The concept of light pollution was popularized in the 1970s to describe and categorize the adverse effects of artificial nighttime lighting, and has since emerged as an important environmental concern of the 21st century (see Chapter 2). Gallaway (2010, p. 72) defines light pollution as “the unintended consequences of poorly designed and injudiciously used artificial lighting.”

In the USA, approximately 30% of outdoor lighting is considered to be “wasted,” estimated to cost upwards of 7 billion US dollars per year. Furthermore, eliminating this excess lighting could have the same reduction in CO₂ emissions as removing ~9.5 million cars from the road (Gallaway et al. 2010). An estimate of the excess and wasted nighttime lighting in the EU puts the costs at over 5 billion Euros per year (Morgan-Taylor 2014). In addition to the financial costs and energy usage, artificial lighting at night has negative affects on human health, as well as wildlife and ecosystems (e.g., Gaston et al. 2015;

Longcore and Rich 2004; Pottharst and Könecke 2013). And, ever-present *skyglow*, perhaps the most pervasive effect of light pollution around urbanized regions, is increasingly hindering access to the night sky and its features – something that is argued to be of immense cultural value (e.g., Bogard 2013; Gallaway 2014).

Acknowledging that light pollution is an important issue in its own right, and intertwined with larger societal concerns (e.g., sustainability and climate change), we have a moral obligation to work towards eliminating, or at least mitigating, the above adverse effects. Existing efforts to curb the light pollution include ordinances at local, national, and even trans-national levels, with goals of emissions reductions, energy (and cost) efficiency, and in some cases dark sky protection.³² There are also efforts focused on proper technical standards for lighting fixture, colour temperature, and brightness (e.g., IDA-IES 2011). And, in recent years “dark sky reserve” programs have emerged, aimed at the protection and conservation of wilderness areas or national parks with minimal light pollution (Meier 2014). Such efforts are important and have led to successes in both curbing light pollution and raising public awareness. However, much of the developed world continues to get brighter, and this trend is expected to further increase with the widespread adoption of LED streetlights (Falchi et al. 2016; Kyba et al. 2017). Continued efforts are therefore needed, including proposals for more radical or transformative changes. We must consider longer-range ideas to effectively “design out” many of the causes of light pollution in ways that are, in the formulation of van de Poel (2016), both morally acceptable and socially accepted; that is, that can reduce negative effects without hindering the desirable and necessary aspects of nighttime illumination.

In efforts to seek out more radical or transformative strategies to nighttime lighting, it is useful to also seek out new moral frameworks – to elucidate underlying judgments and re-frame the problem at hand. Shaping concerns about light pollution is an important shift in how we perceive and evaluate darkness at night. Historically seen as evil, chaotic, and dangerous, darkness is increasingly seen as something of positive environmental and cultural value (Bogard 2013; Edensor 2017). As explained above, we apply a design for values approach, seeing values not only as constraints against which designs should be checked, but also goals that co-define the product or technology under

³² For an overview of existing nighttime lighting ordinances, see the online appendix to Kyba et al. (2014).

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development. In order to do so, we will first elucidate the valuable-ness of darkness, second explore how it can offer a better way forward to address concerns about nighttime lighting, and finally see how these concerns can inform the development of autonomous vehicles.

For this task, we utilize the framework developed in Chapter 4 to understand the value of darkness. The commonly recognized effects of light pollution are re-framed as nine ways by which, or through which, value is derived from darkness. From these nine values, *prima facie* obligations are derived as principles to be considered in the design of nightscapes, even if not achievable in every case (see Table 4.2, p. 83). Categorizing the values of darkness as such establishes a comprehensive set of design goals for urban nighttime lighting, going beyond mitigating “polluting” effects to fundamentally reconsider how and why we light our nights. As a normative framework the value of darkness can therefore go much further than light pollution, allowing for a re-evaluation of *all* nighttime lighting, and ultimately offering more drastic energy and cost savings. Importantly, this framework does not rest on a total de-valuing of lighting at night, but rather on an appreciation of natural nighttime conditions and the potential created by an attentive and restrained use of artificial lighting.

6.3.2. Designing for darkness

Despite a lack of recognition, street lighting and vehicle lights combine to create one of the largest sources of illumination at night, and therefore should be seen as a pressing environmental issue (Lyytimäki et al. 2012). One needs only to view an aerial photo (at the scale of cities, nations, or even continents) to observe the presence of transportation-related lighting, as illuminated grids and lines carving through the landscape. The car-focused lighting strategy of the 20th century can be acknowledged (Isenstadt 2014), and general numbers exemplify the scope of the opportunity. According to the International Energy Agency (2006), globally there are more than 100 million streetlights, using approximately 114 TWh of electricity annually. Parking lots use an estimated 55 million additional lights in OECD countries alone, consuming an additional 88 TWh of electricity in 2005. Taken together, street and parking lot lighting combine to constitute over 90% of outdoor illumination (International Energy Agency 2006). In the European Union, lighting accounts for 14% of total energy consumption; of that, approximately 14.7% is outdoor stationary lighting, which are mainly streetlights. Globally, almost one-fifth of all electricity produced is

used for lighting, of which approximately 8% is outdoor stationary lighting (De Almeida et al. 2014). Another area of impact is the vehicle lights themselves. It is estimated that each year over 55 billion litres of gasoline or diesel is used to operate vehicle lights, equating to about 3.2% of total vehicle fuel use, and equivalent to the consumption of over 1 million barrels of oil daily (International Energy Agency 2006).

