THE LIGHTING DESIGN PROCESS

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Executive Summary

The purpose of this paper is to enlighten the construction industry regarding the increasing complexity of modern lighting design and its importance to the overall building design and construction process. A review of the Lighting Design Process from the Illuminating Engineering Society of North America (IESNA) Design Guide 7-1994 reveals how the lighting designer must function simultaneously as an engineer, artist, code expert, project coordinator, collaborator, administrator, advocate, and evaluator. According to the IESNA, the lighting designer is active throughout a project's programming, schematic design, design development, construction documentation, bidding, construction administration and post-occupancy phases. A competent lighting designer will be adept at both interior and exterior lighting. Current code trends indicate that lighting designers will soon need to become experts at designing daylight responsive lighting as well. A lighting designer must juggle the following responsibilities:

- energy code, building code, and life-safety code compliance
- achieving sustainability goals
- product selection and specification
- preparation of construction documents
- illumination target levels surveillance
- submittal review
- site construction surveyance
- economic analysis
- resolution of construction issues
- design integrity vigilance
- client requirements advocacy
- coordination of lighting vendor involvement

All the hats that a lighting designer wears and corresponding tasks that are juggled beg the question: "If a lighting designer doesn't perform all of these crucial tasks on a building project, exactly who will?" There was a day not too long ago when it was appropriate for contractors or architects to fulfill such a role, but the rapidly changing contours of lighting design demands that a professional be assigned to the myriad roles and duties inherent to good lighting design. Lighting design has grown so much in complexity over the years that the lighting industry and the U.S. General Services Administration (GSA) have recognized the necessity of an independent validating organization such as the National Council on Qualifications for the Lighting Professions (NCQLP) to test and certify practitioners. More information regarding NCQLP can be found on their website. An NCQLP Lighting Certified (LC) designer is more likely to possess the relevant knowledge base, vendor network, and expertise to successfully illuminate a project's built environment. This paper will explain what the lighting design process entails, what a lighting designer does, and the importance of a lighting designer's contribution to the overall design and build process.

Introduction

It has been my experience as a lighting designer that most people in the construction industry have a dim view of lighting design. The general sentiment is that lighting design is an expendable extravagance added to the price tag of building construction. In actuality, lighting design is a complex

and indispensible component to the construction process. Lighting design guru James Benya comments on this commonly held misconception regarding lighting design:

> ***"Most companies see lighting not as a necessity but as a commodity. Very little attention is paid to its design – after all, can't the contractor lay out the lighting? Why do we need a lighting specialist? First, businesses need to become more informed about proper lighting design. Combining all five points [of lighting design] and making it look good is not easy; it takes knowledge of both equipment and technique to achieve a good result. Businesses need to either develop or maintain in-house expertise, or hire a specialist, like a lighting designer or daylighting consultant." (Wisconsin Focus on Energy, 2006)***

A compelling argument against the sentiment that "anyone can do lighting design" is the GSA mandate that requires an NCQLP Lighting Certified (LC) designer on all GSA work involving lighting design (2005 Facilities Standards for the Public Buildings Service, P-100, Section 6.8). The United States federal government demands the involvement of a trained professional where lighting design is concerned. If a trained and certified lighting designer is a minimum requirement for GSA work, then it's not too difficult to see the importance of an LC designer in private sector work.

Perhaps we, the practitioners of lighting design, have not done a good job of selling ourselves to the construction industry as a whole. What is lighting design and why does a building project need certified lighting designers? Why should the building owner spend money for lighting design services in addition to standard construction costs?

It's difficult to explain to the man on the street why good lighting design is essential to the built environment and why a professional is needed to do it right. One of my lighting design professors once quipped: "Architecture poorly lit is poor architecture." His maxim is a forceful reminder that nothing argues better for good lighting design than bad lighting design. This paper aims to promote an appreciation for lighting design services within the construction industry. I intend to do this with an extensive overview of the lighting design process. By describing all that a lighting designer accomplishes during the course of a project, I hope to show the value of a client's financial investment in lighting design performed by LC practitioners.