In sum, an important domain for intervention has been identified. And, the development of autonomous vehicles provides a unique and momentous opportunity to seek out designs that address, among other things, concerns about light pollution and darkness. This can be done in a weak and a strong way. First, future autonomous vehicles must, at the very least, strive to *reduce* the adverse effects and costs caused by transportation-related illumination. Given the ties to efficiency and sustainability (financial gains, greenhouse gas reductions, etc.), as well as likely health and ecosystem benefits, there is no moral justification for omitting consideration of this design requirement. The degree to which light pollution can be reduced, and if this may compromise other desired goals, are additional questions outside the scope of this discussion. For instance, a position often taken is that nighttime lighting increases safety and should therefore be extended rather than be reduced.³³ We acknowledge the importance of such questions, yet take the position that they should not block the adoption of light pollution concerns as a *prima facie* requirement in the development of autonomous driving systems.

A second, stronger claim, although more bold and visionary, can be derived from a design for values approach: future autonomous vehicles and surrounding infrastructure should actively seek to *promote* the value of darkness. The transformative potential of higher-automation vehicles offers an opportunity to fundamentally re-consider how (and why) we light our nightscapes. We can supersede the vehicle-focused lighting of the 20th century in favour of alternative design strategies that bring some darkness back into our lived spaces. The effects can be far reaching, ranging from lighting that is more attentive to pedestrian and cycling traffic, to more intimate and convivial urban spaces, to ecologically-oriented “dark design” (Edensor 2017), to re-envisioning ideas of the nocturnal sublime within urbanized areas (see Chapter 3). As mentioned above, such an approach does not imply a goal of eliminating *all* nighttime lighting, but

³³ The relationship between lighting and safety (both perceived and actual) is outside the scope of this chapter, but for overviews of the debate see for example Gaston et al. (2015) and Pottharst and Könecke (2013).

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a better balance of light and dark that is attentive to functional needs and environmental values. In sum, we can work towards achieving what Edensor (2015, p. 436) poetically describes as a “re-enchantment of the night” via a conscientious re-introduction of urban darkness.

6.4. Realizing darkness with autonomous vehicles

In this section we move forward with the bolder position articulated above, and ask: if darker nights is a goal of autonomous vehicles and surrounding infrastructure, then how would this steer future innovation? What scenarios and related design requirements would eliminate much of the need for transportation-focused streetlights, thus allowing for a drastic reduction in light pollution and a conscientious re-imagining of (urban) darkness? What does this mean for the design choices for autonomous vehicles themselves, as well as surrounding infrastructure and institutions? Such questions are complex, requiring technical, moral, legal, policy, and design work for a full answer. Here we endeavour to take first steps by providing a preliminary sketch of what such a path forward would entail.

If we accept the timeline of technology development and adoption as laid out in Section 6.2, then we can expect that level 4 automation – where the system has full control for limited tasks – will be available within the next decade, and market saturation may occur over the coming 20-30 years. These tasks, though limited, provide an important and quick testbed for the viability of *driving in the dark* scenarios, and represent “low hanging fruit” for immediate positive effects. We therefore sketch two scenarios that are candidates for full automation in the near future: parking lots and highways. Building on the similar scenarios proposed by Wachenfeld et al. (2016), we add the potential for substantial, and relatively immediate, positive impact towards the creation of darker nights. Both have a singular functionality and are primarily used by vehicles, thus avoiding issues such as pedestrian and cyclist interactions. Equally important, their lighting is singularly focused on vehicle usage, with little or no ancillary benefits (aesthetic, social, etc.), meaning that a drastic reduction would have minimal impact on other nearby types and uses of illumination or nighttime activities. Following these two case studies, we briefly consider what design requirements this would impose on autonomous vehicles themselves.

6.4.1. Scenario 1: Parking in the Dark

For the first scenario, we build on the use case “Autonomous Valet Parking” described by Wachenfeld et al. (2016, pp. 14-16). As the name indicates, the autonomous system acts as a personal valet for your vehicle. You exit the vehicle at your destination, input a nearby parking lot for the system, and the vehicle parks itself. Similarly, you would indicate a pick up location (similar to ride-sharing services) and the vehicle would come pick you up. Such a scenario typically means a short driving distance for the autonomous program (and in cases such as shopping malls, driving only within the parking lot itself), low speeds, and lighter traffic. Hence, this can be seen as an introductory scenario of level-4 automation for (personally-owned) vehicles.

The value-add to this scenario we propose is that parking lots designated for autonomous valet parking no longer require constant illumination. This would be cost-saving for the owner and reduce energy consumption. It would greatly decrease light pollution, especially if this could be introduced in suburban areas around shopping malls etc., where parking lots take up extensive space. With only contingency lighting in place for maintenance, security, and emergencies, the parking lots could be left in the dark. The nature of parking lots also makes the incremental rollout of “parking in the dark” possible – specific lots or sections can be converted gradually, based on demand. Thus in the short term we can imagine designated autonomous parking lots that are darkened, with this trend spreading if autonomous parking becomes the norm in future generations of vehicles, *and* if dark parking gains support and public acceptance.

Overall, this scenario is seen as having high impact potential – recall that globally there are more than 55 million lights used for parking lots (International Energy Agency 2006). Furthermore, it can be applied in a variety of settings – commercial areas, urban downtowns, suburban and residential areas, etc. – allowing for a wide distribution of impact and benefits. It may create new concerns about crime, although dark campus programs have reportedly seen reductions in vandalism through reduced nighttime illumination (Henderson 2010). Even so, it would still necessitate new protocols for security, as well as safety considerations regarding barriers to entry or some form of technology-supported surveillance such as infrared cameras or alarm sensors (especially in areas where pedestrian traffic is close by).

6.4.2. Scenario 2: Dark Highways

For this second scenario, we draw on the use case described by Wachenfeld et al. (2016, pp. 12-14) of “Interstate Pilot Using Driver for Extended Availability.” In this scenario, once the vehicle has entered the highway the driver can – or must – activate the robot and relinquish driving responsibilities. After a destination is entered, the autonomous system will take over navigation, guidance, and control of the vehicle. At the pre-determined off-ramp or exit, the autonomous system coordinates a safe handover, with backup emergency procedures if the driver is unresponsive. Important to note is that “highways” here is used to describe a broader typology of roadways, which are given different names in different (social and use) contexts: freeways, interstates, expressways, etc. However, the common characteristics of these roadways are most important. First, they are used exclusively for high-speed vehicle traffic. Second, access is only possible by special connecting elements, such as on/off ramps (Wachenfeld et al., 2016). This means they will be devoid of pedestrians and cyclists, as well as intersections. Despite their high speeds, the simple surroundings, driving tasks, and minimal “dynamic objects” means that this can be considered as an introductory use case for autonomous systems (Wachenfeld et al. 2016).

Similar to the scenario above our value-add is straightforward, proposing that highways would no longer require lighting, save for on/off ramps and emergency situations. While promising, the adoption of darkened highways presents more complications than the dark parking scenario above. First, it would require that *all* vehicles on the road use autonomous systems; so long as one car has a human driver, all lights are required. Thus, a high level of market saturation, combined with regulatory changes to vehicle requirements, would be required. A second issue would be user acceptance, as this would be a somewhat radical change in driving habits. One can imagine some initial hesitation to being a passenger in an autonomous vehicle travelling 120 km/hr with no lights above, no headlights, and no brake lights! Yet these concerns, though certainly well grounded, are not insurmountable. We have seen the widespread adoption of train and airplane travel, where passengers have eventually come to simply rely on the system to safely bring them to destinations, even if they cannot control or even see what is happening in front of the vehicle. Thus, such concerns do not make darkened highways immediately untenable as an ambitious medium-term goal, and the potential reduction to nighttime lighting offered by such scenarios is great enough to warrant further investigation. Certainly, in line with our design for values approach, this initial *normative*

proposal should be integrated with empirical research into users' behaviour and responses.

6.4.3. Design requirements for dark-driving autonomous vehicles

For these and other possible *driving in the dark* scenarios, a final consideration is the development of autonomous vehicles themselves. When adopting the value(s) of darkness as a design goal, it may seem obvious that efforts towards their realization should directly focus on the brightly lit and extensive road systems, and in a subsidiary way to adaptations of the vehicles for which the roads are meant. Yet, a simultaneous focus on the re-design of the vehicles is also required. For example, efficiency in car lighting is beneficial to increasing the distance cars can drive, establishing a link to the instrumental values of efficiency and sustainability, something particularly relevant for the introduction of electrical vehicles. Also in this respect it should be emphasized that here we are making general *normative* proposals for what should be integrated into the technical and empirical work on autonomous driving systems. Thus, these should simply be understood as initial considerations to be assessed, and if possible integrated, via future technical research.

Towards the goal of formulating general design requirements for autonomous vehicles to function without both streetlights *and* headlights, we can identify a few key considerations (Table 6.1). First, it requires a “higher-order” level of automation – level 4 or higher as per the SAE taxonomy (SAE 2016). This will need to be accompanied by social and institutional changes, for it requires some consideration of when (or if) this technology should be “grandfathered” into new vehicles by laws and regulations, and a timeline for turning off lights in parking lots and especially highways. Both scenarios would also require a re-design of transition zones as well as safety and emergency protocols. Another important consideration is the development of sensor technologies and navigation systems. Our proposal requires a continuous investment in systems that require little or no lighting to navigate at night, such as on LiDAR (“light detecting and ranging”) technology coupled with maps, GPS, etc. This can potentially allow autonomous systems to drive in total darkness, as evidenced in an early test by Ford (e.g., Burgess 2016; Korosec 2016). Designing for low-light navigation will undoubtedly raise new technical challenges, for example how to detect traffic signs and lane markings. And, how to detect unexpected objects such as debris or wildlife – an especially important

issue for highway safety. Further, the required technologies may be financially prohibitive in their current form. But again, this does not detract from our assertion that this *should* be one explicit design goal during the current development phase, in order to explore what possibilities are technically, financially, and socially achievable, and at what scale.