Background

Let's begin by broadly defining lighting design. In order to do so, the history of the building industry needs to be considered. In relative terms, lighting design is the new kid on the block in the construction industry. This might be one reason why the construction industry balks at acknowledging the importance of lighting design in the building process. The following quote from noted lighting designer Randy Burkett illustrates the relative newness of the lighting design discipline:

> ***"The profession of lighting design is a relatively young discipline among the building design and construction fields. Although lighting has certainly been an integral component of the built environment for centuries, its only emerged as a true design specialty in the last 20 to 30 years…Once considered an obscure consulting niche or high-budget luxury, lighting design has become an accepted discipline in the project design process in many parts of North America and Europe. " (EC&M, Dec 2006)***

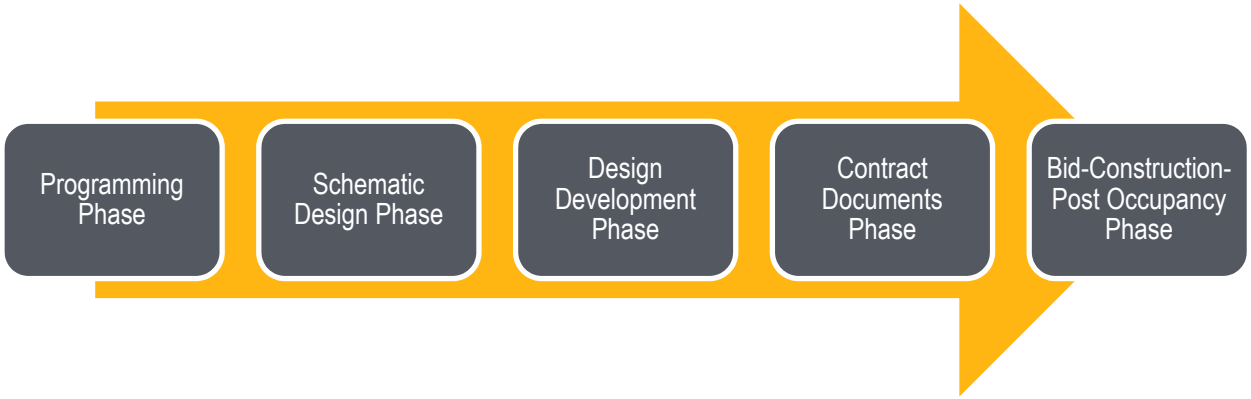
The crucial event that helped to shape the current contours of contemporary lighting design was the Energy Crisis of the 1970's. The oil embargo and resultant skyrocketing energy costs paved the way for a new emphasis on energy conservation in building design. From the energy crisis emerged government mandates for energy efficiency and the development of codes such as ASHRAE 90.1. It originated as a standard in 1975 and achieved code status by the Energy Policy Act of 1992 (EPAct 1992). The International Energy Conservation Code (IECC) followed shortly thereafter in 1998. Prior to the energy crunch the lighting designer's rule of thumb was "more light, better sight." Energy was generally perceived as plentiful and little regard was given to energy conservation. In the aftermath of the energy crunch, however, the lighting designer's design mantra changed to: "the right amount of light at the right place and at the right time." In recent years, the lighting designer's primary concern has become documentable energy code compliance (ASHRAE 90.1, IECC, or California Title 24.6). Increasingly restrictive energy code requirements must be harmonized with IESNA recommended (and/or client required) illumination levels. Many times these two objectives of lighting design are in conflict and illumination levels must be reconciled with compulsory energy codes. So, the concept of good lighting design has morphed since 1992 into a complicated task of balancing energy conservation goals with IESNA recommended target illumination levels. Nowadays, the lighting designer must simultaneously determine proper illumination levels (*"the right amount of light…"*) with proper placement of luminaires (*"…at the right place…"*) and the proper integration of controls (*"…at the right time"*) in order to comply with applicable energy codes while maintaining proper illumination levels. The daunting task of harmonizing reduced energy consumption with adequate lighting levels persists with the advent of ASHRAE standard 189.1 (2010). The emergence of this new code signals the beginning of the codification of "green" construction standards across the United States.