A more general design consideration is the new user experiences that can be offered by driving in the dark. Cars are often framed as means to give people freedom and access to natural settings, which can hypothetically find its way into the design of cars through features like panoramic transparent roofs, allowing passengers to enjoy natural landscapes and nightscapes. Switching off the lights would substantially increase experiences of the wonder and beauty of the starry night sky, further fostering the intrinsic goods of darkness (see Chapter 4, Sections 4.4 and 4.5).

Table 6.1. General design considerations for autonomous driving systems to operate in the proposed “driving in the dark” scenarios (Sections 6.4.1. and 6.4.2.)

Vehicle Feature	Design Considerations
Level of automation	Requires the development and adoption of “higher-order automation” – level 4 or higher as per SAE taxonomy
Sensor technologies	Requires a continuous investment in sensor technologies that require low or no lighting to navigate at night, such as LiDAR (“light detecting and ranging”) technology, coupled with maps, GPS, etc.
Associated social/institutional changes	Requires some consideration of if or when this technology should be “grandfathered” into new vehicles by law, and a timeline for turning off lights in parking lots and on highways; both would require a re-design of transition zones and safety protocols

6.5. Conclusion

In this chapter we proposed that the development of autonomous vehicles should incorporate, among other things, the ethics of nighttime lighting. At the least, autonomous vehicles should be designed to reduce the adverse effects of light pollution. More radically, they can strive to create darker nights and play a role in re-imagining urban nightscapes. In support of this proposal, we argued

for a moral assessment of autonomous driving systems that is broader than the dilemmatic life-and-death questions of trolley problem-style situations. Instead, we showed that autonomous vehicles are a technology that is currently under development, rather than finalized, and that this technology should be developed in tandem with its underlying infrastructure. A *design for values* approach to engineering ethics, in which values are pro-actively incorporated into technologies during their development phase, opens up a range of potential issues that can – and we believe should – be addressed in both the design of autonomous vehicles and their surrounding physical and institutional infrastructure. Here we introduced and explored one such issue in detail: streetlights and the negative impacts of nighttime lighting. To address this, we gave two cases in which autonomous driving systems can be designed for darkness. These cases concerned autonomous valet parking, which would make the lighting of parking lots redundant, and darkened highways, which would substantially reduce the lighting of urban and suburban nightscapes. In sum, the open future of autonomous driving systems allows for a reconsideration of why, and how, to light our world at night.

The scenarios above should not be seen as definitive, but rather starting points for incorporating the ethics of nighttime lighting into a broader ethics of autonomous driving systems. And considered otherwise, it shows how autonomous vehicles, as one example of an emerging technology with profound transformative and disruptive potential, can be inserted into discourse on nighttime lighting. While the development of future roadways may not necessarily adopt these (or similar) scenarios in full, they must at least take this as a *prima facie* consideration in the development process. Future research should address the technical and financial feasibility of these scenarios, as well as study the possible social and psychological resistance to their implementation.

Future research should also consider what new ethical problems could arise if our proposals are adopted. Winner (1980) famously showed the embeddedness of politics in infrastructure by arguing that New York highway overpasses were explicitly made too low for public buses. This prevented public transportation from reaching certain locales, with the goal of hindering access to racial minorities and people of lower socio-economic status. One could similarly imagine that the proposals discussed in this chapter inadvertently contribute to a similar scenario, where affluent areas or access roads are pro-actively darkened, therefore requiring high-automation vehicles and potentially limiting access

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based on socio-economic status. Hence, if “driving in the dark” scenarios are to be adopted, the landscape of potential ethical and political impacts must continually explored alongside technological innovation. What is now needed is an iterative process for if (or how) the value of darkness gets incorporated into autonomous driving systems, and how it fits into the broader ethical framework outlined in Section 6.2.

If the general argument is accepted, a follow-up question is then what other social and environmental issues should be considered during the development phase of autonomous vehicles. This requires a careful consideration of both institutional (e.g., ownership models) and physical (e.g., the design of mixed-use urban centers) infrastructures, as well as new issues created by autonomous systems, such as data security. And, this could lead to a re-design of various services that make use of vehicles (e.g., ambulances, garbage pick-up, or package deliveries). Put more bluntly, ethicists must continue to critically and creatively explore what a future of “driverless cars” can, and should, entail.

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Summary

Nighttime lighting is arguably one of the most influential and transformative modern technologies. Innovations to lighting technologies and their subsequent proliferation throughout the 19th and 20th centuries have been foundational to contemporary urban nightscapes – literally carving space and time out of darkness, and shaping nighttime behaviours and activities. Despite the formative power of artificial lighting, we often take our abundance of illumination for granted. However in recent years, a growing body of literature has begun to analyze the far-reaching influences of artificial illumination, as well as the values and practices with which this technology is intertwined. These interdisciplinary studies position lighting technologies as shaping, and being shaped by, socio-political contexts, urban development, commercial activities, and modern city life. Nighttime lighting is thus examined as a cultural phenomenon with profound environmental, political, economic, behavioural, and aesthetic ramifications.

This dissertation contributes to discourse on artificial illumination via an explicitly normative investigation into the ethics and aesthetics of urban nighttime lighting. Specifically, I draw attention to a topic of growing importance: the relationship between environmental values and urban nighttime lighting. Commonly referred to as light pollution, the negative effects of artificial light at night are increasingly identified as a crucial environmental issue for the 21st century. Nighttime lighting uses enormous amounts of energy, wastes billions of dollars annually, is detrimental to human health and ecosystems, and cuts off access to a starry night sky. Addressing these costs and effects, and more fundamentally understanding the values shaping discourse, is a complex and pressing challenge with moral, aesthetic, political, and technical dimensions. Further, the rapid introduction of new lighting technologies – namely LEDs and “smart” systems – adds urgency to the need for practical and effective solutions. This dissertation takes up this challenge by exploring how to incorporate environmental values into the design of future urban nightscapes, while still appreciating the social and aesthetic functions of nighttime illumination. It does so by moving discourse in a new direction: a design-oriented approach focused on darkness.

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The collection of papers that make up this dissertation are theoretical, analyzing the concepts and values shaping, and shaped by, urban nighttime lighting, as well as practical, proposing forward-looking strategies for responsible urban lighting. It is argued that light pollution is an insufficient problem frame, due to its narrow applicability, ambiguity, limited effectiveness, and constraint-oriented approach. Following a *design for values* orientation, this dissertation instead works to actively re-frame the problem, starting with understanding how and where environmental values manifest in our nightscapes. On both theoretical and practical grounds, I argue for a move away from the concept of light pollution and towards a focus on *darkness* – as a locus of environmental value in nightscapes, and as a design criterion for nighttime lighting. Through developing a *designing for darkness* approach, the possibilities of urban nighttime lighting strategies informed by, and supporting, environmental values are actively re-imagined. By articulating darkness as a design goal, it is possible to address the concerns foundational to light pollution, overcome its limitations, and in the process more fundamentally re-imagine the future of urban nights.

To address the environmental impacts of artificial lighting, darkness is conceptualized via three interrelated facets: as an evaluative tool, as a quality of lived experiences, and as a contextualized phenomenon. Through understanding darkness in this way, a framework for incorporating environmental values into urban nighttime lighting is put forward. As a moral and aesthetic goal for responsible urban lighting strategies, it relies on three core principles:

- (1) Lighting strategies should, as a *prima facie* goal, work to preserve, protect, and promote the value(s) of darkness
- (2) Lighting strategies should create the conditions for positive experiences of urban darkness, and in particular dark skies
- (3) Darkening cities should be utilized as a form of urban (ecological) restoration, for both its instrumental benefits and the possibility of reconnecting cities with an ecological and cosmological sense of place

The dissertation progresses in three interrelated steps. The first is a critical look at the concept of light pollution and its shortcomings as a guiding framework (Chapter 2). Second is a largely theoretical discussion of darkness, laying the conceptual groundwork for an alternative approach to urban lighting (Chapters

3-4). Third is an application of the framework via two cases of new and emerging urban technologies (Chapters 5-6).

Chapter 2 takes a critical look at light pollution, a concept gaining importance and acceptance in environmental discourse. In particular, it analyzes the moral implications of utilizing the concept of light pollution as a problem frame. After examining the origins of the term and contemporary definitions, it is argued that the applicability of light pollution is limited due to its narrow focus on the negative impacts of lighting. Further, it is difficult to use as a decision-making tool due to the ambiguity of thresholds for determining “polluting” lighting, as well as the criteria for establishing said thresholds.

Chapter 3 is a theoretical exploration into the normativity of contemporary urban nightscapes. It examines the aesthetic dimensions of urban and natural nightscapes, and the resultant impact on how we perceive and evaluate nighttime lighting. It is argued that competing notions of the sublime, derived from artificial illumination and the natural night sky respectively, reinforce a geographical dualism between cities and wilderness. To challenge this spatial differentiation, recent work in philosophy of the city, as well as environmental aesthetics, are utilized to envision the moral and aesthetic possibilities of a new urban *nocturnal sublime*. A key theme of this proposal is a re-positioned perspective on urban darkness.

Chapter 4 builds on the critical and conceptual discussions above to present an alternative moral framework for urban nighttime lighting. In doing so, it offers a first comprehensive analysis of the environmental value of darkness from within applied ethics. A *design for values* orientation is utilized to conceptualize, define, and categorize the ways in which value is derived from darkness. Nine values are identified and categorized via their type of good, temporal outlook, and spatial characteristics. These nine values are then translated into *prima facie* moral obligations that should be incorporated into future design choices, policy-making, and innovations to nighttime lighting.