After many years of experience and ruminations regarding the practice of lighting design, here is my personal definition of lighting design:

> ***Lighting design is science and art applied to the built environment for the functional and aesthetic benefit of society; it is the application of objective criteria (science and technology) and subjective criteria (art and inspiration) to every phase of constructing a building or outdoor site to efficiently and properly illuminate constructed spaces for the public good. Lighting design is a specialized multi-faceted discipline woven into the fabric of the construction process. It is a crucial component of the process and is worthy of the rewards commensurate with its demands.***

The Lighting Design Process

A review of the lighting design process provides insight into what the client receives when purchasing lighting design services. Perhaps the most comprehensive overview of all that good lighting design encompasses is illustrated in *The Lighting Design Process* chart featured in IESNA Design Guide 7-1994. This chart serves as a helpful work effort matrix that allocates various lighting design tasks with relevant design and construction phases for a typical building project. Essential lighting design tasks are assigned to each of the following stages of the design and construction process: Programming Phase, Schematic Design Phase, Design Development Phase, Contract Documents Phase, Bidding and Negotiation Phase, Construction Phase, and Post-occupancy Evaluation Phase. We will now review the tasks associated with each design and construction phase per the IESNA in detail.



Programming Phase

The Programming Phase is the initial stage in a building project and requires a fair degree of innovation, inspiration and initiation on the part of the lighting designer. Per IESNA DG-7-1994, at the outset of every project, the lighting designer must account for a myriad of design considerations, such as:

- user needs and preferences
- psychological needs
- space functions
- visual tasks
- quantity/quality of lighting
- glare and visual comfort issues
- architectural features
- coordination with daylighting
- color temperature and color rendering issues
- flexibility of function
- controls requirements
- security issues
- life-safety considerations
- budget concerns
- operating costs
- maintenance issues
- energy codes
- building and electrical codes

All of these items must be continually monitored throughout the life of a project to assure that the established design criteria is not inadvertently compromised due to substitutions, floor plan reconfigurations, or the like. Often changes are initiated by other members of the design team or the client without consideration to the collateral damage on the end-user. For instance, in a recent project a contractor wanted to substitute a shielded basket indirect luminaire with a direct downlight luminaire due to plenum restrictions on the project. Such a change would seem innocent enough until I pointed out that the light location in question was directly over a baby diaper changing station. I informed the contractor and reminded the architect that a baby should not be laying on its back staring up at a bare lamp. Everyone agreed and another solution was found. This is just one small example of the value a lighting designer adds to a typical construction project.

During the Programming Phase, the lighting designer confers with the owner, end-user, and architectural design team to establish design criteria and to address expectations. If applicable, the designer will conduct an initial site survey to establish a design baseline. This early phase of the project requires the lighting designer to assess the project scope – is the project new construction or a

renovation project? Does the project have sustainability goals such as Leadership in Energy and Environmental Design (LEED) certification or compliance with government sustainability regulations such as Unified Facilities Criteria (UFC) 3-400-01? Is site demolition required? Are there any building operations and maintenance (O&M) issues? Is daylighting a factor and, if so, what degree of complexity is required for integration of daylighting with artificial lighting controls? Are there any hazardous locations on the project? What is the schedule for the project – fast track or normal track? What are the budgetary concerns? Are there any custom fixtures on the project that will require UL testing and labeling (new requirement for NEC 2008 – Section 410.6)? Will there be exotic luminaires required on the project whose delivery schedule might impact the project's construction critical path? Will the project utilize a 3-D Building Information Modeling (BIM) platform? Such a wide range of issues and activities must be addressed in every building project. An LC practitioner is an NCQLP certified professional trained to handle such a complex web of responsibilities.

Schematic Design Phase

During the Schematic Design Phase, the lighting designer clarifies specific design criteria established during the Programming Phase and uses such criteria to design the initial lighting scheme. At this time, the designer identifies preliminary luminaire and lamping selections as well as lighting control schemes and technologies. During this stage, the lighting designer will establish the baseline lighting layout and typically confirm the preliminary design with computer generated mock-ups utilizing industry accepted lighting calculation programs (such as AGI-32, LitePro, Visual, etc.) and/or with calculations done manually via the Zonal Cavity Method. In this phase, the designer will conduct a preliminary energy compliance analysis and preliminary economic analysis. As stated previously, energy consumption and illumination target level considerations are so intertwined in contemporary lighting design that illumination levels have to be checked and monitored in conjunction with energy usage every step of the way during lighting design.