Chapter 5 examines the ethical dimensions of a critical urban infrastructure: streetlights. Recent developments to lighting technologies, namely LEDs and “smart” systems, are spurring a new generation of streetlights, with retrofits being rapidly undertaken around the world. While they may offer substantial energy savings, their long-term environmental effects are still under debate. The confluence of technological innovations with the increasing recognition of environmental impacts creates new challenges, but also an opportunity to envision and enact new strategies. For this, *designing for darkness* is presented as

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a value-sensitive framework that incorporates both substantive environmental values and meaningful nighttime experiences into the next generation of streetlights, without compromising the instrumental benefits of new innovations. First steps are taken to explore how this framework can be operationalized within smart LED lighting systems, and three design concepts are put forward as a means to create darker urban nights.

Chapter 6 takes a more radical look at the possibilities of *designing for darkness*. Instead of focusing on lighting technologies, it explores how a transformative emerging technology, namely autonomous vehicles, may be developed towards the goal of reducing light pollution and creating darker nights. The chapter consists of two interrelated arguments. The first is that autonomous vehicles are still under development and have not acquired their definitive shape, meaning the design of both the vehicles and the surrounding infrastructure is open-ended. Second, it is argued that nighttime lighting – a critical supporting infrastructure – should be a *prima facie* consideration for autonomous vehicles during their development phase. It is asserted that a reduction in light pollution, and more boldly a better balance of lighting and darkness, can be achieved via the design of future autonomous vehicles. Two use cases are examined (parking lots and highways) through which autonomous vehicles may be designed for “driving in the dark.”

Taken together, the chapters of this dissertation weave together a critical investigation and constructive contribution to a pressing urban challenge for the 21st century. The development of *designing for darkness* as a framework offers both theoretical grounding and practical pathways for operationalizing environmental values within responsible lighting strategies.

Samenvatting

Nachtverlichting kan worden beschouwd als een van de meest invloedrijke en transformatieve moderne technologieën. Innovaties op het gebied van verlichtingstechnologie en de daaropvolgende verspreiding daarvan in de loop van de 19e en 20e eeuw zijn van fundamenteel belang geweest voor het hedendaagse stedelijke landschap, door letterlijk ruimte en tijd uit de duisternis te halen en vorm te geven aan nachtelijke gedragingen en activiteiten. Ondanks de formatieve kracht van kunstlicht beschouwen we onze overdaad aan verlichting vaak als vanzelfsprekend. Maar de afgelopen jaren is in een groeiende hoeveelheid literatuur de verstrekkende invloed van kunstlicht geanalyseerd, naast de waarden en activiteiten waarmee deze technologie samenhangt. In deze interdisciplinaire onderzoeken worden verlichtingstechnologieën gepositioneerd als zijnde vormend voor – en gevormd door – sociaalpolitieke contexten, stedelijke ontwikkeling, commerciële activiteiten en het moderne stadsleven. Als gevolg daarvan wordt nachtverlichting beschouwd als een cultureel fenomeen met diepgaande milieutechnische, politieke, economische, gedragsmatige en esthetische implicaties.

Dit proefschrift levert een bijdrage aan de discussie over kunstlicht door middel van een expliciet normatief onderzoek naar de ethica en esthetica van stedelijke nachtverlichting. Daarbij vestig ik de aandacht specifiek op een steeds belangrijker wordend onderwerp, namelijk de relatie tussen milieuwaarden en stedelijke nachtverlichting. De negatieve gevolgen van het gebruik van kunstlicht 's nachts – ook wel lichtvervuiling genoemd – worden steeds meer beschouwd als een cruciaal milieuprobleem voor de 21e eeuw. Nachtverlichting kost een enorme hoeveelheid energie, is jaarlijks goed voor de verspilling van miljarden dollars, is schadelijk voor de menselijke gezondheid en ecosystemen, en maakt de nachtelijke sterrenhemel onzichtbaar. Het tegengaan van deze kosten en gevolgen, en meer fundamenteel inzicht in de waarden die ten grondslag liggen aan de discussie, is een complexe en urgente uitdaging met morele, esthetische, politieke en technische aspecten. Daarnaast wordt als gevolg van de snelle introductie van nieuwe verlichtingstechnologieën – LEDs en 'slimme' systemen – de behoefte aan praktische en effectieve oplossingen nog urgenter. Dit proefschrift gaat deze uitdaging aan door te onderzoeken hoe milieuwaarden

kunnen worden ingebed in het ontwerp van de stedelijke nachtlandschappen van de toekomst zonder de maatschappelijke en esthetische functies van nachtverlichting uit het oog te verliezen. Dat gebeurt door de discussie een nieuwe richting te geven: een ontwerpgeoriënteerde benadering waarbij de nadruk wordt gelegd op *duisternis*.

De verschillende artikelen waaruit dit proefschrift bestaat zijn theoretisch van aard en bieden een analyse van de concepten en waarden die vorm geven aan – en worden gevormd door – stedelijke nachtverlichting, maar zijn tegelijk praktijkgericht, doordat zij toekomstgerichte strategieën bieden voor verantwoorde nachtverlichting in steden. Er wordt betoogd dat lichtvervuiling niet volstaat als kadering van het probleem, gezien de beperkte toepasbaarheid, ambiguïteit, beperkte effectiviteit en op beperkingen gerichte benadering daarvan. Met *design for values* als invalshoek wordt het probleem in dit proefschrift actief geherdefinieerd, beginnend met inzicht in de manieren waarop en de plaatsen waar milieuwaarden in onze nachtelijke omgeving tot uitdrukking komen. Op basis van zowel theoretische als praktische argumenten bepleit ik het loslaten van het concept lichtvervuiling en een sterkere focus op duisternis als locus van milieuwaarden in nachtelijke landschappen en als ontwerpcriterium voor nachtverlichting. Door een benadering op basis van *designing for darkness* te ontwikkelen, worden de mogelijkheden met betrekking tot strategieën voor stedelijke nachtverlichting op basis van, en ter ondersteuning van, milieuwaarden actief geherdefinieerd. Door van duisternis een ontwerpdoelstelling te maken wordt het mogelijk om actie te ondernemen met betrekking tot de fundamentele problemen van lichtvervuiling, de beperkingen daarvan te overstijgen en daarbij op fundamenteeler niveau de toekomst van het stedelijke nachtlandschap te herdefiniëren.

Om de milieueffecten van kunstlicht aan te pakken wordt duisternis geconceptualiseerd op basis van drie onderling samenhangende facetten: als evaluatiemiddel, als kwaliteit van beleefde ervaringen en als gecontextualiseerd fenomeen. Door duisternis op deze manier te beschouwen ontstaat er een kader voor het inbedden van milieuwaarden in stedelijke nachtverlichting. Als morele en esthetische doelstelling van strategieën voor verantwoorde stedelijke verlichting wordt dit gebaseerd op drie basisbeginselen:

- (1) De *prima facie* doelstelling van verlichtingsstrategieën moet zijn om de waarde(n) van duisternis te behouden, te beschermen en te bevorderen.

- (2) Verlichtingsstrategieën moeten de omstandigheden scheppen voor positieve ervaringen van duisternis in de stad, met name een donkere hemel.
- (3) De verduistering van steden moet worden gebruikt als een vorm van stedelijk (ecologisch) herstel, zowel vanwege de instrumentele voordelen daarvan als de mogelijkheid om steden opnieuw te verbinden met een ecologisch en kosmologisch gevoel van plaats.

Het proefschrift doorloopt drie onderling samenhangende stappen. De eerste stap is een kritische beschouwing van het concept lichtvervuiling en de tekortkomingen hiervan als richtinggevend kader (hoofdstuk 2). De tweede is een grotendeels theoretische bespreking van duisternis, waarbij de conceptuele basis wordt gelegd voor een alternatieve benadering van stadsverlichting (hoofdstuk 3 en 4). De derde is een toepassing van dit kader aan de hand van twee gevallen van nieuwe en opkomende stedelijke technologie (hoofdstuk 5 en 6).

In hoofdstuk 2 wordt kritisch gekeken naar lichtvervuiling, een concept dat in milieudiscussies steeds belangrijker en steeds meer geaccepteerd wordt. Met name de morele implicaties van het gebruik van het concept lichtvervuiling als probleemkader worden geanalyseerd. Nadat de oorsprong en hedendaagse definities van de term zijn onderzocht, wordt er betoogd dat lichtvervuiling een beperkte toepasbaarheid heeft als gevolg van de nauwe focus op de negatieve gevolgen van verlichting. Daarnaast is het lastig te gebruiken als besluitvormingshulpmiddel vanwege de ambiguïteit van de drempelwaarden voor ‘vervuilende’ verlichting en de criteria die voor die drempelwaarden worden gehanteerd.

Hoofdstuk 3 is een theoretische verkenning van de normativiteit van hedendaagse stedelijke nachtlandschappen. Hier worden de esthetische aspecten van stedelijke en natuurlijke nachtlandschappen onderzocht, plus de daaruit voortvloeiende gevolgen voor onze perceptie en beoordeling van nachtverlichting. Er wordt betoogd dat verschillende ideeën over sublimiteit, die zijn gebaseerd op respectievelijk kunstverlichting en de natuurlijke nachthemel, een geografisch dualisme tussen stad en wildernis versterken. Om dit ruimtelijke onderscheid te bestrijden wordt recent werk op het gebied van de filosofie van de stad en milieu-esthetica gebruikt om een visie te bieden van de morele en esthetische mogelijkheden met betrekking tot een nieuwe stedelijke

nachtelijke sublimiteit. Een belangrijk thema in dit voorstel is een herpositionering van de invalshoek met betrekking tot stedelijke duisternis.

In hoofdstuk 4 wordt voortgebouwd op de eerdere kritische en conceptuele discussies om een alternatief moreel kader te bieden voor stedelijke nachtverlichting. Daarbij wordt vanuit toegepaste esthetica een eerste complete analyse gegeven van de milieuwaarde van duisternis. Er wordt een benadering op basis van *design for values* gehanteerd voor het conceptualiseren, definiëren en categoriseren van de manieren waarop waarde wordt gehaald uit duisternis. Er worden negen waarden geïdentificeerd en gecategoriseerd op basis van het soort nut dat zij bieden, een temporeel perspectief en ruimtelijke kenmerken. Deze negen waarden worden vervolgens vertaald in *prima facie* morele verplichtingen die moeten worden ingebed in toekomstige ontwerpkeuzes, beleidsvorming en innovaties met betrekking tot nachtverlichting.