The Schematic Design phase builds upon the Programming Phase in terms of finalizing the conceptual design. If required, full-scale mock-ups to replicate anticipated lighting effects are built at this juncture of the project. At the very least, computerized mock-ups can be created using readily available lighting calculation programs to verify initial design assumptions. All preliminary design considerations are documented in drawings, specifications, storyboards, 3-D computer modeling, etc. and presented to the client for review, comment, and revision.

Design Development Phase

Refinement is the best description of the work effort during this stage of the project. The client and architect reviewed and approved schematic lighting design is developed further and refined in this process. Details are developed as necessary with the architect for special conditions and/or customized luminaires. The designer begins the process of coordination with other building systems, such as HVAC ductwork and outlet locations, architectural features and constraints, systems furniture locations, automated shading systems and the like. Also, at this juncture the lighting designer initiates a preliminary life safety design to account for code compliance as well as special client requirements. At this time, if not sooner, the lighting designer solicits involvement of lighting industry manufacturers, vendors and experts in the design process to assure a timely, coordinated, and satisfactory project completion. Product availability is investigated and critical path equipment such as specialized or

customized luminaires are noted and monitored. As the design is refined, illumination levels and power density calculations are monitored for code compliance. At this stage, the economic analysis is refined and a budgetary check is in order. The lighting designer now synthesizes all aspects of the lighting design into an official format (drawings and specifications) for the client to review.

Contract Documents Phase

During the contract documents phase of the lighting designer must finalize all aspects of a project's lighting design. The task of extensive coordination with architecture and HVAC systems is tackled at this time to avoid potential problems in the field. This means a thorough review of plenum spaces to assure that installation of specified recessed luminaires is possible as well as a review of furniture systems and/or stationary millwork locations with the overhead lighting system to optimize luminaire placements. It is not unusual for space programming to change even at this late stage of the game. The lighting designer must be flexible enough to accommodate last minute client requests and be diligent to assess the impact of such changes on the lighting design and end-users. At this time, the lighting designer must complete and compile final engineering calculations and prepare them for submission to the proper authorities. Illumination level calculations (interior and exterior) are typically sent to clients for review. Forms for energy compliance are filled out and sent to jurisdictional authorities for review and approval. If the project is a LEED project, appropriate forms and calculations must be compiled and submitted to USGBC for review. The lighting controls scheme needs to be finalized at this stage. This means that any interior occupancy and daylighting sensor schemes need to be documented on the drawings and exterior timeclock and photocell lighting controls need to be indicated as well. If more elaborate controls, such as lighting control panels or dimming panels, are required on a project, now is the time to finalize requirements on the drawings and specifications in coordination with recommended manufacturers. The luminaire schedule should be finalized at this stage of the process to ensure that desired lighting fixtures (types and manufacturers), lamping, mounting heights and installation conditions are specified. In short, the project lighting design must be accurately documented in detail on the contract documents (drawings and specifications) for final client review and contractor bidding purposes.

Bid – Construction – Post Occupancy Phases

During these final phases, the lighting designer's work shifts focus from engineering design to construction oversight matters. The primary focus of each segment of the construction phase is clarification (Bid Phase), administration (Construction Phase), and evaluation (Post Occupancy Phase). At this time, the lighting designer serves as a mother hen or police dog watching over the lighting design to ensure it is incorporated into the built environment as originally conceived and documented on the construction documents. During the Bid Phase and Construction Phase the lighting designer answers contractor's inquiries regarding the lighting design's intent, documented design criteria and detailed specifics. Responsibilities during construction include review of submittals, conducting construction field visits, answering Requests for Information (RFI's), solving field issues, producing a project punch list, and overseeing final adjustments and commissioning of systems. Two typical challenges facing lighting designers during this phase are ensuring luminaires are delivered on time and remaining vigilant regarding substitutions of specified equipment.