In hoofdstuk 5 worden de ethische aspecten onderzocht van een kritiek stuk stedelijke infrastructuur: straatlantaarns. Recente ontwikkelingen op het gebied van verlichtingstechnologie, namelijk LEDs en ‘slimme’ systemen, vormen de drijvende kracht achter een nieuwe generatie straatverlichting, waarvoor wereldwijd vernieuwingen worden aangebracht. Maar hoewel deze ontwikkelingen aanzienlijke energiebesparingen kunnen opleveren, zijn de milieueffecten ervan op lange termijn nog niet duidelijk. Door de combinatie van technologische innovaties en steeds meer aandacht voor milieueffecten ontstaan er nieuwe uitdagingen, maar ook een kans om nieuwe strategieën te ontwikkelen en in de praktijk te brengen. Daarom wordt *designing for darkness* gepresenteerd als een waardegevoelig kader dat zowel substantiële milieuwaarden als betekenisvolle nachtelijke ervaringen combineert voor de volgende generatie straatverlichting, zonder de instrumentele voordelen van nieuwe innovaties tekort te doen. De eerste stappen worden gezet om te verkennen hoe dit kader kan worden geoperationaliseerd binnen slimme systemen voor ledverlichting, en er worden drie ontwerpconcepten gepresenteerd als middel om de stedelijke nacht donkerder te krijgen.

In hoofdstuk 6 worden de mogelijkheden van *designing for darkness* vanuit radicalere invalshoek beschouwd. In plaats van de nadruk te leggen op verlichtingstechnologie wordt hier onderzocht hoe een transformatieve technologie in opkomst – namelijk autonome voertuigen – kan worden ontwikkeld met minder lichtvervuiling en meer nachtelijke duisternis als doel. Dit hoofdstuk bestaat uit twee onderling samenhangende discussies. De eerste behelst het feit dat autonome voertuigen nog in ontwikkeling zijn en nog geen

definitieve vorm hebben gekregen, zodat het ontwerp van zowel de voertuigen als de omringende infrastructuur nog niet vastligt. Ten tweede wordt er betoogd dat nachtverlichting – een kritieke ondersteunende infrastructurele voorziening – *prima facie* moet worden meegenomen tijdens de ontwikkelfase van autonome voertuigen. Er wordt gesteld dat er een vermindering van lichtvervuiling – of krachtiger gesteld: een betere balans tussen verlichting en duisternis – kan worden bereikt via het ontwerp van de autonome voertuigen van de toekomst. Er worden twee *use cases* onderzocht (parkeerterreinen en snelwegen) op basis waarvan autonome voertuigen kunnen worden ontworpen die kunnen ‘rijden in het donker’.

Samen vormen de hoofdstukken van dit proefschrift een kritische verkenning van, en constructieve bijdrage aan, een urgente stedelijke uitdaging voor de 21e eeuw. De ontwikkeling van *designing for darkness* als kader biedt tegelijk een theoretische grondslag én praktische trajecten voor de operationalisatie van milieuwaarden in het kader van verantwoorde verlichtingsstrategieën.

About the Author

Taylor William Stone (1986) was born in Kitchener, Ontario, Canada. As of January 2019, he is a Postdoctoral Researcher at the Department of Industrial Design, Delft University of Technology. He completed his PhD in Ethics of Technology at Delft University of Technology between October 2014 and January 2019. Taylor has an interdisciplinary academic and professional background. He holds an Honours Bachelor of Arts (with Distinction) from the University of Toronto (2008), where he studied architectural design, art history, and environmental ethics, and a Master in Environmental Studies from York University (2011). Before beginning his PhD, Taylor worked as a project manager for an environmental non-profit organization, where he developed and led community programs and urban policy initiatives. He has also organized a student design competition, and worked and taught at OCAD University (Toronto).

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Simon Stevin (1548-1620)

‘Wonder en is gheen Wonder’

This series in the philosophy and ethics of technology is named after the Dutch / Flemish natural philosopher, scientist and engineer Simon Stevin. He was an extraordinary versatile person. He published, among other things, on arithmetic, accounting, geometry, mechanics, hydrostatics, astronomy, theory of measurement, civil engineering, the theory of music, and civil citizenship. He wrote the very first treatise on logic in Dutch, which he considered to be a superior language for scientific purposes. The relation between theory and practice is a main topic in his work. In addition to his theoretical publications, he held a large number of patents, and was actively involved as an engineer in the building of windmills, harbours, and fortifications for the Dutch prince Maurits. He is famous for having constructed large sailing carriages.

Little is known about his personal life. He was probably born in 1548 in Bruges (Flanders) and went to Leiden in 1581, where he took up his studies at the university two years later. His work was published between 1581 and 1617. He was an early defender of the Copernican worldview, which did not make him popular in religious circles. He died in 1620, but the exact date and the place of his burial are unknown. Philosophically he was a pragmatic rationalist for whom every phenomenon, however mysterious, ultimately had a scientific explanation. Hence his dictum ‘Wonder is no Wonder’, which he used on the cover of several of his own books.