I remember one particular project where the vigilance of the lighting design team during construction preserved the integrity of the project's lighting design. The project involved volatile cellulose nitrate storage vaults requiring highly specialized Class 1, Division 2 explosion proof luminaires with a temperature class (T Code) of T6 (NEC 500.8(C)). After many months of searching, we finally found a manufacturer who made a lighting fixture conforming to such stringent criteria. We specified the manufacturer on the drawings as our basis of design along with the specific required T Code. Because it was a federal project, we couldn't single source the luminaire. Our specifications and drawings were specific regarding the strict explosion-proof criteria. No questions were submitted to the design team during the bid period, which worried us. We anxiously awaited the submittal for our review. When the lighting submittal finally arrived several months later, we noticed that the electrical contractor had substituted our specified luminaire with a different luminaire having a lesser T Code rating. We rejected the submittal due to non-conformance. The contractor was livid. To expedite construction, he had already purchased the inferior luminaire prior to our review which was in violation of the contract documents. The project required 350 of these specialized explosion-proof lighting fixtures, so the contractor didn't want to return these expensive luminaires. The design team held firm and insisted on conformance to the contract documents, especially in view of the volatile environment in which the luminaires would be used. Substitutions were allowed, but had to be equal to what was specified on the contract documents. The contractor relented and eventually installed luminaires in compliance with the documented design. This is an example demonstrating the importance of having a lighting designer or team on the job during the construction phase protecting the integrity of the project's lighting design.

The IESNA proposes that the Post Occupancy Phase is a typical part of the lighting design process. Most lighting designers reading this are probably thinking to themselves: "if only!" My experience has shown that post occupancy evaluations typically consist of either complaints from the building owner if the lighting design is unsatisfactory or total silence if the lighting system is acceptable. Therefore, it is difficult for most lighting designers to accurately evaluate the effectiveness of their work. In the NFL, an offensive lineman is considered to have a good game (no sacks or penalties) if his name isn't mentioned at all. In the same way, a lighting designer assumes the lighting system as designed and installed is successful if there is no further comment from the owner upon building start-up and occupancy. This tendency is beginning to change a bit as the building industry is beginning to embrace the ideal in sustainable construction of continuous commissioning. In buildings where real-time monitoring of the lighting system is possible and in fact required for continuous commissioning purposes (such as for LEED re-commissioning), the owner and possibly the designer finally have a legitimate opportunity to accurately study installed lighting systems for the express purpose of improving future designs. Such opportunities, however, are currently rare due to the increased cost of building management systems that enable continuous commissioning. For now, the best indicator of performance for the lighting designer is client feedback.

Summary

A review of the Lighting Design Process from IESNA Design Guide 7-1994 reveals the many hats that a lighting designer must wear and the many tasks he or she must juggle. Personal experience confirms the wide array of roles and responsibilities conferred on a project lighting designer as stipulated by the IESNA. A lighting designer functions as an engineer, artist and advocate whose

primary goal is to properly illuminate the project's built environment with the most energy efficient and aesthetically pleasing lighting system possible. There was a day when it was appropriate for contractors or architects to fulfill the role of lighting designer, but the rapidly changing landscape of modern lighting design demands that a dedicated professional be enlisted to fulfill the roles and to execute the duties inherent to lighting design. A certified lighting designer (LC) is needed to assure the following:

- Meet requirements of GSA projects
- Compliance with energy codes (ASHRAE 90.1, IECC, etc.)
- Adherence to life safety codes (NFPA -101, IBC, NEC)
- Conformance to ADA requirements
- Incorporation of IESNA recommended practices
- Compliance with specified sustainability standards (LEED, UFC, etc.)
- Attention to specialized requirements of Authority Having Jurisdiction (AHJ)
- Contract documentation production
- Dedication to client satisfaction

Hopefully, this paper has clarified the lighting design process, explained what a certified lighting designer does and described why having an LC on the job is important. When purchasing lighting design services, a client should look for firms that provide NCQLP certified professionals to ensure a minimum relevant knowledge base and expertise in the complex world of lighting design. The lighting design team where I work is staffed with Lighting Certified designers to ensure the highest degree of professional attention to every project's lighting requirements. I hope you have enjoyed this excursion into the world of lighting design and will choose an LC designer for your future lighting design needs.